

ANALYZING MATHEMATICS CURRICULUM MATERIALS IN SWEDEN AND FINLAND: DEVELOPING AN ANALYTICAL TOOL

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This paper aims to contribute to two interrelated areas. Firstly, it adds new insights into the variation of curriculum materials within and between two countries, Sweden and Finland, with respect to their potential to contribute to various kinds of teacher learning. Secondly, it aims to build on and develop an analytical tool for analyzing curriculum materials. To accomplish these aims we explored two teacher's guides from each country, applying a tool derived from the context of science education. The analysis reveals substantial differences between all four materials concerning the categories in the analytical tool. We suggest how the analytical tool could be developed to more deeply explore its potential for supporting qualitatively varied teacher learning.

Key words: analytical tool, comparative study, curriculum materials, mathematics teacher's guides, teacher learning

INTRODUCTION

Curriculum materials such as commercially produced textbooks and teacher's guides have a strong presence in mathematics education in large part of the world. These materials are typically a major resource for teachers' planning and practice (Stein et al., 2007; Jablonka & Johansson 2010). One of the tasks of curriculum materials is to bring different discourses together (Jaworski, 2009). On the one hand, there is an academic conceptualization from which the intended curriculum derives and, on the other hand, the socio-cultural settings where teaching and learning occur: the enacted curriculum. Writers of curriculum materials may therefore interpret the intended curriculum and adjust to the socio-cultural settings to function as a bridge between the two different discourses. From this perspective, curricular materials serve as an important tool for teachers in both enabling and constraining their thoughts and actions (Stein et al., 2007). Further, curriculum materials are not only important resources for teachers in designing teaching (Stylianides, 2007), but also for teacher learning (Doerr & Chandler-Olcott, 2009). For instance, Remillard (2000) and Davis and Krajcik (2005) emphasize that curriculum materials could productively contribute to teachers' professional development if they encompass an elaborated attention to the process of enacting the curriculum. Therefore, potentially, well-designed curriculum materials could create opportunities for teacher learning.

There exists no role model for how to design such materials, since teachers' use of, and learning from, curriculum materials are related to their experience, knowledge and the particular classroom situation. This study aims to contribute to the knowledge about teacher's guides and their potential for various kinds of teacher learning in two

neighbouring countries with quite similar school systems but different teaching styles: Sweden and Finland. One rationale for undertaking a comparative approach is that through a process of investigating similarities and differences in various countries' curricular materials we reveal some taken-for-granted and hidden aspects (cf., e.g., Andrews, 2009) of teachers' work in classrooms. Such findings, we believe, could contribute to the international research discourse on aspects of curriculum materials and their influence on teaching and teacher learning.

Teachers in Finland use the textbook and teacher's guides extensively (Joutsenlahti & Vainionpää, 2010). There are indications that many Finnish teachers are satisfied with the way their teacher's guides are built, and that they consider them to be very helpful in differentiating the teaching (Heinonen, 2005). Further, Finnish teachers state that the guides provide help and ideas for new ways to teach and simultaneously ensure that the children learn what they are supposed to learn according to the state curriculum (L. Pehkonen, 2004). The Swedish teachers also use the textbook to a very large extent, but seldom use teacher's guides (Jablonka & Johansson, 2010). Teachers in Finnish classrooms often lead whole-class instructions whereby all pupils are engaged in the same mathematical area (e.g., E. Pehkonen et al., 2007). In Sweden, on the contrary, it is common to conduct teaching as "speed individualization" and as personalized teaching (e.g., Jablonka & Johansson, 2010) where pupils work, in the same classroom, with different mathematical areas. Due to these differences, it is interesting to compare the curriculum materials used in the two countries. In this paper, we aim to answer to the following questions: *What similarities and differences in curriculum materials exist within and between two countries, Sweden and Finland, with respect to their potential to contribute to various kinds of teacher learning? How is it possible to develop and amend an analytical tool for examining the potential for teacher learning in curriculum materials?*

TEACHER LEARNING AND ARTEFACTS

There are numerous ways of conceptualizing teacher knowledge and teacher learning (e.g., Rowland & Ruthven, 2011). However, instead of digging into these theories and frameworks, we regard teacher learning as a process of social participation in communities of practices according to Wenger (1998), and we understand the artefact of the curriculum material as a resource used in the teachers' professional practices. In line with Brown (2009) we emphasize that teachers and curriculum material participate together in a collaborative relationship, whereby teachers are viewed as active agents in developing and constructing the planned and enacted curriculum. Both teachers and curriculum materials have a role in mediating the relationship, which is shaped by historical, social and cultural factors. This implies that the results of this study could be seen as one piece in the building of an understanding of how curriculum material, teacher learning, teacher education, culture, etc. are related to, and constitute, each other. Brown (2009) also reflects upon different resources and how they can lead to different opportunities for teachers' and students' learning. We

want to stress that a teacher's guide can only hold the potential for teacher learning in practice, and that teachers in the schools form a heterogeneous group with respect to their developing identities, competences and professionalism.

METHODOLOGY

Context

This paper presents one of several studies connected to two larger research programs. The first program is a comparative project examining similarities and differences between mathematics education in Sweden and Finland (e.g., Ryve, Hemmi & Börjesson, 2011). The second concerns a design research project carried out within and together with one municipality in Sweden, within which Finnish curricular materials (translated into Swedish) are tested by some teachers. Both Sweden and Finland have a nine-year comprehensive school that begins at the age of seven and is free of charge, and there is no tracking. Teachers in both countries are free to choose what curricular materials they want to use; since the beginning of the 1980s in Finland and 1991 in Sweden, there is no state control over curricular materials (E. Pehkonen et al., 2007; Jablonka & Johansson, 2010).

The analytical tool

Wenger's (1998) theory of learning is very general; hence we need to ascribe meaning to the artefacts used in the teachers' practice (cf. Hemmi, 2010), in our case teacher's guides in school mathematics teaching practice. For this purpose we apply the analytic tool by Davis & Krajcik (2005), which focuses on opportunities for teacher learning within the practice of science teaching, as a starting point for approaching our data. With regard to conducted research in mathematics education, we modified it to fit our purpose (Table 1).

Categories	Categories for data analysis
1a) General knowledge of students' ideas and strategies	Describes why students might hold particular ideas about mathematical concepts and exemplifies common strategies among students.
1b) Suggestions for how to encounter students' ideas and strategies	Gives suggestions for how to deal with/encounter various ideas and strategies of students and how to enhance their learning and prevent future difficulties.
2) Concepts and facts	Describes concepts and facts within mathematics such as history, field of application, derivations, methods, proofs, correct terminology.
3) Progression and connections	Shows the mathematics progression throughout the school years as well as connections between mathematical topics; for example, explains the future development of methods and concepts.

4) Connecting theory and practice	Supports the teacher's actions in practice beyond the curricular materials by connecting theory and practice. Exposes the central ideas in national curriculum and research results for promoting teachers' autonomy.
5) Design of teaching	Supports the teacher's ability to act in practice by suggestions with respect to the design and enactment of lessons, tasks, formative assessment, individualization of teaching, homework, etc.

Table 1: Five categories for data analysis

Data and data analysis

Our selection of teacher's guides was based on two criteria: that they represent curricular materials commonly used in respective countries and that they represent an older and a newer curricular material. In this paper we focus on four different teacher's guides for first-grade mathematics. As publishers do not give access to sales figures, we based our choice on commonly used curricular materials based on our own experiences as teachers and researchers.

The four teacher's guides we investigate are:

- *FIN 1: Laskutaito* (1999), a Finnish teacher's guide still used in Finnish schools,
- *FIN 2: Min Matematik* (2004), a Swedish translation of a Finnish teacher's guide, *Tuhattaituri*, for use in the Swedish-speaking part of Finland,
- *SWE 1: Matte Direkt Safari* (2011), a Swedish teacher's guide that has been on the market for several years, and
- *SWE 2: Matte Eldorado* (2011), a Swedish teacher's guide that has been on the market only a few years.

Four researchers conducted the analyses together. Two of the researchers are of Finnish ancestry, and examined the teacher's guide that was not translated into Swedish. We first discussed the categories in Table 1 in relation to the empirical data. Then, each member of the research group took special responsibility for one teacher's guide and investigated the extent and qualities of the topics connected to each category. This process was followed by a collective analysis of our findings in relation to the data as a way of checking each other's analysis.

RESULTS

We found substantial variation concerning the presence of the topics connected to the first four categories. Either they occurred regularly in connection to most mathematical areas (++), sporadically with only some sentences (+), or were totally missing (-); see Table 2.

	FIN 1	FIN 2	SWE 1	SWE 2
1a) General knowledge of students' ideas and strategies	++	-	-	+
1b) Suggestions for how to encounter students' ideas and strategies	++	-	-	+
2) Concepts and facts	+	++	-	+
3) Progress and mathematical connections	+	+	-	+
4) Connecting theory and practice	++	-	-	+

Table 2: Occurrence of the topics connected to categories 1-4. ++ occurred regularly, + occurred sporadically, - were absent.

In *Laskutaito* (FIN 1), topics connected to all four categories were identified. This suggests that it supports the teacher in acting beyond the curricular materials by connecting theory and research with practice on two pages at the beginning of every chapter (Category 4). These pages present the overall goals as well as how children may think, and what activities a teacher can do to prevent misunderstandings and promote learning (Category 1). For example, it could be a description of prerequisites for learning in geometry according to research, and suggestions for how teachers could work with the ability of spatial perception.

“**7. Visual memory.** Visual memory can be trained, for example, using the traditional KIM games, whereby 10-20 objects are placed on the table and the children get to see them for a short period of time. When the children then close their eyes, the game leader removes an object and mixes the order of the remaining objects. The children then try to remember which item is missing...” (Laskutaito, 1999, p. 124-125).

Min Matematik (FIN 2) is the only teacher's guide that describes concepts and facts regularly (Category 2). The facts deal with, for example, definitions and correct terminology but also the historical background of, for instance, our number system.

“**Facts.** $3+1$, for example, is an expression. An expression can also consist of a single number or a symbol (for example, a). $4=4$ is an equality. An equality that contains one or several unknowns is called an equation.” (Min matematik, 2004, p. 27).

Sometimes, in connection to the mathematical facts, there is information about progression (Category 3). For example, when presenting the correct terms involving subtraction it also states that “*in this textbook the concepts of addition and subtraction are used with the pupils in this phase but the terms sum and difference are taught later*”. Hence, under these sub-headings the guide combines facts with progression, but progression appears more sporadically. Topics belonging to the categories 1a, 1b and 4 are lacking. For example, no references to research are made.

In *Safari* (SWE 1), no topics were found that could be connected to these four categories.

Matte Eldorado (SWE 2) deals with all the categories, but not regularly. There is some information at the beginning of the guide about number sense and arithmetic, with descriptions of possible difficulties and ineffective strategies children can use and how to prevent and encounter them (Category 1a & 1b), but this does not appear regularly in connection to new areas. There is a matrix at the beginning of the guide displaying how the textbook and the goals for the students are connected to the goals in the curricula. Every goal is also described in the text (Category 4). Yet, no connections to research are made. The matrix also gives the teacher an overview of the progression from school year 1 to 3 (Category 3). In the ordinary text, topics connected to this category (progression and mathematical connections) occur sporadically. Topics dealing with mathematical knowledge (Category 2) occur only a few times.

All but *Min matematik* (FIN 2) include a general presentation at the beginning of the guide with an explanation of why one should engage pupils with the activities presented in the guide. In *Safari* (SWE 1) this part is very short, and in *Matte Eldorado* (SWE 2) it is extensive. This could possibly be added as an additional category in the analysis tool, as we can see differences in the guides concerning the underlying assumptions about teaching and learning, something to focus on in further studies.

Design of teaching

As to Category 5, dealing with topics more directly connected to the design of the lessons, we found several aspects important to dig more deeply into. It could involve, for example, support for how teachers could differentiate their teaching; what materials they could use to concretize learning, engagement in problem-solving and playing games; and how they could assess students' knowledge of mathematics. We found considerable differences between the guides concerning the structure of these aspects; something that, we hypothesize, may influence teacher learning in practice.

Laskutaito (FIN1) is structured based on learning outcomes for pupils. The guide also focuses on lesson plans, but leaves a great deal of room for the teacher to design activities suitable to various students in the classroom as there is no suggestion for a certain lesson plan. The guide is based on the pages of the textbook. Sub-headings *Ideas for how to teach/deal with the current object*, *Mental arithmetic*, *Practice and games/plays*, *including challenges for quick and "talented" pupils*, and *Problem-solving* reappear in the section for each lesson. The guide aims to hold the pupils together but offers them partly different activities, and also suggests a small number of tasks connected to every lesson as homework for the pupils. Concerning assessment, there is a short test after every chapter. Ideas for problem-solving are offered in every lesson.

Min Matematik (FIN2) is structured based on learning outcomes for students. The guide focuses on lesson plans, and each session is described on four pages. All the sub-headings (*Discussion about a picture*, *Mental arithmetic*, *Suggestion for a lesson*

plan, On the board, A story, Problem-solving, Tips (for example games), Extra, Facts and The following lesson) reappear in the same order and in the same place on these four pages. The guide suggests a lesson plan with various activities in which the class is held together and the differentiation of the teaching is organized by extra tasks and problems within the same area. It suggests a small number of tasks connected to every lesson as homework for the students. Concerning assessment, there is a short test after every chapter. Ideas for problem-solving are offered in every lesson.

Matte Direkt Safari (SWE1) is structured based on the student textbook, and is not structured according to certain time periods, for example a lesson. Each page in the guide includes information about what “*students learn from the pages*”, sometimes how they should work with the pages in the textbook or with some extra pages from the teacher’s guide (for example, what hands-on material they need). On a few occasions there are suggestions for other activities. At the end of each chapter there is a page with ideas for collective activities, like games and outdoor activities. No ideas are offered for differentiation of teaching until the students have finished all the pages in a chapter and received a diagnosis according to which of two paths they can choose. There are suggestions for homework three times in every chapter. No instructions or ideas for problem-solving can be found in the guide.

Matte Eldorado (SWE2) is structured based on learning outcomes for students. The guide is not structured in relation to a particular time period, for example a lesson, but is based on the pages of the textbook. The sub-headings *Aim* (with some suggestions for activities supporting learning), *Simplify*, *Challenge*, *Observe*, *Material* and *Go on working* reappear in the same order, but not in all units. Under the sub-headings *Simplify* and *Challenge* are ideas for how to differentiate the teaching regularly. Ideas for collective activities, for example games, are presented at the beginning of the book. Considerations regarding assessment take a dominant place at the beginning of the guide, where different ways of observing pupils’ learning are presented. There is one pre-test at the beginning of the school year and one test after each semester. The sub-heading *Observe* aims to help the teacher observe student behaviour during the lessons. There are suggestions for homework on some occasions. General aspects of problem-solving are dealt with at the beginning of the book, while more specific aspects of problem-solving occur at the end of each chapter. The character of the problems seems to be quite different from that in the Finnish guides. For example, they are always placed in an everyday context.

CONCLUSION AND DISCUSSION

The data analysis revealed significant differences between the four teacher’s guides both within and between the countries. Two of the guides (FIN1, SWE2) deal with topics connected to all the five categories, and can hence be regarded as resources for potential teacher learning in practice concerning aspects of encountering pupils’ ideas in a productive manner, confronting the teacher with mathematical ideas and concepts connected to the mathematical topics in the classroom, and making visible the demands of the practice concerning the curricular goals. Only one of the guides

(FIN1) offers resources for teachers' access to the practice of mathematics education research. The older Swedish material distinguishes itself from the other three in that topics connected to these categories were not dealt with.

Concerning Category 5 (Design of teaching), we found the following similarities between the Finnish materials that distinguish them from the Swedish ones: Both focus on lesson plans and offer ideas for teaching, mental arithmetic, differentiating, problem-solving, games and homework in connection to *every lesson*. This is not the case with the Swedish materials, which leave more space for the teacher to decide the units they will use in their teaching. This difference could be connected to differences in teachers' work in practice, which in Finland (e.g., E. Pehkonen et al., 2007) often means leading whole-class instructions whereby all pupils are engaged in the same mathematical area or mathematical problem (Franke, Kazemi & Battey, 2007) whereas in Sweden it involves communicating with individual students and pupils working in the same classroom but often with different mathematical areas (e.g., Jablonka & Johansson, 2010). Our analysis shows that three of the four guides emphasize aims and goals in the curricular program, which is interesting in relation to our study of the role of the aims and goals of lessons in school-based teacher education in Sweden and Finland (Bergwall et al., 2012). The older Swedish teacher's guide, *Matte Direkt Safari* (SWE1), represents material that is extremely dependent on the pupils' textbook and, hence, may have some special impact on teacher autonomy. The Finnish guides offer superfluous ideas for various kinds of activities for each lesson, supporting designs of different kinds of resources for students' learning. On the other hand, there is not much room for teachers to work thematically or spontaneously starting from students' ideas if they try to strictly follow the chains in the teacher's guides in their work.

In regard to the first four categories, the tool worked well in its current design. Based on our data analysis, we could add a category containing topics concerning how the textbook authors motivate their choices concerning the progress, structure and different activities. Teacher learning is situated within the practice of studying textbooks and teachers' guides, discussing the materials with other teachers, planning and evaluating the teaching as well as working with the students in the classroom. The professional skill of designing lessons for unpacking mathematical ideas is a kind of participation in practices. The fifth category appeared to embrace a broader qualitative dimension of potential for teacher learning that we should focus on more in further studies. Teachers have various experiences and identities (cf. Wenger, 1998; Brown 2009) and they have also been active agents in developing their own classroom practices. From this perspective, we are eager to extend this study by data analysis of both collaborative discussions between teachers in planning lessons using the teacher's guides as well as classroom teaching in teachers' daily practice.

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