A cross-cultural study of curriculum systems: mathematics curriculum reform in the U.S., Finland, Sweden, and Flanders

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This paper relates to the mathematics curriculum systems of the United States, Finland, Sweden, and Flanders (Belgium). These four regions are in the midst of curriculum reform, which provides interesting grounds for cross-cultural comparison. Our analysis builds on a framework that focuses on curriculum policy, design and enactment in each of these regions and draws on interview data with teachers in all four regions, sample cases of curriculum use, context descriptions, and available descriptions of mathematics education in these four regions. This leads to a more nuanced understanding of the particular curriculum systems through which reform manifests, and sheds light on a challenging balance concerning a curriculum reform that is both coherent across a region and supported by teachers.

Keywords: Cross-cultural study, Curriculum reform, Mathematics education

Mathematics curriculum reform: a delicate process

Curriculum reform is a delicate process because multiple factors influence implementation, and, ultimately, student performance. If a curriculum is to promote region-wide reform, it should be coherent across that region. Further, there is evidence that the teacher has a crucial role, in that teachers should embrace the underlying vision (e.g., Tarr et al., 2008). Also crucial for educational change is to understand the educational system to which the reform applies (Andrews, 2007; Miyakawa & Winsløw, 2017; Stigler & Hiebert, 1999). This paper aims to add to a better understanding of the mathematics curriculum systems in the U.S., Finland, Sweden, and Flanders (Belgium). All four regions have recently undergone mathematics reform, or are in the midst of reform, which makes them interesting sites for comparison of curriculum systems. The paper's central goal is to describe the curriculum systems of these four regions, and to consider consequences for teacher involvement in, and region-wide coherence of the region.

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Curriculum policy, design, and enactment framework

Because we understand teachers' use of resources to be situated in a broader school system, we draw on the curriculum enactment process as conceptualized in Remillard and Heck (2014) (See Figure 1). Remillard and Heck differentiate between an official and operational curriculum. The official curriculum, authorized by governing agencies includes curricular aims and objectives; assessments; and the designated curriculum – a set of instructional plans specified by a governing agency. The operational curriculum captures the enactment process. It acknowledges the central role that teachers have in interpreting and mobilizing curriculum resources and differentiates between a teacher-intended and enacted curriculum and student outcomes. The location of instructional resources outside of the official and operational curriculum allows to fit both (centralized) systems in which the instructional resources are part of the official curriculum, and other systems in which they are not.

The framework assumes a definition of curriculum, which we also subscribe to: "a plan for the experiences that learners will encounter, as well as the actual experiences they do encounter, that are designed to help them reach specified mathematics objectives" (Remillard & Heck, 2014, p. 707). We use the term instructional resources to refer to the resources used to support curriculum enactment. These resources include curriculum resources that sequence a particular content such as student textbooks and teacher's guides, but also other resources such as digital (online) applications.

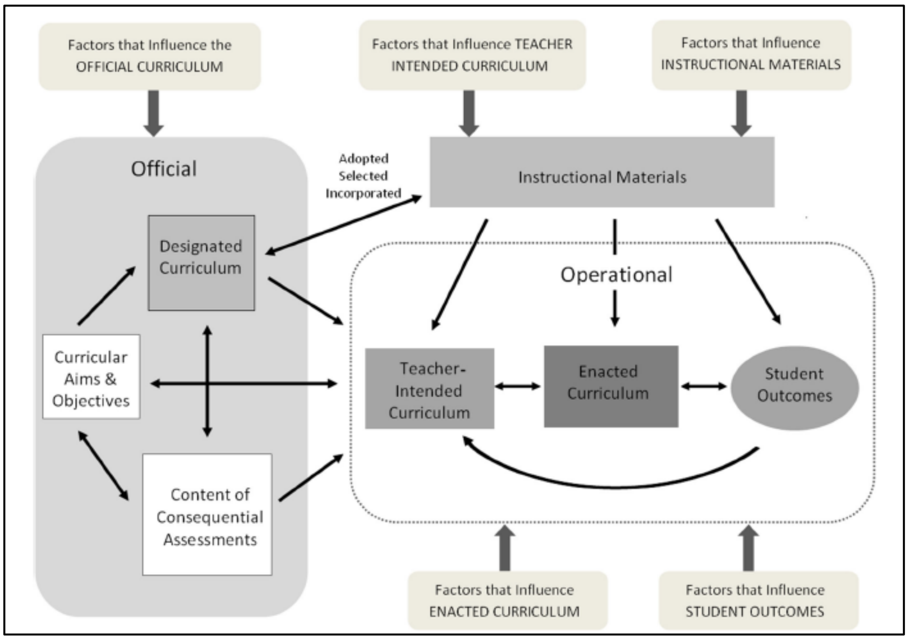

Figure 1. Visual model of the curriculum policy, design, and enactment system (Source: Remillard & Heck, 2014, p. 709)

Context and method of study

This study is part of a larger cross-cultural study on elementary school teachers' use of printed and digital instructional resources in the U.S., Finland, Sweden, and Flanders (the northern part of Belgium, which has its own educational system). Although largely an opportunity sample, the selection of these four regions addresses both constants and contexts (Osborn, 2004) comprising a sound rationale for comparison. Talking to the constants, all four regions value local educational authority, emphasize similar aspects as to the mathematical curriculum, and teachers rely on (printed) curriculum resources when teaching mathematics. Our previous analyses of printed curriculum resources also shed light on differences in provided teacher support, surfacing context-specific assumptions of teaching and learning mathematics (e.g., Remillard, Van Steenbrugge, & Bergqvist, 2016).

When designing and analyzing interviews on resource use in the four regions, we were faced with challenges of equivalence, validity, and comparability (Clarke, 2013; Osborn, 2004), and with challenges related to the undertake of such a study in a cross-cultural team of researchers. To develop the team’s prerequisite intersubjectivity (Andrews, 2007) needed to fully understand the completed interviews as situated in their specific context, we developed case descriptions illustrating curriculum use for one teacher per context, and context descriptions. This paper draws primarily on these four case and context descriptions, but also on interview data specifically relating to the selection of instructional resources and additional readings on mathematics curricula in these four regions (i.e., Hemmi, Krzywacki, & Partanen, 2017; Remillard & Reinke, 2017; Van Steenbrugge & Ryve, 2018; Verschaffel, 2004).

Ten teachers in Finland, the U.S., Flanders, and Sweden were interviewed in fall 2017 and again in spring 2018 on their use of resources when planning and teaching mathematics (Note: In Sweden and the U.S., one teacher was unavailable for the second interview; in Finland, nine instead of ten teachers have been interviewed so far). The first interview was more general and addressed teacher and school backgrounds, what resources teachers used, teachers’ views on the curriculum resources being used, and teachers’ general beliefs on teaching and learning mathematics. The second interview focused in more detail on teachers’ actual use of both print and digital resources, centered around a walk-through of planning, decisions, and enactment of a lesson that the teacher taught recently. Input for Interview 1 initially came from team members’ previous related research on curriculum use and was modified during subsequent team meetings. Interview 2 was also developed collaboratively, based on findings and experiences from Interview 1 and our knowledge of each of the contexts.

Each case description was prepared by a team member who is a cultural insider, written in English for shared use. We first applied low-inference codes to the interviews to index excerpts of the interviews. These codes identified, for instance, teachers’ descriptions of resources, how they were used, reasons for use, background information on the teacher and school, and teacher beliefs on curriculum use and teaching and learning mathematics. The process of coding was tried out individually, discussed in, and refined by the team. Having coded two interviews for one teacher per region, we gathered similarly-coded statements and applied the following structure to the cases: a) teacher education and teaching background, b) information about school and class, c) selection process of the resources, d) use of resources and purposes for use, e) teacher beliefs and conceptions, f) changes in resource use.

The process of writing and reading cases made us aware that significant insider knowledge was necessary to make sense of them, which is why we also developed context descriptions. Context descriptions are organized according to the following structure: a) school system-structure, b) pathways into teaching elementary mathematics, c) school environment, d) financial resources for organizing education, e) decision-making mechanisms in schools in relation to mathematics education (including the selection of instructional resources), f) student assessment, and g) monitoring and quality assurance of education.

An important step in the process of developing the cases and context descriptions was full-team review and discussion of them. In fact, we arrived at a common structure and approach through incremental development, review, and discussion.

Building on the curriculum policy, design, and enactment framework (Remillard & Heck, 2014), we came to the following analytical structure to compare the four educational systems, based on case and context descriptions, interview data, and the abovementioned additional readings:

- Educational jurisdiction and school funding;
- Most recent central mathematics curriculum, including name and launching date, initiators, structure, novel aspects, requirement of adoption;
- Role of assessments;
- Curriculum specification in addition to central curricular aims and objectives;
- Instructional resources and influential factors, including resource market, designers of curriculum resources, embedment of a digital platform, selection of resources, acceptance criteria.

Curriculum systems in the U.S., Finland, Sweden, and Flanders

Table 1 includes our descriptions of the curriculum systems of the U.S., Finland, Sweden, and Flanders. Looking across the table helps to attain a more nuanced understanding of these curriculum systems, which, from the outset share similarities such as local authority, use of a primary (usually printed) curriculum resource available from a commercial publishing market, and the raise of digital resources. Surfaced similarities and differences relate to a) regulations and incentives to steer local authority, b) role of curriculum resources in curriculum reform, and c) curriculum interpretation. We discuss these aspects below and relate them in a final section to two crucial aspects of curriculum reform: coherence and embracement of the reform by teachers.

	U.S.	**Finland**	**Sweden**	**Flanders**
Educational jurisdiction and school funding				
Jurisdiction	School districts with oversite from states	Finnish government	Swedish government	Flemish government
School funding	State and local taxes	National and local funding	Government to municipals to schools	Government; also targeted funding
Most recent central mathematics curriculum				
Name & launching date	Common Core State Standards (CCSS), 2010	National Core Curriculum (NCC), 2016	Läroplan (LGR 11), 2011 – revised 2018	Attainment targets; 1998/under development
Initiative	State governors & educational leaders, private foundations	Finnish National Board of Education commissioned expert group (about every 10	Swedish government commissioned the National Agency of	Flemish government commissioned an entity

		years)	Education	
Structure	Grade-by-grade content and practice standards	Content, competences, learning environment descriptions, assessment criteria; grades 1-2, 3-6, 7-9	Core content, mathematical abilities, knowledge requirements; grades 1-3, 4-6, 7-9	Required knowledge, skills, attitudes by end of grade 6
Novel aspects	Emphasis on visual models and conceptual understanding	Cross-curricular competences (e.g., digital competence)	Mathematical competences, digital competence	Structured around 16 key competences (e.g., digital competence)
Adoption	Not required; Federal government incentivizes states toward CCSS & assessment adoption	Required, but not checked	A nationwide professional development program was launched (2012-2016) to support adoption; checked by school inspectorate	Required, checked by school inspectorates
Assessments				
Grades & aim	Grades 3-8: annual standardized tests, often consequential for student promotion, teacher employment, school funding	Schools are not monitored by national assessments; Teachers are responsible for assessment	Grades 3, 6, 9: Mandatory national tests support equality & check performance on school and population level	Tests assess mastery of attainment targets on student population level (since 2002 and on a 7-year interval)
Continued curriculum specification				
Level & content	Districts and schools often specify instructional resources to be used, and issue	National board of education hosts a website that lists available instructional	/	Three umbrella organizations issue learning plans, which break down attainment targets

	pacing guidelines	resources; School teams and/or local authorities concretize NCC into a central school-level curriculum		per grades, add goals and didactical suggestions
Instructional resources and factors that influence resources and use				
Instructional resource market	Commercial enterprise, limited number of publishers	Commercial enterprise, limited number of publishers	Commercial enterprise, limited number of publishers	Commercial enterprise, limited number of publishers
Designers (printed) curriculum resources	Mathematicians, prior teachers, researchers	Teacher educators, researchers, teachers	Teacher educators, teachers (during their free time)	Teacher educators, teachers, members of inspectorates, representatives umbrella organizations
New curriculum resources accompanied by digital platform?	Yes	Yes	Yes	Yes
Selection instructional resources	Main curriculum resources & larger digital platforms: districts & schools; Digital resources: teachers	Main curriculum resource & digital resources: teachers	Main curriculum resource: schools; Digital resources: teachers	Main curriculum resource: schools; Digital resources: teachers, schools, school groups, umbrella organizations
Acceptance criteria	By some states/districts	No	No	No

Table 1. The curriculum systems of the U.S., Finland, Sweden, and Flanders

Regulations and incentives to steer local authority are present to different extents. The curriculum systems of the U.S. and Flanders have the most explicit mechanisms to steer local authority. In the U.S., states possess authority in relation to educational policy and, sometimes, delegate policy to school districts, but the Government by means of applying specific funding mechanisms influences policy and curriculum use at state, district, and school level. In Flanders, schools are in principle free to determine how to work toward the attainment targets, but the Government, through regulations such as school inspectorates and the requirement to adopt a learning plan, and through targeted funding, sets the framework of the curriculum system and influences curriculum policy and use at the local school level. In Sweden, the Government also sets the framework of the curriculum system, but influences curriculum use at a more implicit level, through rolling out a nation-wide professional development program following the curriculum reform. From our study, it appears that central regulation is the least well manifested in Finland. The Finnish National Board of Education commissions on regular interval-base an expert group to develop a new curriculum. Schools and teachers are provided with guiding documents and regulations, but are not checked upon application of the guidelines and regulations.

Across the four regions, curriculum resources served as interpreters of the official curriculum, hereby serving as mediators between the intended curriculum and the classroom (Valverde, Bianchi, Wolfe, Schmidt, & Houang, 2002). Additionally, and talking to the systems of Finland and Flanders, curriculum resources can also potentially influence curriculum making. In Finland, teachers at times rely on the learning sequence in commercial curriculum resources to design their crucial school-level curriculum. Currently in Flanders, new curriculum resources, often complemented with digital applications, are published before the actual launch of the new attainment targets, hereby possibly influencing the novel aspects of the mathematics reform related to digital competence.

Following the curriculum policy, design, and enactment framework (Remillard & Heck, 2014), we allocate teachers to have a central role in interpreting and mobilizing the curriculum. Indeed, we find related evidence in our interview data. Our comparative analysis also reveals differing levels where significant curriculum interpretation happens to reside. In Sweden, the bulk of interpretation happens at the individual teacher level. In Finland, significant interpretation is applied to compose a school-level curriculum, whereas in Flanders, major interpretation of the attainment targets is located above the school-level, by the umbrella organizations issuing learning plans. In the U.S., significant curriculum interpretation resides in the assessments.

Curriculum reform: a delicate balance between region-wide coherence and teacher approval

Our study of the mathematics curriculum systems of the U.S., Finland, Sweden, and Flanders, suggests that a curriculum reform that is both region-wide and supported by teachers, is a challenging balance. Both Flanders and the U.S., through their layered curriculum infrastructure, succeed most toward a region-wide curriculum coherence, but this goes at the cost of teacher involvement in the reform process. In Finland, teachers are most involved in reform through the design of a school-level curriculum, but this goes at the cost of a nation-wide curriculum-coherence. Sweden stands out in that teachers were asking for reform and that the Government answered the call by means of rolling out a nationwide professional development program. It still has to be seen to what extent that results in curriculum coherence. In all four regions, commercially published curriculum resources are a central aspect in a region-wide curriculum reform. Given this significant position, it is remarkable that only in the U.S., sometimes quality criteria are issued that curriculum resources have to pass.

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