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Developing mathematical competence: From the intended to the enacted curriculum

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ABSTRACT

This study investigates the impact of a national reform in Sweden introducing mathematical competency goals. Data were gathered through interviews, classroom observations, and online surveys with nearly 200 teachers. Contrasting to most studies of this size, qualitative analyses were conducted. The results show that teachers are positive to the message, but the combination of using national curriculum documents and national tests to convey the reform message has not been sufficient for teachers to identify the meaning of the message. Thus, the teachers have not acquired the functional knowledge of the competence message required to modify their teaching in alignment with the reform. The results indicate that for complex reform messages, such as the competency message, to have intended impact on classroom practice, special attention needs to be put on the clarity of the message. To have high-stakes tests, for example, does not alone seem to be sufficient.

1. Introduction

Mathematics teaching is often regulated by some form of governing text through a curriculum or a set of standards. Because ideas about mathematics education are affected by educational, philosophical, and political positions, standards and curricula are changed over time (Ernest, 1991; Niss, 1981). Naturally, stakeholders in this process have great interest in seeing the intentions behind the standards or curricula influence the educational outcome (Ellsworth, 2000). The U.S. is implementing the Common Core State Standards (www.corestandards.org). Australia is in a similar position, and recently, India implemented their National Curriculum Framework in mathematics (Australian Curriculum Assessment and Reporting Authority, 2011; National Council of Educational Research and Training, 2005). Additionally, many countries with longer traditions of national standards, including Norway and Sweden, have recently implemented new national standards.

Our research investigates the impact of goals roughly similar to the NCTM process standards (NCTM, 2000) mediated through Swedish national curricula documents and national mathematics tests since 1994. Our studies were conducted in 2009 and 2010 meaning that teachers from a pure time perspective had ample possibility to absorb and implement the goals. Classroom activities, including each single task performed by any student, were analyzed in terms of their relation to the goals. Further, we conducted interviews with each teacher regarding their goals for student learning and how they viewed the goals expressed in the national curriculum documents and in national tests. The teachers also completed a survey. The

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data collection was conducted in cooperation with the Swedish School Inspectorate.[1] The schools chosen for inspection represented large and small schools, rural and city areas, and large and small municipalities. We believe that our results accurately represent Sweden as a whole concerning how a reform message, 15 years after the initiation of the reform, can be said to permeate teachers' goals and practices. Hence, this study presents an important example of using national curriculum documents and national tests as carriers for a reform message. The present article is largely based on two 60-page technical reports published in Swedish (Bergqvist et al., 2010a, 2010b).

1.1. Reforms for change?

Questions of how policy changes affect classroom practices have been frequently addressed, either in the form of qualitative classroom studies (see e.g., Ball, 1990), in system-wide research based on teacher attitude surveys coupled with assessment outcomes (see e.g., Cohen & Hill, 2000, 2001), from a theoretical perspective (see e.g., Gregoire, 2003), and with empirical support (see e.g., Charalambous & Philippou, 2010). Despite approaching the problem in different ways, all four of these examples paint a complicated but fairly coherent picture of the relation between policy and practice. Whenever the reform message is of a more complicated nature, the effects on teacher beliefs and classroom practice generally deviates from the intended. In general, it seems that if a curriculum includes content goals, such as arithmetic, then arithmetic is indeed taught, but if the curriculum includes competency goals, such as problem solving ability, then the effect on teaching may vary significantly. A commonly described mechanism behind this is that teachers only pick up surface aspects of the reform message and interprets these in terms of their own beliefs instead of actually changing their beliefs and their teaching (Ball, 1990; Charalambous & Philippou, 2010; Cohen, 1990; Frykholm, 1996; Grant, Peterson, & Shojgreen-Downer, 1996). Later in this article we describe how a theoretical and psychology-based model by Gregoire (2003) is applied to analyze how such a situation can occur and to identify the psychological motives (and subsequent actions) needed for a teacher to truly change conceptually.

Cases in which curriculum change did in fact lead to changes in teaching seem sparse, but Cohen and Hill (2000) note that when the state and several professional organizations, such as the NCTM and its California affiliate, home-office curriculum developers, university schools and departments, and others, all worked toward a similar goal, the results were positive. However, even then, only 15–20% of the teachers achieved a level of "coherent relationships among teachers' opportunities to learn, their practice, school curriculum and assessments, and student achievement" (Cohen & Hill, 2000, p. 331). However, conversely, it is not enough for a system to be more homogeneous. Cyprus can be regarded as a highly centralized system in which mandatory curriculum and textbooks are used. Nonetheless, a reform in Cyprus did not achieve the intended impact, and in fact, some teachers even claimed to be more comfortable teaching problem solving using pre-reform approaches rather than the recommended reform techniques (Charalambous & Philippou, 2010).

As Cohen and Hill (2000) point out, there are many aspects of a system that affect whether a message in a curriculum text affects the teachers or not. One tool to consider is national or state mandated tests. The underlying assumption is that by designing the tests so that they reflect important curricula goals the teachers will revise their teaching to make it more aligned with the tests. This assumption is however not thoroughly investigated in large-scale empirical studies (Cimbricz, 2002; Mehrens, 2002). In particular, it is not clear under what conditions such tests have a formatting function concerning a complicated message such as one associated with mathematical competency.

1.2. What reform?

A common feature of all the standards or curricula mentioned in Section 1 is that they present an enriched view of what it means to know mathematics. However, in what sense is this feature new and can be considered a reform?

Mathematics can be described as an autopoietic system in the sense that it produces the objects it discusses (Maturana & Varela, 1980; Sfard, 2008; Varela, Maturana, & Uribe, 1974), which means that the act of being mathematical (Mason, Burton, & Stacey, 1982) or doing mathematics (Schoenfeld, 1994) is scarcely separable from the act of studying or using mathematical structures. Traditional curriculum messages mainly specified the mathematical structures (notions, concepts, theories, methods, results) that should be studied, with little reference to the practice of mathematics (Hoffmann, 1989). During the 1990s, however, a clear trend emerged: the curricula now aimed to clarify the relationship between mathematical content and practice to make the development of a sound mathematical practice an explicit curricular goal. In Freudenthal's words,

> Every researcher, every producer of mathematics will readily admit that mathematics is an activity. (Freudenthal, 1991, p. 14)

[1] The Swedish School Inspectorate (SSI) is an agency of the government that has three main tasks: asserting the right of each individual to knowledge and personal development in a safe environment in school, asserting national equivalence, and contributing to higher national educational standards. The Inspectorate works in different ways: regular inspections of all schools, thematic quality evaluation within certain areas, investigations of complaints concerning the situation for a specific child/student, and approval of independent schools. The collaboration between SSI and the researchers came about due to SSI having the need for specific mathematics education expertise in this thematic quality evaluation.