VIDEO-BASED ANALYSIS OF MATHEMATICS CLASSROOM PRACTICE:
EXAMPLES FROM FINLAND AND ICELAND

by

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ABSTRACT

VIDEO-BASED ANALYSIS OF MATHEMATICS CLASSROOM PRACTICE:
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The method of video analysis can be effective in pedagogical research. With insightful coding schemes, video analysis can generate valuable evidence in the study of the implemented curriculum. The purpose of this study is to explore the power and flexibility of video analysis as an observational tool in classroom research. Furthermore, this dissertation suggests ways in which an individual with limited resources can conduct meaningful video-based classroom research.

Through a review of literature spanning over a century, a historical perspective of video analysis in pedagogical research is outlined. Special attention is paid to video-based studies within the sociocultural, cognitive, and constructivist frameworks.

With recent international studies providing much of the orientation, a method of lesson structure analysis is introduced. The method offers a means of investigating the different forms of classroom interaction teachers use to
achieve their pedagogical goals. The method involves two coding passes. The first pass is inspired by the TIMSS 1999 Video Study and is used to distinguish the main pedagogical functions of lesson segments. The second coding pass, which uses ideas from the Learner’s Perspective Study in addition to TIMSS, focuses on the forms of classroom participation. The coding categories are sample-sensitive.

Videos from Finnish and Icelandic mathematics classrooms are analyzed to demonstrate the coding method for lesson structure. These countries were chosen in part because of their performance in the PISA studies. Finnish students have excelled in all three PISA studies, while Iceland is the only country where girls have significantly outperformed boys in mathematics. The recordings—two lessons from ten randomly chosen mathematics teachers of 14 and 15-year-olds in each country—were collected in the spring of 2007.

Based on this sample, there are differences in how Finnish and Icelandic mathematics lessons are structured. The Finnish lessons in the sample follow the popular Review-Lesson-Practice-script. Approximately half of the recorded Icelandic lessons exhibit versions of the Independent learning-pedagogical strategy. Public instructional discourse can be missing entirely from these lessons, and, 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.
TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>List of tables</td>
<td>v</td>
</tr>
<tr>
<td>List of figures</td>
<td>vi</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>viii</td>
</tr>
<tr>
<td>Chapter 1: Introduction</td>
<td>1</td>
</tr>
<tr>
<td>1.1. Introduction</td>
<td>1</td>
</tr>
<tr>
<td>1.2. Purpose of the study</td>
<td>6</td>
</tr>
<tr>
<td>1.3. Research questions</td>
<td>9</td>
</tr>
<tr>
<td>1.4. Why use video in classroom research?</td>
<td>10</td>
</tr>
<tr>
<td>1.4.1. Affordances of video as an observational tool</td>
<td>10</td>
</tr>
<tr>
<td>1.4.2. Professional development</td>
<td>15</td>
</tr>
<tr>
<td>1.5. Problems and shortcomings of video analysis</td>
<td>17</td>
</tr>
<tr>
<td>1.6. Video and comparative education</td>
<td>26</td>
</tr>
<tr>
<td>1.6.1. Why study teaching in different countries?</td>
<td>26</td>
</tr>
<tr>
<td>1.6.2. How video has benefited comparative education</td>
<td>28</td>
</tr>
<tr>
<td>1.7. On technology and filming techniques</td>
<td>29</td>
</tr>
<tr>
<td>1.7.1. Video analysis technology</td>
<td>29</td>
</tr>
<tr>
<td>1.7.2. Filming techniques in classroom research</td>
<td>34</td>
</tr>
<tr>
<td>1.8. Overview of the chapters</td>
<td>42</td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Chapter 2: Literature review</td>
<td>44</td>
</tr>
<tr>
<td>2.1. Overview</td>
<td>44</td>
</tr>
<tr>
<td>2.2. History of video analysis as a method in pedagogical research</td>
<td>46</td>
</tr>
<tr>
<td>2.2.1. Overview</td>
<td>46</td>
</tr>
<tr>
<td>2.2.2. The early years of video-based research</td>
<td>48</td>
</tr>
<tr>
<td>2.2.3. 1960s: School documentaries</td>
<td>52</td>
</tr>
<tr>
<td>2.2.4. 1970s: Learning from the anthropologists</td>
<td>53</td>
</tr>
<tr>
<td>2.2.5. 1980s: Coming of age</td>
<td>56</td>
</tr>
<tr>
<td>2.2.6. 1990s: The digital decade</td>
<td>63</td>
</tr>
<tr>
<td>2.2.7. 2000s: Coming together in collaboratories</td>
<td>67</td>
</tr>
<tr>
<td>2.2.8. Summary</td>
<td>75</td>
</tr>
<tr>
<td>2.3. Classroom video analysis in the spheres of different</td>
<td>76</td>
</tr>
<tr>
<td>theoretical frameworks</td>
<td></td>
</tr>
<tr>
<td>2.3.1. Overview</td>
<td>76</td>
</tr>
<tr>
<td>2.3.2. Sociocultural theory</td>
<td>77</td>
</tr>
<tr>
<td>2.3.3. Cognitive theory</td>
<td>80</td>
</tr>
<tr>
<td>2.3.4. Constructivist theory</td>
<td>83</td>
</tr>
<tr>
<td>2.4. Major video-based classroom studies in mathematics education</td>
<td>87</td>
</tr>
<tr>
<td>2.4.1. Overview</td>
<td>87</td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>4.2.5. Typicality of lessons</td>
<td>146</td>
</tr>
<tr>
<td>4.3. Results</td>
<td>149</td>
</tr>
<tr>
<td>4.3.1. Overview</td>
<td>149</td>
</tr>
<tr>
<td>4.3.2. Coding categories</td>
<td>150</td>
</tr>
<tr>
<td>4.3.3. Lesson diagrams</td>
<td>157</td>
</tr>
<tr>
<td>4.3.4. First results</td>
<td>166</td>
</tr>
<tr>
<td>4.3.5. Inter-coder reliability</td>
<td>174</td>
</tr>
<tr>
<td>4.3.6. Content</td>
<td>175</td>
</tr>
<tr>
<td>4.4. Discussion</td>
<td>176</td>
</tr>
<tr>
<td>Chapter 5: Summary, conclusions, and recommendations</td>
<td>180</td>
</tr>
<tr>
<td>5.1. Summary</td>
<td>180</td>
</tr>
<tr>
<td>5.2. Conclusions</td>
<td>183</td>
</tr>
<tr>
<td>5.3. Recommendations for future studies</td>
<td>191</td>
</tr>
<tr>
<td>References</td>
<td>197</td>
</tr>
<tr>
<td>Appendix A: Letters</td>
<td>216</td>
</tr>
<tr>
<td>Appendix B: Forms</td>
<td>224</td>
</tr>
</tbody>
</table>
LIST OF TABLES

Table 2.1: Icelandic PISA scores by subject and gender 105
Table 3.1: First pass categories 124
Table 3.2: Forms of classroom participation by teacher and students 131
Table 3.3: Second pass categories 132
Table 4.1: Populations of Finnish municipalities of various sizes 141
Table 4.2: Populations of Finnish regions 141
Table 4.3: Populations of Icelandic regions 144
Table 4.4: Teacher perceptions of student behavior 148
Table 4.5: Review categories 151
Table 4.6: Introducing New Material categories 153
Table 4.7: Practicing/Applying categories 154
Table 4.8: Other categories 156
Table 4.9: Summary of codes 159
Table 4.10: Cohen’s Kappa and inter-coder percentage agreement 174
Table 5.1: Differences in total scores between assessments 191
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Canon ZR500 and Sony DSR-PD150</td>
<td>31</td>
</tr>
<tr>
<td>1.2</td>
<td>Videograph, a software for video analysis</td>
<td>33</td>
</tr>
<tr>
<td>1.3</td>
<td>The recording set-up of the TIMSS 1995 Video Study</td>
<td>39</td>
</tr>
<tr>
<td>1.4</td>
<td>The recording set-up of the IPN study</td>
<td>40</td>
</tr>
<tr>
<td>1.5</td>
<td>The recording set-up of the LPS study</td>
<td>41</td>
</tr>
<tr>
<td>1.6</td>
<td>The recording set-up of the nwu-Essen classroom study</td>
<td>42</td>
</tr>
<tr>
<td>2.1</td>
<td>A typical VideoNoter worksheet</td>
<td>61</td>
</tr>
<tr>
<td>2.2</td>
<td>Progressive refinement with VideoNoter</td>
<td>62</td>
</tr>
<tr>
<td>2.3</td>
<td>A screenshot from vPrism</td>
<td>66</td>
</tr>
<tr>
<td>2.4</td>
<td>A screenshot from Videograph</td>
<td>75</td>
</tr>
<tr>
<td>2.5</td>
<td>Between-school variances on the PISA 2003 mathematics test</td>
<td>95</td>
</tr>
<tr>
<td>2.6</td>
<td>PISA 2000, 2003, and 2006 scores for Finland and Iceland</td>
<td>98</td>
</tr>
<tr>
<td>2.7</td>
<td>Primary school teachers’ salaries</td>
<td>99</td>
</tr>
<tr>
<td>2.8</td>
<td>Upper secondary school teachers’ salaries</td>
<td>100</td>
</tr>
<tr>
<td>2.9</td>
<td>Ratios of teachers’ salaries to GDP per capita</td>
<td>101</td>
</tr>
<tr>
<td>2.10</td>
<td>Mathematics achievement by level</td>
<td>102</td>
</tr>
<tr>
<td>Figure</td>
<td>Description</td>
<td>Page</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Figure 2.11</td>
<td>Mathematics scores by country and gender</td>
<td>106</td>
</tr>
<tr>
<td>Figure 2.12</td>
<td>Gender differences in mathematics and reading</td>
<td>110</td>
</tr>
<tr>
<td>Figure 3.1</td>
<td>A first pass coding of a mathematics lesson</td>
<td>120</td>
</tr>
<tr>
<td>Figure 3.2</td>
<td>First coding pass of Lesson A</td>
<td>129</td>
</tr>
<tr>
<td>Figure 3.3</td>
<td>First coding pass of Lesson B</td>
<td>130</td>
</tr>
<tr>
<td>Figure 3.4</td>
<td>Second coding pass of Lesson A</td>
<td>133</td>
</tr>
<tr>
<td>Figure 3.5</td>
<td>Second coding pass of Lesson B</td>
<td>133</td>
</tr>
<tr>
<td>Figure 4.1</td>
<td>The regions of Finland</td>
<td>142</td>
</tr>
<tr>
<td>Figure 4.2</td>
<td>The regions of Iceland</td>
<td>144</td>
</tr>
<tr>
<td>Figure 4.3</td>
<td>The recording set-up</td>
<td>145</td>
</tr>
<tr>
<td>Figure 4.4</td>
<td>First-pass categories: Finland and Iceland</td>
<td>166</td>
</tr>
<tr>
<td>Figure 4.5</td>
<td>First-pass categories: Finland and Iceland*</td>
<td>167</td>
</tr>
<tr>
<td>Figure 4.6</td>
<td>Forms of <strong>Review</strong>: Finland and Iceland*</td>
<td>168</td>
</tr>
<tr>
<td>Figure 4.7</td>
<td>Forms of <strong>Introducing New Content</strong>: Finland and Iceland*</td>
<td>169</td>
</tr>
<tr>
<td>Figure 4.8</td>
<td>Forms of <strong>Practicing/Applying</strong>: Finland and Iceland*</td>
<td>170</td>
</tr>
<tr>
<td>Figure 4.9</td>
<td>Forms of <strong>Other</strong>: Finland and Iceland*</td>
<td>171</td>
</tr>
<tr>
<td>Figure 4.10</td>
<td>Prevalence of the interaction forms during <strong>Independent learning</strong></td>
<td>172</td>
</tr>
<tr>
<td>Figure 4.11</td>
<td>Prevalence of student presentations</td>
<td>173</td>
</tr>
</tbody>
</table>
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CHAPTER 1
INTRODUCTION

“You can observe a lot by just watching” – Yogi Berra

1.1. Introduction

Video analysis is a powerful observational tool that can help deepen our understanding of classroom practices. As the technology needed to conduct video-based pedagogical research has become increasingly available, video analysis has secured a prominent place in the “toolboxes” of educational researchers studying the complex phenomena that take place in classrooms. While video analysis is not suitable for every pedagogical study, it can be effective in a wide variety of research settings. This dissertation project explores some of the ways in which video can be used to make sense of classroom practices as well as the kinds of challenges the modern videographer\(^1\) faces throughout the research process. With recent major international studies providing much of the orientation, an adaptive method of lesson structure analysis is introduced. Videos from Finnish and Icelandic mathematics

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\(^1\) The term “videographer” is used throughout the report to refer not only to the person collecting the video footage, but also to the researcher making use of the video-based data. This may differ from some of the other literature where the word is used only in the former sense.
Classrooms are analyzed using this method. Although this project focuses on research in mathematics education, much of what is discussed in this report can be applied to video-based classroom studies in general.

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 addition to the variables of interest, the dimensions of variation within those variables can be freely defined. There are thus virtually limitless ways to make meaning from video recordings. There are no predetermined boundaries for the use of video in pedagogical research. There are no standards either, although some have called for them (Derry, 2007).

The use of video in classroom research is not limited to certain types of studies or theoretical frameworks. Video recordings can effectively be used in quantitative, qualitative, or mixed-method studies; comparative or non-comparative studies; bottom-up (from observations) or top-down (from theory) studies; and experimental or non-experimental studies. Less than 40 years in, the mutual history of video technology and pedagogical research is impregnated with ingenious exemplars that apply various types of methodologies and theoretical perspectives. This manuscript provides examples on how data drawn from classroom videos can provide evidence in studies that are grounded in, for instance, sociocultural, cognitive, and constructivist frameworks.
The use of video in classroom research is not without its problems and limitations. Beyond the typical financial and logistical issues, using video analysis in a pedagogical research project presents some unique challenges. These challenges can be classified under two categories: data collection issues and those concerning the analysis of the data (Barron, 2007). Overall, however, the benefits of video analysis seem to outweigh the associated problems.

Video analysis technology—cameras, microphones, computer hardware, and software—has become increasingly affordable and user-friendly in recent years. The technological developments have been welcomed by pedagogical researchers wanting to incorporate video-based data collection methods into their projects. Information about these developments as well as commentary on modern video equipment and classroom filming techniques are included in this report. The concept of a neutral recording of a lesson is introduced.

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 large-scale classroom studies such as the International Association for the Evaluation of Educational Achievement [IEA]-sponsored 1995 Trends in International Mathematics and Science Study [TIMSS] (Stigler, Gonzales, Kawanaka, Knoll, & Serrano, 1999), the TIMSS 1999 Video Study (Hiebert et al., 2003), as well as the Learner’s Perspective Study [LPS] (Clarke, Emanuelsson, Jablonka, & Mok, 2006).
One of the contributions of this project is an adaptive method of lesson structure analysis. The two-pass coding scheme, which combines a predetermined set of categories with an adaptive one, is derived from the TIMSS and LPS studies. With this method, the structures of any set of videoed mathematics lessons can be investigated. The method yields quantitative data that can prove valuable especially when combined with other research methods.

The first coding pass concerns the pedagogical functions of lesson elements. It uses a set of predetermined categories similar to those of the Purpose-variable from the TIMSS 1999 Video Study. In contrast, the second pass-variable is based on the forms of social participation in the classroom. Its coding categories stem from asking “Who is doing what?” and “How are the participants interacting?” These categories vary from sample to sample according to the actions of the teachers and the students. The interaction of the two dimensions—function (first pass) and form (second pass)—is of particular interest as the main idea behind the method is to investigate the different forms of classroom interaction teachers employ in attaining their pedagogical goals.

Videos from Finnish and Icelandic mathematics classrooms are used to demonstrate the coding method for lesson structure. These countries were chosen for the study in part because of their performance in the Program for International Student Assessment [PISA] studies. Finland has come out on top in overall results in all three PISA studies, conducted in 2000, 2003, and 2006, while Iceland is the only country where the girls have significantly outperformed the
boys in mathematics (OECD, 2004, 2007b). The recordings—two lessons from ten randomly chosen mathematics teachers of 14 and 15-year-olds in each country—were collected during the spring of 2007.

Although the terms “a typical teacher” and “a typical lesson” are difficult, if not impossible, to define for any educational community, comparisons of teaching patterns can still be made between Finnish and Icelandic mathematics teachers. Based on the sample, there are differences in the ways in which mathematics teachers in these countries conduct their classes. The Finnish mathematics lessons in the sample exemplify the Review-Lesson-Practice [RLP]-lesson script and are fairly uniform in their functional structure. In contrast, Icelandic mathematics teachers seem to have adopted two distinct pedagogical philosophies: approximately half of the recorded lessons follow the RLP-pattern, while the others are conducted according to versions of Independent learning, a constructivist pedagogical strategy that promotes learner autonomy (see, e.g., Harvey & Chickie-Wolfe, 2007).

Many Finnish teachers promote whole-class learning activities. Those teachers favor class discussions and student presentations over delivering monologues by the blackboard. This is especially apparent during lesson segments dedicated to reviewing content covered in previous lessons. Furthermore, Finnish mathematics teachers spend significantly more time introducing new content than do their Icelandic counterparts. The findings and implications thereof are discussed in the final two chapters of this dissertation.
1.2. Purpose of the Study

The purpose of this study is to investigate the power and flexibility of video analysis as an observational tool in classroom research. To this end, video-based pedagogical research projects are surveyed. A method of lesson structure analysis is introduced and applied to video footage from typical mathematics classrooms in Finland and Iceland. The method is used to identify patterns of pedagogical functions and forms of classroom interaction across the sample.

There is a growing interest in international comparisons within the mathematics education community. Large studies such as PISA and TIMSS have on one hand answered some of the questions within the field, but, on the other hand, these studies have raised a plethora of new, unforeseen issues. As a piece of research in the field of comparative international education, this study hopes to generate insights and techniques that can benefit not just the educators and educational professionals in Finland and Iceland, but the global education community as a whole — albeit the benefit may be miniscule in the grand scheme.

Video analysis is still a relatively new tool in pedagogical research. Although the earliest video-based classroom studies were conducted over thirty years ago, this tool has not reached its full potential. There are many gaps to be filled, much theory-building to be done. While many of the issues that the early videographers faced have been resolved with the aid of improved technology and evolved theoretical perspectives, a number of challenges and open questions
remain. Thus continuing research efforts into the power and flexibility of video as an observational tool in pedagogical research are warranted. The final chapter of this manuscript offers ideas for future research into video analysis as a tool. That chapter also contains suggestions for further research concerning the educational systems of Finland and Iceland, and how video technology can be used to study them.

A secondary purpose of the study is to gauge the feasibility of conducting meaningful video-based classroom research on a “do-it-yourself” basis. Lack of finances, unyielding schedules, and logistical issues are among the difficulties that can deter researchers from taking on new projects and from working on ones already in progress. These problems can compound for new researchers with no financial sponsors or previous fieldwork experience. Some of the sections of this manuscript—Section 1.7 on technology and filming techniques, for instance—can be regarded as parts of a “how-to” guide to independent video-based classroom research. For someone conducting video-based classroom research for the first time, it may be helpful to read about a graduate student’s experiences in selecting a sample of schools, getting permissions to film in classrooms, and carrying out the data collection and analysis processes. Hopefully new videographers, such as graduate students using video analysis in their projects, can find practical support for their work in these sections.

Every researcher has a preconceived set of biases. Like other types of research, video analysis is always subject to these biases—and
misunderstandings stemming from them—in every step of the process.

Therefore, the problem is not the elimination of bias, as all research is done in
terms of a point of view. Rather, the problem is the selection of bias—or a
theoretical framework—appropriate to the research problems at hand (Erickson,
1979; Schoenfeld, 2002, 2007). One of the objectives of this report is to guide new
researchers in the selection of an appropriate theoretical framework within
which to work.

Any piece of research can potentially influence policy. Indeed, findings in
pedagogical research may have significant and long-lasting effects on
educational systems and, therefore, the lives of ordinary people. Although
shaping policy is not one of the primary goals of this project, the power of
academic research can not go unrecognized.

A research tool is only as good as its user, and video analysis is no
exception. Although a video-based study should be evaluated with an amended
set of criteria, its value is still based on the traditional elements of what makes a
good study. A well-conducted scientific inquiry a) has empirically researchable
research questions, b) links research to relevant theory, c) uses methods that
permit direct investigation of the research questions, d) is coherent and logical, e)
is generalizable, and f) discloses data and methods to enable and encourage
scrutiny and critique (Feuer, Towne, & Shavelson, 2002). The original
contributions of this project have been conceived with these principles in mind.
1.3. Research Questions

The main purpose of this study is to explore the power and flexibility of video analysis as an observational tool in classroom research. Emphasis is on lesson structure analysis. Footage from Finnish and Icelandic mathematics classrooms is used to examine the usability and usefulness of a method for analyzing lesson structures. The method involves two coding passes and is inspired by ideas from two of the major international video-based classroom studies, TIMSS and LPS.

A secondary purpose of the study is to gauge the feasibility of conducting meaningful video-based classroom research on a small scale. The methodological, logistical, and technical aspects of obtaining video-based data from classrooms can be problematic, especially when resources are in short supply. This facet of the project is intended to provide practical help for novice videographers.

This study seeks answers to the following research questions:

1. Does the video-based method of lesson structure analysis presented in this report extend the sensitivity of existing methods of lesson structure analysis such as those used in the TIMSS and LPS studies?
2. Does the video-based method of lesson structure analysis presented in this report permit structural comparison of Finnish and Icelandic mathematics lessons?

3. Is it feasible to conduct meaningful video-based pedagogical research on a small scale?

Answers to the above questions are developed throughout this report and formulated in the final chapter. Seeking answers to these questions is significant as the process contributes to the development of video as an observational tool in pedagogical research.

1.4. Why Use Video in Classroom Research?

1.4.1. Affordances of Video as an Observational Tool

This section provides a rationale for the use of video analysis in classroom research. Many advantages of video as an observational tool have been identified in the literature (see, e.g., Stigler et al., 1999; Ulewicz & Beatty, 2001; Ruhleder & Jordan, 1997; Erickson, 1986; Barron, 2007; Hiebert et al., 2003). Though incomplete, a list of ten of them is presented here.
1) Video analysis enables the study of complex social processes that take place in everyday life. Replaying the events—from multiple angles, if more than one video feed is available—can reveal behavioral patterns that would otherwise be hard, if not impossible, to detect. Video can effectively be used to “make the familiar strange” (Erickson, 1986, p. 121) and the commonplace events problematic and interesting. With the audiovisual real-time video record, researchers can reconstruct events to the desired level of detail. Playing the recording back at variable speeds, or out of sequence, also can be useful in detecting the social, didactic, linguistic, and other types of patterns occurring in classrooms. Through the use of video, episodes of dense dialogue can be scrutinized. In addition, video technology enables independent as well as correlatory analyses of overlapping patterns in the behavior stream.

2) The use of video helps eliminate the say/do discrepancy (Ruhleder & Jordan, 1997). Because people do not always do as they say they do, a more truthful account of what actually happens can be obtained with video rather than questionnaires or surveys, which are based on recollections or opinions. However, a post-recording interview or a survey measuring beliefs and attitudes offer complementary accounts that can be important in understanding the motives behind the observable actions.

3) Using video in classroom research lessens recorder bias. Nevertheless, although wide-angle shots of the classroom and appropriately placed microphones can neutralize some of the bias the cameraperson has on the
recording, the process of extracting data from video footage will always be somewhat effected by the filming decisions of the videographer. “Cameras don’t take pictures,” as Byers (1966) put it. But compared to on-the-spot coding, continuous narrative description, or photography, video is relatively bias-free. Using video certainly heightens the possibility of a neutral observation over any paper-and-pencil record.

4) Video increases inter-coder reliability. Using video technology implies that the observable actions are brought to the researchers instead of vice versa, as is the case with live observations (Stigler et al., 1999, p. 4). Observers do not have to be at the same place at the same time to contribute, making it feasible to conduct studies in multiple locations over extended periods of time. The same group of researchers can code classroom videos from around the world. Also, the process of training coders can be standardized since it is possible to use the same set of lessons for all trainees. Inter-coder reliability can now be measured not only between coders observing the same live lesson, but between all coders and an expert coder (Stigler et al., 1999).

5) The permanence of the video record permits unlimited re-analysis. Because the quality of the digital video files does not diminish over time or from usage, the accuracy of the analysis can be verified and the coding decisions deliberated upon and justified afterward. What is more, the same corpus of video records can be used for later studies with different foci and hypotheses because video yields less processed forms of data than direct observations (Ulewicz &
Beatty, 2001, p. 16). Since it is possible to use a neutrally-recorded\(^2\) set of lessons for classroom studies of various types, the recordings retain their value over time.

6) Video analysis allows for multiple viewpoints (e.g., Hiebert et al., 2003; Goldman, 2007b). Commentary from individuals with differing backgrounds and worldviews is often eye-opening and can be valuable to a research project. Multiple viewpoints can have a corrective, safe-guarding effect on the sometimes preconceived notions of an individual researcher. When several people contribute to an analysis of an event, a thick description\(^3\) emerges. For instance, a mathematics educator is likely make a different set of observations about a classroom event than an anthropologist or a psychologist. A thick description can amount to “more than a sum of its parts.” It can be helpful to also consider the viewpoints of the participants by conducting reflective interviews. Ricki Goldman has based much of her work on thick descriptions of educational events. Goldman’s ideas about multiple points of view are discussed in Section 2.2.7.

7) Video analysis facilitates the integration of qualitative and quantitative methods (Ulewicz & Beatty, 2001; Stigler et al., 1999). Because videos can be viewed and re-viewed by experts in various types of research, it is possible to merge complementary perspectives about a set of recorded lessons. Quantitative

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\(^2\) A discussion on how to record lessons neutrally, or so that they can be used in studies with different aims and theoretical frameworks, is presented in Section 1.7.2.

\(^3\) The concept of thick description was introduced by Clifford Geertz. A thin description of a wink describes only the wink itself, but a thick one would provide the context of the wink as well (1973).
analyses may aid in exploring the generalizability of interesting qualitative findings; statistics can be used to validate anecdotal evidence. On the other hand, qualitative analysis may help illuminate trends in quantitatively coded data.

8) The inclusion of video footage enables richer reporting of research results (Hiebert et al., 2003). Video clips can effectively be used in demonstrating findings about teaching and learning. Video studies provide an “audiovisual glossary of teaching tools, strategies, skills, styles, pitfalls, and mistakes” (Ulewicz & Beatty, 2001, p. 8). Videos can thus help build a common language of teaching, which is crucial if educational communities want to learn from one another.

9) Video analysis exposes mechanisms and antecedents (Ruhleder & Jordan, 1997). Video provides process data, rather than “snapshot” data, and therefore it can be useful in finding cause/effect pairings and significant chains of events in the behavior stream. Questions about what led to a particular type of event or state in a classroom may lead to discoveries of noteworthy pedagogical patterns.

10) Video footage can be reduced to still pictures, transcripts, and other forms of event portrayal. Video recordings are multidimensional and contain lots of information. Rather than trying to use it all at once, it can be helpful to reduce video to forms of lesser dimension. These reduced forms can then be correlated or utilized independently. For example, to study participation patterns during a task, a wide-angle freeze-frame shot, transcripts of verbal and non-verbal
communication, and the audio tracks can be used to analyze the seating
arrangement, linguistic and kinesic aspects of the instructional sequence, and
paralinguistic patterns in the group or class discussion, respectively.

1.4.2. Professional Development

In addition to pedagogical research for publications, video analysis can be used
in the training of educators. The merits of video technology in the professional
development of teachers, counselors, and others in the field of education have
been explored in the literature during the last decade (e.g., Bass, Usiskin, &
Burrill, 2002; Erickson, 2007; Frederiksen, Sipusic, Sherin, & Wolfe, 1998; Stigler
& Hiebert, 1999).

Pea and Hay (2003) compiled a list of some of the ways in which video
technology can be used for promoting teacher education. These include using
video to:

1. Illustrate different developmental levels of student or teacher
   thinking
2. Highlight uncommon but effective practices
3. Show a variety of exemplars of a particular teaching strategy or a
   student misconception
4. Provoke reflective conversations about a problematic teaching
   moment in a safe mentoring environment
5. Focus attention to specific aspects of a teaching phenomenon
6. Provide a “common ground” experience for a cohort teacher group
7. Distinguish contrasting cases (such as exemplary use of a teaching strategy versus a “near miss” teaching situation)
8. Provide visions for what is possible
9. Compress experience that would take a long time to gain on one’s own
10. Support role-playing in instructional decision-making by asking “What would you do now?”-type questions
11. Ground predictions for what will next happen in the classroom, and then for discussing variations of predictions from what actually happens when the video continues to play
12. Help teachers build categories of important pedagogical phenomena
13. Enable leaps in time scales (as in longitudinal video illustrating changes in student or teacher thinking over time)

(Pea & Hay, 2003, p. 10)

Practicing teachers can become teacher-researchers by videotaping their own classes. They can do this by inviting a videographer to capture them in action or by setting up an unmanned stationary camera or two in the classroom. Audiovisual records of their own classroom practices allow these teachers to see
and hear themselves and their students in a different light—as objects rather than subjects. What a teacher can learn from watching him or herself perform is virtually unlimited, even if the project is carried out only informally; no coding variables or advanced software applications are necessary to gain valuable knowledge of important, yet often hidden, aspects of teaching and learning. Roth (2007) maintains that although the teacher-researcher is in a unique position to study what happens during their lessons—they can provide plausible accounts as insiders as well as outsiders—their research contributions are not necessarily privileged. This is because of the associated high risk of confirmation bias; teacher-researchers may merely attempt to confirm their own preconceptions instead of looking for interpretations that contradict their prior beliefs (p. 380).

Nevertheless, both experienced and novice teachers may benefit from recording and analyzing their own lessons. It may be especially helpful to analyze lessons within a group of teachers.

1.5. Problems and Shortcomings of Video Analysis

The use of video in classroom research does not come without its problems. Beyond the usual financial and logistical problems, both of the key phases of the research process, data collection and data analysis, present the videographer with unique challenges. Obtaining neutral, high-quality video recordings is not easy. The verisimilitude of the footage, or how true-to-life the recordings are, is an
issue as the presence of the camera and its operator can have an effect on the participants’ behavior. Ethical considerations concerning video-based research are important since human subjects are used; privacy, confidentiality, and the potential for educational colonialism (Goldman, 2007b, p. 33) are issues that should be recognized and addressed at the outset. The evaluation of video research is also problematic. Finally, simply put, the question of how to effectively use video in classroom research will remain pertinent for some time to come as this emerging observational tool is not yet past its puberty. This section considers these and some of the other recognized issues with video analysis.

Why, where, when, and how to capture audiovisual records should be considered well before the fieldwork is begun. Unfortunately, the answers to these questions are generally not straightforward. In fact, the debate about the nature of research-suitable audiovisual records has been ongoing ever since early ethnographers like Mead and Bateson began collecting data (Barron, 2007). It is especially challenging to capture phenomena of interest if the recordings are to be analyzed with varying theoretical and methodological approaches, because the footage should be as neutral and as free of theoretical burdens as possible. For example, zooming and panning may suit one type of study but not another. As a rule of thumb, capturing neutral footage is less difficult if several cameras are used. Section 1.7.2 presents more about classroom filming techniques.

Verisimilitude represents a major challenge for researchers using video technology. Questions like the following have plagued video-based classroom
research from its beginning: Does the presence of the camera, or cameras, have an effect on classroom practice? Would the actions evident on the recordings have happened similarly had the cameraperson not been there? How can camera effects be minimized? Although video cameras are brought in to observe the classroom environment, they also unavoidably interact with that environment. The degree to which the presence of the camera and its operator change the behavior of the participants can not be determined beforehand, but instead has to be evaluated each time (Ruhleder & Jordan, 1997). The effect of the camera can sometimes be apparent to an observer. But the person in the best position to evaluate the camera effects in the recorded lesson is the teacher, who can inform the videographer about the camera effects during a post-recording interview. Issues concerning verisimilitude are not going to disappear completely, but there are measures a researcher can take to combat it. For example, if the participants are given a chance to get used to having the camera and its operator in the classroom prior to the recording, their actions will probably be closer to normal than they would be if they are not provided this chance. The videographer can, for instance, record several lessons with the same participants, but simply not use the first one or two of the lessons for the purposes of the study. It is also possible to capture events with unmanned video cameras. For instance, vom Lehn and Heath (2007) collect all their data this way. In an ideal situation—with regard to verisimilitude—the participants would be completely unaware of the presence of the camera and that they are being observed. However, this is not an
option in pedagogical research for ethical reasons; there can be no “candid camera” classroom studies.

Ethical considerations are important in any kind of video-based research. Privacy and confidentiality are issues that every videographer must recognize and address at the outset. Researchers’ primary ethical responsibility is to those being studied, and therefore effective planning and upfront communication with the participants, including obtaining informed consent from all relevant parties, are crucial. Some people consider being videotaped as a major invasion of privacy, and it should be the researcher’s goal to not make anyone feel uncomfortable before, during, or after the recording. Teachers may be concerned about their supervisors viewing the recordings and making employment decisions based on them. Students may think that the threshold for punishable behavior is different when someone is videotaping the class. It is imperative that the researcher informs each participant about who will see the tapes and how the participants’ identities will be protected. The trust between the researcher and the participants is precious, and thus the research should be conducted with strict adherence to the arrangements made with the participants. Furthermore, the parents of underage students have to be informed of the study and its purposes, and they must consent to having their child as a participant in the study. Finally, because taking part in a research study is voluntary, the videographer must decide beforehand what to do with any non-consenting students. The school and the participants, or their parents in the case of underage
students, must be notified in advance of any alternative educational opportunities or other suitable activities that will take place during the recording, if need be.

Another ethical issue is the potential for educational colonialism (Goldman, 2007b). Linking modern videographers to the explorers and colonists of the past, Goldman asserts:

As travelers and tourists in unknown classrooms, educational researchers are now armed with cameras and handhelds to explore every nook and cranny of the classroom, zooming here and there, observing the real lives of children and teachers in their habitat, not realizing that some element of what we do has a long history based in a worldview that encourages us to shoot, capture, dissect, and organize the bits and pieces of embodied chunks in systemic and ‘objective’ practices — to build one best Truth bespoke by the gathered evidence (2007b, p. 33).

There is no “one-size-fits-all” educational system; what works in Finland or Korea will not necessarily work anywhere else. Cultures—educational and other— are “situated contextual organisms” (Goldman, 2007b, p. 33) that have the ability to adapt and morph within certain limits. It would be insensitive to try to stretch these limits by importing mainstream educational perspectives that act as building blocks to a global educational approach. Rather, the gains from international classroom studies should be used “to build strong bridges between what we know and what others know” to improve upon each educational system in suitable ways (Goldman, 2007b, p. 34).
Video analysis of classroom practice is time-consuming and, in many cases, expensive. The process has two main phases: data collection and data analysis. Data collection for video-based research projects involves three, possibly quite lengthy, stages: gaining all the necessary permissions and consents, recording (including scheduling the recordings, travel, and equipment management), and manipulation of the tapes and the digital files. The analysis phase also can require lots of time due to the amount of data usually involved in video-based pedagogical studies, and since coding for each variable typically requires much more time than the length of the recording. In addition, another person should code some of the lessons to establish inter-coder reliability for the variables. The analysis phase can take particularly long if transcripts of the recordings have to be conceived. Barron (2007) suggests that, depending on the level of detail required, it can take up to 4 to 10 hours to transcribe one hour of videoed human interaction (p. 174). Furthermore, the re-representation of the lessons through transcribing takes even longer if the transcripts have to be translated. If additional personnel have to be hired to code, transcribe, or translate the recorded lessons, the associated costs can become prohibitive. Hay and Kim (2007) define as friction the “additional time it takes to do research beyond the time it takes for the actual event to occur and be reviewed” (p. 525). A reasonable goal of any researcher using video is to reduce friction within their projects. Hay and Kim’s Integrated Temporal Multimedia Data (ITMD) research
system is an example of an effort to cut down on friction by, for instance, enhancing synergy between the computer and the recording technology.

Video imagery may be too persuasive (Ulewicz & Beatty, 2001). Seeing a few videoed lessons from an unfamiliar educational culture does not qualify one as an expert of that culture. Although watching recorded lessons can be a powerful experience, an uninitiated observer can easily make unfounded inferences about what can be seen on the recordings. Video can be “seductive” (Tobin, as quoted in Ulewicz & Beatty, 2001, p. 10) and exaggerate confidence about what observers think they know about classroom practice after seeing just minutes of it on a videotape.

Not enough contextual information is extractable from video footage. Erickson (1986) argues for the importance of contextual information to make sense of what can be witnessed through video imagery. Video records behavior but not the meaning behind the behavior. According to Erickson, the aim should be to understand the participants’ thought processes, wherein the meaning lies. Therefore video should not be used as the lone source of data. Videographers should use appropriate supplementary methods, such as interviews and questionnaires, in addition to video-based observational data to obtain adequate contextual information. Indeed, triangulation, or obtaining evidence from multiple sources, is strongly encouraged by current literature on educational research methods (see, e.g., Schoenfeld, 2007).
The evaluation of video research is problematic. How can the value of a video-based research project be estimated? The educational research community is currently tackling the challenge of developing criteria for evaluating video-based research. Goldman (2007b) suggests that reports on pedagogical research utilizing video be measured using criteria such as the following:

1. Wholeness/particularity
   - The research exhibits an appropriate balance of details and “the big picture”

2. “Being there/being with”
   - Readers/viewers are made to feel as if they are in the classroom with the videographer

3. Perspectivity
   - The videographer’s point of view is made clear

4. Genre consistency/breech
   - The research follows a genre, yet it breaks convention

5. Authenticity
   - The research sheds new light

6. Chronological verisimilitude
   - A truthlike and suitable ordering of events is presented

7. Conviviality
   - The research is beneficial to the public, not just the scholars
8. Resonance
   - Readers/viewers can connect the research with their own situation
9. Immersion (Murray, 1997)
   - The research products—written reports and audiovisual accompaniments—demonstrate deep engagement and involvement with the topic
10. Commensurability (Geertz, 1973)
    - The research provides a “toolkit” for sharing concerns, beliefs, attitudes, and pedagogical practices
    (Goldman, 2007b, pp. 30-32)

Obtaining a set of classroom videos, no matter how high their quality, does not guarantee a useful data set. Videos are merely sources of information, not data (Erickson, 2006). Each video-based research project includes the essential task of constructing appropriate data from video recordings. The selection of phenomena to be studied, and the question of how to best use videos to study them, are guided not only by the research aims and their theoretical underpinnings, but also the eye of the observer. What a keen, trained eye sees as present or absent is critical to an expert analysis. Therefore it is important that new generations of videographers are introduced to the affordances and the challenges of video analysis through a broad selection of existing literature.
1.6. Video and Comparative Education

1.6.1. Why Study Teaching in Different Countries?

International comparative research in education is a growing field. Recent major studies such as PISA and TIMSS have only added to the momentum. Conducting large-scale international studies is expensive and logistically difficult, but the returns are potentially very high. Smaller studies also can yield considerable advantages to the participants, the field, as well as the educational community. Sound incentives to compare teaching across national borders and cultures can be identified. Some of them are presented in this short section.

Although it may seem that teachers and their practices vary widely even within a country, studies suggest that the apparent variability may be relatively minor when compared with the major differences in teaching practices across national borders (Stigler, Gallimore, & Hiebert, 2000, p. 88). It also can be useful to look at differences across regions, states, and different cultural and linguistic areas, especially in larger countries. International collaborations like PISA, TIMSS, and LPS have the capacity of revealing “similarity within difference, structure within extreme diversity” (Clarke, Emanuelsson et al., 2006, p. 2).

Hiebert et al. (2003) offer four other reasons to study teaching cross-nationally:

1. Reveal one’s own practices more clearly
2. Discover new alternatives
3. Stimulate discussion about choices within each country
4. Deepen educators’ understanding of teaching

Even though many teaching practices are culture and/or context-specific, and as such not directly exportable, much good can come out of a comparative study on teaching. The first step toward improving one’s own practices is to expose them. A video-based study on classroom practices can reveal practices that have been taken for granted and gone unchallenged. Also, the adage about traveling far and wide only to find yourself may apply here. On national, regional, and school levels, policy choices can be re-examined in a new light following a comparative study. On the level of an individual educator of students or teachers, useful alternative pedagogical methods can emerge from an international study on classroom teaching; such study may reveal possibilities of practice that would otherwise not be recognized (Hiebert et al., 2003, pp. 3-4).

International comparative studies offer an alternative to process-product and experimental studies (Clarke, Emanuelsson et al., 2006). Process-product studies have fallen out of favor within the educational research community, and varying local constraints deter researchers from conducting large-scale experimental studies (Schoenfeld, 2007, 2002; Clarke, Emanuelsson et al., 2006). International studies offer researchers possibilities to place their local educational settings within larger frames by providing them with a macro perspective from which to view, and improve upon, their educational micro culture.
1.6.2. **How Video Has Benefited Comparative Education**

Some comparisons of educational systems were already conducted in the nineteenth century and even earlier. National emissaries and journeymen like Marc-Antoine Jullien de Paris (1775-1848) reported on others’ school systems in order to advance their own. However, their commentaries were often anecdotal, biased, and void of explanations (Noah & Eckstein, 1998, p. 17). Eventually the descriptive and historical accounts gave way to more structured research in the field of comparative education. The field gained considerable momentum following World War II, and especially the 1960s were a time of rapid change. By the end of that decade the methods of social sciences had irreversibly transformed the field.

Methodology is of central importance to comparative education, perhaps more so than any other area of educational research. The emergence of video technology has provided researchers in this field with a data collection tool that enables the study of the *implemented curriculum* — the strategies, practices, and activities of the classroom culture (Valverde, Bianchi, Wolfe, Schmidt, & Houang, 2002). Prior to the 1960s, researchers had been able to investigate and compare system-level variables such as retention rates, teacher-student ratios, and costs of education — the inputs to an educational system (Robitaille & Travers, 1992, p. 688). Some of the outputs, the *attained curricula*, of these systems were studied by the ambitious IEA student achievement surveys, first of which was conducted in 1964. But it was not until the adoption of video technology into educational
research that the teams within IEA, and later other organizations, were able to conduct significant cross-national studies of the implemented curricula; the TIMSS 1995 Video Study was the first major investigation into what actually happens in the classrooms.

1.7. On Technology and Filming Techniques

This section covers some of the basics of the technology needed to conduct video-based classroom research as well as the kinds of filming techniques that have proven useful in various studies. While it is not intended as an all-inclusive “how-to” guide, the section can provide a starting point for new videographers.

1.7.1. Video Analysis Technology

Video analysis technology—cameras, microphones, computer hardware, and software—has become increasingly affordable and user-friendly in recent decades. Twenty years ago video-based research projects required big budgets, and it would have been nearly impossible for a graduate student to independently conduct video research. The financial hurdles have since been lowered considerably; a new consumer-level digital video camera can now be purchased for less than three hundred dollars. One or two such cameras are enough for many studies. However, if better sound quality is desired, more advanced—and more expensive—equipment is required. Appropriate computer
hardware and software are essential. There are excellent, affordable, and easy-to-use video analysis software packages available. Most of them, like Videograph (Rimmele, 2002) and Studiocode (Sportstec, 2005), support multiple types of analyses and are thus suitable for a variety of video-based studies.

The camera selection is usually steered by the needs of the study and the available finances. While the picture quality from virtually any modern digital video camera is acceptable, the most important differences between cameras for the purposes of classroom research are found in their audio recording features. Inexpensive consumer-level cameras usually take in sound only with inferior built-in microphones. However, some of them, like the Canon ZR500 (pictured on the left in Figure 1.1), can support an external microphone. On the other hand, Sony DSR-PD150, pictured on the right in Figure 1.1, is an example of a “prosumer”-level three-chip camera that has two microphone inputs. This is a useful feature, especially if an additional microphone, such as a wireless teacher microphone, is used. Unlike the inexpensive models, this camera has audio input level controls and a headphone jack. Sony DSR-PD150 is no longer in production, but it is still popular among researchers and independent filmmakers because of its reliability and picture quality. At this time, the cost of a used one is around $1500. The recording set-up used in the Finnish and Icelandic classrooms included one of each of the aforementioned cameras.
Good microphones are essential to obtaining high-quality audio tracks. Especially if transcripts of the recordings are made, the videographer should pay careful attention to the selection of the microphones and how they are used in the recording process. If capturing everything the teacher says is essential, a wireless lavalier⁴ microphone system should be used. They cost around $300, and, after some practice, take less than two minutes to set up for each recording. When using a consumer-level camcorder that accepts an external microphone, a condenser microphone should be used to optimize sound quality. An example of a popular model is the AKG C-1000S, which is currently priced at around $200. Sony DSR-PD150 comes equipped with an external condenser microphone.

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⁴ A lavalier system includes a small microphone that can be pinned to clothing, a transmitter, and a receiver.
Stands for cameras and microphones as well as a set of appropriate cables belong to the recording set-up. Camera stands usually have three legs forming a tripod. A heavier camera should be coupled with a sturdy stand that can provide stable support during the filming. Fluid-head stands can prevent jerky camera movements. An external microphone requires a dedicated stand, unless it can be mounted on the camera as with the Sony DSR-PD150. It is important to bring all the necessary cords and cables to each shoot, and to make sure they are of high quality. For instance, it is possible to ruin an otherwise good recording with a faulty microphone cable. Furthermore, the videographer can avoid a disaster by bringing an extra power strip and a long power cable in case the classroom does not have enough power outlets.

The price of the recording set-up depends mainly on the number and quality of cameras and microphones. While a teacher who wants to informally review his or her own lessons can do so with the aid of a single camcorder, a “pro-sume”-level camera and a wireless microphone form the core of a more sophisticated set-up needed for more formal research. Prices for recording set-ups range from a few hundred to several thousand dollars.

Videograph and Studiocode represent the current generation of video analysis software. Both of these versatile programs can handle multiple video screens, transcripts, and unlimited user-definable coding variables. Of the two, Studiocode supports a larger variety of functions such as advanced indexing and searching of video and transcript tags. Users of both programs can export
information to statistical software such as SPSS. Videograph runs on the PC platform and retails for about $400, while Studiocode is a Macintosh-based program with variable pricing options. Trial versions of both are available (Rimmele, 2007; Sportstec, 2005). Ideally, video analysis programs should not limit the ways in which researchers can interpret the footage. In reality, however, all video analysis software tools constrain the set of possible interpretations by limiting the type of data that can be generated and managed (Clarke, Emanuelsson et al., 2006, p. 250). These two pieces of software are not exceptional in that regard, but they do offer much more flexibility than did the video analysis programs of the past.

Figure 1.2: Videograph, a software for video analysis (Rimmele, 2002)
1.7.2. Filming Techniques in Classroom Research

Video provides an incomplete story. It is not possible to capture every word spoken and heard, every body movement and facial expression, not to mention every thought and intention. If there is no perfect recording, then what constitutes a good video documentation of a lesson? Is it possible to standardize the recording procedure so that the same footage could be used in studies that use different theoretical and methodological approaches? This section discusses these issues and other aspects of filming techniques in classroom research.

Recording set-ups from four classroom studies are described.

A neutral recording⁵ is one that can be used in studies with various aims and theoretical frameworks. The potential benefits of recording lessons neutrally include saved time and resources as well as minimizing the interference of school activities. If multiple studies can be conducted from the same set of videoed lessons, researchers can work more efficiently and without unnecessarily distracting schools, teachers, and students. Some studies may require a particular approach to recording classroom interaction, as it can be difficult to extract a specific kind of data needed to answer certain research questions from a neutrally recorded lesson. For example, if extreme close-ups of the participants are needed to study facial expressions, recording neutrally would probably not

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⁵ Perfectly neutral recordings can not be achieved since not all interaction can be captured. However, the term “neutral recording” will be used hereafter to refer to footage that is recorded for research purposes without a specific set of research questions in mind.
be fitting. Hence it must be decided at the outset of the project whether neutral recordings can provide the necessary type of data.

A classroom recording is always influenced by decisions made by the videographer. These decisions are made before, during, and after the recording, and they can have a major impact on the data generation process. The number of cameras and their general function—teacher camera, classroom camera, etc.—are usually known well in advance of the recording. Once the videographer reaches the location of the shoot, decisions about the exact positions of the various recording equipment must be made. During the lesson, decisions about what to have in the frame, and when to zoom or pan, are unavoidable. Finally, post-recording edits also have an effect on the kind of data that can be extracted from the footage.

Although achieving a perfectly neutral video recording is impossible, during each step of the recording process the videographer can make decisions that reduce recorder bias and foster the neutrality of the footage. Miles and Huberman (2004) discuss the idea of data reduction as an inevitable, and often unconscious, aspect of data collection; each decision by the videographer reduces the options for later data analysis. The research process reduces the behavior streams of the classroom to the data of interest. A neutrally-recorded lesson, or a set of lessons, can postpone some of the data reduction into a later stage of the research process. Neutrally-recorded footage increases the researcher’s options
during data analysis by reducing the need to converge to answering a predetermined set of questions with predetermined methods.

Characteristics of a neutral recording include the usage of multiple cameras; a dedicated wireless teacher-microphone; high quality audio from various sections of the room; primarily wide-angle, “master of scene” shots capturing as many of the participants as possible (Stigler et al., 1999, p. 17); continuous takes—it is best to record the whole lesson without breaks; and minimal editing of the footage (Erickson, 2007). It is essential that the videographer begins the recording before the participants enter the classroom, and that he or she does not interfere with the lesson in any way. While it is important that the videographer behaves in a friendly, nonthreatening manner, the events that would typically unfold during the lesson should not be obstructed. Therefore, communication with the participants is discouraged.

Technological issues that may hinder the recording process can be largely avoided through proper equipment maintenance; it is important to check cameras and cables for problems prior to each recording, charge camera batteries, clean the cameras’ recording heads periodically, keep fresh batteries in the transmitter of the wireless microphone, etc. It is also important that the digital video tapes used are of high quality and made by the same manufacturer. This is because different tape manufacturers use different tape lubricants, and they do not mix well. For later archiving, it is a good idea to properly label the tapes.
Each video recording in a set of lessons should be recorded similarly. Thus guidelines for filming lessons are necessary in order to systematically observe teaching via video. Clear and thorough guidelines prevent the need for improvisation during the recording. Although different classrooms present different challenges for the videographer, it is important that the same type of data is extractable from each recorded lesson. Trial runs in a few different classrooms can prove extremely helpful in preventing last-minute issues during the recording phase. Furthermore, training sessions to standardize the recording procedures have proven indispensable for studies that use footage obtained by several videographers (Stigler et al., 1999; Hiebert et al., 2003; Clarke, Emanuelsson et al., 2006; Seidel, Prenzel, & Kobarg, 2005).

High quality audio is crucial in videoing classroom interaction for research purposes. The natural acoustics of many classrooms are bad; screeching chairs, people all over the room chatting, and excessive room echo that boosts noise levels can add up to a difficult recording environment. However, if the teacher wears a wireless microphone and the other microphones are properly placed, viewers of the recordings can generally make out what is being said by the participants. Attaching the wireless microphone on the teacher’s clothing will ensure a constant distance between the source of the sound and the microphone. The room microphone(s) should be placed away from the corners of the room about five or six feet off the ground. It is a good idea to monitor the sound levels throughout the recording.
Any best practices of videoing in general are applicable to capturing classroom events with a video camera. In order to make the classroom recordings as useful as possible, basic principles of filming should be acknowledged. To name a few, balancing the elements in the frame, cropping, and lighting are filming issues that should not be ignored by the classroom videographer. For instance, one should not shoot toward the classroom windows, but instead, the cameras should be placed so that the main light sources are behind them.

Next, recording set-ups from four video-based classroom studies are presented as examples. The recording designs from the TIMSS 1995 Video Study, the IPN Video Study on German physics classroom practices (Seidel et al., 2005), the LPS, and the nwu-Essen study on science education (Fischer & Neumann, 2005) are described here. The number of cameras used in these set-ups range from one to three and the number of microphones from two to five. Every set-up includes a wireless teacher microphone. Furthermore, each set-up requires at least one camera with two microphone inputs.

A one-camera recording set-up was used in the TIMSS 1995 Video Study. The videographers in this study were to record each lesson from the perspective of an “ideal student” by pointing the camera so as “to capture the experience of a student who is paying attention to the lesson as it unfolds” (Stigler et al., 1999, p. 15). While less expensive and easier to manage than the more common two-camera set-up, using only one camera restricts the information that can be drawn about classroom practice. It is also risky; if the main camera malfunctions, the
recording may be compromised in the absence of a back-up camera. The recording set-up for this study utilized two microphones: a wireless lavalier microphone on the teacher and an external microphone mounted on the camera positioned near the front of the room. In Figure 1.3, “A” marks the approximate position of the video camera and its operator, and “T” stands for “Teacher microphone.”

Figure 1.3: The recording set-up of the TIMSS 1995 Video Study (Stigler et al., 1999)

The set of equipment used in the IPN Video Study includes two cameras and two microphones. The IPN recording design is similar to the TIMSS 1999 Video Study (Seidel et al., 2005, p. 31). A wireless teacher microphone is connected to the teacher camera, and an external microphone, mounted on a boom stand and located next to the teacher camera, is connected to a fixed overview camera. The videographer follows the teacher’s actions with the teacher camera, i.e. the action camera, while the fixed camera captures as much
of what is happening in the classroom as possible. The secondary function of the fixed camera is to back up the action camera. Figure 1.4 shows the approximate locations of the cameras and the microphone. “A” stands for “Action camera,” “F” for “Fixed camera,” and “M” for “Microphone.”

A three-camera approach sets the recording design of the LPS apart from the others presented in this section. Since this study attempted to gain insights into the perspective of the learner, one camera was dedicated to capturing the actions and interactions of a group of four students. In cases when two videographers were available, one operated the teacher camera and the other the student-group camera. If only one videographer handled the recording, only the teacher camera was manned. The teacher camera was positioned in the back of the room and followed the teacher at all times, except possibly when a student presented something at the board. As in the IPN study, a fixed overview camera
captured a view of the whole class from the front. In this set-up, the teacher carries a lavalier microphone connected to the action camera; the focus student group is recorded with a wireless microphone that is connected to the student-group camera; and the fixed camera records sound with its built-in microphone. The “S” in the diagram below marks a possible location of the student-group camera.

![Diagram of classroom setup](Image)

Figure 1.5: The recording set-up of the LPS study (Clarke, Emanuelsson et al., 2006)

The video researchers studying science classroom practice at the nwu-Essen center at the University of Duisburg-Essen deem it especially important to hear as many of the students’ utterances as possible. Their audio set-up includes a wireless teacher-microphone, three microphones to record the classroom sounds, and one microphone dedicated to a group of students. The audio tracks

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6 Nwu stands for “Naturwissenschaftlicher Unterricht,” which means “Teaching and Learning of Science.”
can be listened to separately as they are recorded with the aid of a multi-track recorder. The set-up requires a sound board, a laptop computer, as well as several stands and cables for microphones and cameras. All this equipment takes a long time to set up, and may create added anxiety among the participants.

Figure 1.6: The recording set-up of the nwu-Essen classroom study (Fischer & Neumann, 2005)

1.8. Overview of the Chapters

This dissertation contains five chapters. The first one serves as an introduction to the use of video analysis in pedagogical research, its affordances, and the associated problems. A rationale for conducting international comparative classroom research is given as well as some notes on current video technology and classroom filming techniques.
The second chapter surveys relevant literature. A historical account of video-based research is followed by a section that connects three major theoretical families—sociocultural, cognitive, and constructivist—to classroom video analysis. A section of this chapter is dedicated to the TIMSS and LPS studies and another one to the educational systems of Finland and Iceland.

Chapter 3 introduces an original method for lesson structure analysis. It is derived from the major international comparative classroom studies, TIMSS and LPS. This method is comprised of two coding passes, the first of which concerns the pedagogical functions of lesson elements. The first pass-variable has four categories: Review, Introducing New Content, Practicing/Applying, and Other. In contrast, the coding variable for the second pass is based on the forms of social participation, and it is adaptive to the set of recorded lessons under consideration. The strengths of this coding scheme include not only the ability to aid in the investigation of the form (second pass) and the function (first pass) of lesson segments, but also of the interaction between these two dimensions.

Chapter 4 presents an application of the coding scheme introduced in the third chapter. The structures of forty mathematics lessons from Finland and Iceland are analyzed to demonstrate the usability of the new method.

The final chapter of the dissertation contains a summary of the findings of the current study and recommendations for further research.
2.1. Overview

This chapter contains a review of literature relevant to the current study. It has four sections in addition to this overview: 1) History of video analysis as a method in pedagogical research, 2) Classroom video analysis in the spheres of different theoretical frameworks, 3) Major video-based classroom studies in mathematics education, and 4) Finland and Iceland: PISA and mathematics education.

Section 2.2 gives a historical account of video-based pedagogical research. Developments in both video technology and video analysis software are discussed along with some of the theoretical, methodological and epistemological approaches of the research community. Many examples of uses of video in pedagogical as well as ethnographical research are given. Reaching back over a century, this section links the work of today’s classroom videographers with earlier uses of video in pedagogical and anthropological research.
According to Schoenfeld (2002), the most prevalent theoretical perspectives in recent mathematics education research have been sociocultural, cognitive, and constructive in nature. Section 2.3 offers a brief look at these three theoretical families with examples of how classroom video analysis has been situated within them.

Section 2.4 examines recent major video-based classroom studies in mathematics education. Focus is on the largest of the international studies: the 1995 Trends in International Mathematics and Science Study [TIMSS], the TIMSS 1999 Video Study, and the Learner’s Perspective Study [LPS]. The approaches and methodologies of these studies are analyzed and compared. Emphasis is on the lesson structure coding schemes of the three studies.

Mathematics classrooms in Finland and Iceland provide the data for the original example of this manuscript. These countries were chosen partially due to their performances on the Program for International Student Assessment [PISA]: In PISA 2003, Finland scored the highest overall while Icelandic girls significantly outperformed the boys on the mathematics scale, a unique feat (OECD, 2004). The final section of this chapter offers a PISA-based review of the educational systems of these two Nordic countries.
2.2. History of Video Analysis as a Method in Pedagogical Research

2.2.1. Overview

Although video technology has existed in some form or another for over a hundred years, video analysis is a relatively new tool in pedagogical research. Video was adopted into classroom research from ethnographers in the early 1970s. However, some footage from classrooms was collected for commercial purposes earlier with possibly the first classroom video recording dating back to 1937 (Erickson & Wilson, 1982). With hopes of bridging the gap between theory and practice, researchers in the 1980s and 90s embraced video as an observational tool for an increased understanding of what was actually happening in the classrooms. As video recording equipment has become more available, portable, and user-friendly, the uses of video in classroom research have grown more numerous and sophisticated. Computer technology has been instrumental in video analysis for the past two decades. The rapid development of video analysis software has been shaped by the evolving epistemological perspectives and methodological needs of the research community.

The benefits and challenges of photography—and later video—as a means for collecting data were considered by ethnographers in the middle of the 20th century as foundations were being laid for meaningful ways to analyze everyday events based on visual records (e.g., Bateson & Mead, 1942; Mead, 1956; Byers, 1966). By the 1960s, researchers in the social sciences, particularly anthropology,
were making strides in video-based research (e.g., McCarty & Hockings, 1967; Condon & Ogsten, 1967; Birdwhistell, 1970). Many documentaries about life in schools were made in the 1960s, yet educational researchers did not take up video as an observational tool until the 70s while getting help from their anthropologist colleagues in more ways than one (Erickson & Wilson, 1982). By the end of the 1980s many researchers were using video technology to investigate educational practices (e.g., Erickson, 1986; Spindler & Spindler, 1987; Tobin, Wu, & Davidson, 1989). The first generation of computer software was created at that time to aid in the analysis of the video recordings (Roschelle, Pea, & Trigg, 1990; Goldman-Segall, 1990; Mackay, 1989; Losada & Markovitch, 1990). The digital revolution took place in the 1990s. It had a major impact on the way video data could be recorded, edited, analyzed, and archived. Today, with portable, affordable cameras and advanced video analysis software, any researcher can be a videographer. Furthermore, video researchers can now collaborate online with their colleagues, regardless of their geographical locations.

In what follows, some of the major historical developments in video analysis are considered. Beginning with the earliest days of moving images and then, starting with the 1960s, the sections proceed by decade. The reader should keep in mind that many of these developments span more than one decade, and a case could surely be made for discussing them in some other order. In this historical overview, the general guideline for placing developments under a certain decade is that it is discussed either under the decade during which it was
first published or when kindred works were published. Also, this overview is not intended to be comprehensive; such a work would require many more pages than what is reasonable to allocate here. Instead, works by authors like Goldman and the Spindlers have been selected to represent the field and have thus received added attention.

2.2.2. The Early Years of Video-Based Research

The roots of video-based classroom research are in visual anthropology. Early work by ethnographers such as Franz Boas, Gregory Bateson, and Margaret Mead laid the groundwork for studying human interactions using video. Although the first video-based classroom research was not published until the 1970s\(^7\), it is important to acknowledge the work of these pioneers.

The earliest documented use of silent moving images for research purposes was probably by Félix-Louis Regnault, who filmed a Wolof\(^8\) pottery maker at work in 1895. He published a paper on the unique Wolof method of pottery making in December of that year (de Brigard, 1975; Lajard & Regnault, 1895). December of 1895 also was the month the Lumière brothers held the first commercial screening of a film, thus launching the motion picture industry.

Earlier that year, the brothers had invented the \textit{cinématographe}, which was more  

\(^7\) Technology was used to carry out classroom research as early as 1910. Exploratory studies by Romielt Stevens, a Teachers College faculty member, utilized a stenographer to transcribe lessons for later analysis. She identified issues, such as verisimilitude, that are still concerns for videographers (Stevens, 1910).

\(^8\) The Wolof are an ethnic group in Western Africa. See http://en.wikipedia.org/wiki/Wolof_people for more information.
like a serial photography machine than a modern day film camera, but still an improvement over the first film camera, the *kinetograph*, by Thomas Edison (Mast & Kawin, 2006).

Another early ethnographical video study was conducted by Sir Baldwin Spencer, an English biologist and anthropologist, in 1901. He documented many of the rituals and social interactions of tribes of Australian aboriginals with a Warwick cinematograph. Spencer and co-author F.J. Gillen published their findings in two books, *The Native Tribes of Central Australia* and *The Northern Tribes of Central Australia*, in 1899 and 1904, respectively. Video-based data were only used in the latter. As rare glimpses into lost cultures, these works are still essential references in Australian ethnography (Spencer & Gillen, 2000a, 2000b).

In 1930, a 70-year-old Franz Boas, an anthropologist at Columbia University, took a motion picture camera with him to study the Kwakiutl, a tribe in Western Canada he had been researching for over 40 years. With the then-latest in technology, a 16mm film camera and a wax cylinder phonograph for sound, he documented interactions among the Kwakiutl with plans of studying rhythm and body movement. He envisioned “a theory of rhythm which encompassed dance, music, song, and many other aspects of culture” (Ruby, 1980, p. 8). Unfortunately he did not get to publish any findings based on these recordings. Ruby provides possible reasons for this. First, the audio records apparently were stolen. Second, Boas could not find an appropriate approach, an effective conceptual framework, to analyze the tapes (p. 7). Also, there were
technical problems: Boas did not realize that his “spring-wound camera motors run at erratic speeds and, therefore, produce footage which could not be used to study rhythm” (p. 8). Finally, due to shortage of film, he was forced to shoot only a few seconds of each activity whereas it would have taken several minutes to capture the events in their entirety (Wavens, 1978).

Six years after Boas’ endeavor, Gregory Bateson and Margaret Mead, who had received her PhD from Columbia under Boas in 1929, started using film to document and analyze the habitus\(^9\) of the Balinese. The husband-and-wife team collected 25,000 still photographs and shot 20,000 feet of 16mm film\(^{10}\), without sound, during their two years in Bali where they sought to find connections between the concepts of culture and national character. They also collected comparative data in Papua New Guinea and the United States. Results from this early visual ethnographical work were published as a book, Balinese Character (1942) which included photographs and still images taken from the films.

Bateson and Mead also produced a series of short films of which Trance and Dance in Bali and Bathing Babies in Three Cultures, 22 and 9-minute presentations, respectively, both narrated by Mead, are perhaps the best known (1951a; 1951b).

Erickson and Wilson (1982) cite a documentary film from 1937, Glimpses of the Workers’ Education Program in Florida, in which scenes from classrooms and

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\(^9\) Bourdieu describes habitus as “a system of long-lasting dispositions... a set of acquired characteristics which are the product of social conditions and which, for that reason, may be totally or partially common to people who have been the product of similar social conditions” (2005, p. 45).

\(^{10}\) This was more film than had been used in the totality of anthropological film making since its beginnings in 1895 (Hockings, 1995, p. 509).
recreational activities are shown. This 17-minute black-and-white film is among the first, if not the first, classroom recordings. It appears, however, that the makers had no research agenda. The documentary was filmed at a workers’ camp for girls that was operated by the Department of Works Projects Administration (p. 10).

In the 1930s and early 40s, Arnold Gesell, a child psychologist and a pediatrician, made use of video technology in his research. He often used one-way mirrors to study the behaviors of children. In order to observe their stages of development, he constructed the “Gesell dome,” an igloo-like structure that consisted of a one-way mirror in the shape of a dome and was equipped with video cameras focused on the inside of the dome (Gesell, 1952). In his autobiography, he writes

> Scientifically controlled cinematography fortunately is a paradoxical form of embalming. It not only preserves the behavior in chemical balm, but it makes that behavior live again in its original integrity. The cinema registers the behavior events in such coherent, authentic and measurable detail that... the reaction patterns of infant and child become almost as tangible as tissue (1952, p. 132).

Videos can be viewed and re-viewed through various “lenses”. The range of information and knowledge that can be extracted from any video recording is immense. The ways in which these early anthropologists used their field recordings differ greatly from one another and from the ways in which, for instance, a present-day ethnographer with the understanding of the latest
theories would use the same recordings. A case in point is William Holt’s re-analysis of the recordings by Boas. More than 40 years after the documentation, Holt edited the tapes and provided meticulous and extensive original commentary that contextualized the otherwise silent film (Holt, 1973; Wavens, 1978).

2.2.3. 1960s: School Documentaries

Even though some classroom footage was recorded in the 1960s, no educational video-based research seems to have been published during that decade. Instead, several highly-edited documentary films from schools were made for commercial purposes in the 1960s as well as the 70s. Erickson and Wilson (1982) list 298 school-related for-profit documentaries published prior to 1979. Eighty-nine of them date back to the 1960s with four films dating back to 1960\(^\text{11}\). Those early documentaries include *Country School*, a film about a rural one-room school; *Lectures Are a Drag*, a 19-minute documentary of a high-spirited class session on the Bill of Rights; *Some of Our Schoolmates Are Blind*, a color film which depicts some of the interactions of blind and sighted children in a California elementary school; and *The Story of the Harlan-Shoemaker School*, a film about a therapy program for physically handicapped children. The films mentioned by Erickson and Wilson range in length from 2 to 74 minutes and most of them are black-and-white. Many of them were shown on television in the United States.

\(^{11}\) No publication year was listed for 115 of the 298 documentaries in (Erickson & Wilson, 1982).
Some of the documentaries were a part of a series such as the 1966 *California Project Talent*, which included fourteen half-hour programs highlighting specific skills helpful in learning, or the 1976 *As We See It* series, which contained twenty-six student-written segments on school desegregation.

Gump (1967) used time-lapse photography to investigate the behavior streams occurring in third-grade classrooms. His study focused on the relationship between the teaching and learning environment and the behavior of the participants. Gump used sequences of still photographs, taken every 20 seconds, together with written chronicles to identify activity segments in classroom action. He found that seven types of activities accounted for the majority of the classroom action with recitations and seatwork being the most dominant. This type of segmenting strategy has been used by many *ecological psychologists* (see, e.g., Barker, 1968) and is similar to the ones used by recent video-based classroom studies, such as the demonstration of the method of lesson structure analysis presented in this manuscript.

2.2.4. **1970s: Learning from the Anthropologists**

The field of mathematics education was in turmoil in the 1970s as behaviorist theories were giving way to cognitive frameworks (Kilpatrick, 1992; Schoenfeld, 2002). There was a substantial disconnect between what the researchers were studying and what the practitioners were doing. The end of the decade saw some attempts at bridging this gulf as “more and more, research in mathematics
education was moving out of the library and laboratory and into the classroom and school” (Kilpatrick, 1992, p. 31). This paradigm shift eventually led to the rising popularity of video-based classroom studies. By 1979, video analysis as an observational research method received extended consideration in the third edition of Borg’s popular textbook *Educational Research* (Borg & Gall, 1979, pp. 326, 338-339).

In the 1970s, video technology was expensive and not very user-friendly. The cameras were bulky and required a separate VCR unit. Before the more mobile camcorder\textsuperscript{12} was introduced in 1982, two people usually were needed to operate a video recording system (Shapiro, 2006). Despite the technical and financial obstacles video researchers faced in the early days, some of them were able to conduct meaningful video studies. Like earlier in the history of video-based research, the most important video studies of the 70s were done within the field of anthropology.

In 1973, a group of anthropologists including Mead, Paul Hockings, Jean Rouch, and 25 others, contributed to a volume entitled *Principles of Visual Anthropology* (Hockings, 1975). This was the first collection of articles on the use of visual representations in the social sciences (Goldman, 2007b). It came out at a time when anthropologists had started to use video to study their own cultures instead of ones far away. As de Brigard asserted in her chapter, “We now turn our cameras on ourselves for a good hard look at our own societies” (1975, p. 14).

\textsuperscript{12} Word came from CAMera and reCORDER.
Principles of Visual Anthropology includes a seminal introduction by Mead (1975). In it she urges researchers to document customs of endangered cultures before it is too late. She makes a case for the scientific value of video and scolds some of her fellow anthropologists for failing to recognize its worth:

“Anthropologists… have continued to use questionnaires to ask mothers how they discipline their babies, words to describe how a pot is made, and a tangle of ratings to describe vocal productions” (p. 6). The ever-foresighted Mead argues that using video in research can “refine and expand the areas of accurate observation,” and that video for scientific purposes is best left unedited (p. 10).

Hockings and his colleagues called for an international, collaborative effort to archive and index video data. They drafted the Resolution on Visual Anthropology in which they envisioned repositories for easy retrieval and exchange of visual data (1975, p. 483). Indeed, at that time gaining access to others’ videos was not as simple, or cheap, as it is today. Not only did one have to order the tape from the distributor, there were considerable costs involved. For instance, obtaining a copy of Emitaï (Sembene, 1970) cost $1295. Leasing Juvenile Court (Wiseman, 1973) for $750 would only grant one access to the tape for a limited time before having to send it back. A typical short-term rental fee was $50 (Hockings, 1975). Copying tapes required special equipment and the quality declined significantly with each generation (Shapiro, 2006). Today’s online collaboratories make possible the kind of sharing of data and ideas that
Hockings and his peers could only imagine. They will be revisited in Section 2.2.7.

Frederick Erickson was a pioneer in using video technology in educational research. His approach to video analysis is a phenomenological one; he prefers to make meaning of the phenomena he witnesses on minimally edited video footage. His studies at Harvard and Michigan State during the 1970s have served as examples for many videographers. For example, Erickson (1975; Erickson & Shultz, 1982) studied counseling encounters in junior colleges in the US. The purpose of this video-based ethnographic study was to investigate differences in verbal and non-verbal communication patterns between various cultural and ethnic groups. Erickson saw the counseling interview as a gate into the “real world” and the counselor as its gatekeeper. His research showed that oftentimes the cultural and ethnic differences of the counselor and the student had a negative effect on the emotional tone of the interview as well as its outcome. Sometimes, however, the negative influences of differences in communication style were overcome after the participants found common ground.

2.2.5. 1980s: Coming of Age

If the 1960s and 70s were decades of apprenticeship for the pedagogical videographers, then the 80s was when they came to their own. The decade began with a continued push from within the field of mathematics education to bring research closer to classroom practice. The focus of educational research had
traditionally been on the individual, but now it was time to examine the learners within their social contexts (e.g., Bishop, 1988; Lave & Wenger, 1991). Overall, the 1980s were marked by a diversification of research thrusts. New phenomena of interest gave rise to new research methods, and some of them, such as reflective interviewing (Spindler & Spindler, 1987), relied on video as a tool.

Besides the momentum from the field, the videographers of the 1980s had the rapidly-developing technology on their side: In 1985, Sony introduced its popular Handycam® camcorder, which weighed only one kilogram (Sony, 2007). With decreased costs as well as increased quality and portability of video equipment, it was now feasible for an individual researcher to carry out fieldwork in a classroom. As a result, video gained popularity as a research tool. The first generation of software such as VideoNoter (Roschelle et al., 1990), Learning Constellations (Goldman-Segall, 1990), and EVA (Mackay, 1989) were being developed late in the decade to aid in the analysis of classroom video footage. Projects such VIDEOSHARe (Walmsley & Neilsen, 1991) helped researchers and schools share videos and video technology with parents.

George and Louise Spindler represent an important link between education and anthropology. True interdisciplinary scholars, the Spindlers, together and separately, made valuable contributions to anthropology, education, and educational anthropology for over 50 years. They seamlessly blended the two together as they saw “education as cultural transmission”
 Appropriately, the Spindlers were among the first to use video recording techniques in classroom research.

George Spindler started a pedagogical research project in an elementary school in Schoenhausen, Germany (name is fictional) in 1967. He eventually published an article on the urbanization of a German village (1973) as well as his first report of the Schoenhausen school and how cultural transmission occurred there (1974). He used the Instrumental Activities Inventory (IAI), a research technique developed for a study of acculturation among Native Americans (Spindler & Spindler, 1965). The main component of IAI consists of showing contrasting pairs of pictures to a group, forcing them to make choices between, in this case, urban-oriented and tradition-oriented activities (Spindler, 1974). The results of the test showed an “interesting mix of idealization of rural village life—being a vintner or farmer and working in and with nature—and pragmatism about occupational choices and lifestyles” (Spindler & Spindler, 1982, p. 212). In 1977, George Spindler returned to Schoenhausen with Louise. This time, in addition to the IAI, they used a super-8 camera to film classroom activities of the third and fourth grade classes at the school. Inspired by video-based research in visual anthropology, they used over 2000 feet of film in recording interactions not only in the classrooms, but also on the playgrounds, class excursions, and around the communal spaces in Schoenhausen. Among

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13 2000 feet of Super-8 film contains just over 2 hours of video material when operated at 18 frames per second (http://en.wikipedia.org/wiki/Super_8_mm_film).
other discoveries, they observed the different teachers’ varying use of control over the class, their territorial behaviors, and the overall task-oriented nature of the instruction in this educational culture. They also noticed that some of the male teachers favored female students (1982, p. 223).

In 1981, the Spindlers showed classroom footage to the teachers whose classes had just been taped. They then gathered reactions from the teachers, individually as well as in groups, in a procedure they called reflective interviewing. The group showings proved to be more productive as the teachers eagerly commented about the teaching methods and the children’s behavior. Good conversation among the teachers ensued after each showing, and the Spindlers were able to get a better look into the teachers’ perceptions, understandings, and assumptions. Four years later the Spindlers tried another technique for collecting data: cross-cultural interviewing. This time they showed recordings from a US school to the principal and the teachers from Schoenhausen. The proceedings, which were recorded on video, revealed important cultural differences. Issues such as classroom atmosphere, teacher-student relationships, discipline, and motivation for learning were discussed at length. The Spindlers coined the term “cultural screen” to aid in describing the significance of a viewer’s cultural perspective (Spindler & Spindler, 1987).

The Spindlers effectively used their peers’ and graduate students’ eyes to maximize the information that could be extracted from the tapes. During subsequent viewings, others distinguished incidents and patterns that the
original videographers had missed (1982, p. 219). The strategy of utilizing multiple researchers’ interpretations and analyses would later be advocated by Ricki Goldman in her *points of viewing* theory (1998) and the *perspectivity framework* (2007b). They will be encountered later in this chapter.

By the end of the 80s, several groups of pedagogical researchers were using video technology and developing software to investigate classroom practices. Roschelle, Pea and Trigg (1990) developed VideoNoter, an early software tool capable of supporting multi-faceted video analysis. VideoNoter was *time-based*¹⁴ and had four windows for various functions such as annotation, text editing and grouping of objects. The program only ran on Macintosh® computers and required a VCR and a TV monitor. Although VideoNoter was never released for public use, its development was an important step for the generations of video analysis software to follow; Roschelle went on to develop CVideot (1998), which was essentially an improved version of VideoNoter and a popular commercial, pre-digital video analysis tool in the 90s. Pea currently heads the Stanford-based DIVER project. Pea and his colleagues (2003) have created a program enabling its users to view video from varying perspectives.

¹⁴ as opposed to event-based like its contemporary Learning Constellations (Goldman-Segall, 1990). Event-based analysis can be done using thematically indexed, non-linear chunks of video data.
One of the fundamental capabilities of VideoNoter was *progressive refinement*. It was possible to start the analysis with a coarse coding scheme and “zoom in” by adding progressively more intricate layers. This is a technique employed by many videographers today: It is common to classify the larger themes first before putting short episodes under the analytic microscope. Indeed, analysis at varying levels of detail can offer useful, complementary accounts. A demonstration of the usefulness of multi-level analysis is given in chapter 3 of this manuscript. The method of analyzing lesson structures described there makes use of two coding passes, the second more refined than the first.
Tobin, Wu and Davidson (1989) studied pre-schools in Japan, China, and the United States. They used video differently from their predecessors as, with their work, there is an emphasis on the aesthetic features of the recordings. Tobin et al. argue that classroom videos can be made more effective as “provocations and stimuli” by making them more aesthetically pleasing and entertaining. Videos that can stand on their own, and not just as research tools, must be “hybrid constructions, blurred genres that are simultaneously social scientific documents and works of art” (Tobin & Hsueh, 2007, p. 79). This is certainly desirable for videos meant for professional development. However, as Mead...
(1975) argued, if the recordings are being used only by researchers, it is usually more practical to view unedited and wide, perhaps unexciting, group shots.

As evidenced by these new ways to see and use classroom videos, mathematics education enjoyed a breath of fresh air in the 1980s. Schoenfeld (2002) writes: “The field [of mathematics education] had escaped from the paradigmatic and theoretical straightjackets of the earlier part of the century, and it was virtually bursting with energy and excitement” (p. 443). A diversification of research thrusts had taken place. Research in mathematics education was now about more than just studying the retention rates of facts and procedures. Instead, for example, social contexts in education and different aspects of cognition, such as problem-solving strategies and beliefs, were being explored. The widening research interests required new methods, and video was seen as a useful means for obtaining data. On the other hand, the emergence of video as a research tool necessitated new theoretical directions. Thus the theoretical developments and the new tool went hand-in-hand, with a symbiotic relationship to each other.

2.2.6. 1990s: The Digital Decade

Significant theoretical, methodological, and technical advances in mathematics education research took place during the “digital decade”. The 1980s had ended with a flurry of activity within the domain of video-based classroom research, and the 90s saw this “hot” tool being used in many new lines of research. Video
technology was becoming ever more available, and the video analysis software developers continued their efforts to stay abreast of the evolving needs of the pedagogical researchers. The projects grew more ambitious; the TIMSS video studies of 1995 and 1999 were the first large-scale international studies using data from classroom video footage.

The first major international video-based classroom research project was the TIMSS 1995 Video Study (Stigler et al., 1999; Stigler & Hiebert, 1997). The scope of the study was unprecedented: 231 eighth-grade mathematics lessons were taped in the three participating countries: Japan, Germany, and the US. It was the first time a nationally representative sample of classroom video data was obtained in the US (Stigler et al., 1999, p. 2). The TIMSS-team found significant cross-national differences in lesson structures, content, the type of mathematical thinking evoked during the lessons, and the teachers’ views about reform in mathematics education (Stigler et al., 1999). The follow-up to the TIMSS study, the TIMSS 1999 Video Study was a more ambitious undertaking than its predecessor: 638 lessons in seven countries were recorded (Hiebert et al., 2003). In many ways the second TIMSS study was a major improvement on its predecessor, although much of the philosophy and methodology remained the same. These studies, as well as another important international video study, the Learner’s Perspective Study, will be discussed in Section 2.3.

The advent of digital technologies facilitated the development of video analysis into the powerful tool it is today. The so-called digital revolution of the
1990s transformed video-based research by making it easier to record, edit, analyze, and archive video footage. Digital camcorders, which became available in 1995 (Shapiro, 2006), and a new generation of powerful software utilizing digital video made it feasible for researchers to conduct larger and more substantial studies than before. In the 1990s, video technology quickly became cheaper, more user-friendly, and smaller in size. Furthermore, the 1989 introduction and the subsequent growth of the World Wide Web made it easier to conduct and share research (Gillies & Cailliau, 2000).

An early example of a digital video analysis program is vPrism. It was created in 1996 for the first TIMSS study and was available for Macintosh® computers only (Johnson, 2002). This software made it easier to code and organize video content, log events, create links to other documents, and publish the coded information. Transcripts could be made to run along the video. Additionally, having random access to the footage enabled jumping to any point on the video with just a click of a mouse — no more fast-forwarding and rewinding. With vPrism, as with other digital video analysis software, it was no longer necessary to have a separate monitor and a VCR unit; the analysis could now be done with the computer alone. Another major advantage of vPrism and other digital video analysis software over analog programs is that the footage does not deteriorate in quality regardless of how many times it is viewed or copied. vPrism is no longer developed or supported (Johnson, 2002).
Other digital video analysis programs developed in the 1990s include Transana (Fassnacht & Woods, 1999), NVivo (Richards & Richards, 1999), and ATLAS.ti (Muhr, 1996). The last two have roots in the pre-digital era but were transformed into digital tools later. Some of the video analysis programs that were developed in the 90s, like CVideo (Roschelle, 1998) and Timelines\(^\text{15}\) (Harrison, Owen, & Baecker, 1994), did not make the transition into the digital era. Not all video analysis programs are meant for educational research; Sanderson and her colleagues (1994) refer to more than forty pre-digital video analysis tools with wide-ranging applications. The current number is in the

\(^\text{15}\) An earlier version of Timelines was VANNA, whose name came from Video ANNotation and Analysis (Harrison & Baecker, 1992).
hundreds with specialized software for fields like health care (e.g., Dartfish, 2007), focus group analysis (InterClipper, 2007) and various team and individual sports such as hockey (TechniCoach, 2003) and golf (e.g., cSwing, 2007).

2.2.7. 2000s: Coming Together in Collaboratories

The new millennium’s first decade saw the emergence of pedagogical video collaboratories, or online collaborative video-based research communities (e.g., Baecker, Wolf, & Rankin, 2004; Pea, 2006). Via collaboratories, researchers can work with each other independent of their geographic locations. Ideally, a collaboratory is an agent for synergy. Goldman’s perspectivity framework (2007b) offers an approach to learning collaboratively from video. It encompasses four cornerstones: epistemology, ethnography, evaluation, and ethics. A consideration of these cornerstones reveals many of the current views on video-based pedagogical research. These views also are transparent in the latest technology. Current video analysis tools, such as Studiocode (Sportstec, 2005) and Videograph (Rimmele, 2002), represent significant upgrades over their predecessors in the lineage of software development. Using experiences and know-how from the past few decades, several reports on the issues of using classroom videos for research purposes have been published in recent years (e.g., Goldman, Pea, Barron, & Derry, 2007; Clarke, Sahlström, Mitchell, & Clarke, 2004; Ulewicz & Beatty, 2001). These works are recommended for anyone planning to use video analysis in educational research.
Historically, collaboration has depended on physical proximity (Kraut, Egido, & Galegher, 1990). However, the thought of being able to work together over distances has fascinated research communities for quite some time. In fact, the idea of researchers archiving their data, video or any other kind, and collaborating through a “virtual” location can be traced back to at least Mead and her colleagues (Hockings, 1975). But perhaps the first major step toward a collaboratory in a modern sense was the NSF-supported invitational workshop at Rockefeller University (Lederberg & Uncaphar, 1989). The term “collaboratory” was coined by William Wulf, one of the participants in the workshop. He envisioned the collaboratory as a "center without walls, in which the nation’s researchers can perform their research without regard to physical location, interacting with colleagues, accessing instrumentation, sharing data and computational resources, [and] accessing information in digital libraries" (Wulf, 1989, p. 19). Following Wulf’s vision, many groups dedicated to the study of collaboratories have actively developed and operated them (e.g., www.scienceofcollaboratories.org).

Collaboratories were conceived primarily for researchers in the physical sciences. Indeed, they were the first to experiment with collaboratories (e.g., Star & Ruhleder, 1994; van Buren, Curtis, Nichols, & Brundage, 1995; Caspar et al., 1998). Researchers in other fields, like the learning sciences, have followed. A National Research Council panel chaired by Wulf laid out four main criteria for successful online collaboration: 1) archiving and retrieving of data, 2) software
sharing, 3) synchronous and asynchronous communication, and 4) ability to control remote instruments. The last criterion was formulated with the physical sciences in mind, but the others apply to all fields still today. Remote collaborations are prone to problems, but if the above criteria are met, failure is less likely (National Research Council, 1993). Examples of collaboratories include ePresence (Baecker, Fono, & Wolf, 2007), ORION (Goldman, 2007a), DIVER, VideoPapers, VideoTraces, and TalkBank. All of these allow collaborators around the world to access live or archived video feeds, communicate with one another, and share commentary. Each of the current and future collaboratories must consider the important ethical issue concerning the safety of the audiovisual records. Can the anonymity and the confidentiality of the participants be guaranteed? At least the former seems difficult to protect (Ulewicz & Beatty, 2001, p. 18). Another issue connects the collaboratories with the teachers and the students: Given how unpredictable future uses of the recordings might be, how are the study participants informed of possible sharing of the audiovisual documents (Barron, 2007)?

There is some evidence that computer-mediated communication, or CMC, (email, bulletin boards, mailing lists, collaboratories, etc.) enhances research productivity (e.g., Walsh & Roselle, 1999; Walsh & Maloney, 2007). Walsh and Roselle (1999) suggest that the use of CMC increases academic productivity by facilitating knowledge and information exchanges and increasing scholarly collaboration. Walsh and Maloney (2007) discuss some of the many factors
related to the efficiency of CMC: the effects of the group size, diversity in the backgrounds of the group members, physical distance, group cohesion, task interdependence, competition among group members, and commercialization. They identified two main types of problems: 1) problems of coordination and misunderstandings, and 2) problems of cultural differences and information security. Problems of the first type are associated with group size, distance, interdependence, and competition. Problems of the second type are associated with group size, distance, scientific competition, and commercialization. The use of email reduces coordination problems of the first type, but not the second.

Goldman (2007b) explores the idea of collaborating through multiple viewing perspectives in her perspectivity framework. Still working from the notion that different viewpoints significantly enhance sense-making as well as reduce bias and misrepresentation, she describes a framework which embraces different conceptual perspectives and is open and flexible to the many theories and methodological approaches that have emerged—and will continue to emerge—within the field of education. In the perspectivity framework, the researchers do not attempt to arrive at a universal perspective, but rather view the differing perspectives as data. According to Goldman, the perspectivity framework “illustrates how emerging video technologies become epistemological tools, perhaps better tools than any we have had to date, for researchers, viewers, and those being videotaped to share what they are seeing, making, doing, and thinking while in the process of learning” (p. 15).
The perspectivity framework is based on four cornerstones: epistemology, (post-modern) ethnography, evaluation, and ethics. Goldman explains the epistemological component of her framework via the “galactic metaphor” (2007b; Goldman-Segall, 1998): A galaxy consists of stars and constellations. Constellations are clusters of stars interacting within large systems of constellations. Viewing from any one location, a constellation seems to be moving about the sky as one entity. Yet they seem to remain intact with respect to each other. But it is in fact our standpoint that is changing as our planet turns. This metaphor is meant to convey the idea that each person has a unique viewpoint, a situated context in the sense of Lave and Wenger (1991), from which to experience and try to understand the world. Combining the idea of “galactic” viewpoints with a post-positivist understanding of representations—dynamic and relative rather than fixed and universal—Goldman imparts a way to think about sense-making in collaborative terms: “multiple representations of thinking change our limited perspective” (2007b, p. 20).

Some of the ethnographical methods and attitudes have successfully crossed over from anthropology to educational research during the past few decades. Video techniques were first utilized by ethnographers to describe and represent what they experienced while becoming involved with unfamiliar people carrying out their daily lives (Goldman, 2007b, p. 26). Using video, different cultures—in the marketplace or the classroom—can be documented and interpreted. These interpretations often take on a qualitative nature. This is in
stark contrast with the process/product-type descriptions that were so common in pedagogical research prior to the cognitive revolution. The ability to share videos, a pre-requisite of the perspectivity framework, has become nearly universal with the reach of the internet and related technologies. Goldman believes that this ability helps us overcome culture-centrism and move “from exploitation to placing value on transcultural representations of self, identity, community, and culture” (p. 28). In her work, Goldman carries on the torch that Mead and the Spindlers carried before her.

Evaluation, or E-Value-ation, as Goldman calls it, is another cornerstone of the perspectivity framework. It is imperative that pedagogical researchers using video strive for accountability, reliability, and rigor (2007b, p. 29). However, as James Clifford pointed out in 1986, the most we can have is “partial truths, partial insights, and partial knowledge,” or as Gaensler put it, “a galaxy thriving on chaos” (both quoted from Goldman, 2007b, p. 29). With this in mind, Goldman urges pedagogical researchers to obtain many intersecting viewpoints when analyzing video in order to provide the reader/viewer with a valuable artifact (2007b).

Ethical considerations round out Goldman’s perspectivity framework. She warns of “educational colonialism,” and advises researchers to not repeat with these powerful visual tools what “the tall ships of yesteryear did to others—capture, collect, dissect, categorize, and construct hierarchies” (2007b, p. 34). Instead, these new tools should be used to the advantage of all, to build bridges
instead of borders. Researchers should be aware of how their actions affect those being studied, and find ways to share insights with all the members of the learning community.

The perspectivity framework is a culmination of Goldman’s work over the last twenty years. Her dissertation, *Learning constellations: A multimedia ethnographic research environment using video technology to explore children's thinking* (Goldman-Segall, 1990), and related projects represent the first phase of an active career in video-based research. Goldman has created several video analysis programs based on her *points of viewing theory* (2007b; Goldman-Segall, 1998; Goldman-Segall & Reicken, 1989). Her latest program is called ORION and, like Learning Constellations (Goldman-Segall, 1990) and Web Constellations (Goldman-Segall, 1998) before it, derives its strength from the thick descriptions emerging from the multiple viewpoints of the users. The collaborative knowledge construction process of ORION takes place online. According to Goldman (2007a), its most important feature is the *significance measure*, which enables the users to rate keywords and create charts containing the significance measures of all the users working with a given database. ORION-users must be team players; as events are viewed through intersecting viewpoints, the viewers must maintain an open mind in order to learn from each other’s interpretations.

Researchers have come to expect much from video analysis software. Pea and Hay (2003) identified several functionalities that video analysis tools of various kinds possess. These include interoperability between tools, flexible
acquisition of video, chunking of lesson events, transcription, easy navigation, organization and asset management, commentary, coding/annotation, reflection, sharing, and presentation (p. 12). It is not conceivable for any one piece of video analysis software to support all of the above functionalities, although many of the current software packages do support a number of them. One such program is Studiocode (Sportstec, 2005), which was used in the LPS. Another program is Videograph (Rimmele, 2002), which was created to aid in the analysis of the German IPN Video Study classroom video footage. The main strength of Videograph lies in the effective facilitation of quantitative analyses of videos. The visual, timeline-based coding tool is the core feature of this software. The user has complete control over the coding categories. Coding may also be based on events rather than time segments. The coding intervals can be grouped with definable filtering criteria. With this feature, lists of segments can be put together for playback and analysis. Videograph supports multiple video screens. It features easy exportation of coded data to statistical programs like SPSS. It also is possible to export coded data and transcripts to other programs such as EXCEL and Word. Studiocode has similar, perhaps even more flexible functionalities. Studiocode and Videograph represent a video analysis software generation that can support the classroom researchers in many more ways than those in the past.
2.2.8. Summary

Video analysis has come a long way in a hundred years. Advances in technology as well as the diversification of theoretical, epistemological, and methodological perspectives have contributed to the importance of video analysis as an observational tool. Video analysis is no longer the perplexing and often problematic research method it once was for Boas and other pioneers. Instead, the use of video has been accepted into many fields of research as the flexible and powerful—though not issue-free—tool that it is.

Section 2.2 highlighted some of the important authors, studies, and software tools regarding video analysis as a research tool. This section, decade by decade, called attention to the kinds of evolutionary stages this tool has
undergone. Now that the method of video analysis has matured and researchers have had the opportunity to use it in numerous ways, it is time to take stock. It is reasonable to ask what the most useful ways to use video are. As Schoenfeld (2002) writes about the proliferation of theoretical and methodological perspectives within the field of mathematics education, “Having let a thousand flowers bloom, it is time for researchers in mathematics education to prune their garden. We must begin to ask and address the difficult questions about theory and methods that will help us move forward” (p. 443).

2.3. Classroom Video Analysis in the Spheres of Different Theoretical Frameworks

2.3.1. Overview

All research is grounded in theory. The theoretical assumptions of the researcher greatly effect both the observation and the interpretation processes. This section demonstrates how researchers with differing theoretical dispositions can make and manipulate data from video footage.

A diversification of aims took place within the educational research community in the late 1970s and early 80s. Some of the prevalent—and often overlapping—theoretical frameworks in mathematics education from the 1980s on have been sociocultural, cognitive, and constructivist in nature (Schoenfeld,
What follows is a brief synopsis of each of these theoretical frameworks together with examples of video-based studies that have been conducted under each theoretical umbrella.

2.3.2. **Sociocultural Theory**

The central premise of sociocultural research in education is that pedagogical practices are always embedded in a culture and a value-system. The cultural context of the learning environment and the social interactions occurring within it are essential in portraying a thorough representation of the teaching/learning process. Vygotsky’s idea that learning occurs through social interaction, while largely ignored by the educational research community prior to the 1970s, was resonated by a growing group of mathematics education researchers in the 1980s and 90s. Prior to the diversification of theoretical frameworks that started in the 70s, researchers had been focusing on the isolated individual, the single learner or the single teacher. Subsequently, the importance of the individual’s social and cultural surroundings was acknowledged. Symbolic of this development was a change in the meaning of the word “interaction.” Prior to the 1980s, the word had been used by researchers mainly to refer to interaction between variables such as aptitude and treatment, but since then, it has usually been understood to refer to interpersonal interaction (Bauersfeld, 1993, p. 133)\(^{16}\).

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\(^{16}\) The word is used with both meanings in the later chapters of this report.
There are numerous strands of pedagogical theory stemming from the genius of Vygotsky: activity theory (e.g., Leont'ev, 1978; Engeström, 1987), situated learning (Lave & Wenger, 1991), situated cognition (Clancey, 1997), and sociolinguistics (e.g., Bourdieu, 1991; Zevenbergen, 2001) to name a few.

Looking at education through a sociocultural lens is not a new concept. During the Stanford Education-Anthropology Conference in 1954, George Spindler addressed “the necessity for sociocultural contextualization of the educative process” (Spindler & Spindler, 1987, p. 3). Stressing the cultural relativity of education, he suggested a new, more sociocultural direction for pedagogical research. However, it was not until decades later that researchers would follow his advice. In a paper for the 1954 conference Spindler wrote

all [societies] have groups structured into a social organization. Whether this structure is formalized by a widely ramifying kinship system, or by rank, or by a complex political-social system, or is atomistic and individuated – the who, what, when, and why of education will reflect this structure at every turn (1955, p. 9).

Language is crucial in the learning process. Zevenbergen (2001) argues that students will often be either recognized or marginalized in school based upon their linguistic background. This predisposition correlates with academic performance: Those who speak the language used in classroom interactions are more likely to succeed (p. 202). The flipside of the coin is alarming; as Bourdieu, Passeron, and de Saint Martin put it, “[t]he more distant the social group from
scholastic language, the higher the rate of scholastic mortality” (as quoted in Zevenbergen, 2001, p. 214). The same could be said for cultural backgrounds. Fortunately, as Harker (1984) points out, students can rise above their linguistic and cultural circumstances. The habitus, or the totality of learned habitual structures and cultural knowledge, can be reconstituted to be closer to that which is necessitated by the culture of the classroom. However, such reconstitution will not occur without substantial effort (Harker, 1984).

Using video, Lemke (1990) analyzed the role of language in the social interaction patterns in science classrooms. He identified certain highly ritualized discursive patterns within the classroom interactions through which knowledge is transmitted and acquired. These patterns are not explicitly taught, but instead, they are embedded in the classroom culture. An example of such a discursive pattern is the triadic dialogue, also known as the IRE pattern (from teacher-initiated question, student response, and teacher evaluation) (Hiebert & Grouws, 2007; Mehan, 1985). The following is an example of such a pattern of discourse:

Teacher: What is the circumference of a circle with radius 1?

Student: Pi.

Teacher: Well, pretty close. Someone else?

Another student: Two times pi.

Teacher: That’s it.
This common form of classroom dialogue can be detrimental to the development of the students’ critical thinking skills. Lemke recognizes the prevalence and the danger of it:

Triadic dialogue is an activity structure whose greatest virtue is that it gives the teachers almost total control of the classroom dialogue and social interactions. It leads to brief answers from students and lack of student initiative in using scientific language. It is a form that is overused in most classrooms because of a mistaken belief that it encourages maximum student participation. The level of participation it achieves is illusory, high in quantity, low in quality (1990, p. 168).

Even teachers who attempt to teach toward deeper understanding of concepts often maintain this paralyzing discursive pattern in their classrooms. Franke, Kazemi, and Battey (2007) provide healthy alternatives.

2.3.3. Cognitive Theory

Cognitive theories have been popular in mathematics education for over 30 years (e.g., Schoenfeld, 2002). There is a plethora of theoretical approaches that involve the study of cognitive processes: what they are, which mechanisms are involved, how they are related to technology and culture, etc. The amount of literature devoted to problem-solving alone is vast (e.g., Newell & Simon, 1972; Kilpatrick, 1978; Schoenfeld, 1985, 1992; Lesh & Zawojewski, 2007; Cooney, 1985). Furthermore, there is considerable overlap with other theoretical families. For instance, many have argued that the sociocultural context is crucial for
understanding cognitive development (Saxe, 1991; Perret-Clermont, 1993; de Abreu, 2000; Chaiklin & Lave, 1993; Resnick, Saljo, Pontecorvo, & Burge, 1997).

Some of the lines of inquiry into cognitive processes rely on video as a tool. Three examples of different ways to utilize video technology are presented here. Goldman (1998) studied how children think and construct meaning by giving a class of middle school students video cameras and instructing them to make their own media portraits. The participants then became the researchers as the class collaboratively analyzed the culture-rich creations. Goldman’s student-videographers layered the recordings with contextual descriptions and commentary, thus creating a thick description of each portrait (Goldman-Segall, 1998).

One way to use video in research into cognitive processes is to record think-aloud problem-solving protocols and/or clinical interviews. One such study using these protocol methods was done by Randhawa (1994). Her methodology is typical of this type of study and will be summarized here. The forty participants in the study represented the top and the bottom quartiles of 12th grade students, as determined by the results of the 40-item Canadian MAT (Mathematics Ability Test). Equal numbers of boys and girls were selected. Each child was given nine “everyday mathematics” problems to solve, and they were asked to think aloud while solving them. A video record of the session was kept. A clinical interview was held the day after the problem-solving session and the children were questioned about their strategies of solving the problems. This
session also was recorded. The videotapes of both sessions were then coded with regard to the evidence of nine cognitive and meta-cognitive skills using a five-point Likert scale. The ratings were analyzed in a 2x2 (ability level x gender) ANOVA design for each skill. Not surprisingly, the high-achieving students obtained more correct answers and used each of the problem-solving skills more frequently. The multivariate gender effect also was significant (p<.05), but the univariate gender effect was significant only for four of the nine skills. Of those, the frequency of only one, mental computing, was higher for the girls. Her results suggest that boys and girls acquire different cognitive structures for dealing with mathematical problems (Randhawa, 1994).

Although verbal accounts and self-reports can never give a complete representation of cognitive mechanisms, and there can be concerns with the contingency effects and report interference with these methods, they can still be useful in enhancing our understanding of children’s thinking (e.g., Ginsburg, Kossan, Schwartz, & Swanson, 1983). Video can improve the accuracy of protocol methods as it offers the possibility of repeated viewings by multiple researchers. However, the challenge of having to externalize the internal cognitive processes remains (Randhawa, 1994, p. 218).

Another example of effective use of video technology involves the stimulated recall strategy. It can be used in a wide variety of research applications. As part of this method, the participants are shown video footage of their own actions shortly after the taping. They are asked to talk about what they witness
on the recordings. In a sense, they are asked to relive the original situation in a clinical setting. Some researchers ask the participants to stop the tape when they see something worthy of a remark so that there is ample time for comments. The self-analyses are recorded and analyzed. They provide the researchers with an insider’s viewpoint that may differ considerably from that of their own. The viewings may be done individually with each participant or in groups. The first use of stimulated recall was by Bloom (1953), but he used only audio recordings. The Spindlers used this technique with the teachers at Schoenhausen in what they called reflective interviewing (Spindler & Spindler, 1987). Hmelo-Silver, Katić, Nagarajan, and Chernobilsky (2007) offer a more recent application of stimulated recall. They analyzed the interactions of student-centered peer learning groups and identified “soft leaders” within them.

2.3.4. Constructivist Theory

At the core of the constructivist learning theories is the idea that the learner actively constructs new knowledge based upon his or her own experiences (e.g., Steffe & Gale, 1995; von Glasersfeld, 1987). The process of learning is thus a personal endeavor from the constructivist point of view. According to Anthony (1996), learning is an “idiosyncratic, active and an evolving process” (p. 349). Wang, Haertel, and Walberg (1993) consider “learners as architects building their own knowledge structures” (p. 277). Although constructivism does not imply a particular kind of pedagogy, it is understood that the role of the instructor is one
of a facilitator and that the learners learn by doing (e.g., Cobb & Bauersfeld, 1995).

The sociocultural aspects of learning also are recognized in constructivist educational theories. In fact, social constructivism is one of the most important strands of research in the family of constructivist theories. Its main idea is that knowledge construction is a social process. Working with others gives us opportunities to share, organize, and clarify information (Gredler, 1997; Steffe & Gale, 1995). Gredler (1997) maintains that the construction of social meanings (i.e. socially agreed-upon notions about the world) involves intersubjectivity among the members of the learning community. Other key approaches found in the educational constructivist continuum include constructionism (Papert, 1991), radical constructivism (Steffe & Kieren, 1994), discovery learning (Bruner, 1961), and cognitive flexibility theory (Spiro & Jehng, 1990).

The anchored instruction paradigm stresses the importance of situating learning in a meaningful, problem-solving context. It uses context as a learning device (Bransford, Sherwood, & Hasselbring, 1988; Cognition and Technology Group at Vanderbilt (CTGV), 1990). In this pedagogical approach, video technology is used to situate, or anchor, the learner in a relevant context. The video anchors are shown to the learner in order to bond the content with the context (CTGV, 1990). Petrosino and Koehler (2007) studied the usage of video technology in teacher training. They use a system, IVAN (Interactive Video Access Neighborhood, developed at Michigan State University in 2003), which
working at all” (p. 1070). According to Brophy, an effective teacher presents information, develops concepts through lecture and demonstration, elaborates and/or re-teaches when required, and works out examples for the class among other forms of instruction. In addition, an effective teacher “carries the content to the students personally, rather than depending on curriculum materials alone to do so” (Brophy, 1986, p. 1070). Finally, Mayer (2004) urges we “move educational reform efforts from the fuzzy and unproductive world of ideology—which sometimes hides under the various banners of constructivism—to the sharp and productive world of theory-based research on how people learn” (p. 18).

Cognitive theory provides a rationale for avoiding minimally-guided instruction for novices. In essence, the cognitive load theory [CLT]-based argument states that it is sensible to teach basics and procedures to the class so that the students do not overload their cognitive faculties with trivialities, but can instead concentrate on understanding the concepts at hand. If the students 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 the basics before meaningful learning can begin (see, e.g., a special CLT-issue of Instructional Science, 2004, 32(1-2)). CLT is similar in spirit to the notions of cognitive apprenticeship (Collins, Brown, & Newman, 1989) and cognitive modeling (Bandura, 1997). Both see the teacher as a coach who first shows the apprentice how something is done, and then provides assistance at the most critical level—the level just beyond what the apprentice could do by him or herself.
2.4. Major Video-Based Classroom Studies in Mathematics Education

2.4.1. Overview

The digital revolution of the 1990s made large-scale video-based studies feasible. Major international classroom studies include IEA-sponsored TIMSS 1995 Video Study (Stigler et al., 1999) and the TIMSS 1999 Video Study (Hiebert et al., 2003), as well as the Learner’s Perspective Study [LPS] (Clarke, Emanuelsson et al., 2006). Although these international collaborations share some characteristics, the philosophy behind the TIMSS studies differs significantly from that of the LPS. In fact, in many ways they are complementary. This section offers a short discussion of each of these studies as well as some comparative remarks.

2.4.2. TIMSS 1995 Video Study

In search of national patterns and cross-national variations, the initial TIMSS video-based classroom study set out to analyze single lessons from 231 mathematics and science teachers from Germany, Japan, and the US. Researchers from each of these countries participated in devising a coding system that includes variables for analyzing lesson structure, interaction, discourse, pedagogical techniques, and content among others. The first TIMSS video study

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17 IEA also sponsored the 2003 TIMSS, but it did not include a video study.
found that students from Germany and the US are guided to think similarly about mathematics and mathematics lessons, while the high-achieving Japanese students encounter different kind of pedagogy. For instance, the average percentage of seatwork time spent on practicing routine procedures is 96 in the US and 90 in Germany as opposed to only 41 in Japan. On the other hand, Japanese students spend 44% of seatwork time inventing new solutions compared to 1% and 4% in the US and Germany, respectively (Stigler et al., 1999, p. 102). Apparently, Japanese lesson structures differ significantly from those of the other two participating countries. According to Stigler and colleagues, teachers in the US and Germany generally follow the acquisition/application script (see also Hiebert et al., 1996)—a taught lesson precedes practice. In the Japanese lessons the order of activities is often reversed; an initial problem-solving phase is followed by a summary of methods and concepts.

The TIMSS 1995 Video Study used a one-camera recording design as described in Section 1.7.2. The videographers were instructed to record the lessons from the perspective of an “ideal student,” primarily following the teacher, but also capturing other significant events (Stigler et al., 1999, p. 15). Using only one camera restricts the information that can be drawn about classroom practice. Especially the social dimension of the learning environment can be difficult to study with only a teacher camera that is positioned in the front of the classroom, largely ignoring the majority of the participants.
2.4.3. **TIMSS 1999 Video Study**

Similar in its theoretical underpinnings, the second major international video-based classroom study was a more ambitious undertaking than its predecessor. The many lessons learned from the 1995 study contributed to a more informative second effort. In addition to 638 eighth-grade mathematics lessons from seven countries—Australia, Czech Republic, Hong Kong, Japan, Netherlands, Switzerland, and the US—science classes from five of those countries also were videotaped and analyzed for the purposes of the 1999 study. This section focuses on the analysis of the mathematics lessons.

Perhaps the most important finding of the TIMSS 1999 study is that there are many paths to success; mathematics lessons in countries with high-achieving students are conducted in a variety of ways. After the TIMSS 1995 study, it may have been tempting for some to conclude that the adoption of the Japanese way of teaching mathematics is necessary to significantly boost mathematics test scores. However, this is not the case, as the TIMSS 1999 results indicate.

The Japanese lessons stood out also in this study. Japanese students spend less time on procedural practice and more time making connections, writing proofs, thinking at a higher level, using physical materials, and finding original solutions to application problems than do the students in the other participating countries (Hiebert et al., 2003, Chapters 4 and 5). Ironically, the pedagogical methods that the Japanese mathematics teachers employ are closer to those
recommended by the US mathematics reforms than are those used by the US
teachers (Stigler et al., 1999, p. viii).

The methods of the TIMSS 1999 Video Study were largely inherited from
the initial study. However, a two-camera recording approach was used this time.
The recording set-up is similar to that of the IPN study, described in Section
1.7.2. The coding schemes used in the 1999 study were based on the 1995 study.
Some new variables were developed, and several of the old variables were
adjusted to catch some of the unique, hypothesized pedagogical characteristics
evident in the classrooms of the participating countries. To identify these
characteristics, experts from each participating country were consulted prior to
the study. As in the first study, the focus of the analysis was on lesson structure,
the nature of the mathematics presented, and the ways in which mathematics
was considered in the lessons (Hiebert et al., 2003, pp. 9-10).

To be able to obtain nationally representative samples, the TIMSS team
decided to again include only one lesson per teacher. Since mathematics
curricula are not divided into daily units, a better idea of each teacher’s
instructional methods can be obtained by analyzing a sequence of lessons instead
of a single lesson (Clarke, Emanuelsson et al., 2006). Although the teachers are
asked to conduct a “typical” mathematics lesson, it may be tempting for some of
them to conduct the kind of lesson that they think the researchers want to
observe. If several lessons are recorded, this temptation may be reduced.
Additionally, camera effects may be reduced after the first recorded lesson.
In discussing “national patterns” in teaching and learning, it is generally assumed that such patterns exist. However, it might well be that a nation does not have distinct classroom patterns or lesson structures (Clarke, Emanuelsson et al., 2006, p. 26). Although national borders provide convenient groupings for comparative studies, other ways of clustering classrooms may also prove useful.

2.4.4. The Learner’s Perspective Study

The LPS research design was created to complement the TIMSS studies. Since some of the researchers in the LPS team, most importantly David Clarke, had worked on at least one of the TIMSS studies, the TIMSS research was familiar to them. Instead of nationally representative samples, the LPS project looked at the classroom practices of small samples of “hand-picked” teachers in twelve countries. Like the TIMSS studies, the LPS also set out to look for “structure in diversity” (Clarke, Emanuelsson et al., 2006, p. 3). However, identifying generalizable national patterns was not the objective in this study. Instead, the goal was to recognize some of the similarities and differences in the classroom practices of competent teachers around the world. To this end, at least ten consecutive lessons were recorded in order to capture a more complete picture of each teacher’s practices. Lesson events, such as “Kikan-Shido” (i.e. between-desks instruction: students work while the teacher walks around the classroom and helps) and “Student(s) at the Front,” rather than the whole lesson, were taken as the units of analysis. Instead of the “survey-style approach” (Clarke,
Emanuelsson et al., 2006, p. 30) of the TIMSS studies, the LPS makes use of complementary accounts. The sources of the data—comprehensive audiovisual records, video-based reflective interviews with the teachers and some of the students, standardized tests, recent mathematics exams, questionnaires, learning materials, and student written material—constitute a thorough, well-triangulated approach to data collection (Clarke, Emanuelsson et al., 2006).

The premise of the LPS is that education is culturally-situated. Teaching practices are innately culture-bound and value-laden. One of the main ideological differences between the studies discussed in this section is that the LPS includes extensive analyses of the interactions of the forms and the functions of classroom events. In classroom research, “what you see is often not what you get” (Eva Jablonka, personal communication, June 7th, 2007); similar forms of classroom activity can serve a variety of pedagogical functions. Investigation of this kind can be effective in examining evidence of the situatedness of teaching and learning.

Drawing on the ideology and the video footage of the LPS, Jablonka (2004) conducted a lesson structure analysis of six mathematics classrooms as part of her habilitation thesis. Her main research question is “To what extent are teacher and learner practices in a mutually supportive relationship?” Jablonka’s qualitative approach uses the forms and the functions of lesson events in attempt to find cross-cultural differences and similarities in classroom practices. Particular attention is paid to the participants’ perceptions of classroom events.
Jablonka found that there are cross-cultural similarities in how students deal with the classroom setting and how they assign meaning to distinct aspects of classroom practices. She also found that there are often discrepancies in what the teacher and the students perceive to be the aim of the lesson and that the students generally perceive lesson structure in terms of the forms of classroom interaction rather than knowledge development (Jablonka, 2004).

While the TIMSS studies offer quantitative analyses of teaching, the LPS is a mixed-method study focused on the learner. For instance, only word counts of public talk were included in the TIMSS studies, whereas the LPS reports include qualitative analyses of student-student interactions. The recording set-up, described in Section 1.7.2, allows for an in-depth look at each lesson from the perspectives of the different participants. The LPS offers an emic (insider, culture-specific) analysis of classroom practice and TIMSS an etic (outsider, culturally neutral) one. Considered together, the TIMSS and LPS studies give a comprehensive picture of classroom practices in the participating countries.

2.5. Finland and Iceland: PISA and Mathematics Education

2.5.1. Introduction

Finland and Iceland are in many ways noteworthy within the domain of mathematics education. Recent large-scale international studies have brought attention to the educational systems of these two Nordic countries. For example,
Finland has excelled in all three PISA studies, while Iceland is the only country where girls have significantly outperformed boys in mathematics (OECD, 2004, 2007b). This section offers a PISA-based look at the educational systems of Finland and Iceland. The emphasis is on PISA 2003, since that assessment focused on mathematics. A short account of few of the parallels and differences is followed by sections dedicated to each country. A comparative look at teachers’ salaries is also given.

Finland and Iceland have much in common politically and historically. Controlled by other Nordic countries— and Russia, in case of Finland— for hundreds of years, these two countries declared independence only within the last century. Both have subsisted in the fringes of Europe only to flourish recently, benefiting from globalization and the digital revolution. The populations of both countries are quite homogeneous due in part to their relative geographic isolation and strict immigration policies. Universal social rights and healthy economies have helped boost Finland and Iceland into becoming some of the most livable countries in the world: Iceland is second after Norway and Finland’s rank is 11th in the United Nations’ Human Development Index list that takes into account such quality-of-life variables as life expectancy, education, and GDP (United Nations, 2006, Table 1). Both Finland and Iceland have a state church, the Evangelical Lutheran Church, to which over 80% of the population belongs (Statistics Iceland, 2007; Kääriäinen, 2007).
The school systems in both Finland and Iceland exhibit extraordinary egalitarianism. The between-school variances in mathematical achievement in these countries are by far the lowest two of the PISA countries at around 10% of the OECD average level (See Figure 2.5) (OECD, 2005, Table 4.1a). In addition, Finland and Iceland are the only PISA countries in which the Economic, Social, and Cultural Status, or ESCS, index of the school has no effect on average student performance (OECD, 2005, Table 4.5).

![Between-School Variance on PISA 2003 Mathematics Test: Selected Countries](image)

Figure 2.5: Between-school variances on the PISA 2003 mathematics test (OECD, 2005, Table 4.1a)

Literature plays an important role in the lives and culture of both the Finns and the Icelanders. According to PISA figures, the Finnish students’ engagement in reading—newspapers, library books, etc.—is the highest in the world (OECD, 2003, Table A9.1). What is more, the “Finnish character” has a
sound literary foundation. Among the most important Finnish works of literature is Elias Lönnrot’s *Kalevala*, the Finnish national epic from the 1830s. It is a collection of poems which has significantly shaped the Finnish identity (see, e.g., Friberg, 1988). *Kalevala* has also represented the rich Finnish folklore canon in the field of comparative mythology (see, e.g., Pentikäinen, 1999).

Icelandic literature is probably best known for the medieval *sagas*—more or less historical accounts about, for instance, the Vikings’ voyages and migration to Iceland—and the more mythological *Eddas*. However, several more recent Icelandic writers have also been recognized on the world stage. A case in point is Halldór Laxness, a master of many literary styles, who won the Nobel Prize for literature in 1955. In his best-known novel, *Independent People* (1997), Laxness offers a consequential, left-leaning social commentary. The book’s main character is a proud and stubborn sheep farmer, who has a firm stance against the establishment. Despite living in harsh conditions and being plagued by superior forces, the farmer refuses help from others, and, instead, puts up a futile fight to gain absolute independence.

Education is deemed important in Finnish and Icelandic societies as evidenced by the number of Finns and Icelanders that attend school beyond the compulsory years. 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% puts them in third place behind Denmark, where 38% of people in the twenties are students (OECD, 2007a, Table C2.2). Finns and Icelanders spend
on average about 20 years of their lives in school, placing both of them among the top 5 of OECD countries with regard to the years of educational attainment (OECD, 2005, Chart C1.2). Both countries provide equitable access to higher education as attending a public university is virtually free of charge.

Parallels between Finland and Iceland are more difficult to draw when it comes to academic achievement. Finnish 15-year-olds excelled in PISA 2003 with an average score of 544 in mathematics and 543 in reading, both highest among the OECD countries\textsuperscript{18}, while the Icelandic students averaged 515 in mathematics (11\textsuperscript{th} among the OECD countries) and 492 in reading (18\textsuperscript{th}) (OECD, 2004, Tables 2.5c and 6.2). Finland’s mean score on the science scale was 548, another first place finish (tied with Japan), with Icelandic students scoring 495 (18\textsuperscript{th}) on average. The differences are even larger in PISA 2006 as Finnish scores have improved and Iceland’s declined. Finland’s scores and ranks in PISA 2006 are 548 (1\textsuperscript{st}) in mathematics, 547 (2\textsuperscript{nd}) in reading, and 563 (1\textsuperscript{st}) in science, while Iceland’s are 506 (12\textsuperscript{th}) in mathematics, 484 (18\textsuperscript{th}) in reading, and 491 (20\textsuperscript{th}) in science (OECD, 2007b, Tables 2.1c, 6.1c, and 6.2c). The differences were there also in PISA 2000, though they were not as pronounced: Finland’s reading, mathematics, and science scores were 546, 536, and 538, ranking 1\textsuperscript{st}, 4\textsuperscript{th}, and 3\textsuperscript{rd}, respectively, while Icelandic students had mean scores of 507 in reading (12\textsuperscript{th} among OECD countries), 514 in mathematics (13\textsuperscript{th}), and 496 in science (16\textsuperscript{th})

\textsuperscript{18} The ranks given in the PISA reports come with a degree of uncertainty since not all students answered the same set of questions. The country means, from which the ranks are computed, are given with 95\% confidence intervals.
(OECD, 2002, Tables A5.2, A6.1, and A6.2). The differing trends for Finland and Iceland can be seen in Figure 2.6. The mean scores are generally 500 points for each scale.

Figure 2.6: PISA 2000, 2003, and 2006 scores for Finland and Iceland (OECD, 2002, 2004, 2007b)

Teachers get paid more in Finland than in Iceland. The mean Finnish primary school teachers’ starting salary is $27,806 as opposed to $24,134 paid to new teachers in Iceland. The OECD average is $27,703\(^\text{19}\). After 15 years of teaching, both countries’ primary school teachers get paid less than the OECD average of $37,603: Finnish teachers earn on average $32,406, whereas in Iceland the mean salary after 15 years is $27,295 (See Figure 2.6). In higher grades the differences in pay are more significant. Finnish upper secondary school teachers

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\(^{19}\) All the amounts in this section are expressed in equivalent US dollars and using Purchasing Power Parities, or PPPs.
start at $34,681, while in Iceland the mean starting salary is $25,952. The OECD average is $31,154. After 15 years of teaching experience, a typical Finnish upper secondary school teacher earns $43,346, which is just slightly above the OECD average of $43,239. In Iceland the figure is only $31,966 (See Figure 2.7) (OECD, 2007a, Table D3.1). Furthermore, Finnish primary school teachers’ starting salaries have increased 34% between 1996 and 2005, the second highest increase among the OECD countries after Hungary. Teachers of older students have enjoyed even larger pay increases: Finnish upper secondary school teachers’ starting salaries have increased 43% between 1996 and 2005 (OECD, 2007a, Table D3.2). No data on teachers’ pay increases was readily available for Iceland.

Figure 2.7: Primary school teachers’ salaries (OECD, 2007a, Table D3.1)

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20 This was calculated using GDP deflators to convert the price levels of each year to those of 2005.
Finnish teachers earn above average wages when compared to all Finnish wage earners. The ratio of the mean salary (after 15 years of teaching experience) to GDP per capita is 1.05 for primary school teachers, 1.23 for lower secondary school teachers, and 1.40 for upper secondary school teachers. In contrast, Icelandic teachers earn below average wages: The salary to GDP per capita ratios are 0.75 for primary and lower secondary school teachers and 0.88 for upper secondary school teachers. The OECD averages are 1.28, 1.30, and 1.41, respectively (See Figure 2.8) (OECD, 2007a, Table D3.1).
2.5.2. **Mathematics Education in Finland: Equity and Efficiency**

Since their impressive showing in the first PISA study in 2000, the high-achieving Finnish schools, teachers, and students have been studied by educational researchers. The consensus seems to be that there is an intricate network of interrelated factors behind Finland’s success. They include many teacher-related variables such as the good quality of the teacher education programs, the relatively high status of educators—and the respect they command—within the Finnish society, professional pride among teachers, and the amount of creative freedom they enjoy. School-based curricula with active learning pedagogies, a national endeavor (the LUMA-project) to improve the teaching and learning of natural sciences and mathematics, effective remedial education in the early grades, and small class sizes have also been identified as contributors (Björkqvist,
The Finns’ unequivocal promotion of equity, typical Finnish characteristics such as obedience as well as other social, cultural, and historical factors also have been mentioned by some (Gorard & Smith, 2004; Simola, 2005). Furthermore, the Finnish school system has succeeded in supporting the weaker students as evidenced by the performance of the lowest-achieving 10 percent; the difference in the PISA 2003 mathematics test to the OECD average was 69 points and the difference to the runner-up, South Korea, was 15 points (OECD, 2005, Table 2.5c). The aim of the Finnish educational system seems to be to graduate full cohorts of well-educated citizens instead of concentrating only on the brightest students.

![Figure 2.10: Mathematics achievement by level (OECD, 2004, Table 2.5a)](image-url)
Teaching is a “Plan A”-type profession in Finland. This is evidenced by, among other things, the low acceptance rates of the teacher education programs; nationally, only some 15% of applicants are accepted. The rate is even lower for future primary school teachers, but higher for programs in mathematics and science education (Kansanen, 2003; Malaty, 2004).

Finnish teacher education takes place in universities. The prospective primary and secondary school teachers are given a research-based education generally lasting for five years and resulting in a 160-credit Master’s degree. Every future teacher writes a comprehensive research thesis, earns at least 35 credits from pedagogical courses, and practices classroom teaching in a university-affiliated school. In addition, subject teachers undertake a rigorous training within their fields (Kansanen, 2003). Effective in-service training is provided by various institutions such as the Ministry of Education, National Board of Education, local authorities, and teachers’ associations (Malaty, 2004).

The Finnish educational system seems immune to the common problems of time and money. Finnish students spend less time in the classroom and doing homework than any of their peers in countries that participated in PISA 2003 (OECD, 2005, Tables D1.2 and D1.3). Compared to all other OECD nations, a Finnish child can expect to receive the smallest number of intended instruction hours, 5523. On average, 7-14 year-old children in the OECD countries are intended to receive 6898 instructional hours (OECD, 2007a, Chart D1.1). The educational expenditure per student is only at the OECD average (OECD, 2005,
Thus it seems that in addition to being effective, the Finnish mathematics teachers and students are remarkably efficient in what they do.

A “grain of salt” is necessary when digesting the exceptional Finnish PISA results. PISA 2003 emphasized “mathematical literacy”. It was not meant to measure upper level mathematical skills required of future mathematicians and scientists, but instead the sort mathematics know-how that one might deal with in everyday life. Finnish students are probably at an advantage in such a test because of their sound reading skills; Finnish 15-year-olds received the highest marks in reading in both PISA 2000 and 2003 (OECD, 2004, p. 282). Although the differences in the average scores were rather small, the Finnish students received the lowest marks in the space and shape section which is considered to have the smallest percentage of test items highly correlated with reading ability (OECD, 2004; Roe & Taube, 2006). The language itself may also have something to do with the Finns’ accomplishments. Based on the virtually identical sociocultural circumstances of the Finnish students that speak Finnish and those that speak Swedish, and the fact that the Finnish-speakers have scored higher on the PISA tests, Björkqvist (2006) suggests that the speakers of Finnish may have an advantage. He asserts

It should be mentioned that the Finnish language is pronounced the way it is written, in the very regular way, which makes it easier to concentrate on the meaning of that which is read. Since there are strong correlations between the results on the different scales of the PISA study, these factors are relevant in the interpretation of the results with respect to mathematics. (p. 45)
2.5.3. **Mathematics Education in Iceland: The Gender Question**

Iceland is the only country in PISA 2003 with a statistically significant gender difference in the mathematics achievement scores in favor of girls (OECD, 2005, Table 2.5d). Although the gender difference is no longer statistically significant in PISA 2006 (OECD, 2007b, Table 6.2c), the gender issue keeps puzzling researchers. Despite a downward trend from 2000 to 2006, Iceland’s scores on the mathematics scale have remained above the OECD average. However, the PISA 2006 reading and science scores are below OECD averages. Table 2.1 summarizes the Icelandic PISA scores for all three assessments (M = Mathematics, R = Reading, and S = Science).

<table>
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<th>PISA 2000</th>
<th>PISA 2003</th>
<th>PISA 2006</th>
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<tr>
<td><strong>Girls</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>M</td>
<td>518*</td>
<td>523</td>
<td>508</td>
</tr>
<tr>
<td>R</td>
<td>528</td>
<td>522</td>
<td>509</td>
</tr>
<tr>
<td>S</td>
<td>499</td>
<td>500</td>
<td>494</td>
</tr>
<tr>
<td><strong>Boys</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>M</td>
<td>513*</td>
<td>508</td>
<td>503</td>
</tr>
<tr>
<td>R</td>
<td>488</td>
<td>464</td>
<td>460</td>
</tr>
<tr>
<td>S</td>
<td>495</td>
<td>490</td>
<td>488</td>
</tr>
<tr>
<td><strong>All Students</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>514*</td>
<td>515</td>
<td>506</td>
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<tr>
<td>R</td>
<td>507</td>
<td>492</td>
<td>484</td>
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<tr>
<td>S</td>
<td>496</td>
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Table 2.1: Icelandic PISA scores by subject and gender\(^{21}\) (OECD, 2001, 2004, 2007a)

\(^{21}\) The asterisks by the PISA 2000 mathematics scores signify that the mathematics scores from the first assessment are not fully comparable to the later scores because only two subscales, instead of four, were used in PISA 2000.
The Icelandic girls performed quite similarly to the Finnish girls on the PISA 2003 mathematics scale. Over a quarter of both groups scored at Level 3. However, compared to the Icelandic girls, a smaller percentage of Finnish girls scored below that level and a larger portion above it. The Finnish scores are the most remarkable at Level 1 and below; among the PISA 2003-countries, Finland had the smallest portion of students at these levels as only 6.3% of Finnish girls scored in the lowest two levels combined. The next lowest percentage, 9.0%, belongs to the Hong Kong girls. 11.6% of the Icelandic girls scored at Level 1 or below while 18.2% of the Icelandic boys did so (OECD, 2004, Table 2.5b).

![PISA 2003 math achievement levels by country and gender](image)

Figure 2.11: Mathematics scores by country and gender (OECD, 2004, Table 2.5b)

Ólafsson, Halldórsson, and Björnsson (2006) argue that there is no single explanation for the gender difference in mathematics. In particular, the so-called “Jokkmokk effect,” the idea that boys in rural areas of Iceland value traditional
careers such as fishing over academics, does not alone account for the gender differences. Other suggested possible explanatory factors include the high level of women’s empowerment, democratic development, and economic situations in Iceland (Ölafsson et al., 2006) as well as the type of gendered discourse that is common among Icelandic teenagers (Magnusdottir, 2005; Steinthorsdottir & Sriraman, 2007).

Within the educational community, the small rural town of Jokkmokk in Northern Sweden is known for its stellar female students as well as their male counterparts, who are far below them in academic achievement levels. The traditional explanation for this phenomenon is that the boys in this rural community usually decide to stay and work in their hometown, a situation that prevents some of them from seeing the value in formal education. On the other hand, girls in Jokkmokk see the local work situation as hopeless and thus look forward to establishing themselves in the bigger cities further south. This in turn motivates them to do well in school (see, e.g., Steinthorsdottir & Sriraman, 2007).

Although the rural areas of Iceland such as the Western Fjords and Southern Iceland show the largest gender gaps in mathematics achievement, there are gender differences in favor of the girls throughout the country (Ölafsson et al., 2006, p. 193). This is not in line with the set of circumstances in Jokkmokk. Also, according to Ölafsson et al., the urban/rural gender differences are not consistent over the years nor are the gender differences within any particular region. Another reason why the Jokkmokk effect is not the likely cause
of the Icelandic gender phenomenon is that rural Icelandic teenagers of both
genders seem to leave their hometowns with the same frequency. In a recent
unpublished, preliminary study of 139 Icelandic 16-year-olds, Halldórsson found
that Icelandic girls don’t leave their hometowns any more often than do the boys.

The Icelandic school system has several advantages over many around the
world. The standard of living is high in this Nordic welfare state. In fact, Iceland
has the highest ESCS index of all the countries that participated in PISA 2003
(OECD, 2004, Table 2.6). At a mere 300,000, the population of Iceland is quite
manageable and homogeneous. Without excessive bureaucracy, reforms are
relatively easy to organize and execute. While the per student educational
expenditure for secondary schools is only slightly above the OECD average, the
Icelandic government spends annually on average about 45% more on each
primary school student than is the OECD mean, $8434 compared to $5832
(OECD, 2007a, Table B1.1). Moreover, the class sizes and student-to-teacher
ratios at all levels of schooling are some of the most favorable in the world
(OECD, 2007a, Table D2.1 and D2.2).

Given such propitious circumstances, one might ask why Icelandic
students have not performed better in recent international assessments. Their
scores fail to impress especially when taking into account factors such as the
GDP and the ESCS index, both of which are positively correlated with
mathematics scores on the PISA test (OECD, 2004, p. 100 and 176). In PISA 2003
the mean mathematics score after adjustment by the GDP per capita is 501 for
Iceland while the same figure is 537 for Finland. When adjusted by the ESCS index, Iceland’s score is 469 with Finnish students averaging at 528 (OECD, 2005, Table 2.6). Amount of time spent in mathematics class is not the answer: Icelandic students in their early teens spend about 3.6 hours per week in mathematics class as opposed to the 2.6 hours that their Finnish peers spend in mathematics class (OECD, 2007a, Table D1.2b; 2005, Table D1.3).

Along with mathematics, the gender differences in reading ability are also large in Iceland. While girls did better than boys in all the PISA 2003-countries, Icelandic girls scored on average 58 points higher than their male schoolmates. This represents the largest gender gap in reading in all the countries that participated in the study. Norway, where the girls bested the boys by 49 points, has the second largest difference. Finland’s figure is 44 points while the OECD average is 34 points. Japan, Korea, and the Netherlands are among the countries with the smallest gender differences in reading at just over 20 points (OECD, 2004, Table 6.3). Among the OECD countries the largest gender gap in mathematics, in favor of boys, is in South Korea, while the differences in Finland, Japan, the Netherlands, and Norway are rather small (OECD, 2004, Table 2.4c).

Roe and Taube (2006) discuss the correlation of reading ability with the score on the mathematics scale on PISA 2003. On the whole, there seems to be a close relationship—the correlation coefficient is 0.57—between the two. Figure 2.12 displays the gender differences in mathematics and reading for the OECD countries. The correlation may be partially explained by the fact that the PISA
tests measure *mathematical literacy*; reading plays an important part in solving the mathematics problems. Although Roe and Taube focused on only the Norwegian and Swedish students, similar correlation is likely to be found in most countries. Ólafsson et al. (2006) found that the correlation coefficient for the Icelandic scores exceeds 0.6. They also found that if the effect of reading ability is controlled for, then the Icelandic boys actually do slightly better at mathematics than the girls. This seems to be true in other countries as well: When the gender gap in reading is only slightly in favor of the girls, the gender gap in mathematics—in favor of boys—tends to be larger. This implies that mathematics should not be isolated as a subject when considering the gender differences (p. 196).

![Figure 2.12: Gender differences in mathematics and reading (OECD, 2004, Tables 2.4c and 6.3)](image)
3.1. Introduction

A method of lesson structure analysis is described in this chapter. The coding scheme, which combines a predetermined set of activity categories with an adaptive one, is derived from ideas used in the TIMSS and LPS studies. With this method, any set of video recordings of complete mathematics lessons can be used to empirically investigate lesson structures. One of the strengths of this open-ended method is its ability to capture unique, yet often subtle classroom practices. 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. The method is intended to be generalizable across a variety of applications, including analyses of lessons given in subjects other than mathematics. Section 3.2 provides some background and is followed by a detailed discussion of the method of lesson structure analysis.

The method offers a way to look at some of the different forms of classroom interaction by which teachers attempt to achieve their pedagogical goals. The approach is thus two-dimensional: function vs. form. On the one hand
the focus is on the pedagogical functions of lesson elements: What are the educational purposes of the classroom activities? Are they employed, for instance, to review previously covered material, to introduce new content, or to provide an opportunity to practice recently-learned material and techniques? On the other hand, the forms of social participation are of interest as the teacher’s and students’ participatory patterns play a key role in the instructional process.

The method involves two coding passes. The first pass is inspired by the Purpose-variable from the TIMSS 1999 Video Study (Hiebert et al., 2003). During the first coding pass, each second of the lesson is classified as belonging to one of the following four categories, based on the pedagogical function it serves: Review, Introducing New Content, Practicing/Applying, and Other. The second pass focuses on the forms of social interaction, and it is based on ideas of the LPS (Clarke, Emanuelsson et al., 2006; Jablonka, 2004). The categories of the second pass are sensitive to the sample and ask “Who is doing what?” and “How are the participants interacting?” The actions of the teacher and the students are first considered separately and then integrated into a single variable. A study using this coding system may focus on the form and function-dimensions independently and/or on the interaction of the two.

Lesson structure analysis can expose a variety of patterns in classroom practices. Data from lesson structure analysis can be linked with factors such as

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22 Thus the length of each coding interval is one second, although other interval lengths can also be justifiably used.
curricular materials, content, the level of the teachers’ pedagogical and content knowledge, the physical set-up of the classroom, technology, as well as the teachers’ intentions about planning and structuring lessons. Ideas for further research can be developed by combining lesson structure analysis with variables like the above.

A research tool in a comparative study is only effective if it can reveal differences and similarities across a sample. More specifically, 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 in this chapter can be used to distinguish even the slightest variations in patterns of classroom behavior.

3.2. Lesson Structure Analysis in Video-Based Pedagogical Research

Lesson structure analysis is an important part of many video-based pedagogical studies. It can be used to discover cross-cultural similarities and differences in classroom practices (see, e.g., Clarke, 2003). Lesson structure analysis can be combined with achievement tests, questionnaires, and other sources to produce triangulated data sets (see, e.g., Schoenfeld, 2007; Fischer et al., 2005). Lesson
structure analysis also can be used as a stand-alone research tool, as it is capable of yielding complex data about teaching and learning. However, one should avoid making hasty cause/effect pairings based on lesson structure analysis and, for instance, test results.

Considering structures in lessons 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.

A European-based pedagogical reform movement in the 1950s advocated a different philosophy. Each lesson was to be divided into phases, each of which were to consist of three activating steps: reception, processing, and evaluation (Oser & Baeriswyl, 2001). The number of phases was left to the teacher, but each of them was to have the aforementioned three-fold structure. In the decades to
follow, this kind of obligatory structuring of lessons was viewed as inhibitory to more spontaneous teaching styles.

More intuitive instructional methods began to flourish during the 1960s and 70s (Oser & Baeriswyl, 2001). More recently, research efforts within various theoretical frameworks have helped educational professionals to recognize various dimensions of teaching and learning. This in turn has diversified the types of lessons being carried out by teachers. However, lesson plans based on Herbart’s formal stages of learning are still common.

The three main dimensions of observable lesson structures are form, function, and task structure. The TIMSS and LPS studies consider each of them. In the TIMSS 1999 Video Study the pedagogical functions of the lesson elements are investigated via the Purpose-variable. The Classroom Interaction-variable yields information about the forms of social participation, while the Content Activity-variable is used to analyze tasks, albeit quite superficially. On the other hand, the research design for the LPS was developed to examine the interactions between the functions and the forms of lesson events. Indeed, it is especially useful to study the interconnections of these dimensions and not simply their proportions or frequencies (Clarke, 2003). The LPS is grounded in the idea that similar forms of activity can serve different pedagogical functions. Although task analysis was not in the foreground in the LPS, it did receive attention as well (see, e.g., Liljestrand & Runesson, 2006). The method of lesson structure analysis
introduced in this chapter considers the form and the function of pedagogical elements; tasks are not analyzed.

Clarke, Mesiti, Jablonka, and Shimizu (2006) discuss three levels at which lesson structures can be analyzed: whole lesson, topic, and lesson event. Researchers can look for “teacher scripts” at the lesson level, that is, regularities of instructional units within the lessons. It is sometimes possible to identify idiosyncrasies in the classroom practices of groups of teachers—nationally, for instance—if lesson elements are combined similarly. Instructional patterns also can be considered at the level of the topic. Teaching trends may emerge when the content is held constant, or, in other words, when lessons covering the same topic are analyzed for their pedagogical components. Finally, video-based classroom research may focus on lesson events. An analysis of the form and function of specific lesson activities can form a basis for discussing the similarities and differences of classroom practices (Clarke, Mesiti et al., 2006). The LPS-project adopted the lesson event-approach, while the lesson structure analysis for the TIMSS studies was done at the level of the whole lesson. The coding method introduced in this project attempts to merge the two approaches. Furthermore, content is not considered relevant here; this study does not seek to analyze lessons covering a particular topic. Instead, the lessons deal with algebra, geometry, and other areas of mathematics. Although advantageous, it is logistically difficult to keep the topic constant across the sample.
Oser and Baeriswyl (2001) distinguish between sight and deep structures of lessons. Sight, or visible, structures are the observable pedagogical elements of a lesson. These include teaching methods, social interaction, media, and so on. For instance, anyone observing a lesson can tell when the teacher is using the board to teach new material, when a student is presenting a solution to a homework problem to the rest of the class, or when work is done in groups. In contrast, deep structures refer to the learner’s mental operations that are prompted by the classroom activities. Oser and Baeriswyl coined the term “basis-model” to characterize the hidden cognitive structures underlying learning. The limited number of basis-models—a list of fifteen is given by Oser and Baeriswyl—includes problem-solving, knowledge and concept building, and learning by experience, to name just a few. The learning steps of a basis-model are linked together like paths that can be analyzed. They can not be observed directly observed; the basis-model of any given learning situation must be hypothetically inferred or solicited from the learner (p. 1043). This implies that coding for deep structures carries lower degrees of reliability than analyzing sight structures. The method of lesson structure analysis introduced in this chapter concerns the sight structures only. Deep structure analysis can offer valuable insights when comparing learning environments and can be the basis of a future study.

The uses of lesson structure analysis are limited. Although it can yield valuable information about classroom practices, this method of 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 can not be deduced from the coded data. Furthermore, researchers should avoid making hasty cause/effect pairings based on lesson structure analysis and, for instance, PISA results; even a clear national pattern in lesson structures should only be considered a starting point of an investigation into a performance by a country. Section 1.5 has more about the shortcomings of video analysis in general.

An evolution in the terminology regarding lesson structure analysis is ongoing (Clarke, Mesiti et al., 2006, p. 28). The term “lesson script” was used in the reports of the TIMSS 1995 Video Study (Stigler et al., 1999). Stigler and colleagues advocated the term “lesson pattern” (Stigler et al., 2000). A few years later “hypothesized country models” and “lesson signatures” were used (Hiebert et al., 2003). The existence of “national teaching scripts” was discussed more recently (Givvin, Hiebert, Jacobs, Hollingsworth, & Gallimore, 2005). According to Clarke et al. (2006), this evolution signifies “an increasing recognition that meaningful comparison of teaching practice across an international sample requires a multi-dimensional framework and greater sensitivity to variation than is possible within the confines of a ‘lesson script’” (p. 28). The term “lesson structure” is used by the LPS research team, and, although it does not imply the inherent multi-dimensionality of how lessons are composed, it also has been adopted for this study.
3.3. First Pass: Function

The first pass of the coding method concerns the pedagogical functions of lesson segments. It is based on the *Purpose*-variable from the TIMSS 1999 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 system discussed in this chapter these categories are referred to as *Review, Introducing New Content, and Practicing/Applying*. They bear a strong resemblance to Herbart’s formal stages of learning (Dunkel, 1969). Indeed, Herbart’s two-hundred-year-old contributions to the learning sciences are still relevant today.

An additional category, *Other*, is included in the set of categories for the first pass-variable. This is done because the aforementioned three were deemed non-exhaustive and over-inclusive even for a rough analysis of lesson structures. On the other hand, the first pass-variable lacks sensitivity to nuances of pedagogical functions of lesson elements in order to give a general idea about the main purpose of each of them. Thus the first pass of this coding scheme should be considered only a starting point to lesson structure analysis. Although the categories — with the addition of *Other* — can be seen as covering each moment of
any mathematics lesson, only a limited amount of information can be drawn from this kind of simplified analysis.

Figure 3.1 presents a timeline-based visualization of a lesson coded with the first pass-variable. The left edge of the diagram represents the beginning of the lesson.

Figure 3.1: A first pass coding of a mathematics lesson

It is essential that each lesson in the sample is coded using the same criteria. The criteria should be established by the researcher at the outset, since changing any coding rules or conventions can mean having to start the coding process over. A set of suggested coding criteria for the first-pass variable is included in this section. Several of the conventions were inspired by the TIMSS 1999 Video Study. Table 3.1 presents a summary of the first-pass categories.

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. The lesson may begin with non-verbal activity, such as the teacher writing something on the board or handing out materials; however, if there is more than
one minute between this non-verbal act and the actual start of the lesson, the
non-verbal act is ignored. 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 coder should merge it with the segment following the
short one. 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 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.

A lesson segment during which the class goes over material that has been
covered previously is coded as Review. An average student is expected to know
the content discussed during review. The purpose of this type of segment
generally is to review, reinforce, or re-teach material from previous lessons
(LessonLab, 2003, p. 94). Going over a test, a quiz, or homework problems are
considered *Review*. Some teachers like to conduct quick oral surveys about students’ knowledge. This practice should also be coded as *Review*.

The code for lesson segments during which students are not expected to know all the content under discussion is *Introducing New Content*. This category concerns the second and the third of Herbart’s formal learning stages (see Section 3.2 or Dunkel, 1969). This type of lesson element can be an exploration or a demonstration of a new idea, procedure, or type of problem. The exploration can be teacher-led or done by students individually, pair-wise, or in groups. Discussions or presentations of any previously unseen formulas, techniques, or approaches are categorized as *Introducing New Content*. The students may be asked to read or write about new material. Stating a learning goal for the day and other forms of “foreshadowing” of lesson content (LessonLab, 2003, p. 95) are coded as *Introducing New Content* only if the segment in question is immediately followed by the actual introduction of new material. When a new type of problem is demonstrated through multiple examples, only the first one should be considered *Introducing New Content*. Any subsequent examples using the same ideas and procedures should be coded as *Practicing/Applying*, even if the whole class is involved; however, if substantially different content or procedures emerge in a later example, the coder should go back to *Introducing New Material*.

A summary is coded as *Introducing New Content* only if it directly follows the

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23 Taking a written test or a quiz should also be classified as *Review*. However, it is a good idea for the videographer to request that these types of assessments not be conducted during the lesson to be recorded, especially if only one or two lessons per teacher are included in the sample. If a sequence of lessons is recorded, then tests and quizzes should be held as usual.
demonstration. If the students are already practicing when a summary takes place, then the segment should be coded as Practicing/Applying.

The Practicing/Applying-code is used for lesson segments during which students are expected to work on problems using the content and procedures presented that day. The work may be done individually, in pairs, in small groups, or as a class. Generally any examples beyond the first one are coded as practice, unless they carry a significant new idea. An example should be coded as Practicing/Applying if the answer to the question “Can an average student accomplish the task without having to make leaps?” is to the affirmative. Otherwise, code the example as Introducing New Content. The code for Practicing/Applying includes the assignment of practice problems.

If a lesson segment does not fit any of the abovementioned three categories, it should be coded as Other. Examples include classroom management (roll calls, getting settled for the lesson, disciplinary action, etc.), mathematics management (announcement of tests or homework; goal statements; distributing or collecting quizzes, tests, class materials, calculators, rulers, notebooks, or other technology, etc.), interruptions, technical set-up/problems, cleaning the board, announcements over the intercom, and other breaks such as a fire drill. As with all codes, these are used only if they last at least 30 seconds, except when in the very beginning or the end of a lesson. Public social talk during the lesson is also coded as Other, but chatting with a student or a group of students before or after the lesson is not considered to belong to the lesson. Finally, if a lesson segment
involves more than one of the other three categories, and there is no clear
dominant category, the Other-code should be used. An example of this type is
discussed in the next chapter.

To summarize, Table 3.1 presents a non-exhaustive list of the types of
classroom activities that are included under each first-pass category.

<table>
<thead>
<tr>
<th>Category</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Review</td>
<td>- Discussing content covered in a previous lesson</td>
</tr>
<tr>
<td></td>
<td>- An average student is expected to know the content</td>
</tr>
<tr>
<td></td>
<td>- Going over homework</td>
</tr>
<tr>
<td></td>
<td>- Going over a quiz/test</td>
</tr>
<tr>
<td>Introducing New Content</td>
<td>- Students are not expected to know all of the content</td>
</tr>
<tr>
<td></td>
<td>- Exploring or demonstrating a new idea, procedure, or a type of problem</td>
</tr>
<tr>
<td></td>
<td>- Reading or writing about new content</td>
</tr>
<tr>
<td></td>
<td>- 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?”)</td>
</tr>
<tr>
<td></td>
<td>- Summary is part of the segment only if it directly follows the demonstration</td>
</tr>
<tr>
<td>Practicing/Applying</td>
<td>- Working on the types of problems that were introduced that day</td>
</tr>
<tr>
<td></td>
<td>- Students are expected to know how to work with the new idea(s) using the content presented that day and previously</td>
</tr>
<tr>
<td></td>
<td>- Assignment of practice problems</td>
</tr>
<tr>
<td>Other</td>
<td>- If none of the other three categories apply, or if two or three apply</td>
</tr>
<tr>
<td></td>
<td>- Classroom management (roll calls, getting settled, disciplinary action, technical set-up, etc.)</td>
</tr>
<tr>
<td></td>
<td>- Mathematics management (announcing tests or homework, goal statements, distributing/collecting materials or technology, etc.)</td>
</tr>
<tr>
<td></td>
<td>- Interruptions (fire drill, etc.)</td>
</tr>
<tr>
<td></td>
<td>- Public social talk</td>
</tr>
<tr>
<td></td>
<td>- Announcements over the intercom or TV</td>
</tr>
</tbody>
</table>

Table 3.1: First pass categories
3.4. Second Pass: Form

The second pass of the original coding scheme concerns the forms of social interaction and classroom participation. This part of lesson structure analysis is closely related to what was done during the first coding pass. Having seen the videoed 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 of the lesson elements. The categories of the second pass-variable are based on questions such as “Who is doing what?” and “How are the participants interacting?” They vary from sample to sample according to the range of actions of the teachers and their students. The creation of appropriate categories is not easy and it is almost certain that two coders would conceive different sets of categories. Most importantly, 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.

In order to reduce friction (see Section 1.5 or Hay & Kim, 2007), it is best to take notes of participatory actions—such as “students present homework solutions on the board” or “teacher helps individual students”—during the first coding pass. The actions of the main contributors to classroom participation, the teacher and the students as a group, initially are considered separately; however,
the categories of interaction of the teacher and the students are then combined into a single coding variable.

The main idea behind this method is to discover some of the different forms of classroom interaction teachers employ to achieve certain pedagogical goals. To this end, the lesson segments defined by the first pass-variable are classified further according to the forms of social participation they exhibit. Segments belonging to each of the four categories of pedagogical function—Review, Introducing New Content, Practicing/Applying, and Other—are considered as subsets of the original sample. This approach is similar to that of the LPS, except that Clarke and his colleagues focused on lesson events such as “Kikan-Shido” (between-desks instruction) and “Student(s) at the Front” instead of the four categories of first pass-variable; the LPS team used the form as the grouping variable instead of the function as is done here.

Classroom interaction can have a significant effect on learning (see, e.g., Hiebert & Grouws, 2007). Following Vygotsky’s lead, educational researchers have recognized the importance of the sociocultural context of learning environments (see, e.g., Cobb & Bauersfeld, 1995; Lave & Wenger, 1991; Atweh,Forgasz, & Nebres, 2001; Saxe, 1991; Bishop, 1988). Bauersfeld (1980) considers human interaction to be constitutive and one of the “hidden dimensions in the so-called reality of a mathematics classroom.” He writes
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 method is a response to Bauersfeld’s call for attention to the sociocultural aspects of classroom practices. Many have heeded his call, but continued research in this area is still warranted. In fact, it is important to consider the social context in any pedagogical research project.

Drawing on the ideology and the video footage of the LPS, Jablonka (2004) conducted a lesson structure analysis of six mathematics classrooms. Although hers is more of a qualitative investigation, there are some similarities between Jablonka’s method of lesson structure analysis and the one used in this study. For example, Jablonka’s approach is also based on the functions and forms of lesson elements as well as the interaction of those dimensions. The coding system in her thesis, as well as those used in the TIMSS and LPS studies, provided direction for the coding system described in this chapter. One of the main differences between the two methods is that Jablonka coded the forms of classroom participation with occurrence codes rather than coverage codes. This limits the kinds of statistical analyses that can be conducted from the coded data. Furthermore, Jablonka does
not use a grouping variable for the second coding pass as is done in this study. Overall, the two methods can be considered complementary—one is qualitative, the other quantitative.

One of the criticisms of the TIMSS studies has been that not enough attention was paid to the interactions of the overlapping variables. For instance, the *Purpose*, *Classroom Interaction*, and *Content Activity* dimensions have significant overlap, yet no analysis of their interaction was offered (Clarke, Mesiti et al., 2006). The second pass of the current coding scheme is an attempt to analyze the interaction between two dimensions: a form-dimension (second pass) and a function-dimension (first pass). The two TIMSS-variables closest to these coding variables are *Purpose* and *Classroom Interaction*\(^{24}\). However, a major difference between the current approach and TIMSS is that the coding method used in TIMSS is not sample-sensitive; the coding categories were determined before all the lessons were viewed. Because of that fact, the categories had to be simplified—perhaps oversimplified—to offer a reasonable basis for comparison across classrooms (Clarke, Mesiti et al., 2006, p. 28).

In the second pass of the coding method of this study, the lesson segments classified using the various categories of the first pass-variable are 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-

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\(^{24}\) In the latter TIMSS video study, classroom participation was also studied via “opportunities to talk,” essentially word counts of the teachers and the students (Hiebert et al., 2003).
based, sample-sensitive 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, perhaps there is a “golden mean” for each set of videos. This depends not only on the variability of 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 (see Angelillo, Rogoff, & Chavajay, 2007).

To demonstrate, two mathematics lessons are coded. Figures 3.2 and 3.3 represent Lesson A and Lesson B after the first coding pass.

![Figure 3.2: First coding pass of Lesson A](image-url)
The lessons clearly are of different lengths, but they seem to have somewhat similar structures at the function-level; they both follow the common Review-Lesson-Practice-structure. Both lessons begin and end in Other-segments. Some differences also can be identified. For example, the Introducing New Content-code covers a significantly larger portion of Lesson A than Lesson B, 45% compared to 16%. Also, Practice/Applying takes up only about 37%, of Lesson A, but more than half, 55%, of Lesson B is used for this pedagogical purpose.

Appropriate second-pass coding categories should be formulated next. To do this, all significant participatory actions taken by the teachers and the students in the recorded lessons are catalogued. The formulation of the categories can not be done prior to the first phase of the analysis since the participatory actions are grouped by the first-pass variable. The actions in Lessons A and B, as seen in Table 3.2, are grouped by the first pass-variable.
<table>
<thead>
<tr>
<th>Phase</th>
<th>Actions (Teacher)</th>
<th>Actions (Students)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Review</td>
<td>Assign students to present homework solutions</td>
<td>Write solutions on the board</td>
</tr>
<tr>
<td></td>
<td>Go over student solutions on the board</td>
<td>Pay attention to the teacher</td>
</tr>
<tr>
<td></td>
<td>Present examples on the board</td>
<td></td>
</tr>
<tr>
<td>Introducing New Content</td>
<td>Present a lesson by addressing the class and writing on the board</td>
<td>Pay attention to the teacher</td>
</tr>
<tr>
<td></td>
<td>Ask isolated questions or series of connected questions (Jablońska, 2004)</td>
<td>Ask and answer questions</td>
</tr>
<tr>
<td></td>
<td>Answer questions</td>
<td>Copy text from the board</td>
</tr>
<tr>
<td>Practicing/Applying</td>
<td>Gauge student progress</td>
<td>Work individually on practice problems</td>
</tr>
<tr>
<td></td>
<td>Help individual students</td>
<td>Ask for help from the teacher</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check answers from the teacher’s book</td>
</tr>
<tr>
<td>Other</td>
<td>Classroom management</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mathematics management</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Social talk</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Interruption</td>
<td></td>
</tr>
</tbody>
</table>

Table 3.2: Forms of classroom participation by teacher and students

The most relevant interactions of the teachers and the students are formulated into distinct coding categories. Table 3.3 shows an example of how the list of participatory actions in Table 3.2 can be transformed into a set of form-based categories. Visual codes are assigned to each category. The lines in the diagrams are just one way to visually represent the different coding categories.
### Review
- Teacher discusses examples on the board
- Students write solutions on the board

### Introducing New Content
- Teacher presents a lesson
- Teacher elicits responses from the class by asking a series of connected questions
- Students copy text from the board (no other interaction)

### Practicing/Applying
- Students work individually on practice problems while the teacher helps those in need

### Other
- Classroom management
- Mathematics management
- Social talk
- Interruption

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Table 3.3: Second pass categories

Some forms of interaction are not explicitly included in the coding categories. For instance, “Students paying attention to the teacher” and “Teacher asking isolated questions of the students” are both omitted, though for different reasons. The former is implicitly included in existing categories, and the
segments where the latter would apply are generally too short to be included, since segments less than 30 seconds in length are generally ignored.

Coding for the forms of classroom interaction is more challenging than coding for the pedagogical function. The coding categories must be formulated 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 of pedagogical goals often are clearly expressed and followed.

Carefully defined, mutually-exclusive categories help with this process. Lines are not the only visual devices that can be used to distinguish segments. The checkerboard pattern, for instance, can represent a category, if needed.

The second coding pass reveals new layers of similarities and differences between Lesson A and Lesson B:

![Figure 3.4: Second coding pass of Lesson A](image-url)

![Figure 3.5: Second coding pass of Lesson B](image-url)
Some of the forms on the diagram for Lesson A are not present in Lesson B, and vice versa. “Students write solutions on the board,” “Teacher elicits responses from the class by asking a series of connected questions,” and “Students copy text from the board” are only evident in Lesson A, while “Social talk” and “Interruption” are subcategories of Other that only appear in Lesson B. However, both teachers seem to conduct the Practice-segment similarly.

Although this method can offer significant insights about classroom practice, many questions remain unanswered. How does the teacher present new material? How does the teacher help individual students during seatwork? Are the pedagogical goals achieved? What kind of learning, if any, is taking place during the lesson? Some of these questions can be answered through further analysis of the classroom footage, while some require a triangulated data set.
4.1. Introduction

This chapter presents an application of the method of lesson structure analysis described in Chapter 3. The two-pass coding method can be used to identify patterns in classroom practices in terms of the pedagogical functions and the forms of social participation evident in video recordings of lessons. The interaction of the two dimensions—form and function—is of particular interest as the main purpose behind the method is to investigate the different forms of classroom interaction teachers employ in attempting to meet their pedagogical goals. To demonstrate, the structures of forty mathematics lessons from Finland and Iceland—two lessons from ten teachers in each country—are analyzed.

Finland and Iceland were chosen for the study in part because of the PISA studies. Finnish students have excelled in all three PISA studies—conducted in 2000, 2003, and 2006—while Iceland is the only country where girls have significantly outperformed boys in mathematics (see Section 2.5; OECD, 2007b, 2004). As illustrated in Figure 2.6, Finland’s PISA scores, though already excellent in PISA 2000, have increased over the three assessments. In contrast, the
Icelandic scores have followed a downward trend. Both countries’ educational systems are worthy of individual investigation, but, given the many similarities between these two Nordic countries, it may be especially enlightening to look at them side-by-side.

The Finns are efficient teachers and learners (see, e.g., Kupari & Välijärvi, 2005). Among their peers in the OECD countries, the Finnish children can expect to receive the lowest number of instruction hours, 5523, between the ages of 7 and 14. This is 20% less than the OECD average (OECD, 2007a, Chart D1.1). Furthermore, Finnish students spend less time studying outside of school—less than five hours a week—than any of their peers in countries that participated in PISA 2003 (OECD, 2005, Table D1.3). These facts, coupled with Finland’s exceptional PISA results, spark questions such as: Do the classroom practices of Finnish teachers exhibit any national patterns? Can these patterns, if found, help explain the effectiveness and efficiency of Finnish teachers and learners?

Definitive answers to the Icelandic gender question have eluded researchers thus far (Ólafsson et al., 2006). 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. Furthermore, the recent reduction in the gender gap is unfortunately not due to an increase in the boys’ scores—Icelandic boys’ mathematics scores dropped 4

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25 Finnish children generally start school in August of the year when they turn 7 years old. This is at least a year later than in most other countries, including Iceland.
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. Can lesson structure analysis offer useful evidence with regard to a) the Icelandic gender enigma, and b) the current state of the Icelandic educational system? Given the similarities between the two countries on the one hand and the differences in their students’ achievement scores on the other, it may be helpful to investigate the similarities and differences between classroom practices in Finland and Iceland.

While interest in the educational systems of Finland and Iceland seems justified, it is reasonable to ask whether video analysis is the appropriate tool to study mathematics teaching in these countries. Other ways, such as surveys and on-the-spot coding of classroom observations, may also be useful. However, as discussed in Section 1.4.1, video footage offers superior data-yielding capabilities in classroom research and can be particularly useful 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).

Therefore, instead of studying the intended curricula, a study of the implemented curricula, or what actually happens in the mathematics classrooms, is carried out here. Using data derived from classroom videos, revealing similarities and differences in the classroom practices of typical mathematics teachers in Finland and Iceland are sought and discussed in this chapter. The methods developed for this research project are intended to be generalizable and of use across a variety of applications.

4.2. Sampling

4.2.1. Introduction

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). The methods used in selecting the teachers are described in sections 4.2.2 and 4.2.3.
At the time of the taping, the mean age of the teachers was 46.2. Their ages and the years of teaching experience range from 29 to 66 years and 2 to 35 years, respectively. Although the Finnish teachers in the sample are younger than their Icelandic counterparts—44.4 years of age as opposed to 47.9—they had more teaching experience: 18.2 years versus 15.1 years. Six of the Icelandic teachers and seven of the Finnish teachers are female.

4.2.2. Finland

The ten Finnish teachers that participated in this study were randomly chosen. Because comprehensive lists of Finnish mathematics teachers or primary schools were not 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 the ten providers of education were chosen\textsuperscript{26}. 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, 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

\textsuperscript{26} The random number generator from www.random.org was used in the selection process.
selected. 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 the Finnish principals and teachers feel as if they have already contributed enough to educational research, since many research projects have focused on the Finnish educational system following its success in the PISA studies.

The schools that participated in the study are located in cities and towns of various sizes. Three of the schools are in large municipalities (population above 100,000), four in medium-sized municipalities (population between 15,000 and 100,000), and three in small ones with populations less than 15,000. These numbers correspond well with the proportions of Finns living in municipalities of various sizes as can be seen in Table 4.1.
Table 4.1: Populations of Finnish municipalities of various sizes (Statistics Finland, 2007)

Table 4.2 shows the populations of the official legislative regions of Finland and the number of representative schools. Four of the seven regions—indicated with bold type—are not represented accurately according to their populations. However, the misrepresentations are not substantial, only one school in each case. Although approximately 6% of Finns are Swedish-speaking, coincidentally no Swedish-speaking schools participated in the study.

<table>
<thead>
<tr>
<th>Region</th>
<th>Population (on Dec 31, 2006)</th>
<th>% of Population</th>
<th>Ideal # of Schools</th>
<th>Actual # of Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater Helsinki</td>
<td>989,251</td>
<td>18.75</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Southern Finland</td>
<td>1,166,885</td>
<td>22.11</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Western Finland</td>
<td>1,867,434</td>
<td>35.39</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Eastern Finland</td>
<td>576,509</td>
<td>10.93</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Oulu</td>
<td>465,018</td>
<td>8.81</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Lapland</td>
<td>184,935</td>
<td>3.50</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Åland</td>
<td>26,923</td>
<td>0.51</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TOTALS</td>
<td>5,276,955</td>
<td>100.00</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 4.2: Populations of Finnish regions (Statistics Finland, 2007)

There is one exception: the Greater Helsinki area, which includes Helsinki, Espoo, Vantaa, and Kauniainen, is usually included as part of Southern Finland.
Despite the lack of co-operation among some of the schools, 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. In particular, the teachers were not selected according to their professional reputations as was done in the LPS (Clarke, Emanuelsson et al., 2006). 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.
4.2.3. **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 pick 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 in his or her place; however, this happened only with one school.

Half of the schools in the sample are located within the greater Reykjavik area and the other half in smaller municipalities around the country. Table 4.3 shows the populations of the Icelandic regions as well as how the numbers of schools selected from each region correspond with the respective regional populations.
<table>
<thead>
<tr>
<th>Region</th>
<th>Population (on Dec 31, 2006)</th>
<th>% of Population</th>
<th>Ideal # of Schools</th>
<th>Actual # of Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater Reykjavik</td>
<td>191,927</td>
<td>62.4</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Southwest</td>
<td>18,912</td>
<td>6.1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>South</td>
<td>22,959</td>
<td>7.5</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>West</td>
<td>15,284</td>
<td>5.0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Western Fjords</td>
<td>6,449</td>
<td>2.1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Northwest</td>
<td>9,572</td>
<td>3.1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Northeast</td>
<td>27,915</td>
<td>9.1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>East</td>
<td>14,654</td>
<td>4.8</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>TOTALS</td>
<td>307,672</td>
<td>100.1</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 4.3: Populations of Icelandic regions (Statistics Iceland, 2007)

![Map of Iceland regions](image)

Figure 4.2: The regions of Iceland

All primary schools in Iceland participate in the PISA studies (Ólafsson et al., 2006). The national average on the mathematics scale of PISA 2003 is 515. The girls’ score is 523 and the boys’ 508. Námsmatstofnun (Educational Testing Institute) released the PISA 2003 scores for the schools in the sample\(^{28}\). The mean

\(^{28}\) One of the schools did not yet exist in 2003.
score for these schools is 516. The girls in the sample schools scored 520 and the boys 512 on the mathematics scale. While the mean score of the sample is nearly equal to the national mean, the gender difference within the schools in the sample is not as pronounced as it is in the nation as a whole.

4.2.4. Recording Procedures

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 design. The video cameras are situated in the back of the classroom as shown in Figure 4.3.

The action camera ("A") follows the teacher, while the fixed camera ("F") captures as much of the classroom as possible. It is important to include the front
aids teachers in authoring video anchors for use in their classrooms. Making the video anchors unleashes the creative powers of the teachers or teachers-to-be and can get them more excited about the content. Also, learning to work with video technology in this way can help in keeping up with the current technological developments (Petrosino & Koehler, 2007). While this idea seems promising, further research needs to be done about the impact of this type of teacher training on the teachers as well as their students.

Some researchers have criticized the use of minimally-guided instruction methods. Kirschner, Sweller, and Clark (2006) argue that minimally-guided instruction methods are less effective on novice and intermediate students than direct instruction. According to Kirschner et al., empirical evidence collected over the past half-century supports the view that minimally-guided instruction is not the optimal pedagogical approach for novice to intermediate learners. Instead, directly guiding learning with worked-out examples can be a more effective approach. However, minimally-guided instruction can be effective for learners who possess significant content knowledge (Kirschner et al., 2006; Tuovinen & Sweller, 1999).

Chall (2000) called the ideas behind minimally-guided instruction “romantic” as opposed to “rational”. In a meta-analysis of studies identifying characteristics of effective mathematics teaching, Brophy (1986) concludes that “students achieve more in classes where they spend most of their time being taught or supervised by their teacher rather than working on their own or not
of the classroom in the fixed camera shot, as the record from that camera may, in
\[\text{case of an action camera malfunction, have to serve as the main video record of the lesson. This recording design utilizes three microphones: a wireless lavalier microphone on the teacher and an external microphone connected to each of the video cameras. The main two audio tracks are recorded by the action camera, while the sound captured by the fixed camera can serve as backup. See Section 1.7.2 for more information on recording techniques.}

The students’ faces are typically not shown in the recordings. In order to protect the identities of the approximately one thousand students who participated in this study, the cameras were deliberately placed in the back of the classrooms. In addition, parents of the students were given the option of having their child take part in another educational experience instead of their usual mathematics lesson (see Appendix B for the consent forms). However, none of the parents chose to keep their child from attending the lesson.

4.2.5. 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\(^{29}\) when there were

\[^{29}\text{The lessons were typically recorded during one day. However, there were four instances when this was not possible, and the recordings were conducted over two days.}\]
no tests or only a review for a test (see Appendix A for the written correspondence with the teachers).

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. Scheduling to observe three mathematics classes in one day was more difficult in Finland; 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 of the recordings.

Based on post-observation teacher interviews, the majority of the recorded lessons were similar or at least somewhat similar to typical lessons; 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. Teacher perceptions of student behavior during the classroom recordings are summarized in Table 4.4. Students were not interviewed, although that would have given a more complete picture of the typicality of the recorded lessons.

<table>
<thead>
<tr>
<th></th>
<th>Finland</th>
<th>Iceland</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students behaved normally</td>
<td>14 (70%)</td>
<td>17 (85%)</td>
<td>31 (77.5%)</td>
</tr>
<tr>
<td>Students were more active</td>
<td>2 (10%)</td>
<td>0 (0%)</td>
<td>2 (5%)</td>
</tr>
<tr>
<td>Students were less active</td>
<td>4 (20%)</td>
<td>3 (15%)</td>
<td>7 (17.5%)</td>
</tr>
<tr>
<td>TOTALS</td>
<td>20</td>
<td>20</td>
<td>40</td>
</tr>
</tbody>
</table>

Table 4.4: 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, although a larger proportion of the Icelandic classrooms seemed 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 behavior of the students. According to their teachers, students

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30 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 12 students due to a flu epidemic. The teacher used the class for review.
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 4.4 are consistent with those found in the TIMSS 1999 Video Study (Hiebert et al., 2003, p. 29) as well as the IPN study (Seidel et al., 2005, p. 17).

4.3. Results

4.3.1. 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 functional structure. In contrast, Icelandic mathematics teachers seem to have adopted two distinct pedagogical philosophies: nine of the lessons in the sample demonstrate the RLP-structure, whereas eleven lessons are conducted according to a constructivist pedagogical strategy the Icelandic educational community calls Individual learning [IL].

Many Finnish teachers seem to promote collaborative learning activities. Those teachers often favor class discussions and student presentations over delivering monologues or assigning independent seatwork. This is especially apparent during lesson segments dedicated to review. Furthermore, Finnish
mathematics teachers spend significantly more time introducing new content than do their Icelandic counterparts.

The following section offers an explanation of the coding categories specific to this sample. First results of the coding process are summarized in Section 4.3.4. The use of a second coder to establish inter-coder reliability for the method of lesson structure analysis is explained in Section 4.3.5.

4.3.2. 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 in Chapter 3. Tables 4.5 through 4.8 show the various categorizations, and Table 4.9 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 4.5 displays the three Review categories for the lessons in this sample.

<table>
<thead>
<tr>
<th>Review</th>
<th>Teacher discusses examples or a concept in the front</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students write solutions on the board</td>
<td></td>
</tr>
<tr>
<td>Class works together on a problem</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.5: Review categories

The lesson segments during which new material is introduced are further categorized during the second coding pass. Five categories of classroom participation during lesson segments dealing with new content are distinguished. 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. These types of segments are often conversational in nature. One or two IRE (see Section 2.3.2) sequences are not enough to trigger this code.

“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 through a problem-solving activity not unlike the structured problem-solving pedagogical strategy used by many Japanese mathematics teachers (Clarke, Mesiti et al., 2006).

“Students copy text”-code covers two types of lesson elements: 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.

<table>
<thead>
<tr>
<th>Introducing New Content</th>
<th>Teacher presents new content, intermittent questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher elicits responses from the class by asking a series of connected questions</td>
<td></td>
</tr>
<tr>
<td>Students work on a new type of problem, teacher helps</td>
<td></td>
</tr>
<tr>
<td>Students copy text from the board or the book (no other interaction)</td>
<td></td>
</tr>
<tr>
<td>Students read the book (no other interaction)</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.6: Introducing New Content categories

Four categories of Practicing/Applying are identified. “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 4.7 summarizes the second-pass codes for Practicing/Applying.

<table>
<thead>
<tr>
<th>Practicing/Applying</th>
<th>Teacher discusses examples in the front</th>
<th>Students work on practice problems individually or in small groups, teacher helps</th>
<th>Students work on practice problems individually or in small groups, teacher does not help</th>
<th>The class, led by the teacher, works together on a problem</th>
</tr>
</thead>
</table>

Table 4.7: Practicing/Applying categories

This sample requires an extended range of Other-categories. This is partly due to the prevalence of the Independent learning [IL] pedagogical strategy employed by several Icelandic teachers. During their lessons there is typically 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.

Three distinct types of IL are identified: “Kikan-Shido” (i.e. between-desks instruction: students work while the teacher walks around the classroom 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 4.8. The checkerboard patterns visually unify the IL-segments.

<table>
<thead>
<tr>
<th>Other</th>
<th>Classroom management</th>
<th>Mathematics management</th>
<th>Homework/progress check</th>
<th>Interruption</th>
<th>Social talk</th>
<th>Independent learning—Kikan-Shido</th>
<th>Independent learning—Teacher presents in the front</th>
<th>Independent learning—Student presents in the front</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.8: *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.

4.3.3. Lesson Diagrams

This section contains illustrations of the coded lessons. A summary of all twenty codes, a necessary companion to the lesson diagrams, is presented as Table 4.9. The lesson diagrams from the first coding pass are followed by those from the second. The second-pass diagrams were made wider to better make visible the interaction between the forms and the functions of lesson elements. Time is the third dimension in these diagrams.

Below are some notes about specific lessons.

FIN-4A At the end of the lesson, the teacher conducted a brief review for a physics exam that was to be held the following day.

FIN-5B There was a “morning service” delivered over the intercom in the beginning of the lesson.

FIN-7A There was a “morning service” delivered over school TV in the beginning of the lesson.

ICE-5B Only 5 of 12 students were present due to a flu epidemic.
ICE-6A  This school was experimenting with 30-minute lessons as well as larger classes—whole cohorts—taught simultaneously by several teachers following the IL-strategy.

ICE-6B  This class was comprised of eight students who required additional help and had been pulled out of the large class (see ICE-6A). The teacher only helped one student one-on-one, the others received no assistance.

ICE-10B  The teacher spent a significant amount of class time sharing internet resources meant to help students to review for the Icelandic National Mathematics Test.
<table>
<thead>
<tr>
<th>Review</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher</td>
<td>reviews examples or a concept in the front.</td>
</tr>
<tr>
<td>Students</td>
<td>Students write solutions on the board.</td>
</tr>
<tr>
<td>Class</td>
<td>Class works together on a problem.</td>
</tr>
<tr>
<td>Introducing New</td>
<td>Teacher presents new material, intermittent questions.</td>
</tr>
<tr>
<td>Material</td>
<td>Teacher elicits responses from the class by asking a series of connected questions.</td>
</tr>
<tr>
<td>Students</td>
<td>Students work on a new type of problem, teacher helps.</td>
</tr>
<tr>
<td>Copy</td>
<td>Students copy text from the board or the book (no other interaction).</td>
</tr>
<tr>
<td>Read</td>
<td>Students read the book (no other interaction).</td>
</tr>
<tr>
<td>Practicing/Applying</td>
<td>Teacher discusses examples in the front.</td>
</tr>
<tr>
<td>Students</td>
<td>Students work on practice problems, teacher helps.</td>
</tr>
<tr>
<td>Class</td>
<td>Class works together on a problem.</td>
</tr>
<tr>
<td>Other</td>
<td>Classroom management</td>
</tr>
<tr>
<td>Mathematics</td>
<td>Mathematics management</td>
</tr>
<tr>
<td>Homework/progress</td>
<td>Homework/progress check</td>
</tr>
<tr>
<td>Interruption</td>
<td>Interruption</td>
</tr>
<tr>
<td>Social talk</td>
<td>Social talk</td>
</tr>
<tr>
<td>Independent</td>
<td>Independent learning—Kikan-Shido</td>
</tr>
<tr>
<td>Student</td>
<td>Independent learning—Student presents in the front</td>
</tr>
<tr>
<td>Teacher</td>
<td>Independent learning—Teacher presents in the front</td>
</tr>
</tbody>
</table>

Table 4.9: Summary of codes
4.3.4. **First Results**

This section offers a brief summary of the preliminary findings from this video study. The focus is on relative frequencies of lesson elements\(^{31}\). The first coding pass sheds light on the lessons with regard to the pedagogical functions. Figure 4.4 shows how class time is distributed over the four first-pass categories.

![Figure 4.4: First-pass categories: Finland and Iceland](image)

Eleven of the twenty Icelandic lessons typified the IL-pedagogical philosophy. Since those lessons are coded as *Other*, that category is by far the most prevalent for Iceland. Figure 4.5 displays the comparison between the

\(^{31}\)Sequencing of lesson elements is also worthy of investigation and can be the basis of a future study.
Finnish lessons and the remaining nine Icelandic lessons, which essentially followed the RLP-script. This set of lessons is denoted with an asterisk: Iceland*.

Based on this “apples-to-apples” comparison, the Finnish mathematics teachers seem to spend less time reviewing and more time introducing new material than do the Icelandic teachers not using the IL-strategy. 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 prevalence 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
Applying such analysis, the only statistically significant difference at the .05-level is in the category of *Introducing New Content*, for which a t-test yields $t = 2.78$ and $p = .010$.

Figures 4.6 through 4.9 show the prevalence of the various forms of classroom interaction for each of the first-pass categories.

![Graph showing prevalence of classroom interaction forms](image)

Figure 4.6: Forms of *Review*: Finland and Iceland*

In this sample, 50.1% of the *Review*-segments within the Finnish lessons can be classified as having 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 a 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 4.7: Forms of Introducing New Content: Finland and Iceland*

Figure 4.7 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 lesson-level: $t = -1.96$ and $p = .061^{32}$.

---

32The above analysis assumes equal variances. Levene’s test yields $p = .084$. If variances are not assumed to be equal, the difference is significant with $t = -2.52$ and $p = .021$. 
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 Icelandic teachers spent 83% of that time presenting in the front. This is significant at the level of the lesson with $t = -2.146$ and $p = .044$.

Figure 4.8: Forms of Practicing/Applying: Finland and Iceland*

Figure 4.8 shows the relative frequencies of the various forms of Practicing/Applying. The most common form is Kikan-Shido, between-desks
instruction. The differences in proportions are not statistically significant.

However, the Finnish teachers spent 12.5% and the Iceland*-teachers 23.4% of the Practicing/Applying segments discussing examples in the front.

![Bar chart showing forms of Other: Finland and Iceland*](image)

Figure 4.9: 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 seemed to settle 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 4.10 shows the relative frequencies of the forms of classroom interaction the teachers in these classes chose to employ. Kikan-Shido is by far the most common form at 82.1%; seven of the eleven lessons contained no public instructional discourse. ICE-8A, ICE-8B, ICE-9A, and ICE-9B stand out from rest of the IL-lessons. There was a considerable amount of public instructional discourse during these four lessons since either the teacher or one of
the students presented examples 45.2% of the time during IL-segments. Both teachers directed their public instruction to the below-average students. These lessons will be discussed in more detail in the final chapter.

Students presented in the front in both countries, but this seems to be a more common activity in Finland. In fact, only one Icelandic lesson, ICE-9B, featured student presentations. Students presented in six of the Finnish lessons, and in two others the teacher received no volunteers for a call to the board as some of the Finnish students 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.
4.3.5. **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 and independently coded two Finnish and two Icelandic lessons. 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 4.9 displays the Cohen’s Kappa as well as the percentage agreement between the coders for each pass.

<table>
<thead>
<tr>
<th></th>
<th>Cohen’s Kappa</th>
<th>Percentage Agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Pass</td>
<td>0.968</td>
<td>97.6</td>
</tr>
<tr>
<td>Second Pass</td>
<td>0.881</td>
<td>88.7</td>
</tr>
</tbody>
</table>

Table 4.10: 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 lessons 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, many of the disagreements probably stem from different interpretations of lesson elements.

4.3.6. Content

Although content is not the focus of this study, a brief account of the topics covered in the mathematics lessons is warranted. About half of the lessons in both countries covered algebra topics such as solving equations. However, none of the Icelandic algebra lessons involved systems of equations, which was the focus of four of the Finnish lessons. Some of the Icelandic lessons dealt with more elementary concepts like fractions and ratios. Overall, the mathematical content of the Finnish lessons was somewhat more advanced than the content covered in the Icelandic lessons. This can be partially due to the fact that the Icelandic lessons were recorded approximately 1-2 months before the Finnish lessons.

While the Icelandic lessons dealt with ordinary topics in arithmetic (e.g., fractions and percentages), algebra (e.g., solving and simplifying equations), and geometry (e.g., properties of triangles and circles), some of the Finnish lessons offered glimpses into less common school mathematics. For example, two Finnish lessons, FIN-2B and FIN-4B, dealt with tax mathematics. Various topics in statistics and probability were covered in three of the lessons. In one Finnish
8th grade geometry lesson, the teacher showed the class how to draw solids using the Cavalier projection method.

4.4. Discussion

There are numerous dimensions on which teaching can be analyzed and compared. This study considers only a few of them; others can be the foci of future research projects. The main objective here is to investigate the forms of classroom interaction Finnish and Icelandic mathematics teachers use in attempting to achieve their educational goals. To this end, the structures of forty lessons were analyzed with respect to the form of interaction and the pedagogical function.

Based on this small sample, there seem to be differences in the ways in which Finnish and Icelandic mathematics lessons for 14 and 15-year-olds are structured. First, approximately one half of the Icelandic lessons in the sample follow versions of the Independent learning-pedagogical strategy—students learn by solving problems independently and at their own pace, while the teacher walks around the classroom helping the students one-on-one. Public instructional discourse can be missing entirely from these lessons. This is in contrast with the Finnish lessons where about half of the lesson time is dedicated to teacher-lead activities in which often the students are actively involved. If a
student needs further instruction or clarification, he or she can ask for it during seatwork, an important part of all of the Finnish lessons.

Finnish teachers seem to use less class time for reviewing than Icelandic teachers. In the Finnish lessons the Review-segments are efficiently conducted, often with the whole class engaged in the process. Based on this sample, the Review-segments in the Finnish lessons typically consist of going over the homework problems. The Finnish teachers’ effective use of time enabled them to spend more time introducing new material.

Social interaction in the classroom facilitates the students’ constitution of mathematical meanings (Cobb & Bauersfeld, 1995). Compared with the Icelandic RLP-lessons, the Finnish lessons have less teacher presentations and more student involvement during Review and Introducing New Content-segments. Thus, based on this sample, the Finnish mathematics teachers provide more opportunities for learning through classroom interaction during Review and Introducing New Content.

Educational professionals around the world may be interested in learning about the structures of Finnish mathematics lessons and how those structures compare to ones common in their country. For example, the TIMSS 1999 Video Study found that the average percentage of US 8th grade mathematics lesson time devoted to review is 53 (Hiebert et al., 2003, p. 50). This figure is not fully comparable with what has been found in the current study, as the coding criteria between the two studies differ. Most importantly, there was no Other-category in
the TIMSS study; according to the TIMSS coding criteria, any Other-segment preceding a Review-segment would have been coded as part of the latter. However, the difference in the prevalence of reviewing between the Finnish and the US lessons is drastic: 14% vs. 53%. There seems to be a significant disparity in the use of review as a pedagogical device within the two educational cultures.

Finnish teachers help their students systematically. Some teachers in the sample made a point to talk to each student during seatwork, not just those who asked for help. Five of the ten Finnish teachers also interacted with all of their students in the beginning of class by checking to see whether they had completed the homework assignment; only one Icelandic teacher did so.

The role of homework yields another dimension of comparison between the Finnish and Icelandic teachers. In only two of the Icelandic lessons was homework mentioned at the beginning of the lesson, and in only one of them were homework problems discussed publicly; in the other lesson the teacher collected homework assignments that were 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, as was mentioned previously, it is common for the teacher to verify the level of homework completion directly from the students’ notebooks. It seems that the Finnish students are directly held accountable for their homework responsibilities. Perhaps the Icelandic students are also held accountable, but this was not apparent during the recorded lessons.
Further research into the role of homework in the Icelandic mathematics classes is warranted.

The Finnish teachers in this sample started teaching directly after finishing their own education. Finnish teachers generally start their higher education in the early twenties (Malaty, 2004). In contrast, many Icelandic teachers apparently try out a different career path before settling on teaching; the average age of students at Kennaraháskóla Íslands, the main provider of teacher education in Iceland, is 35 (Kaaber, 2007, p. 23). These facts support the notion that teaching is a “Plan A”-type profession in Finland and a “Plan B”-type profession in Iceland. The latter is not surprising given the teachers’ salaries in that country; primary school teachers make only 75% of an average Icelandic worker’s salary (see Section 2.5.1).
5.1. Summary

Video can provide powerful evidence in the study of the implemented curriculum (e.g., Goldman et al., 2007; Erickson, 2006). As the technology needed to conduct video-based pedagogical research has become increasingly available during the last few decades, video analysis has secured a prominent place in the “toolboxes” of educational researchers studying the complex phenomena that take place in classrooms. While video analysis is not suitable for every pedagogical study, it can be effective in a variety of research settings; the use of video is not restricted to certain kinds of studies or theoretical frameworks.

Using video in classroom research offers many affordances (see, e.g., Stigler et al., 1999; Ulewicz & Beatty, 2001; Ruhleder & Jordan, 1997; Erickson, 1986; Hiebert et al., 2003). For example, replaying recorded events can reveal complex behavioral patterns that would otherwise be difficult, if not impossible, to detect. Also, because people do not always do as they say they do, a more truthful account of what actually happens can be obtained using video rather than interviews, questionnaires, or surveys, each of which are based on
recollections and opinions. The permanence of the video record permits unlimited re-analysis and allows for multiple viewpoints that can be merged to give a more complete representation of reality.

Using video technology can be particularly helpful in the professional development of teachers and other educational professionals (see, e.g., Bass et al., 2002; Erickson, 2007; Stigler & Hiebert, 1999). Video technology can effectively be used, for instance, to highlight examples of pedagogical strategies, provoke reflective conversations about a problematic teaching moment, and help teachers build categories of important pedagogical phenomena (Pea & Hay, 2003). Furthermore, practicing teachers can become teacher-researchers by videotaping their own classes. Teachers can benefit greatly by seeing themselves teach, even if the project is carried out only informally.

Beyond the usual financial and logistical problems, both of the key phases of the research process—data collection and analysis—present the videographer with unique problems. Ethical issues and verisimilitude represent just some of the challenges associated with the use of video in pedagogical research. Ethical considerations concerning video-based research are important since human subjects are used; privacy, confidentiality, and the potential for educational colonialism (Goldman, 2007b, p. 33) are issues that should be recognized and addressed. The effects of the presence of the video equipment, as well as their operator, on the classroom environment have to be considered since they unavoidably interact with that environment. Evaluation of video-based research
projects is also problematic. The educational research community is currently
tackling the challenge of developing evaluation criteria for video-based research.

Lesson structure analysis is one area of educational research that has
significantly benefited from the emergence of video as a tool. Large-scale video-
based studies such as TIMSS and LPS have considered structures of mathematics
lessons from various countries. This dissertation project examines the structures
of forty mathematics lessons from Finland and Iceland. The method of analysis
involves two coding passes and draws its main influences from the two
aforementioned international studies. The focus is on the pedagogical functions
and the forms of classroom interactions of lesson segments.

This project seeks answers to the following research questions:

1. Does the video-based method of lesson structure analysis presented in
   this report extend the sensitivity of existing methods of lesson
   structure analysis such as those used in the TIMSS and LPS studies?

2. Does the video-based method of lesson structure analysis presented in
   this report permit structural comparison of Finnish and Icelandic
   mathematics lessons?

3. Is it feasible to conduct meaningful video-based pedagogical research
   on a small scale?
5.2. Conclusions

This section contains an attempt to answer the research questions as well as some discussion based on the lesson structure analysis of the Finnish and Icelandic mathematics classes. First of all, the scope and methodology of the study are limited. Thus, while some of the findings may prove helpful, they should only be considered a starting point for more comprehensive research endeavors to increase our understanding of the educational cultures of these two countries.

The first research question concerns the sensitivity of the method of lesson structure analysis presented in this report. The question juxtaposes this method against those used in the TIMSS and LPS studies. Can this tool add sensitivity to the methods used in these larger projects? Can it reveal differences and similarities across a sample of classroom videos in a new way? The tools used in the three studies are as different as their foci and scope. When analyzing their videos, the TIMSS-teams used numerous variables that concern important aspects of classroom practice such as pedagogical function (or purpose), content, and task structure. Class participation was studied, for instance, using word counts of the teachers and the students. However, in contrast to the current study, the methods of the TIMSS studies are not conducive to analyzing the interactions of the variables. Also, the Purpose-variable used in the TIMSS study seems non-exhaustive and over-inclusive even for a rough analysis of lesson structures. Therefore the Other-category is introduced in the current method.
While the LPS did focus on the interactions of the functions and forms of lesson elements, its methods produced different kinds of data than the one presented in this report. One of the main differences stems from the fact that Clarke and his colleagues focused on lesson events such as “Kikan-Shido” and “Student(s) at the Front” instead of the four categories of first pass-variable; the LPS team used the form as the grouping variable instead of the function as is done here.

The method of lesson structure analysis presented in the previous chapters enables quantitative study of complete lessons. It is sensitive to the nuances within the types of forms of classroom interaction teachers employ in attaining their pedagogical goals. One of the strengths of this open-ended method, which allows for the creation of any form-based categories deemed necessary, is its ability to capture unique, yet often subtle classroom practices. Because it is sample-sensitive, the method can potentially be of use in the analysis of any set of classroom video recordings. However, this method of lesson structure analysis is only one tool among many, all of which have limitations. An example of such a limitation is that this method offers a biased view of classroom practice; the researcher’s views and agenda will inevitably steer the creation of the coding categories. Collaborating can reduce these biases.

The method does not produce data about many important dimensions of classroom teaching, such as the success of the lesson. It is impossible to tell from the relative frequencies of lesson elements or the diagram whether the
pedagogical goals of the lesson were achieved. Consider ICE-3A and ICE-3B. The lesson diagrams seem to imply that the teacher was successful in drawing the students into these lessons. In reality, these lessons were not particularly conducive to learning as the teacher confused many of the students by making crucial mathematical mistakes on the board. In order to avoid pitfalls such as hasty cause/effect pairings based on lesson structure analysis and, for instance, quality and quantity of learning or test results, it is best to triangulate the data set by collecting information using various methods.

The second research question concerns the kinds of structural information that can be extracted from Finnish and Icelandic mathematics lessons using this method of lesson structure analysis. Can this tool reveal differences and similarities in lesson structures across a sample of classroom videos from these two countries? As evidenced by the findings described in Chapter 4, the answer is in the affirmative. Data from the method indicates that there are significant differences between the Finnish and Icelandic mathematics lessons. Beyond identifiable patterns within many of the teachers’ lessons, some national teaching patterns can indeed be detected. The Finnish mathematics lessons in the sample demonstrate the Review-Lesson-Practice [RLP]-lesson script and are fairly uniform in their functional structure. Many of the Finnish teachers tend to engage the students as a class especially during lesson segments dedicated to reviewing previously covered material. In contrast, the Icelandic mathematics teachers seem to have adopted two distinct pedagogical philosophies. About one half of
the recorded lessons’ structures approximate RLP. The rest are conducted using versions of Independent learning [IL], a constructivist pedagogical strategy in which the learner assumes increased responsibility for his or her learning.

The answer to the third research question, “Is it feasible to conduct meaningful video-based pedagogical research on a small scale?” is also in the affirmative. While collecting and analyzing video-based data can be time-consuming, carrying out a classroom study does not have to be expensive. Naturally, the larger the study, the more resources are required. But classroom studies do not have to be big or highly systematic to be helpful. For instance, two teachers can tape each other in their respective classrooms and analyze the recordings together in an informal setting. During the viewings, they can simply stop the playback when they see something worthy of comment. While it may not necessarily lead to publications, many eye-opening discussions about teaching and learning can ensue from this kind of reflective collaboration\(^3\).

The inputs and outputs of the educational systems of Finland and Iceland can be reconsidered in the light of the findings from this study. If measured by rankings in international assessments, the Finnish school system has been very effective in recent years. Reasons for this success have been widely discussed in the literature (see, e.g., Kupari & Välijärvi, 2005; Björkqvist, 2006). The importance of the teachers’ relatively high status within the society should not be

\(^3\) It is important that the students and their parents are appropriately informed about any videotaping, even if the recordings will only be used for informal professional development.
underestimated in this discussion. Teaching is a “Plan A”-type profession in Finland (see Section 2.5.2). Finnish teachers are given ample freedom within the national curricular guidelines (Björkqvist, 2006). However, based on data from this study, they seem to have found a common tune in their classrooms. By and large, the Finnish lessons in this sample follow the RLP-script. Exceptions consisted primarily of the lessons for which there was no homework assignment due. Activities during Review and Introducing New Content-segments are lead by the teacher, who regularly engages the class by asking series of connected questions or by having students present solutions on the board. The most common form of classroom interaction during the Practice/Applying-segments is Kikan-Shido, or between-desks instruction.

Iceland is the only OECD country where the girls have significantly outperformed the boys in mathematics (OECD, 2004, 2007b). While this study has not resolved the Icelandic gender question, it does provide new evidence in the quest for answers. But, instead of the gender differences, perhaps the focus of the research should be on the causes of the across-the-board declines in assessment results. It is indeed alarming that Iceland’s PISA scores in all three areas—mathematics, reading, and science—have declined since 2000 (see Tables 2.1 and 5.1). The 22-point drop in the reading scores from 2000 to 2006 is the third largest among the OECD countries (OECD, 2007b, Table 6.3a).

The data from this lesson structure analysis may prove particularly useful in the investigation of the current state of affairs of the Icelandic educational
Based on this study, the IL-strategy appears to be commonplace in Icelandic mathematics classrooms. Like other constructivist pedagogical strategies, IL, when executed properly, can be rewarding and successful; the premise of autonomous knowledge construction, by discovery or otherwise, is appealing. Unfortunately it seems that some Icelandic teachers may have misinterpreted this teaching strategy. For these educators, the implementation of the curriculum is based on the students’ abilities to move ahead in the book on their own, save the occasional visit from the teacher. In fact, some of the Icelandic students appear to receive very little or no guidance during mathematics class, and their approach to learning seems not unlike that of the farmer in *Independent People* (Laxness, 1997), the popular Icelandic novel.

To effectively teach within the constructivist framework is demanding. The teacher has to operate within the *zone of proximal development* (Vygotsky, 1978) of each student and use pedagogical tools such as *scaffolding* to aid in the students’ knowledge construction process (e.g., Cobb & Bauersfeld, 1995). Furthermore, successful constructivist teaching emphasizes language and the social dimension; learning is a social, interactive process (see, e.g., Lave & Wenger, 1991; Steffe & Gale, 1995).

Because teaching people to be autonomous students of mathematics is particularly challenging, many experts recommend that classroom instruction of this subject be carefully guided by the teacher (Hmelo-Silver, Duncan, & Chinn, 2007; Harvey & Chickie-Wolfe, 2007). Hmelo-Silver, Duncan, and Chinn (2007)
insist that problem-based and inquiry learning are not minimally-guided instructional strategies; instead, these methods employ extensive scaffolding. 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\textsuperscript{34}—a cyclical problem-solving process including preparation, performance, and appraisal—when adapting to various applications.

One Icelandic IL-teacher ensured that her students had an opportunity to carry out all of the steps in the aforementioned sequence. Although they were IL-lessons, ICE-9A and ICE-9B included public content-related discourse in the form of teacher and student presentations. These were true “No child left behind”-lessons. While letting the faster students work independently, this teacher controlled and carefully scaffolded the learning process for the slower students. Also, tutoring relationships or “study buddies,” a pedagogical device recommended by IL-research, were encouraged in this classroom (Harvey & Chickie-Wolfe, 2007; Rafoth, 1999). By doing the above, she was successful in creating “a community of learning.” ICE-8A and ICE-8B also exhibited these characteristics to some degree.

\textsuperscript{34} Self-regulation is a key concept in IL. See also (Schunk & Zimmerman, 1994; Pintrich, Boekaerts, & Zeidner, 2000).
The instructional methods used by the teacher of ICE-9A and ICE-9B are effective (see next section). This teacher has realized that novice learners may need plenty of guidance. Her position is supported by cognitive load theory (see, e.g., a special CLT-issue of Instructional Science, 2004, 32(1-2); Section 2.3.4); if the students 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 the basics before meaningful learning can begin.

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. This is particularly important for those teachers who choose to use IL in their classrooms. Alternatives to 100% Kikan-Shido-style instruction, such as a mix of direct instruction and IL or guided discovery, need to be spelled out.

Finally, Iceland—as well as other nations that wish to raise their academic profile—will likely get the most overall improvement by concentrating on the students in the lower echelons of achievement. After all, the potential gains for these students are greater than for the ones that are already doing well. Furthermore, it is important that this effort not be limited to a single subject. Instead, promotion of “reading across the curriculum”-type programs could prove helpful.
5.3. Recommendations 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-classroom, 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 (Ólafsson et al., 2006). An interesting phenomenon surfaces when the boys’ and girls’ PISA scores from the three main areas are combined into a total score, and the differences between assessments are determined. Table 5.1 shows the differences in total scores between assessments.

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Girls</td>
<td>0</td>
<td>-34</td>
</tr>
<tr>
<td>Boys</td>
<td>-34</td>
<td>-11</td>
</tr>
</tbody>
</table>

Table 5.1: Differences in total scores between assessments (Table 2.1)

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 an important factor.
PISA data obtained from Námsmatsstofnun 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. For instance, 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? If the students were held more directly accountable for completing their homework assignments, would the out-of-school effort levels increase?35

Attention should be paid to what the Icelandic students do nowadays instead of homework. Some of the teachers that participated in the video study indicated that videogames and the internet seem to preoccupy the majority of their students. Accordingly, one theory about the Icelandic gender phenomenon

35 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, yet they scored very high in all areas of the test (OECD, 2005, Table D1.3). Thus what they do in the classroom must be effective and efficient (see Section 2.5.2).
goes along the following lines: Many Icelandic boys replaced doing homework with playing videogames and using computers for entertainment purposes in the late 1990s and early 2000s. This resulted in a plunge in PISA scores in 2003. At this time, girls were still generally “good students” who did their homework. However, the emergence and the subsequent popularity of social networking websites such as MySpace and Facebook—launched in 2003 and 2004, respectively—prompted a significant proportion of the Icelandic girls to adopt an IT-centered after-school lifestyle that, with the exception of the videogames, resembled that of their male schoolmates’. As a consequence, the out-of-school effort levels of many girls declined sharply, which then resulted in a plunge in their PISA 2006 scores. Although boys are still the more frequent and confident users of IT, preliminary analysis of the PISA data shows that the gender gap has narrowed; the gender difference in internet usage decreased from 1.3 points (on a 0-10 scale) in 2003 to 0.9 points in 2006. The gap in the confidence of high level software use decreased from 1.6 to 0.8. Further research into the possible connection between the usage of IT and videogame consoles and time spent on homework is recommended.

Since the Icelandic mathematics teachers set aside so much class time for individual problem-solving, 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 thirteen\textsuperscript{36} Icelandic mathematics lessons with 598 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. The mean number of visits per girl and per boy was calculated for each class. Based on these lessons, a teacher pays each female student an average of 2.77 visits per class while the number for boys is 2.07. The length of a typical visit is 31 seconds for both genders. Possible explanations for this phenomenon include: 1) By now some teachers have higher learning expectations of girls and that has 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 analysis of the natures 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 help 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? Are the teacher-student interactions similar in Finland and in

\textsuperscript{36} 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.
other countries? What are some of the Icelandic teachers’ and students’ attitudes and beliefs about gender roles in the mathematics classroom?

It would be interesting to consider the students’ “potential”, a variable based on academic achievement with the deviation from the mean amount of time spent on homework factored out (Almar Halldórsson and Ragnar Ólafsson, personal communication, September 14, 2007). Do Icelandic girls and boys have equal potential? How can we best harness this potential for learning?

The instructional methods used in ICE-9A and ICE-9B are effective. This IL-teacher can be associated with outstanding PISA mathematics scores. What makes her scores even more noteworthy is that the school is located in a small, 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 her students’ scores is by far the smallest within all Icelandic schools. Further research is necessary to identify factors that contribute to this teacher’s apparent success. Are her instructional methods transferable to other classrooms?

Based on this study, two main instructional philosophies prevail in Iceland: Independent learning and direct instruction based on Herbart’s formal stages of learning (Dunkel, 1969). 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 retain their
study habits. 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, and the teachers’ intentions about planning and structuring lessons. Combining variables such as the above with lesson structures can yield interesting information about teaching. What is the effect of student feedback—voiced and unvoiced—on lesson structures?

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. Also, adding the dimension of the deep structures to the sight structures-model presented in this report is one of its natural extensions (Oser & Baeriswyl, 2001).

Countries, states, linguistic regions, etc. can be compared to one another using the method of lesson structure analysis described in this report. Furthermore, 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 recorded lessons.
REFERENCES


the Nordic countries (pp. 33-45). Copenhagen, Denmark: Nordic Council of Ministers.


<table>
<thead>
<tr>
<th>APPENDIX A: Letters</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Letter to principal (English)</td>
<td>217</td>
</tr>
<tr>
<td>Letter to principal (Finnish)</td>
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<td>Letter to principal (Icelandic)</td>
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<td>Email to teacher (English)</td>
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<td>Email to teacher (Finnish)</td>
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<td>Letter to teacher (English)</td>
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<td>Letter to teacher (Finnish)</td>
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Dear Principal,

I plan to carry out a pedagogical research study using video analysis. The study focuses on the state of mathematics education in the 9th and 10th grades in Finland and Iceland. This study is a part of my dissertation research at Columbia University.

I hereby request co-operation with your school, which was chosen to partake in this study by random selection. You are asked to sign and return the enclosed consent form by (DATE). I am also asking that you fill out the other form about mathematics teachers. Please send the two forms back in the enclosed envelope at your earliest convenience.

If granted permission, I will visit your school for one day in the spring of 2007 to record three mathematics lessons given by a single teacher. The lessons for that day should be the same as they would be normally. The video taping process is meant to have minimal effect to the educational goals of the teacher. The overall potential risks to the teacher and the students are minimal, or the same as they would be on a normal school day.

I will randomly select a mathematics teacher from your school to participate in the study. In the enclosed form, please write the names of the mathematics teachers that are teaching both 9th and 10th grade classes. I will send the teacher a separate request letter. You need not prepare him/her, or the students, in any way. The names of the teacher and the students will be kept confidential. Also, the name or location of your school will not be mentioned in the write-up of the study.

Letters to parents will be sent to the selected teacher for distribution approximately ten days prior to the taping.

This study is sponsored by Reykjavík University and Columbia University.

If you need any further information, please do not hesitate to call me at (NUMBER) or email me at (EMAIL ADDRESS).

Best regards,

Lasse Savola
Näin kirjeitse koska aion toteuttaa videoanalyysiin perustuvan pedagogisen tutkimuksen Suomessa. Tutkimus on osa väitöskirjaani, joka tullaan tarkastamaan Columbian yliopistossa New Yorkissa ensi vuonna. Tulen analysoimaan toimintaa matematiikan oppitunteilla sekä Suomessa että Islannissa.


Aion lähetä valitulle opettajalle noin kymmentä päivää ennen kuvausta nipun oppilaiden vanhemmille tarkoitettuja kirjeitä. Toivoin, että hän jakaisi kirjeet oppilaille, jotka puolestaan kehvävät ne koteihinsa. Vanhemmille annetaan näin mahdollisuus kieltäytyä lapsensa osallistumisesta tutkimukseen.

Tutkimuksen sponsoreita ovat sekä Columbian yliopisto että Reykjavikin yliopisto. Jos teillä on kysymyksiä tästä tutkimuksesta, niin voitte ottaa yhteyttä numeroon (PHONE NUMBER) tai sähköpostiosoitteen (EMAIL ADDRESS).


Yhteistyöterveisin,

[Signature]

Lasse Savola
Í nóvember mun ég gera myndbandsrannsókn á stöðu stærðfræðikennslu í grunnskólum á Íslandi. Þessi rannsókn er hluti af lokaverkefni minu við Columbia Háskóla í Bandaríkjunum. Sambærilegar myndbandsrannsóknir munu eiga sér stað í nokkrum skólum á Íslandi og einnig í Finnlandi.

Ég óska hér með eftir samstarfi við þinn skóla, sem valinn var af handahófi til þess að taka þátt í rannsókninni. Ef þú ért rannsókninni samþykkt/ur vinsamlegast skrifaðu nafn þitt á meðfylgjandi skjal og sendu það til undirritaðs fyrir (DATE) næstkomandi. Eyþublaðið er ritað á ensku til þess að styrtkaraóðar erlendis geti lesið það.

Niðurstöður rannsóknarinnar munu nýtast við mótn grunnskólar kennslu og í þjálfun stærðfræðikennara sem eru í námi við Háskólan í Reykjavík.

Fái ég samþykki, mun ég heimsækja skolann þinn í einn dag um eða eftir miðjan nóvember til þess að taka upp þrjár stærðfræðikennslustundir hjá einum kennara. Kennslustundir þessu dags eiga að vera eins og venjulega. Myndbandsupptakán á að hafa sem minnst áhrif á námsmarkmið kennarans en allt kapp er lagt á það að skólastarfræði á rannsóknartíma sé líkt og alla aðra daga. Því eru hverandi líkur á því að myndbandsupptökurnar hafi neikvæð áhrif á kennara og nemendur.


Bréf til foreldra munu verða send til kennarans til dreifingar um það bil tíu dögum fyrir upptökuna.

Þessi rannsókn er styrkt af Háskólanum í Reykjavík og Columbia Háskóla í New York. Rannsóknin hefur verið tekinn til umfjöllunar hjá Menntasviði og verið samþykkt.

Þurfrir þú nánari upplýsingar, ekki hika við að hafa samband í síma (NUMBER) eða með tölvupóstí í (EMAIL ADDRESS).

Bestu kveðjur,

Lasse Savola
Hello!

My name is Lasse Savola. I am working on my doctoral thesis at Teachers College, Columbia University. The title of my dissertation is “Mathematics education in Finland and Iceland: What actually happens in the classroom?” As you may already have heard, your school was randomly chosen to participate in my study. Your principal, (NAME), has given his/her preliminary consent. Now I would like to ask you to participate.

Your participation in the study is voluntary and would involve the following: 1) distribute letters to your students (I will provide you with enough copies for three classes), 2) let me videotape three of your typical mathematics lessons during one day, 3) fill out a short questionnaire, and 4) participate in a short interview (in Icelandic or English) after the classes. You are asked not to prepare anything special for the classes to be videotaped; they should be typical lessons. Therefore participating in the study should not take much of your time.

I will videotape the classes from the back of the classroom so that the students' faces don't show on the recordings. The recordings will be used for the purposes of this study and possibly other scholarly publications. If you separately agree, I may show a recording of one of your classes at professional meetings of mathematics educators.

Please respond to this email. If you are willing to take part in the study, please send me your weekly teaching schedule as well as any other pertinent scheduling information, such as test dates.

If you are not willing to cooperate with me on this study, please let me know.

I thank you in advance for your timely response.

Best regards,

Lasse Savola
Hei!


Osallistuminen tutkimukseen on vapaaehtoista. Siitä on seuraavat toimenpiteet: 1) oppilaille annetaan kirje kotiin vietiäväksi (Lähetän koululle tarvittavat kopiot), 2) yhden päivän aikana (jos mahdollista) kuvataan kolme tyypillistä matematiikan oppituntia, 3) lyhyen kyselykaavakkeen täyttö, ja 4) lyhyt haastattelu kuvattavien tuntien jälkeen. Pyydän ettei kuvattaviin tunteihin valmisteltaisi eri tavalla kuin muihin tunteihin. Täten tutkimukseen osallistuminen ei tule viemään juurikaan ylimääräistä aikaa.


Toivon että vastaatte myös mikäli ette halua osallistua.

Kiitos. Hyvää lukukauden jatkoa ja terveisä Islannista.

Lasse Savola
Dear (TEACHER NAME),

Thanks for your continued co-operation. Enclosed you will find 75 copies of the letter that should be handed out to the students of the 9th and 10th grades whose classes will be recorded. The students are to take the letter home and show it to their parents. They are also welcome to read it themselves.

The letter explains some of the basic information about the study in Icelandic. The main issue is that the students’ faces will not be on the recording. The students will remain completely anonymous.

If any of the parents prefer that their child not participate in the study, the form will be returned to you with the child’s name written on it. Please keep the returned forms, if there are any. My assistant will give a similar lesson to those students who will not attend the class to be recorded. Upon my arrival, I will ask for a location where this alternate lesson could be held, if need be.

Once again, please do not prepare the classes on (DATE) in any special way. They should be as typical as possible. Also, please do not schedule a test for that day.

Thank you very much.

Best regards,

Lasse Savola
Hei (TEACHER NAME)!

Kiitos avustasi tähän mennessä. Tässä tulee nippu (75) kirjeitä, jotka haluaisin sinun jakavan ensi viikolla kuvattavien luokkien oppilaille kotiin vietäväksi.

Kirje kertoo tutkimuksestani pääpiirteittäin. Ehkä tärkein juttu on se, etteivät oppilaiden kasvot tule näkymään videolla.

Luettuaan kirjeen vanhemmat voivat halutessaan kieltää lapsensa osallistumisen tutkimukseen. Oppilaiden tulee palauttaa kirje vain siinä tapauksessa. Eli jos vanhemmat hyväksyvat tutkimuksen, heidän ei tarvitse tehdä yhtään mitään.


Sydämellinen kiitos osallistumisesta!

Yhteistyöterveisin,

Lasse Savola
APPENDIX B: Forms

<table>
<thead>
<tr>
<th>Form</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Letter of approval</td>
<td>225</td>
</tr>
<tr>
<td>Names of mathematics teachers (English)</td>
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<td>Names of mathematics teachers (Finnish)</td>
<td>227</td>
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<td>Names of mathematics teachers (Icelandic)</td>
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<tr>
<td>Principal’s consent (English)</td>
<td>229</td>
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<td>Teacher’s consent (English)</td>
<td>230</td>
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<td>Parental consent (English)</td>
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<td>Parental consent (Icelandic)</td>
<td>233</td>
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<tr>
<td>Assent form for minors (English)</td>
<td>234</td>
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<td>Assent form for minors (Finnish)</td>
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<td>Assent form for minors (Icelandic)</td>
<td>236</td>
</tr>
<tr>
<td>Participant’s rights (English)</td>
<td>237</td>
</tr>
<tr>
<td>Research description (English)</td>
<td>238</td>
</tr>
</tbody>
</table>
Letter of Approval

As the principal of (NAME OF SCHOOL) in (TOWN), I hereby grant Lasse Savola permission to conduct research in my school. Lasse will video 3 mathematics lessons in the spring of 2007.

_____________________________
Name

_____________________________
Signature

_______/________/_______
Date
Names of 9th and 10th grade mathematics teachers in your school

In this form you are asked to write down the names of the mathematics teachers who teach the 9th and/or the 10th grades at your school. Please note that you are only asked to write down the names of those teachers that are currently teaching, not those who are on a leave of absence.

Please write the names of the teachers in the table below and mark with an “X” in the appropriate column whether they teach the 9th grade, the 10th grade or both grade levels.

Upon completion, we kindly ask you to return this form along with the signed letter of approval (enclosed).

<table>
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<tr>
<th>Name of teacher</th>
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8. ja 9. luokkien matematiikan opettajien nimet


Kirjoittakaa opettajien nimet taulukkoon ja merkatkaa x:llä opettaako kyseinen henkilö 8:ttä luokkaa, 9:ttä luokkaa tai molempia.

Palauttakaa tämä lomake palautuskirjekuoressa suostumuskirjeen (letter of approval) kanssa. Kiitos.

<table>
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<tr>
<th>Opettajan nimi</th>
<th>8. luokka</th>
<th>9. luokka</th>
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Listi yfir stærðfræðikennara í 9. – 10. bekk í þínum skóla

Í þessu skjali erði beðin/beðinn um að skrifa nöfn þeirra kennara sem kenna stærðfræði í 9. og 10. bekk í þínum skóla. Athugið að einungis er beðið um nöfn kennara sem eru starfandi þetta misserið, ekki nöfn þeirra sem eru í leyfi frá störfum.

Vinsamlegast ritaðu nafn kennara í töfluna hér fyrir neðan og merkuði með x í viðeigandi reit eftir því hvort kennarinn/kennararnir kenni stærðfræði í 9. bekk, 10. bekk eða í báðum bekkjardeildum.

Að því loknu, vinsamlegast sendu þetta bréf til verkefnisstjóra ásamt eyðublaðinu með samþykki þínu.

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<tr>
<th>Nafn kennara</th>
<th>9. bekkur</th>
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</table>
DESCRIPTION OF THE RESEARCH: Your school is invited to participate in a research study on the state of mathematics education in Finland and Iceland. One mathematics teacher from your school will be asked to allow video-taping of three of his/her lessons. The research will be conducted by Lasse Savola and is sponsored by Teachers College, Columbia University and Reykjavik University. The research will be conducted at 20 randomly selected primary schools of which 10 are in Finland and 10 in Iceland.

RISKS AND BENEFITS: The research has the same amount of risk the teacher and the students would encounter during a usual classroom activity. There are no direct benefits to the participants. Indirect benefits of the study include the possibility of improvement of the mathematics teacher training programs in Finland and Iceland. If a student does not wish to be in the classroom during the taping, alternate educational activities will be provided.

PAYMENTS: There is no monetary compensation for participating in this study.

DATA STORAGE TO PROTECT CONFIDENTIALITY: The digital video data will be kept confidentially by the researcher. However, with permission from the teacher and the parents, some of the video may be shown at professional meetings in support of pedagogical research. The names of the school, the teacher and the students will be kept confidential and will not be presented or published.

TIME INVOLVEMENT: The video taping will take place during one day. A total of three mathematics lessons will be recorded.

HOW WILL THE RESULTS BE USED: The results of the study will be used for a dissertation project and possibly other publications such as articles in pedagogical journals.

By writing and signing your name, you agree, as the principal, to have your school participate in this research study.

Name: ________________________________________

Signature: ______________________________________________________________________

Date: __________/________/________
INFORMED CONSENT

DESCRIPTION OF THE RESEARCH: A research study on the state of mathematics education in Finland and Iceland is being conducted. You are invited to participate in the study. With your permission, I would like to record three of your mathematics lessons using video cameras. The research is conducted by Lasse Savola and sponsored by Teachers College, Columbia University. The research is being conducted at 20 randomly selected primary schools of which 10 are in Finland and 10 in Iceland. Please refer to the “Research Description” document for more information.

RISKS AND BENEFITS: The research has the same amount of risk as you and the students would encounter during a usual classroom activity. There are no direct benefits to the participants. Indirect benefits of the study include the possibility of improvement of the mathematics teacher training programs in Finland and Iceland.

PAYMENTS: There is no monetary compensation for participating in this study.

DATA STORAGE TO PROTECT CONFIDENTIALITY: The video data will be kept confidentially by the researcher. However, with your permission, some of the video may be shown at professional meetings in support of pedagogical research. Your identity as well as the name of the school and the students will be kept confidential and will not be presented or published. If you prefer not to have the recordings of your lessons shown at professional meetings, the videos will be destroyed upon completion of the study. In any case, the material will not be shown to the public or your employer.

TIME INVOLVEMENT: The video taping will take place during one day. A total of three mathematics lessons will be recorded.

HOW WILL THE RESULTS BE USED: The results of the study will be used for a dissertation project and possibly other publications such as articles in pedagogical journals.

If you agree to have three of your classes recorded, please write and sign your name below. If you agree to the recording but prefer to not have the material used anywhere outside of this study, please mark an “X” in the box below.

☐

Name: __________________________________________

Signature: ________________________________________

Date: _______/_______/_______
DESCRIPTION OF THE RESEARCH: A research study on the state of mathematics education in Finland and Iceland is being conducted. Your child’s mathematics teacher is participating in the study. A single mathematics lesson will be videotaped. Your child’s face should not show on the recording as the camera will be placed in the back of the classroom. The research is conducted by Lasse Savola and is sponsored by Teachers College, Columbia University and Reykjavik University. The research is being conducted at 20 randomly selected primary schools of which 10 are in Finland and 10 in Iceland.

RISKS AND BENEFITS: The research has the same amount of risk as your child would encounter during a usual classroom activity. There are no direct benefits to the participants. Indirect benefits of the study include the possibility of improvement of the mathematics teacher training programs in Finland and Iceland. If you wish that your child not be in the classroom during the taping, alternate educational activities will be provided.

PAYMENTS: There is no monetary compensation for participating in this study.

DATA STORAGE TO PROTECT CONFIDENTIALITY: The video data will be kept confidentially by the researcher. However, some of the video may be shown at professional meetings. Your child’s identity as well as the names of the teacher and the school will be kept confidential and will not be presented or published. Your child’s face should not show on the recordings.

HOW WILL THE RESULTS BE USED: The results of the study will be used for a dissertation project and possibly other publications such as articles in pedagogical journals.

Please note the following options:

1) You agree to have your child’s class recorded and possibly shown at a professional meeting in support of pedagogical research. No action is required.

2) You prefer that your child not be in the classroom when the recording is taking place. Please write your child’s name on the line and have your child return this form to his/her mathematics teacher.

Child’s name: ____________________________

Date: ______/______/______
TUTKIMUS MATEMATIIKAN OPETUKSESTA


RISKIT JA EDUT: Tutkimukseen ei liity suurempaa riskiä kuin yleensäkään koulunkäyntiin. Suoranaisia etuja ei osallistujille ole, joskin on mahdollista että havainnoista on hyötyä opettajankoulutusohjelmille. Jos haluatte että lapsenne ei osallistuisi tähän tutkimukseen, hänelle voidaan järjestää jotain muuta ohjelmaa sen tunnin ajaksi.

RAHALLINEN ETU: Osallistumiseen ei liity rahallista etua.

TIETOJEN SÄILYTYS: Videotiedostot tullaan pitämään mahdollisimman turvallisesti salassa. On tosin mahdollista, että osia jotain nauhoitusta tullaan näyttämään matematiikan opettajien kokouksissa. Lapsenne henkilöllisyys sekä opettajan että koulun nimi pidetään salassa eikä niitä tulla julkaisemaan.

TIETOJEN KÄYTTÖ: Tutkimuksessa esille tulevia tietoja tullaan käyttämään Lasse Savolan väitöskirjassa sekä mahdollisesti muissa akateemisissa julkaisuissa.

Teillä on kaksi vaihtoehtoa:

1) Jos teillä ei ole mitään tätä tutkimusta vastaan, niin teidän ei tarvitse ryhtyä jatkotoimenpiteisiin.
2) Jos haluatte että lapsenne EI osallistu tutkimukseen, niin kirjoittakaa lapsen nimi allaolevalle viivalle ja palauttakaa tämä lomake lapsenne matematiikan opettajalle.

Kiitos yhteistyöstä.

Lapsen nimi: _______________________________________

Päivämäärä: _____/_______/_______

ÁHÆTTUR OG ÁGÓÐI: Rannsóknin hefur ekki meiri áhættu í för með sér en hefðbundin kennslustund sem barnið er þátttakandi í. Barnið hlýtur engan ágóða af því að taka þátt í rannsóknarverkefnið. Óbeinn ágóði af rannsókninni er m.a. fólginn í framlagi rannsóknarinnar til þess að bæta og efla stærðfræðikennslu í Finnlandi og á Íslandi. Ef þú óskar þess að barnið þitt sé ekki inni í kennslustofunni á meðan myndbandsupptakar fer fram mun skólinn útvega önnur úrræði án þess að barnið tapi af kennslustund.

FJÁRHAGSLEGUR ÁGÓÐI/GREÍDSLÁ: Það er enginn fjárhagslegur ágóði af þátttöku í þessari rannsókn.

GEYMSLA GAGNA OG LEYND PERSÓNUUPPLÝSINGA: Verkefnið er styrkt af Kennslufræðideild Columbia háskóla í New York og Háskólanum í Reykjavík. Tutugu grunnskólar voru valdir með slembivali til þess að taka þátt í rannsókninni, þar af þiu á Íslandi og þiu í Finnlandi. Úm er að ræða kennslustundinu þann (DATE).

Vinsamlegast veljið annan af tveimur eftirfarandi valmöguleikum:

1) þú samþykkir að kennslustund sem barnið þitt er í verði tekin upp á myndband og m ògulega s ynd á faglegum fundum og r áðstefnum með hliðsjón af kennslufræðilegum r annsóknunum. Í þessu tilviki þarf þú ekki að verða eyðilagðar um leið og kennslufræðilegum r annsóknunum.

2) þú samþykkir ekki að barnið þitt sé í kennslustund sem er tekin upp á myndband. Ef svo er, vinsamlegast ritaðu nafn barnsins á línuna þar af þess að samþykkja það þarf að skila eyðublaðinu til viðkomandi stærðfræðikennara.

Nafn barns: ______________________________________

Dagsetning: _______/_______/_______
Assent Form for Minors (8-17 years old)

I ________________________________ (child’s name) agree to participate in the study entitled “Mathematics education in Finland and Iceland: What actually happens in the classroom?” The purpose and nature of the study has been fully explained to me by Lasse Savola or his agent. I understand what is being asked of me, and should I have any questions, I know that I can contact Lasse Savola at any time. I also understand that I can to quit the study any time I want to. I have been informed of the room where I can go if I want to leave.

Name of Participant: ________________________________
Signature of Participant: ________________________________
Witness: ________________________________
Date: ______/_____/______
Suostumuslomake alaikäisille (8-17 vuotiaat)


Osallistujan nimi: _______________________________
Osallistujan allekirjoitus: _______________________________
Todistaja: _______________________________
Päivämäärä: ______/______/______
Samþykki ólögráða einstaklinga (8-17 ára)

Ég ______________________________ (nafn barns) samþykki hér með að taka þátt í rannsókninni “Stærðfræðimenntun í Finnlandi og á Íslandi: Hvað gerist í kennslustofunni?” Lasse Savola eða samstarfsaðili hans hafa útskýrt fyrir mér tilgang og markmið þessarar rannsóknar. Ég skil til hvers er ætlast af mér og ef ég hef einhverjar spurningar get ég haft samband við Lasse Savola hvenær sem er. Ég skil einnig að mér er heimilt að hætta við þátttöku í rannsókninni hvenær sem er og farið í ákveðið herbergi sem er til staðar ef þess þarf.

Nafn þátttakanda: ______________________________

Undirskrift þátttakanda: ______________________________

Vottur: ______________________________

Dagsetning: ______/______/______
PARTICIPANT'S RIGHTS

Principal Investigator: Lasse Savola
Research Title: Mathematics education in Finland and Iceland: What actually happens in the classroom?

- I have read and discussed the Research Description with the researcher. I have had the opportunity to ask questions about the purposes and procedures regarding this study.

- My participation in research is voluntary. I may refuse to participate or withdraw from participation at any time without jeopardy to future medical care, employment, student status or other entitlements.

- The researcher may withdraw me from the research at his/her professional discretion.

- If, during the course of the study, significant new information that has been developed becomes available which may relate to my willingness to continue to participate, the investigator will provide this information to me.

- Any information derived from the research project that personally identifies me will not be voluntarily released or disclosed without my separate consent, except as specifically required by law.

- If at any time I have any questions regarding the research or my participation, I can contact the investigator, who will answer my questions. The investigator's phone number is (____)___________.

- If at any time I have comments, or concerns regarding the conduct of the research or questions about my rights as a research subject, I should contact the Teachers College, Columbia University Institutional Review Board /IRB. The phone number for the IRB is (212) 678-4105. Or, I can write to the IRB at Teachers College, Columbia University, 525 W. 120th Street, New York, NY, 10027, Box 151.

- I should receive a copy of the Research Description and this Participant's Rights document.
RESEARCH DESCRIPTION

Finland and Iceland are in many ways noteworthy within the domain of mathematics education. Recent large-scale international studies such as the Program for International Student Assessment (PISA) have brought attention to the educational systems of these two Nordic countries. Finland came out on top in overall results in PISA 2003 while Iceland is the only country where girls significantly outperform boys in mathematics. The mathematics curricula as well as the students’ out-of-school circumstances are quite similar in the two countries, but the results in recent international comparisons are not. The current research project entitled “Mathematics education in Finland and Iceland: What actually happens in the classroom?” is a comparative study that uses video analysis to determine whether there are significant differences in the ways in which Finnish and Icelandic mathematics teachers educate their students.

After videotaping typical lessons from 10 randomly chosen mathematics teachers from each country, the recordings will be reviewed and coded. The coding system is similar to that used in the TIMSS 1999 Video Study and it includes variables that deal with concepts such as teaching mode, the structure of the lesson, resources used, and problem solving. Statistical methods will be employed in summarizing the data and identifying potential patterns. The initial hypothesis is that there is no significant difference in how Finnish and Icelandic mathematics teachers conduct their classes.