Structures of Finnish and Icelandic Mathematics Lessons

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Abstract: Videos from forty Finnish and Icelandic mathematics lessons are analyzed using a two-pass coding method. The method, which uses ideas from two major video-based comparative studies, the 1999 TIMSS Video Study and the Learner's Perspective Study, offers a way to investigate the different forms of classroom interaction by which teachers attempt to achieve their pedagogical goals. Two lessons from ten randomly chosen mathematics teachers of 14 and 15-year-olds were recorded in each country. Despite the modest sample size, some national patterns and cross-national differences can be detected. The Finnish lessons in the sample essentially follow the conventional *Review-Lesson-Practice*-script, whereas more than half of the recorded Icelandic lessons exhibit versions of *Individualized learning*, a learner-based instructional philosophy. Public content-related discourse can be missing entirely from these lessons; instead, the teacher tutors the students one-on-one. This is in contrast with the Finnish lessons where teacher-lead activities, which often involve student participation, are emphasized.

This chapter presents a video-based analysis of the structures of forty Finnish and Icelandic mathematics lessons. The first of the six sections contains a rationale for the study. The method of lesson structure analysis is described in the second section. The third section explains the data collection process. Results, including lesson diagrams, make up the fourth section. Some interpretations and implications of the findings are discussed in the fifth section, and the final section suggests directions for future research.

1. Rationale

Finland and Iceland are noteworthy within the domain of mathematics education. These countries—like all Nordic countries—share many characteristics, yet their performances in the

PISA assessments differ considerably. While both Finland's and Iceland's PISA scores show very small between-school differences, the Finnish students have fared much better than their Icelandic counterparts in all three rounds of PISA studies. Furthermore, Iceland is the only country where the girls have significantly outperformed the boys in mathematics (OECD, 2004, 2007b).

Finland and Iceland have much in common. Both have subsisted in the fringes of Europe only to flourish in recent decades as they have reaped benefits from globalization and the digital revolution. The populations of these welfare states are some of the most homogeneous in the world. Universal social rights and healthy economies have helped boost Finland and Iceland into becoming some of the most "citizen-friendly" and affluent countries in the world; Iceland ranks first and Finland eleventh in the United Nations' Human Development Index list that takes into account such quality-of-life variables as life expectancy, access to education, and GDP (United Nations, 2007).

People in the Nordic countries exhibit similar patterns of educational attainment. They tend to study relatively little when they are young, but they often remain as students well into their adult lives. A Finnish child can expect to receive only 5523 hours of school instruction between the ages of 7 and 14, the lowest hour total in the OECD. In Iceland, children in that age range typically receive 6277 instructional hours, which is also well below the OECD average of 6898 hours (OECD, 2007a, Chart D1.1). According to PISA 2003 data, an average Finnish youth studies 4.9 hours weekly outside of school—the least in the OECD—while in Iceland 5.9 hours per week is normal for primary school students. In 2005, 43% of Finnish people aged 20 to 29 were at least part-time students. This is the highest percentage among the OECD countries. Iceland's 37% ranks third behind Denmark, where 38% of people in their twenties are students (OECD, 2007a, Table C2.2). Overall, Finns and Icelanders spend on average about 20 years of their lives in school, placing them—along with the other Nordic nations—at the top of the OECD countries with regard to years of educational attainment (OECD, 2005, Chart C1.2).

Parallels between Finland and Iceland are more difficult to draw when it comes to academic achievement as measured by recent international assessments. Finnish 15-year-olds have excelled in all areas of the PISA studies. In PISA 2006, for instance, Finland had the highest scores in mathematics and science among the OECD countries, while ranking second in reading after South Korea. In the same test, Icelandic students scored significantly below the OECD average of 500 in reading and science and just above it in mathematics (OECD, 2007b). The differing trends for the PISA scores for Finland and Iceland can be seen in Figure 1[1].

[1] The science scores are not fully comparable across assessments because the science framework was only developed for PISA 2006. Since the mathematics framework was developed for PISA 2003, the first round of mathematics scores is not fully comparable with the latter two. The reading scores are comparable across all three assessments.

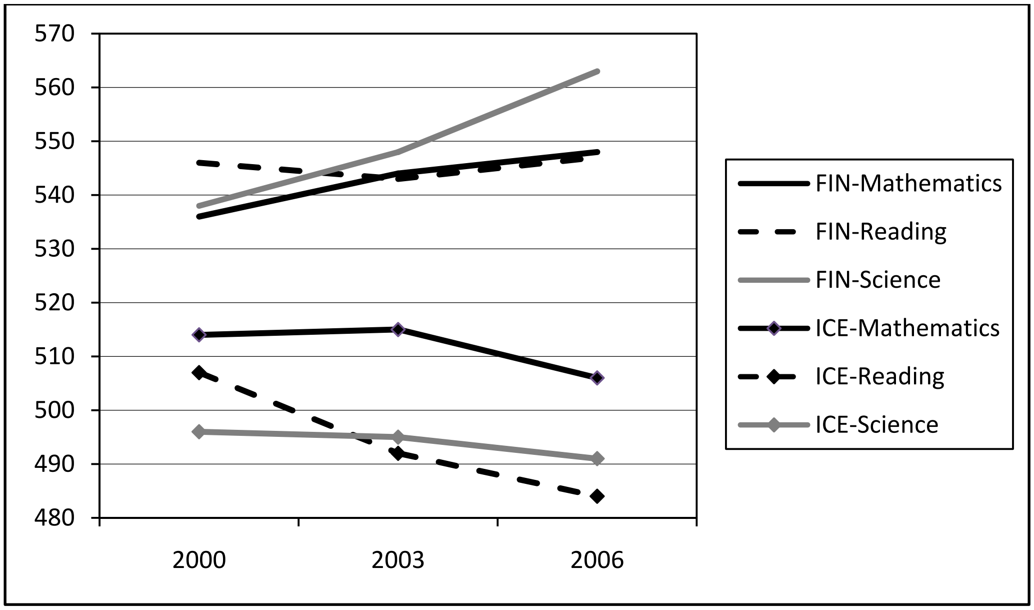


Figure 1: PISA 2000, 2003, and 2006 scores for Finland and Iceland (OECD, 2002, 2004, 2007b)

Student assessment results are inevitably influenced by a network of interrelated variables. Some of the factors that likely have contributed to Finland's recent success are teacher-related: the good quality of the teacher education programs, the relatively high status of educators—and the respect they command—within the Finnish society, and the amount of creative freedom they enjoy in schools. School-based curricula with active learning pedagogies, the structure of the educational system, a national endeavor (the LUMA-project) to improve the teaching and learning of natural sciences and mathematics, effective special education starting with the early grades, students' own interests and leisure activities, the nature of the Finnish language, the Finns' ethos of obedience, as well as Finland's unique socio-historical and cultural heritage also have been identified as possible contributors (Välijärvi et al., 2007; Björkqvist, 2006; Simola, 2005; Malaty, 2006).

Factors behind Iceland's declining PISA scores and the unusual gender differences are elusive. Despite spending 45% more money per each primary school student than is the OECD average, the Icelandic educational system is facing concerns about student achievement (OECD, 2007a, Table B1.1). Reasons for the recent declines are uncertain. On the other hand, although definite answers do not yet exist, some plausible explanations for the gender differences, such as the "Jokkmokk-effect" and the gendered discourse-explanation, have at least been ruled out (Halldórsson, Ólafsson, & Björnsson, 2007; Ólafsson, Halldórsson, & Björnsson, 2006; Steinthorsdottir & Sriraman, 2007). Although the gender differences are smaller in PISA 2006 than they were in PISA 2003, Icelandic girls are still outperforming their male counterparts on all scales, including mathematics. The recent reduction in the gender gap is unfortunately not due to an increase in the boys' scores—Icelandic boys' mathematics scores dropped 4 points from 2003 to 2006—but instead a steep 15-point decline in the girls' scores (OECD, 2007b, Table 6.3b). It is clear that the current challenges of the Icelandic educational system concern all students, not just the boys.

Given the similarities between the two countries on the one hand and the differences in their students' achievement scores on the other, a comparative look at the educational systems of Finland and Iceland seems justified. Since Finnish and Icelandic students spend so little time studying outside of school, it may be particularly helpful to investigate the similarities and differences between classroom practices in these countries.

It is reasonable to ask whether video analysis is the appropriate tool to study mathematics teaching in Finland and Iceland. Other tools, such as surveys and on-the-spot coding of classroom observations, may also be useful. However, as discussed in recent literature (e.g., Goldman, Pea, Barron, & Derry, 2007; Erickson, 2006), video footage offers superior data-yielding capabilities in classroom research and can be effective in detecting patterns in instructional practices. One approach to carrying out international comparative studies in education would be to compare national curricula. But a study of Finnish and Icelandic mathematics curricula would probably not prove very helpful. Olsen (2006) writes

> To some extent Finnish students have the same relative strengths and weaknesses as their Nordic peers. This implies that overall, the Finnish students are stronger than their Nordic peers in all aspects of mathematics covered by PISA. Hence, if the data from large scale international comparative assessments are perceived as a resource for learning from others, this finding implies that detailed studies of the subject matter of the curriculum are not necessarily the way ahead (p. 33).

2. Method of Lesson Structure Analysis

2.1. Introduction

Video-based classroom studies can effectively complement other pedagogical research (see, e.g., Erickson, 2006). Large video-based classroom studies such as the 1999 TIMSS Video Study (Hiebert et al., 2003) and the Learner's Perspective Study [LPS] (Clarke, Emanuelsson, Jablonka, & Mok, 2006) have on one hand answered many questions about how to use video technology to study classroom practices, but, on the other hand, they also have raised new issues. For instance, it is not clear which aspects of classroom practice offer the most useful evidence for cross-national comparison. How should quantitative and qualitative video-based research methods be combined in the analysis of classroom practices? What criteria should be used in the evaluation of video-based classroom studies?

Classrooms are complex, dynamic settings. Therefore classroom video footage is always multilayered and rich, filled with nuances and subtleties. Deciding which aspects of the *behavior stream* (Barker, 1963) to investigate is a crucial task. Indeed, it is possible to scrutinize classroom video footage with respect to countless research variables. In this study, the dimensions of the pedagogical *function* and the *form* of classroom interaction are used to model classroom practices and, more specifically, to reveal structures in lessons.

Considering lesson structures is not a new idea. Johann Friedrich Herbart, a follower of Kant, first postulated a cyclical sequence of learning steps in 1835 (Dunkel, 1969). Herbart believed that knowledge acquisition is comprised of formal stages that are linked together by association and that must be completed in order for learning to occur. Many understood his idea to imply that all teachers should follow the same step sequence in their teaching. As a result, lessons were often designed to follow Herbart's formal stages of learning: 1) creating cognitive clarity of previously learned material, 2) stimulating new knowledge elements by associating them to knowledge already possessed, 3) systematizing these associations, and 4) applying the new knowledge (see, e.g., Dunkel, 1969; Oser & Baeriswyl, 2001). Herbart's ideas shaped classroom practices significantly in Europe and the US, especially during the first half of the twentieth century. In fact, his ideas about learning are still prevalent in many classrooms today.

Lesson structure analysis is an important part of many video-based pedagogical studies. Examples of different coding schemes for lesson structure can be found in classroom studies such as the 1995 and 1999 TIMSS Video Studies (Stigler, Gonzales, Kawanaka, Knoll, & Serrano, 1999; Hiebert et al., 2003), as well as the LPS (Clarke, Emanuelsson et al., 2006). The approach used here combines aspects of the TIMSS and the LPS studies. For example, the LPS also uses the function and form dimensions; however, the analysis there is based on *lesson elements*—not whole lessons as in the TIMSS and in this study—and is more qualitative in nature. Some of the coding criteria in the current method were adapted from the TIMSS studies and Jablonka's (2004) habilitation thesis.

The two-pass coding method presented in this section can be used to identify patterns in classroom practices in terms of the pedagogical functions and the forms of social participation. The interaction of the two dimensions—function and form—is of particular interest as the main purpose of the method is to offer a way to investigate the different forms of classroom interaction teachers use in attempting to meet their pedagogical goals.

The categories for the function-variable (first pass) are fixed, but the ones for the form-variable (second pass) are sample-sensitive. One of the strengths of this open-ended method is its ability to capture unique, yet often subtle classroom practices. After all, a research tool in a comparative study is only effective if it can reveal meaningful differences and similarities across a sample. Thus the utility of any method of lesson structure analysis lies in its ability to provide evidence for differentiating sets of lessons. Whereas a method using only predetermined categories may miss subtle, yet critical differences in classroom practices, the adaptable method described here can be used to distinguish even the slightest variations in patterns of classroom behavior. The output of this coding method is a set of data that can be utilized in a variety of ways including many types of statistical analyses and visual representations[2]. The method is

[2] Videograph (Rimmele, 2002), the coding software that was used in this study, is capable of exporting data into SPSS. However, it does not produce useful visual representations. Those can be made with, for instance, Adobe Illustrator.

intended to be generalizable across a variety of applications, including analyses of lessons given in subjects other than mathematics.

Lesson structure analysis has its limitations[3]. Although it can yield valuable information about classroom practices, lesson structure analysis does not shed light on many interesting and relevant facets of teaching and learning. For instance, the success of the pedagogical strategies employed and the types of cognitive structures provoked by the instruction generally cannot be deduced from the coded data. Moreover, researchers should avoid making hasty cause/effect pairings based on lesson structure analysis and other dimensions of interest such as PISA results.

2.2. First Pass: Function

The first pass of the coding method is based on Herbart's formal stages of learning. It is nearly identical to the *Purpose*-variable from the 1999 TIMSS Video Study. The *Purpose*-variable is a *coverage code*—every moment of the lesson is coded—and has three mutually exclusive categories: *Addressing content from a previous lesson(s)*, *Introducing new content*, and *Practicing/Applying/Consolidating content introduced in the current lesson* (Hiebert et al., 2003; LessonLab, 2003). In the first pass of the coding scheme discussed in this chapter these categories are referred to as *Review*, *Introducing new content*, and *Practicing/applying*. An additional category, *Other*, is included in the set of categories for the first pass-variable because the aforementioned three were deemed non-exhaustive and over-inclusive even for a rough analysis of lesson structures.

The first pass-variable, i.e. the function-variable, lacks sensitivity to nuances in order to give a general idea about the main purpose of lesson segments. Thus the first pass should only be considered a starting point to lesson structure analysis. Although the four categories can be seen as covering each moment of any mathematics lesson, only limited information can be drawn from this kind of simplified analysis.

Many of the coding criteria for the first pass are adapted from the 1999 TIMSS Video Study. For coding purposes, the lesson starts when the teacher begins the first public statement and it stops when the teacher concludes the last such statement. If the lesson begins with a problem-solving phase, and the starting point is not clear, coding starts when half of the students are sitting down and working. If the ending point is not clear, coding ends when the bell rings or when approximately half of the students have stopped working.

A segment less than 30 seconds in length is not coded, unless it is in the very beginning or the end of the lesson. If a segment lasts for less than 30 seconds, and the segments before and after it are of the same type, the short segment is simply ignored. However, if the segments adjacent to the short segment are different, the short segment is merged with the segment following it. A segment is considered to start at the beginning of its announcement. For example, if the teacher says "Take out your books, notebooks, and pencils because we're going to start

[3] For a discussion about the problems and shortcomings of video analysis in classroom research, see (Savola, 2008).

practicing the new idea now," the code for *Practicing/applying* should begin as the teacher says "Take." The length of the coding interval is one second.

Table 1 lists the types of classroom activities that are included under each first pass-category. A more detailed discussion of these categories and the coding criteria is presented in (Savola, 2008).

Review	- Discussing content covered in a previous lesson - An average student is expected to know the content - Going over homework - Going over a quiz/test
Introducing new content	- Students are not expected to know all of the content - Exploring or demonstrating a new idea, procedure, or a type of problem - Reading or writing about new content - Only the first problem counts here. Subsequent examples of the same type count as practice ("Can an average student accomplish the task without having to make leaps?") - Summary is part of the segment only if it directly follows the demonstration
Practicing/applying	- Working on the types of problems that were introduced that day - Students are expected to know how to work with the new idea(s) using the content presented that day and previously - Assignment of practice problems
Other	- If none of the other three categories apply, or if two or three apply - Classroom management (roll calls, getting settled, disciplinary action, technical set-up, etc.) - Mathematics management (announcing tests or homework, goal statements, distributing/collecting materials or technology, etc.) - Interruptions (fire drill, etc.) - Public social talk - Announcements over the intercom or TV

Table 1: First pass-categories

2.3. Second Pass: Form

Classroom interaction can have a significant effect on learning. Following Vygotsky's lead, educational researchers have recognized the importance of the sociocultural context of learning environments (e.g., Cobb & Bauersfeld, 1995; Lave & Wenger, 1991). Bauersfeld (1980) considers *human interaction* to be constitutive and one of the "hidden dimensions in the so-called reality of a mathematics classroom." He asserts

> Teaching and learning mathematics is realized through *human interaction*. It is a kind of mutual influencing, and interdependence of the actions of both teacher and student on many levels. It is not a unilateral sender-receiver relation. Inevitably the student's initial meeting with mathematics is mediated through parents, playmates, teachers. The student's reconstruction of mathematical meaning is a construction via social negotiation about what is meant and about which performance of meaning gets the teacher's (or the peer's) sanction. How can we expect to find adequate information about teaching and learning when we neglect the interactive constitution of individual meanings? (Bauersfeld, 1980, p. 35)

The second pass of this coding scheme concerns the forms of social interaction and classroom participation. It is intended to shed light on the "hidden dimension" discussed above. This part of lesson structure analysis is closely related to what was done during the first coding pass. Having seen the lessons and classified each moment in them as belonging to one of the four categories of the first pass-variable, the researcher is in a position to devise and carry out a finer categorization. The categories of the second pass-variable, i.e. the form-variable, stem from asking "Who is doing what?" and "How are the participants interacting?" They vary from sample to sample according to the range of actions and interactions of the teachers and their students on the recordings. The creation of appropriate categories is not straightforward, and it is almost certain that two coders would conceive different sets of categories. The basic idea is that each significant type of participatory action by the teacher and the students should be classifiable with an appropriate label, and that significantly different types of actions are not "lumped" together.

During the second coding pass the lesson segments classified using the four categories of the first pass-variable are further divided by the kind of classroom participation they exhibit. There is one exception: Lesson components classified as *Other* are generally divided further using non-form-based categories such as *Classroom management*, *Mathematics management*, and *Interruption*. With the other three categories, important decisions about the level of detail of social interaction to be included in the coding system must be made since not all kinds of interaction can be represented. The smaller the differences in the classroom practices within the sample are, the finer the distinctions between the second pass-categories can be. While there are no limits to the number of categories that can be used, a "golden mean" for each set of videos probably exists. This depends not only on the recorded lessons, but also on the agenda of the researcher. During their development, the coding categories should be checked against specific cases to ensure that they are capturing meaningful differences and not creating misleading contrasts (Angelillo, Rogoff, & Chavajay, 2007).

Coding for the form-variable can be more challenging than coding for the pedagogical function. The coding categories are formulated specifically for each sample, a task whose difficulty tends to increase with the sample size. In addition, the endpoints of the form segments can be more difficult to identify than those of the function-segments. This is partly because different forms of classroom interaction can have considerable overlap, whereas the teacher's intentions about pedagogical goals more often are clearly expressed and followed. Carefully defined, mutually-exclusive second pass-categories help with this process.

3. Data Collection

3.1. About the Teachers

The twenty teachers involved in the study were randomly selected from among the Finnish and Icelandic mathematics teachers who taught 14 and 15-year-olds during the academic year 2006-7. This age range is the one targeted by the PISA studies, and it corresponds to 8th and 9th graders in Finland and 9th and 10th graders in Iceland. Twelve of the twenty teachers were observed teaching both 14 and 15-year-olds. The remaining teachers were observed in two classes of the same age group (4 cases), or a class with 13-year-olds was included (4 cases).

At the time of the taping, the mean age of the teachers was 46.2. Their ages and their years of teaching experience range from 29 to 66 years and 2 to 35 years, respectively. Although the Finnish teachers in the recordings are younger than their Icelandic counterparts—44.4 years of age as opposed to 47.9—they have more teaching experience: 18.2 years versus 15.1 years. Six of the Icelandic teachers and seven of the Finnish teachers are female.

3.2. Sampling: Finland

The ten Finnish teachers that participated in this study were randomly selected. Because comprehensive lists of Finnish mathematics teachers or primary schools were not readily available, the first step of the selection process involved the choosing of ten educational providers. Typically these are municipalities (i.e. cities, towns, or villages) or, less frequently, foundations. The educational providers, which vary considerably in size, were weighted according to the number of students they serve (Finnish Department of Education, 2005). Then ten providers of education were chosen using a random number generator. In effect, ten "dummy" students were randomly selected, and the towns in which they attend school listed.

The schools were chosen next. In case the selected educational provider oversees only one primary school with 14 and 15-year-olds, that school was asked to participate in the study.

If, on the other hand, the educational provider operates multiple primary schools, the schools were listed alphabetically and one of them randomly chosen. The principals of the selected schools were contacted. They were asked to participate and to provide a list of active mathematics teachers. If the principal agreed to the study and submitted the said list, a teacher was then randomly chosen. If the teacher was not willing to cooperate, another one from the same school was chosen instead.

To obtain the sample of Finnish schools, a total of thirty schools had to be contacted. Only two of the originally-selected ten schools ended up in the final sample. Whenever a school declined, another school from the same educational provider would be invited to participate. In two instances every school in a municipality refused to take part. In those cases a municipality of similar size in the same geographical region was selected. The reasons for the low participation rates of the Finnish schools can only be speculated. Perhaps some of the Finnish educators feel as if they have already contributed enough to research, since many research projects have focused on the Finnish educational system following its success in the PISA studies.

Despite the relatively low rate of cooperation, this sample can be considered to sufficiently represent the Finnish mathematics teachers—at least to a degree afforded by the modest sample size. The teachers were randomly selected by the researcher, who was not familiar with any of them or their professional reputations. Furthermore, in almost all cases, the teacher selected first agreed to participate in the study; the principals were more likely to refuse to co-operate.

3.3. Sampling: Iceland

The Icelandic teachers were selected using a two-step process: first the school, then the teacher. A list of Icelandic primary schools together with their attendance figures was available from an online source (Statistics Iceland, 2005). Schools were assigned weights according to the number of students they serve. A random number generator was then used to select the participating schools. Of the original set of ten schools, eight were willing to participate. Two additional schools were chosen with the above method to replace the schools that did not want to take part in the study. As in the Finnish sample, the principals were asked to list his or her school's active mathematics teachers. One teacher was then randomly selected. If the teacher was not willing to cooperate, another one from the same school was chosen as a replacement; however, this happened only with one school.

3.4. Recording Procedure

The two-camera recording set-up described below was used to capture all forty lessons in the sample. One videographer can carry out the recordings using this recording design. The video cameras are situated in the back of the classroom as shown in Figure 2.

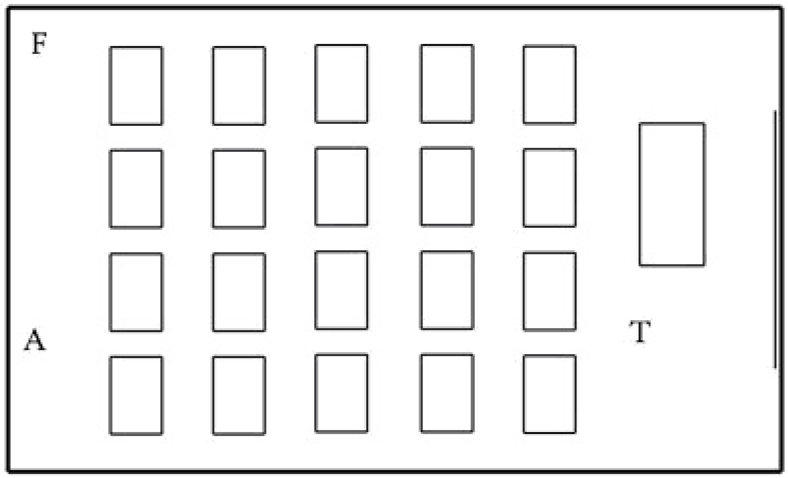


Figure 2: The recording set-up

The action camera (A) follows the teacher (T), while the fixed camera (F) captures as much of the classroom as possible. This recording design utilizes three microphones: a wireless lavalier microphone on the teacher and an external microphone connected to each camera. The two main audio tracks are recorded by the action camera, while the sound captured by the fixed camera serves as backup. See (Savola, 2008) for more information about recording techniques.

The students' faces are typically not visible in the recordings. In order to protect the identities of the approximately one thousand students who participated in the study, the cameras were placed in the back of the classroom. In addition, the parents of the students were given the option of having their child take part in another educational experience instead of their usual mathematics lesson; however, none of the parents chose to keep their child from attending the lesson.

3.5. Typicality of Lessons

Based on the teachers' judgments, the lessons recorded for the purposes of this study were close to typical mathematics lessons. The teachers were asked to follow their normal lesson plans and not to arrange anything special for the day of the recording. The observations were scheduled for a day[4] when there were no tests or only a review for a test.

Whenever it was logistically possible, a "warm-up" lesson was recorded to allow the teachers some time to become accustomed to being filmed. In the case of eight of the twenty schools, three lessons were observed and videoed, but only the last two were coded and used as part of the data set. This was done in order to minimize the effects the video cameras may have on classroom practices. In the remaining twelve schools only two lessons were recorded.

[4] The lessons were typically recorded during one day. However, there were four instances when this was not possible, and the recordings were conducted over two days.

Scheduling to observe three mathematics classes in one day was more difficult in Finland since there most mathematics teachers teach other subjects, such as natural sciences or information technology, in addition to mathematics. There seemed to be no major differences between the omitted “warm-up” lessons and the lessons used for the study. Nevertheless, recording an extra lesson is a recommended precautionary measure to lessen the camera effects and thus increase the *verisimilitude*—or trueness-to-life—of the recordings.

Based on post-observation teacher interviews, the practices of the teachers and the students were in most cases not significantly changed by the presence of the researcher and the cameras. During the interview each teacher commented on the typicality of the lessons in general as well as the typicality of student behavior. All but two of the teachers in the sample said that the lessons were typical for the most part[5]. Teacher perceptions of student behavior during the classroom recordings are summarized in Table 2. The Finnish students were slightly more influenced by the presence of the cameras. Students were not interviewed, although that would have given a more complete picture of the typicality of the recorded lessons.

	Finland	Iceland	Total
Students behaved normally	14 (70%)	17 (85%)	31 (77.5%)
Students were more active than normal	2 (10%)	0 (0%)	2 (5%)
Students were less active than normal	4 (20%)	3 (15%)	7 (17.5%)
TOTALS	20	20	40

Table 2: Teacher perceptions of student behavior

There were above-normal levels of student activity—mainly rowdiness—in two of the Finnish lessons. In both instances the teacher remarked that a small group of students felt the need to “perform” for the cameras. This was not a phenomenon that any of the Icelandic teachers recognized despite the fact that a larger proportion of the Icelandic classrooms appeared to have discipline problems. The reduction in student activity in the four Finnish lessons was attributed to shyness, being afraid to provide wrong answers while being videotaped, and overall better-than-normal behavior of the students. According to their teachers, students behaved better than normal in three Icelandic lessons. There were no mentions of shyness or being afraid to provide wrong answers within the Icelandic sample. The figures in Table 2 are consistent with those found in the TIMSS 1999 Video Study (Hiebert et al., 2003, p. 29).

[5] One Finnish teacher remarked that the students were so afraid to raise their hands and participate that this may have changed the way the lesson was run. The other not-so-typical lesson was attended by only 5 of the 12 students due to a flu epidemic.

4. Results

4.1. Overview

Based on the analysis of the lessons in the sample, there are differences in the ways in which Finnish and Icelandic mathematics teachers conduct their classes. The Finnish mathematics lessons exemplify the *Review-Lesson-Practice* [RLP]-script and are fairly uniform in their functional structure. In contrast, Icelandic mathematics teachers seem to be working from two distinct pedagogical philosophies: nine of the lessons in the sample essentially follow the RLP-structure, whereas eleven lessons are conducted using versions of the *Individualized learning* [IL]-instructional strategy, a learner-based pedagogical paradigm.

Many Finnish teachers seem to promote collaborative learning activities. Those teachers often favor class discussions and student presentations over delivering monologues in the front of the classroom. This is especially apparent during lesson segments dedicated to reviewing material from previous lessons. Furthermore, Finnish mathematics teachers spend significantly more time introducing new content than do their Icelandic counterparts.

Section 4.2 offers an explanation of the coding categories specific to this sample. Visualizations of the coded lessons are presented in the form of *lesson diagrams*. A summary of the initial results of the coding process is followed by a section on inter-coder reliability.

4.2. Coding Categories

The first pass-categories are *Review*, *Introducing new content*, *Practicing/applying*, and *Other*. The categories for the second pass were created specifically for this sample according to the guidelines discussed earlier. This section explains the coding criteria for the second pass in some detail. Tables 3 through 6 show the various categorizations, and Table 7 presents a summary of all the coding categories for this particular sample.

The *Review*-segments in the lessons in this sample are divided into three categories based on classroom interaction: "Teacher discusses examples or a concept in the front," "Students write solutions on the board," and "Class works together on a problem." The teacher may elicit responses from the students during his or her presentation. For example, the teacher may ask the students to recall a certain formula. In contrast, during an episode when the class is working together, the teacher would be more likely to lead the discussion by asking questions such as "What do we do next?" or "What do you think?" The amount of creative freedom with which the teacher empowers the class can be an important factor while coding the *Review*-segments. Open-ended questions can reveal higher levels of such empowerment and should trigger the "Class works together"-code. However, the occurrence of open-ended questions is not a necessary condition for that code; teachers can accomplish a collaborative learning atmosphere in various ways. "Students write solutions on the board" includes the time during which the teacher assigns problems to be done on the board. Table 3 displays the three *Review* categories for the lessons in this sample.

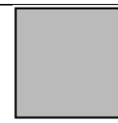
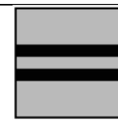
Review	Teacher discusses examples or a concept in the front	
	Students write solutions on the board	
	Class works together on a problem	

Table 3: *Review*-categories

The lesson segments during which new material is introduced, i.e. the “lessons”, are further categorized during the second coding pass. Five categories of classroom participation during lesson segments dealing with new content are distinguished for this sample. The first category, “Teacher presents a lesson, intermittent questions,” is used for the segments where the teacher presents new content while the students pay attention and answer the teacher’s sporadic questions. Students may also ask questions of the teacher. The teacher may use various types of technology—blackboard, overhead projector, document reader, PowerPoint presentations, etc.—in delivering the lesson. In one Finnish lesson, FIN-7A, the teacher demonstrated a concept using a student volunteer. The “Teacher presents”-code was applied for this 45-second segment, although one of the students had a physically active role in the presentation.

The second code, “Teacher elicits responses from the class by asking a series of connected questions,” identifies segments where the teacher draws the students into the lesson via the Socratic method or another type of questioning technique involving a series of related questions (Jablonka, 2004). These types of segments are often conversational in nature. One or two *Initiation-Response-Evaluation*-sequences are not enough to trigger this code (see, e.g., Hiebert & Grouws, 2007).

“Students work on a new type of problem, teacher helps”-code applies for two distinct pedagogical situations: 1) Students are asked to work on a new type of problem—the first example—directly following an instructional segment, and 2) students explore a new concept via the “problem of the day”-approach. The latter was observed in only one lesson, FIN-9B. The new material in this lesson was delivered via a problem-solving activity not unlike the *Structured problem-solving*-pedagogical strategy used by many Japanese mathematics teachers (Clarke, Mesiti, Jablonka, & Shimizu, 2006).

“Students copy text”-code covers two types of activities: 1) There is so much writing on the board that the students need time to catch up with their note taking, and 2) Students are asked to copy text from a book. “Students read the book” was used in only one lesson.

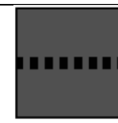
Introducing new content	Teacher presents new content, intermittent questions	
	Teacher elicits responses from the class by asking a series of connected questions	
	Students work on a new type of problem, teacher helps	
	Students copy text from the board or the book (no other interaction)	
	Students read the book (no other interaction)	

Table 4: *Introducing new content*-categories

Four categories of *Practicing/applying* are identified in the lessons in this sample. “Teacher discusses examples in the front” is used for any teacher-centered segments where the new content for the day is practiced. It is used for any teacher-presented examples beyond the first one, which should be coded as *Introducing new content*. If the role of the teacher is closer to a “guide on the side” as opposed to a “sage on the stage,” it may be that the class is practicing the new content collaboratively. In this case the “The class, led by the teacher, works together on a problem”-code would be appropriate.

During *Practicing/applying*-segments where the students work on problems, the teacher may or may not actively offer help to the students. Some teachers simply have the students work while they, for instance, prepare materials for the next class, set up technology, or perform bookkeeping duties. Gauging student progress is considered helping. Furthermore, the helping can be considered to begin when the teacher makes him or herself available to the students. Table 5 summarizes the form-categories for *Practicing/applying*.

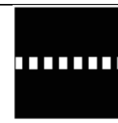
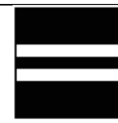
Practicing/applying	Teacher discusses examples in the front	
	Students work on practice problems individually or in small groups, teacher helps	
	Students work on practice problems individually or in small groups, teacher does not help	
	The class, led by the teacher, works together on a problem	

Table 5: *Practicing/applying*-categories

This sample requires an extended range of *Other*-categories. This is mainly due to the prevalence of the *Individualized learning* [IL]-pedagogical strategy employed by several Icelandic teachers. During their lessons there is often no public instructional discourse. Instead, each student works on problems at his or her own pace for the duration of the lesson while the teacher walks around the room and helps. Therefore the pedagogical function of any particular moment is undeterminable; it is impossible to assign a label such as reviewing or working with a new concept to the class as a whole during IL-segments.

Three distinct forms within IL are identified: “Kikan-shido” (i.e. between-desks instruction: students work at their desks while the teacher walks around and helps) (O'Keefe, Xu, & Clarke, 2006), “Teacher presents in the front,” and “Student presents in the front.” The latter two categories are used when the students are individually working on problems, but either the teacher or one of the students presents material on the board.

“Homework/progress check” is used to accommodate for two specific pedagogical devices. Several of the Finnish lessons contained a segment during which the teacher checked each student’s notebook to see whether the homework assignments had been completed. The same category was used for the verbal progress check some Icelandic teachers conduct at the beginning of an IL-style lesson.

The “Interruption”-code can be applied to various situations such as a visit to the classroom by someone or an announcement over the intercom. One teacher had to leave the classroom to take a student to another location to take a test. This also was considered an interruption to classroom activities as were the “morning services” delivered during two of the Finnish lessons; one was broadcast over the intercom, the other via school TV.

The eight *Other*-categories, together with their visual codes, are summarized in Table 6. The checkerboard patterns visually unify the IL-segments.

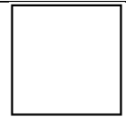
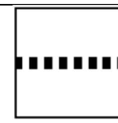
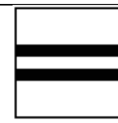
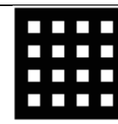
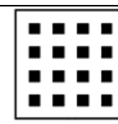
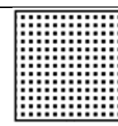
Other	Classroom management	
	Mathematics management	
	Homework/progress check	
	Interruption	
	Social talk	
	Individualized learning—Kikan-shido	
	Individualized learning—Teacher presents in the front	
	Individualized learning—Student presents in the front	

Table 6: *Other*-categories

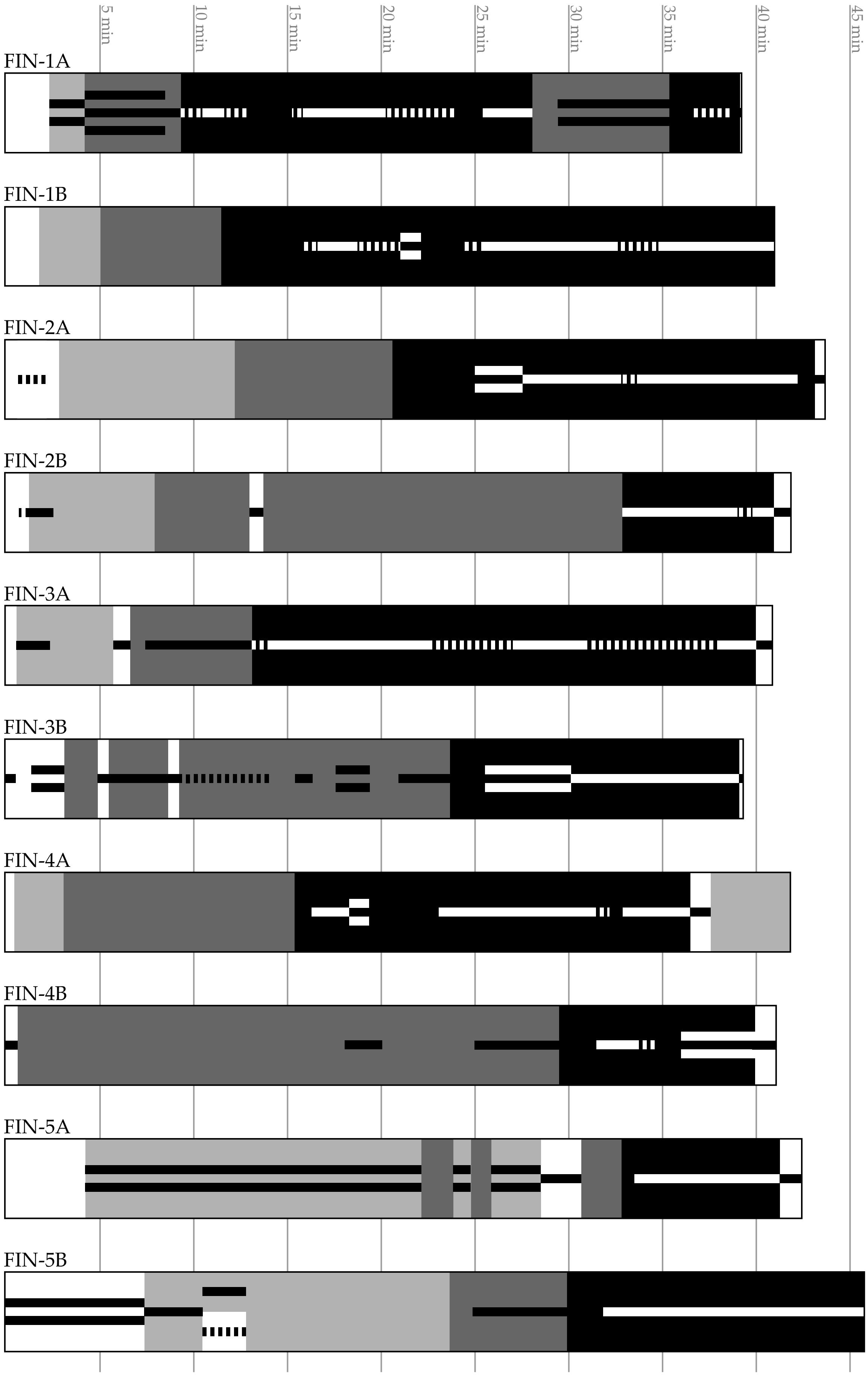
There were three Finnish lessons where one code was not sufficient to describe the key participatory actions. In these cases one or more students were writing solutions to homework problems on the board while the teacher visited each student's desk to check whether they had completed the assignment for the day. Since these are significant events in a lesson, both "Students write solutions on the board" and "Homework/progress check" codes were assigned to these lesson segments.

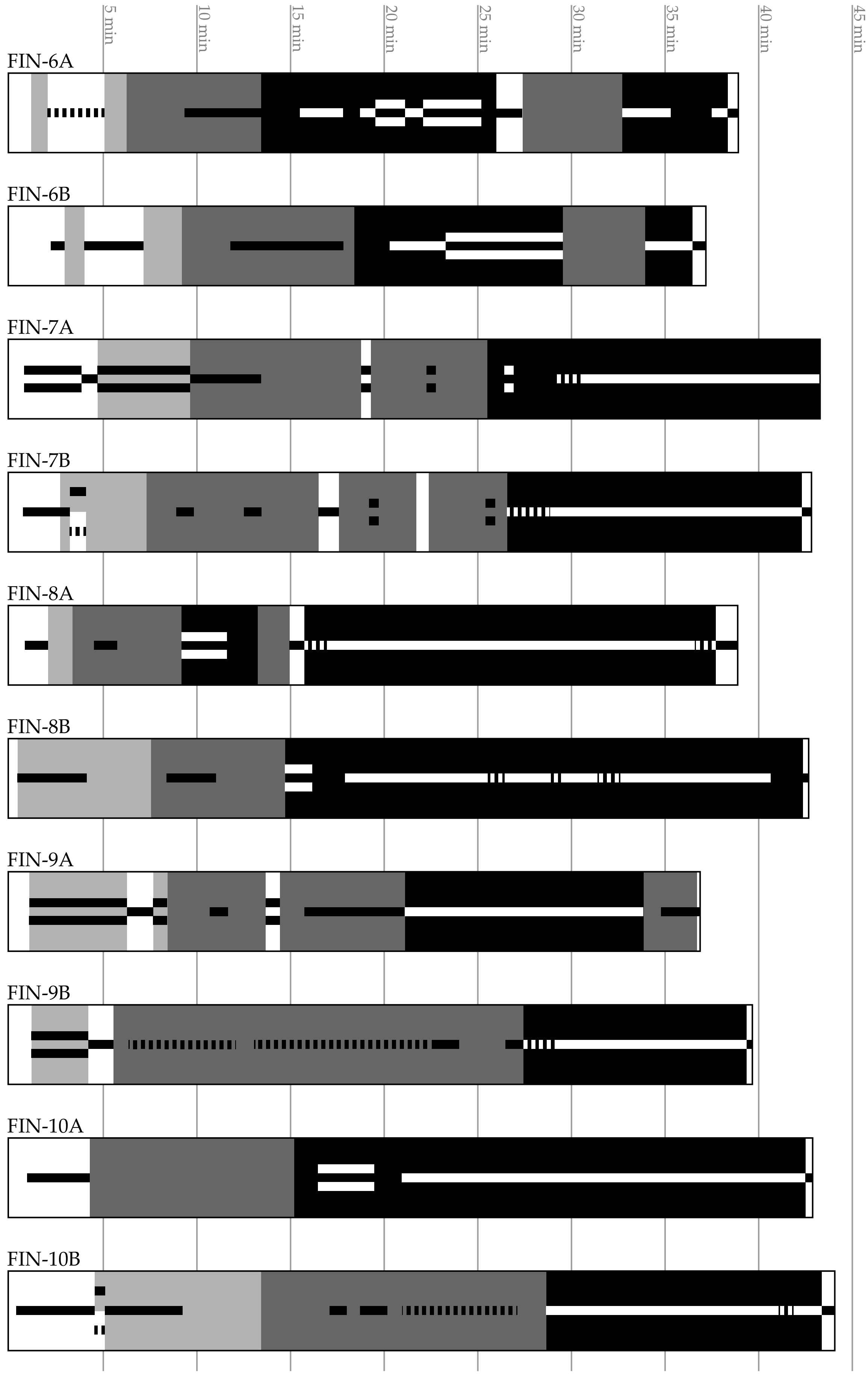
4.3. Lesson Diagrams

This section contains illustrations of the coded lessons. A summary of all twenty codes, a necessary companion to interpreting the lesson diagrams, is presented as Table 7. Time is the third dimension in these diagrams. Lessons FIN-1A and FIN-1B were given by the Finnish teacher FIN-1, and so on.

Review	Teacher discusses examples or a concept in the front	
	Students write solutions on the board	
	Class works together on a problem	
Introducing new material	Teacher presents new material, intermittent questions	
	Teacher elicits responses from the class by asking a series of connected questions	
	Students work on a new type of problem, teacher helps	
	Students copy text from the board or the book (no other interaction)	
	Students read the book (no other interaction)	
Practicing/applying	Teacher discusses examples in the front	
	Students work on practice problems, teacher helps	
	Students work on practice problems, teacher does not help	
	Class works together on a problem	
Other	Classroom management	
	Mathematics management	
	Homework/progress check	
	Interruption	
	Social talk	
	Individualized learning—Kikan-shido	
	Individualized learning—Teacher presents in the front	
	Individualized learning—Student presents in the front	

Table 7: Summary of codes


5 min
10 min
15 min
20 min
25 min
30 min
35 min
40 min
45 min
FIN-1A
FIN-1B
FIN-2A
FIN-2B
FIN-3A
FIN-3B
FIN-4A
FIN-4B
FIN-5A
FIN-5B


5 min
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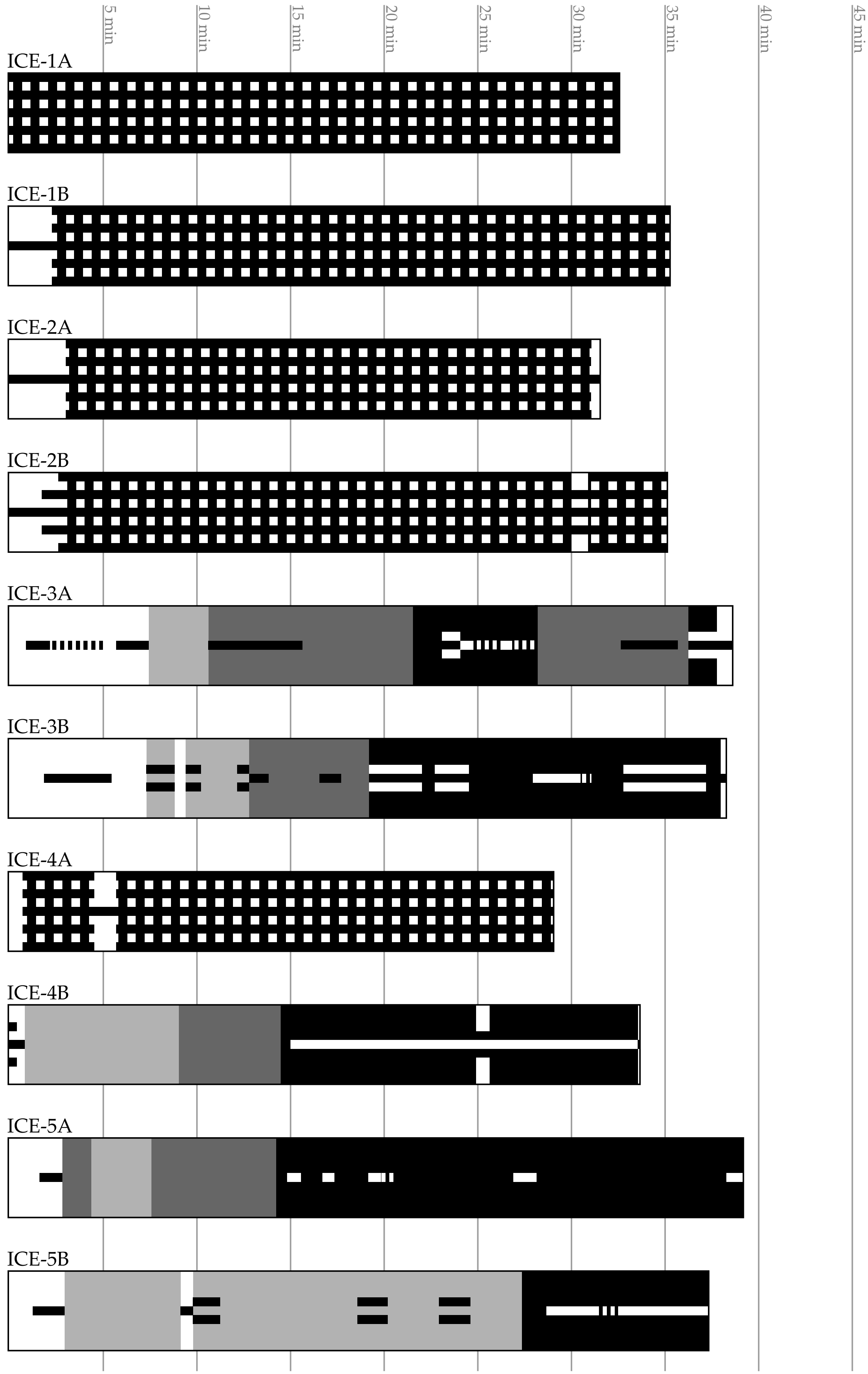
15 min
20 min
25 min
30 min
35 min
40 min
45 min
FIN-6A
FIN-6B
FIN-7A
FIN-7B
FIN-8A
FIN-8B
FIN-9A
FIN-9B
FIN-10A
FIN-10B


5 min
10 min
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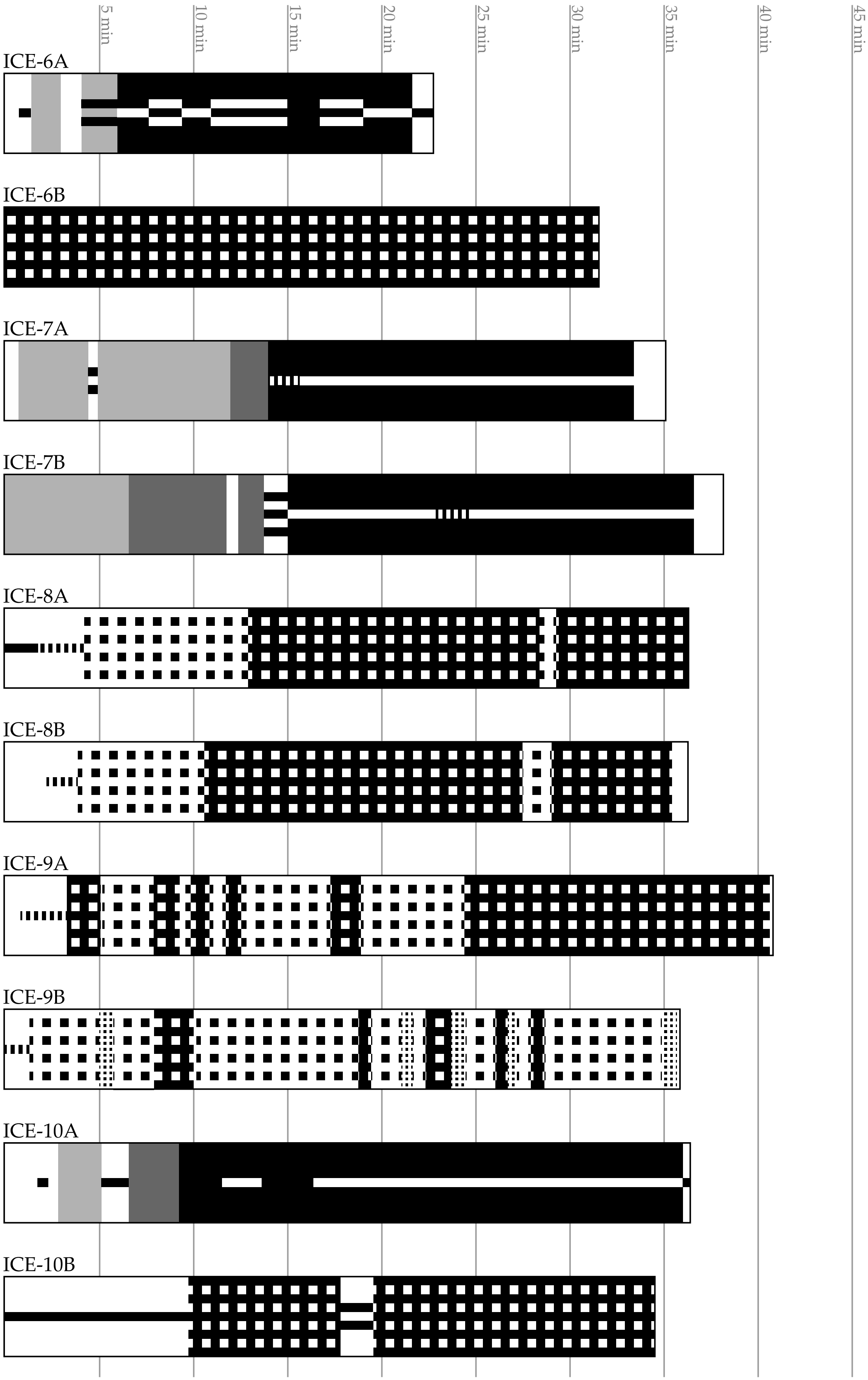
20 min
25 min
30 min
35 min
40 min
45 min
ICE-1A
ICE-1B
ICE-2A
ICE-2B
ICE-3A
ICE-3B
ICE-4A
ICE-4B
ICE-5A
ICE-5B


5 min
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20 min
25 min
30 min
35 min
40 min
45 min
ICE-6A
ICE-6B
ICE-7A
ICE-7B
ICE-8A
ICE-8B
ICE-9A
ICE-9B
ICE-10A
ICE-10B

4.4. First Results

This section offers a brief summary of the preliminary findings from this video study. The focus is on the relative frequencies of the various codes. The first coding pass sheds light on the lessons with regard to the pedagogical functions. Figure 3 shows how class time is distributed over the four first pass-categories in the Finnish and Icelandic lessons.

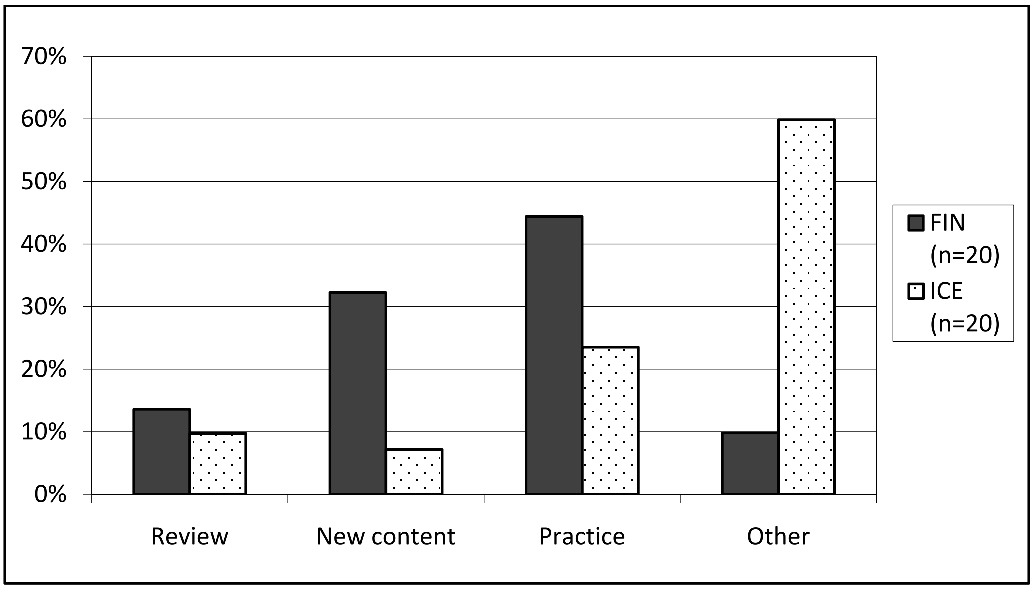

Figure 3: First pass-categories: Finland and Iceland

Eleven of the twenty Icelandic lessons demonstrate versions of the IL-strategy. Since IL-segments are coded as *Other*, that category is by far the most prevalent for Iceland. Figure 4 displays the comparison between the Finnish lessons and the nine non-IL Icelandic lessons, which essentially follow the RLP-script. This set of lessons is denoted with an asterisk: Iceland* or ICE*.

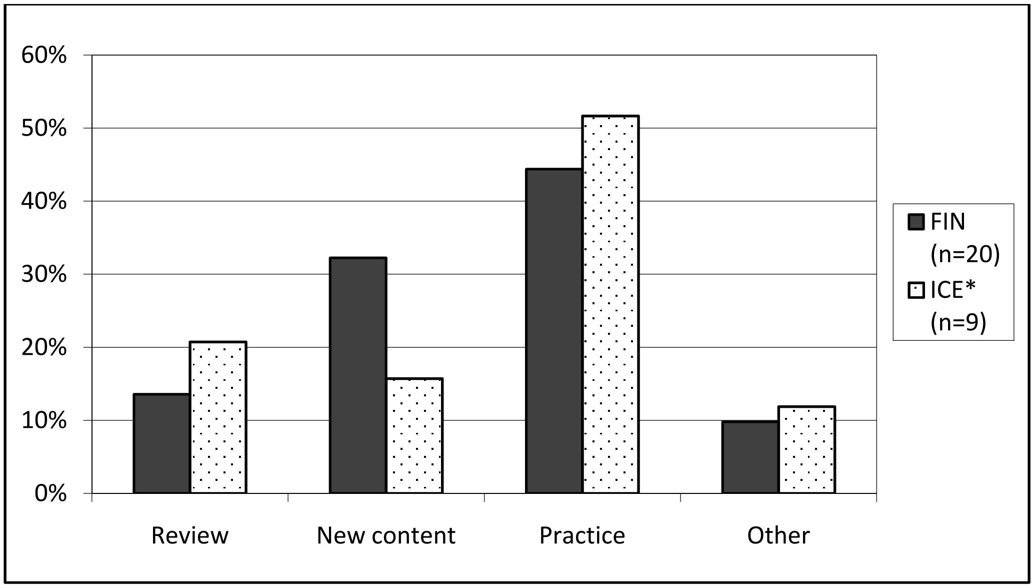

Figure 4: First pass-categories: Finland and Iceland*

Based on this "apples-to-apples" comparison, the Finnish mathematics teachers appear to spend less time reviewing and practicing and more time introducing new material than do the Icelandic teachers not using IL. In all, the Finnish teachers in the sample spent 13.6% of lesson time reviewing, while the percentage for Iceland* is 20.7. New content was being taught 32.2% of the time in the Finnish lessons versus 15.7% in the Iceland*-lessons.

The relative frequencies of the first pass-categories in the two countries can be compared using the proportion of time spent on each of the categories in each lesson. Applying such analysis, the only statistically significant difference at the .05-level is for the category of *Introducing new content*, for which a t-test yields $t = 2.78$ and $p = .010$.

Figures 6 through 9 show the prevalence of the various forms of classroom interaction for each of the first pass-categories for Finland and Iceland*.

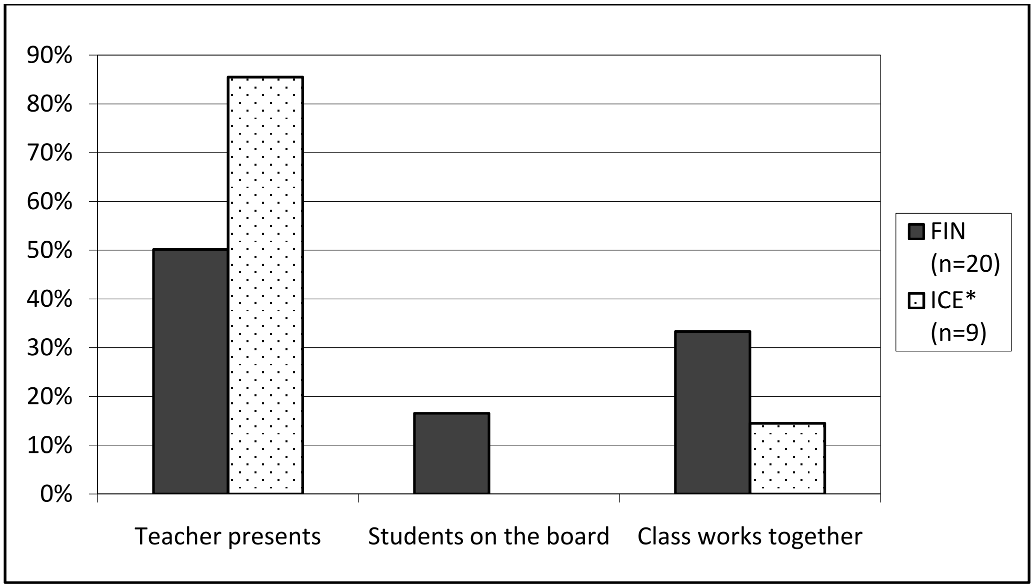

Figure 6: Forms of *Review*: Finland and Iceland*

In this sample, 50.1% of the *Review*-segments within the Finnish lessons can be classified as having the form "Teacher discusses examples or a concept in the front." In contrast, 85.5% of the time spent reviewing during the Iceland*-lessons feature that form of interaction. This is statistically significant when considered at the level of the lesson: t = -2.80 and p = .010. Notably no student presentations took place during the Iceland*-lessons.

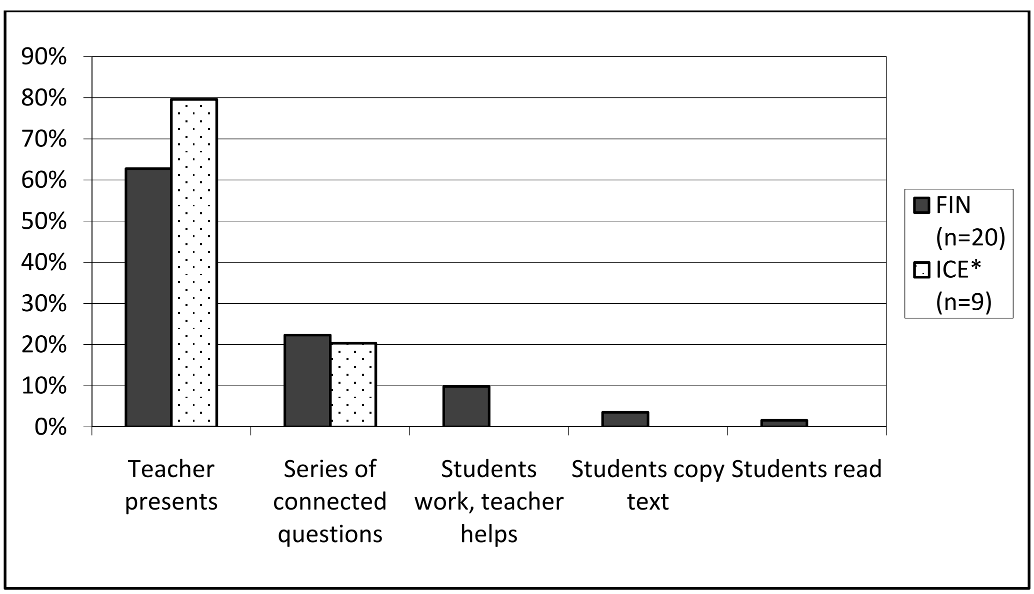

Figure 7: Forms of *Introducing new content*: Finland and Iceland*

Figure 7 shows the relative frequencies of the various forms of *Introducing new content*. Overall, when introducing new material, Finnish teachers spent 62.7% of the time presenting in the front without involving the students for more than an occasional question. For Iceland*, the percentage is 79.6. This difference is nearly significant at the .05-level: t = -1.96 and p = .061.

Approximately 10% of the time when the Finnish teachers were introducing new material, they asked their students to work on the new type of problem rather than first demonstrating how they should do it. However, in all but one class, FIN-9B, the teacher did show the students how to get started.

In *Review* and *Introducing new content*-segments combined, the Finnish teachers presented 59% of the time, whereas the Iceland*-teachers spent 83% of that time presenting in the front. This is significant at the lesson-level with t = -2.146 and p = .044.

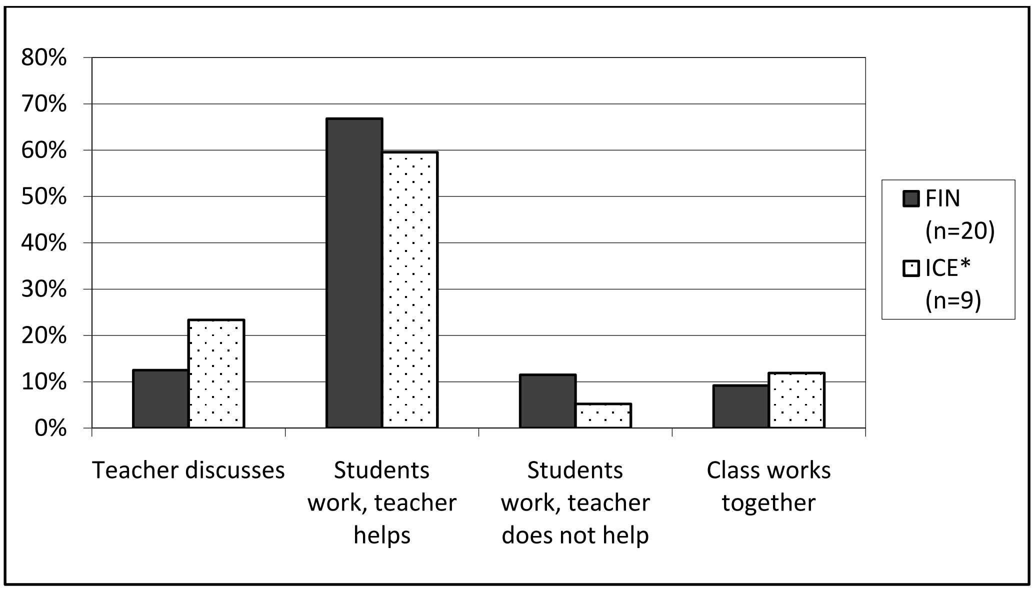

Figure 8: Forms of *Practicing/applying*: Finland and Iceland*

Figure 8 shows the relative frequencies of the various forms of *Practicing/applying*. The most common form is Kikan-shido, or between-desks instruction. The differences in the proportions are not statistically significant, although Finnish teachers seem to, again, spend less time presenting on the board than the Iceland*-teachers.

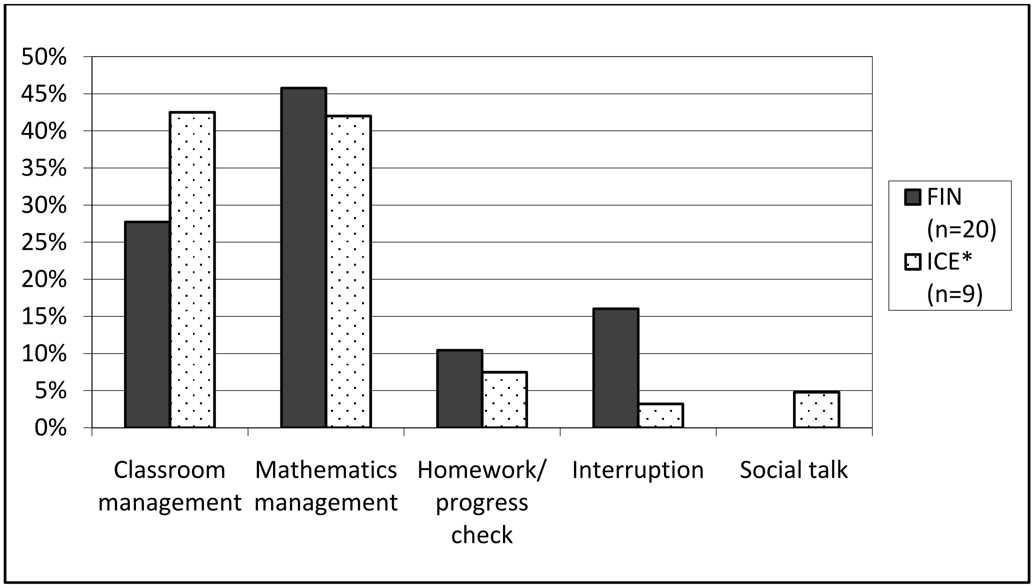

Figure 9: Forms of *Other*: Finland and Iceland*

Though not statistically significant at the lesson-level, there may also be differences in the relative frequencies of the teachers' administrative actions. Some of the differences can perhaps be explained by cultural factors. For example, there were less discipline problems in the Finnish classrooms, and the classes settled down faster there. This may be one reason why the time spent on managing the classroom is lower in Finland than in Iceland. The two "morning services" that were coded as "Interruption" explain much of the difference for that code. There were no episodes of social talk during the recorded Finnish mathematics lessons.

Eleven of the twenty Icelandic lessons were conducted using the IL-pedagogical strategy. Figure 10 shows the relative frequencies of the forms of classroom interaction the teachers of these lessons chose to employ.

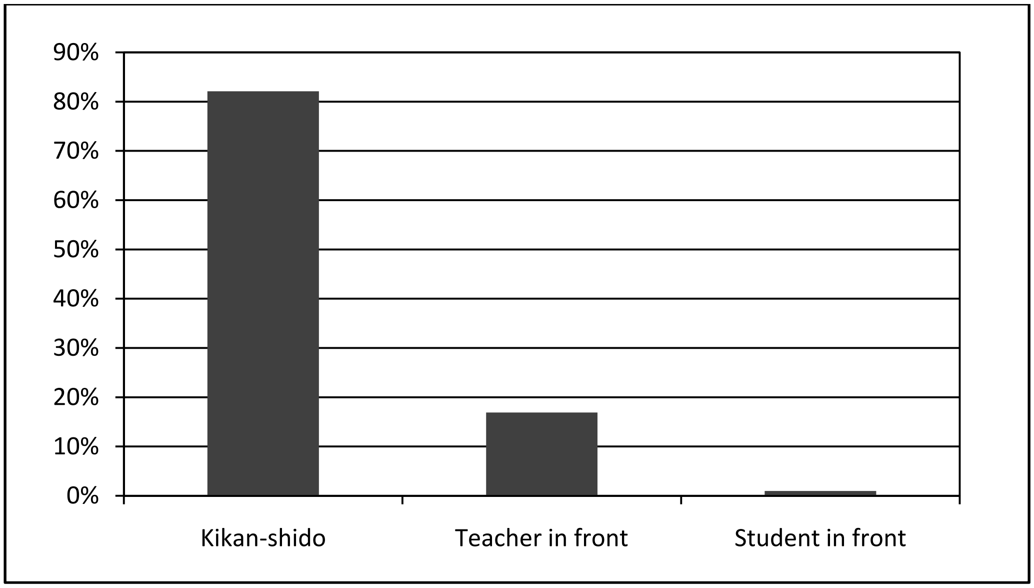

Figure 10: Prevalence of the interaction forms during *Individualized learning*

Kikan-shido is clearly the most common form of interaction during IL as 82.1% of the time the IL-teachers essentially tutored the students one-on-one. Seven of the eleven IL-lessons contained no public content-related discourse. The lessons from two IL-teachers, ICE-8 and ICE-9, stand out. During the IL-segments of these lessons either the teacher or one of the students presented examples 45.2% of the time. Both teachers directed their public instruction to the below-average students. These teachers' methods will be discussed in more detail in Section 5.

Figure 11 displays the proportions of class time in the Finnish and Icelandic lessons during which a student was presenting in the front. This seems to be a much more common activity in the Finnish classrooms. In fact, only one Icelandic lesson, ICE-9B, featured student presentations. On the other hand, students presented solutions on the board in six of the Finnish lessons. In two others the teacher received no volunteers for a call to the board as some of the Finnish students may have felt shy being videotaped. The overall percentage of time devoted to student presentations for the lessons in the sample is 2.24 for Finland and 0.48 for Iceland.

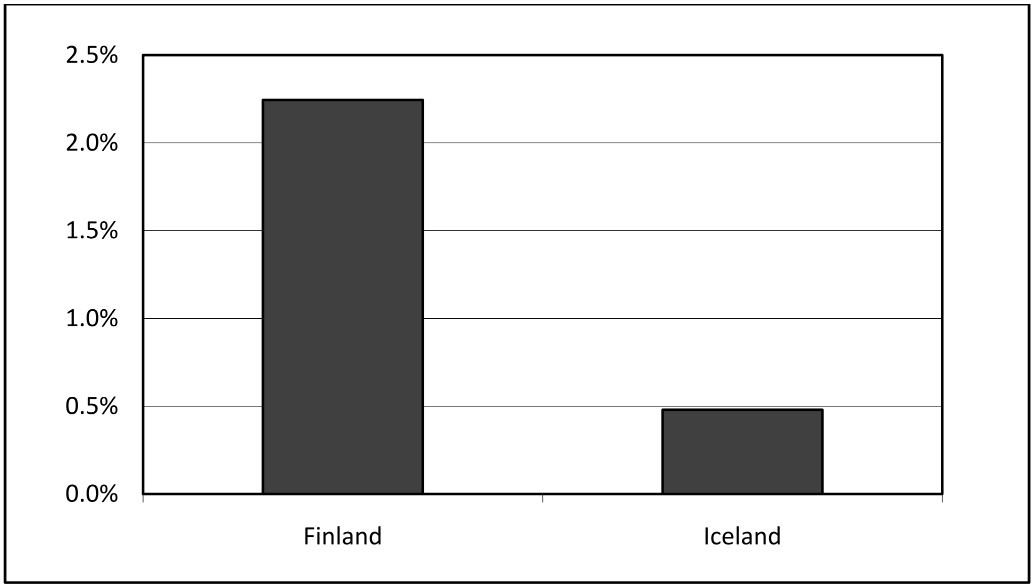

Figure 11: Prevalence of student presentations

4.5. Inter-Coder Reliability

As for any coding system, inter-coder reliability needs to be established for this method of lesson structure analysis. It can be done by having a second person code a portion of the lessons and comparing the results. A mathematics educator studied the coding guidelines created by the author and independently coded two Finnish and two Icelandic lessons in the sample. A total of 9036 seconds, or just over 2.5 hours, of classroom footage was coded by the second coder.

The two coders agreed on both coding passes at above satisfactory levels. As expected, there were more disagreements in the second coding pass. Table 7 displays the Cohen's Kappa as well as the percentage agreement between the coders for each pass.

	Cohen's Kappa	Percentage Agreement
First Pass	0.968	97.6
Second Pass	0.881	88.7

Table 7: Cohen's Kappa and inter-coder percentage agreement

Cohen's Kappa is regarded as a more accurate measure of inter-coder reliability than percentage agreement as it takes into account the possibility that the coders agreed by chance. According to criteria of the TIMSS 1999 Video Study, a Cohen's Kappa of 0.7 or higher indicates an acceptable level of agreement (Jacobs et al., 2003).

Though careful translations of the lesson transcripts were made, some of the disagreements may have been due to the fact that the second coder understands neither Finnish nor Icelandic, while the first coder is a native Finnish speaker and also has some understanding of spoken Icelandic. However, most of the disagreements probably stem from different interpretations of lesson activities.

5. Discussion

This section offers some interpretations and implications of the data. Due to its limited scope and methodology, any findings from this study should above all be considered grounds for more comprehensive research endeavors to increase our understanding of the Finnish and Icelandic educational systems and cultures.

Finnish and Icelandic mathematics teachers seem to be on separate tracks. Based on the video evidence, Finnish teachers are rather traditional and pedagogically conservative in the classroom. This is in contrast to the Icelandic teachers many of whom use progressive-minded, learner-based instructional strategies. The classroom practices in Finland include a substantial social component, while many students in Iceland are getting used to learning independently, without significant collaboration with others.

Despite being given ample freedom within the national curricular guidelines (Björkqvist, 2006), Finnish mathematics teachers appear to have found a common tune in their classrooms. By and large the Finnish lessons in the sample follow the *Review-Lesson-Practice* [RLP]-script. Activities during *Review* and *Introducing new content*-segments are lead by the teacher, who regularly engages the class by asking questions, provoking discussions, or by having the students present solutions on the board. The most common form of interaction during the *Practicing/applying*-segments is Kikan-shido, or between-desks instruction, during which the teacher gauges the students' learning progress and those in need can ask for a hint or additional instruction.

A British educational research team visited fifty Finnish primary schools in the mid-1990s. They reported of highly disciplined and ordered lessons, where catering to the students' individual differences was not a priority:

> whole classes following line by line what is written in the textbook, at a pace determined by the teacher. Rows and rows of children all doing the same thing in the same way whether it be art, mathematics or geography. We have moved from school to school and seen almost identical lessons, you could have swapped the teachers over and the children would never have noticed the difference.
>
> in both the lower and upper comprehensive school, we did not see much evidence of, for example, student-centered learning or independent learning (Norris et al., 1996, as quoted in Simola, 2005, p. 462).

To some extent, data from the current study supports these aspects of the British report. Naturally there are differences between teachers and their methods, but it does seem that the Finnish teachers conduct their classes in fairly uniform ways. They are comfortable with their teaching methods, which evidently are effective for the students in Finland under the unique conditions that exist in that country.

The Icelandic educational system is in transition. In recent years the more traditional methods of teaching have begun to give way to versions of “*einstaklingsmiðað nám,”* or *Individualized learning* [IL]. IL has become—from the top down—the nationally endorsed pedagogical philosophy (Sigurgeirsson, 2003). While there are many facets to IL, probably the most important is the increased responsibility on the part of the learner; students are expected to assume control of their own learning process. Based on the recorded lessons, Icelandic mathematics teachers are having varying success in implementing IL in their classrooms. Furthermore, there appears to be some confusion as to what IL-teaching should entail.

The Icelandic educational authorities have promoted Tomlinson’s ideas about *differentiated instruction* (Sigurgeirsson, 2003). Tomlinson (e.g., 1999) calls attention to the students’ dissimilar learning needs and suggests that teachers use, for instance, differentiated curricular materials and tiered activities to accommodate for them. In a *differentiated classroom*, the content, the learning process, as well as the product—what the students know and can do at the end of the learning process—vary for each student. In such a classroom, the teacher responds to the learning style, instructional needs, interests, and readiness of each unique learner (Tomlinson, 1999). Based on the evidence from the video study, Tomlinson’s ideas have been only partially implemented in the Icelandic mathematics classrooms. The reality is that the students are usually taught using the same instructional methods and learning materials; they are only moving ahead in the book at somewhat different speeds[6].

Teachers and administrators should keep in mind that IL-teaching is challenging. It is not simply omitting the public lesson and tutoring the students instead. In fact, using IL in the classroom probably requires more planning and effort from the teacher than does teaching using more conventional methods. The IL-teacher should find ways to vary the curriculum, curricular materials, motivators, scaffolding, expectations, and ways of assessment to suit each student’s needs. The teacher has to actively operate within the *zone of proximal development* (Vygotsky, 1978) of each student. Furthermore, the shift in the responsibility for learning—from the teacher to the student—must be structured and monitored by the teacher. If there are fifteen or more students in a class[7], the total amount of individual guidance needed can become overwhelming for a teacher, unless his or her lessons are well-planned. As a result, in some classes many or all students can be left without enough guidance.

Minimally-guided instruction has not been shown to be effective (Kirschner, Sweller, & Clark, 2006; Mayer, 2004). The *cognitive load*-based argument against minimally-guided

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[6] Based on teacher interviews, the individual differences in progress usually are not significant.
[7] The mean class size for the Icelandic mathematics classrooms in this sample is 16.6. However, this figure does not include the students who were absent the day of the recording. Probably closer to the truth is 19.7, the OECD’s estimate for the mean class size in the Icelandic lower secondary schools (OECD, 2007a, Table D2.1).

instructional strategies, such as *pure discovery,* essentially states that if novice learners are left to learn how to work problems by themselves from start to finish, much of their cognitive capacity and working memory is spent grasping trivialities before more meaningful learning can begin (see, e.g., the special cognitive load theory-issue of Instructional Science, 2004, 32(1-2)). It is thus more effective to guide the learning process by, for instance, scaffolding, or by letting students study worked-out examples before tackling more complex tasks by themselves.

Based on the recorded lessons, the learner-based teaching strategy so prevalent in Iceland may be more aptly termed *Independent learning* rather than *Individualized learning*. This is because in the IL-lessons many students received only minimal attention from their teacher; thus they essentially studied mathematics on their own. Because teaching people to be autonomous students of mathematics is particularly challenging, some experts recommend that classroom instruction of this subject be more thoroughly guided by the teacher than other subjects (Hmelo-Silver, Duncan, & Chinn, 2007; Harvey & Chickie-Wolfe, 2007). Harvey and Chickie-Wolfe (2007) suggest the following steps for students learning mathematics in an IL-classroom: 1) observe and recognize success in another person's performance, 2) emulate and adopt patterns and processes, 3) self-monitor while practicing the strategies, and 4) *self-regulate*—a cyclical problem-solving process including *preparation*, *performance*, and *appraisal* (Pintrich, Boekaerts, & Zeidner, 2000)—when adapting to various applications. Direct instruction on a just-in-time basis can also be used as a pedagogical tool in learner-based learning environments (Edelson, 2001).

Social interaction and the use of language in the classroom facilitate the students' constitution of mathematical meanings (e.g., Cobb & Bauersfeld, 1995; Steffe & Gale, 1995). The Finnish lessons in the sample include many segments during which the teacher stimulates whole-class discussions about the topic at hand. Also, Finnish students regularly are asked to present their solutions in front of the class. These lesson elements are not as common in the Icelandic RLP-lessons, and they are almost entirely missing from the IL-lessons. Overall, Finnish mathematics teachers in the sample provided more opportunities for learning through classroom interaction and the use of language than their Icelandic counterparts.

Some learner-based instructional methods, such as *problem-based learning* and *inquiry learning*, promote social interaction and the use of language through collaborations (e.g., Hmelo-Silver et al., 2007). In the Icelandic mathematics classrooms it is common for the students to sit in clusters. This, however, does not ensure any of the benefits that collaboration can yield. As Slavin (1983) points out in his meta-study, all forms of collaborative learning are not equally effective; group study without group rewards and a strong sense of individual accountability is not linked with increased student achievement. Additionally, students should be guided through the collaborative process to keep the discussion focused on the targeted skills (Palinscar & Brown, 1984).

There needs to be a discussion within the Icelandic education community about the pros and cons of IL, and about how it can be effectively executed. The Icelandic mathematics teachers need a better support system—with clear recommendations for instructional design—to help them attain their pedagogical goals. Alternatives to 100% Kikan-shido-style instruction, such as a mix of direct instruction and learner-based methods (e.g., Rainforth & Kugelmass, 2003), need to be spelled out.

So should Iceland and other countries aspiring to do better in international assessments[8] start, or return to, teaching like the Finnish mathematics teachers? While some of the classroom practices from the Finnish schools may prove effective elsewhere, we must keep in mind that there is no "one-size-fits-all" educational system; what works in Finland will not necessarily work anywhere else. Cultures—educational and other—are "situated contextual organisms" (Goldman, 2007, p. 33) that have the ability to adapt and morph only within certain limits. Finland is, after all, a bit different from its Nordic neighbors and other nations. It is a border country that has gone through three bloody wars in the last one hundred years. It fought against Russia, whose influences still permeate the Finnish culture at all levels. Perhaps it is because of this unique socio-historical background that the Finns are rather obedient and allow a sense of authoritarianism, all the while maintaining a democratic, Western society (Simola, 2005). This bodes well for the Finnish schools where traditional instructional methods are still prevalent.

6. Suggestions for Further Research

This study has raised more questions than it has answered. For instance, the Icelandic gender issue, the role of homework in the Icelandic IL-classrooms, and various extensions of the lesson structure analysis can yield many ideas for future studies. This final section puts forth some ideas for further research.

The Icelandic gender enigma keeps puzzling researchers (Steinthorsdottir & Sriraman, 2007; Ólafsson et al., 2006). An interesting phenomenon surfaces when the boys' and girls' PISA scores from the three main areas are summed into a *total score*, and the differences between assessments are determined[9]. Table 8 shows the differences in total scores for Iceland between assessments.

	PISA 2000 – PISA 2003	PISA 2003 – PISA 2006
Girls	0	-34
Boys	-34	-11

Table 8: Differences in the Icelandic total scores between assessments

[8] No single assessment can fully measure the effectiveness of teaching. For example, there are skills, such as the ability to work in groups, which are not measured by the major assessments. However, due to space concerns, this chapter does not focus on the pros and cons of PISA or any other assessment.
[9] See Footnote 1 for an issue regarding between-assessment comparisons.

While the boys lost ground between each pair of assessments, the girls did so only between 2003 and 2006. Why did these major declines happen first for the boys and only then for the girls? The Icelandic students' homework habits may be a factor.

PISA data obtained from Námsmatsstofnun, or the Icelandic Educational Testing Institute, suggest that Icelandic students are now spending less time doing mathematics homework than before. The changes between the 2003 levels and the 2006 levels are considerable and more pronounced for the girls. Figure 12 shows the changes in the mathematics homework levels from 2003 to 2006. In 2003, 40% of the girls and 50% of the boys did less than two hours of homework each week; in 2006, 64% of girls and 70% of boys reported doing so. In 2003, 34% more boys than girls reported to doing no mathematics homework at all; the difference had decreased to 24% by 2006. The percentage of students who spend six or more hours doing mathematics homework dropped from 16.2% in 2003 to a mere 1.6% in 2006. What has prompted the Icelandic students, and especially the girls, to spend so much less time than before doing homework? What is the role of homework in the Icelandic curriculum, especially for the IL-teachers? How do the teachers monitor their students' homework completion?

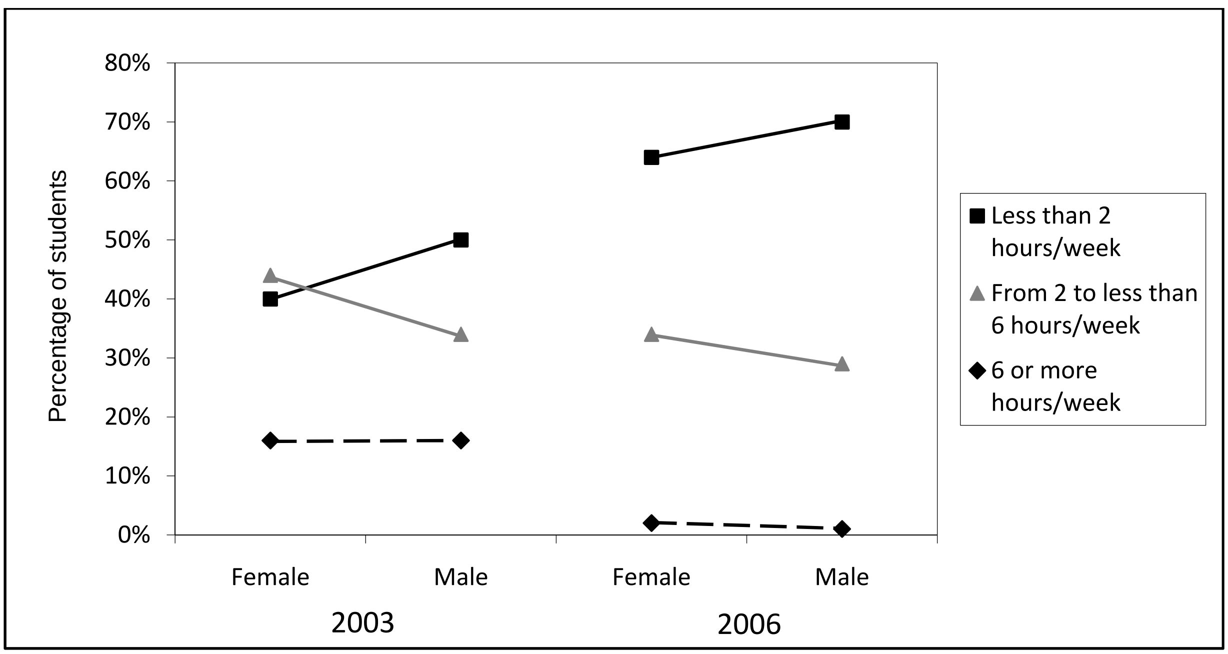

Figure 12: Time spent on mathematics homework each week

The video study offers some empirical evidence. In only two of the Icelandic lessons in the sample is homework mentioned at the beginning of the lesson, and in only one of them, an RLP-lesson, are homework problems discussed publicly; in the other lesson, the teacher collected a written assignment that was due that day. In comparison, homework was mentioned in fifteen of the twenty Finnish lessons, and problems were discussed in twelve of them. In addition, it is common for the Finnish teacher to verify the level of homework completion directly from the students' notebooks. It seems that the Finnish students are asked to do short, yet frequent homework assignments. They also are directly held accountable for their homework responsibilities. Perhaps the Icelandic students are also held accountable, but this is not apparent from the recorded lessons. If the students were held more directly accountable for completing their homework assignments, would the out-of-school effort levels increase?[10]

Since the Icelandic mathematics teachers set aside so much class time for individual seatwork, a look at the teacher-student interactions that take place during these sessions may be in order. The teacher-student interactions can be analyzed using various quantitative and qualitative approaches. A preliminary analysis of fourteen[11] Icelandic mathematics lessons with 622 teacher-student interactions shows that teachers do not treat girls and boys equally during problem-solving sessions. In these lessons almost all teachers, especially the males, paid more individual attention to the girls. On average, these Icelandic teachers assisted each girl for 88 seconds and each boy for 64 seconds per class. These means differ significantly with $t = 3.78$ and $p = 0.002$. Possible explanations for this phenomenon include: 1) By now some Icelandic teachers have higher learning expectations of girls which been shown to increase attention from teachers (Meece, Glienke, & Burg, 2006), and 2) teachers help those who ask for help, not necessarily those who need it the most. Girls tend to ask for help more and they also seem to be more appreciative of it. A qualitative discourse analysis of these interactions could help answer questions such as: Do the teachers pay the same kind of attention to male and female students? Is the individual assistance perhaps more procedure-related to one gender and more conceptual for the other? What kind of scaffolding is evident in the teacher-student interactions? Do these interactions veer off-topic more frequently for one gender? What proportion of students receives no individual attention at all during seatwork, and why? Some Finnish teachers help their students more systematically by interacting with each student during seatwork, and not just those who asked for help. But are the teacher-student interactions similar in Finland as in Iceland? It would also be helpful to know what some of the Icelandic teachers' and students' attitudes and beliefs about gender roles in the mathematics classroom are.

The instructional methods used by the teacher in ICE-9A and ICE-9B are effective. This IL-teacher, ICE-9, can be associated with outstanding PISA 2003 mathematics scores[12]. What makes this teacher's scores even more noteworthy is that the school is located in an isolated fishing village, and rural schools generally fare worse in achievement tests than the urban schools (Ólafsson et al., 2006). In addition, the standard deviation of the PISA scores is by far the smallest within all Icelandic schools. These were true "No child left behind"-lessons.

[10] Time spent on homework may not be a good predictor of academic success. This is true at the level of the individual—high-achieving students may feel like they don't have to do homework while weaker students do a lot of work at home to keep up with the class—as well as cross-nationally. For example, students in Finland did the least amount of homework according to PISA 2003 data, yet they scored very high in all areas of the test (OECD, 2005, Table D1.3).

[11] From the twenty recorded Icelandic lessons, only those that were attended by 10 or more students and that included at least 10 minutes of seatwork were included.

[12] PISA 2006 scores are not available for this school.

Although they were IL-lessons, ICE-9A and ICE-9B included public content-related discourse in the form of teacher and student presentations. While letting the faster students work independently, the teacher controlled and scaffolded the learning process for the slower students. Worked-out examples were presented on the board by the teacher as well as the students. All students were able to study the examples; in fact, it was required of the slower students. Others could use them as a "safety net." There were tiered activities (Tomlinson, 1999). Students sat by themselves, but tutoring relationships or "study buddies," a pedagogical device recommended by IL-research (Harvey & Chickie-Wolfe, 2007; Rafoth, 1999), were encouraged. ICE-9 was successful in creating "a community of learning." Further research is necessary to identify factors that contribute to this teacher's apparent success. Are the instructional methods used by this teacher transferable to other classrooms in Iceland and elsewhere?

Based on this study, two main instructional philosophies prevail in Iceland: *Individualized learning* [IL] and *direct instruction* based on Herbart's formal stages of learning. It is natural to ask what effects the choice of instructional method has on the quality and quantity of learning. Do students who have learned to study independently have different study habits? A longitudinal study can be used to determine whether the IL-learners preserve and benefit from their study habits later in life. Also, do the IL-learners retain information differently than those who have been taught by direct instruction?

Data from lesson structure analysis can be linked with factors such as curricular materials, content, the level of the teachers' pedagogical and content knowledge, the physical set-up of the classroom, technology, the teachers' intentions about planning and structuring lessons, and student feedback. Combining variables such as the above with lesson structures can yield interesting information about classroom practices.

This study focused on the relative frequencies of lesson segments. An additional approach to analyzing lessons would be to consider the sequencing of lesson segments. The learning experiences supported by lessons with similar relative frequencies for lesson segments can be quite different depending on how those segments are sequenced.

Countries, states, linguistic regions, etc. can be compared to one another using the method of lesson structure analysis described in this chapter. In addition, this method can be used by institutions of teacher education to monitor the effectiveness of their training programs. For example, it may be instructive to compare the IL-methods taught at the Icelandic institutions of teacher education with the ones observable in the field.

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