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CHAPTER TWO

Addressing the Challenge of Legitimate International Comparisons: Lesson Structure in the USA, Germany and Japan

INTRODUCTION

One of the major challenges confronting the international mathematics education community is how best to learn from each other's classroom practices. Central to this issue is the choice of the instructional unit that will serve as the basis for any cross-cultural analysis of classroom practice. In most, probably all, countries, students interact with mathematics content via the instructional unit of the lesson. The lesson, therefore, seems a sensible place to start in the search for a viable unit of international comparative analysis of classroom practice.

In this chapter, analyses of lesson structure from each of the USA, Germany and Japan are reported. These reports are based on analyses of sequences of ten lessons, documented using three video cameras, and interpreted through the reconstructive accounts of classroom participants obtained in post-lesson video-stimulated interviews. The methodological approach of conducting case studies of the classroom practices over sequences of at least ten lessons in the classes of several competent eighth grade teachers in each of the participating countries offers an informative complement to the survey-style approach of the two video studies carried out by the Third International Mathematics and Science Study (TIMSS) (Hiebert et al., 2003; Stigler & Hiebert, 1999). Perhaps it is inevitable that a research design predicated on a nationally representative sampling of individual lessons, as in TIMSS, should report a statistically-based characterization of the representative lesson. A more fine-grained study of sequences of ten lessons, informed by the reconstructive accounts of the participants, has the potential to address questions such as:

- What are the recurrent pedagogical elements that might typify a teacher's classroom practice and is there evidence of a recurrent lesson structure or sequence of such elements within the practices of a single teacher or group of teachers?
- What degree of variation in lesson structure is evident in the practices of the competent teachers studied in the USA, Germany and Japan?

The analyses reported in this chapter reveal significant structural variation in the different lessons in any one teacher's lesson sequence. This degree of structural variation suggests that a single lesson pattern is unlikely to be an accurate or a useful representation of either an individual teacher's lessons or of any nationally-representative sample of lessons. However, the recurrence of particular lesson components in the practices of teachers participating in the same or similar school systems suggests that some form of typification may be possible, given the correct unit of comparison. The chapter concludes with the suggestion that the comparison of lesson components ('lesson events') is more likely to be helpful than a lesson pattern or script as a guide to the similarities and differences between the practices of different mathematics teachers and their classrooms.

Meaningful International Comparisons

What are the contending bases for international comparative research and how is lesson structure situated within the logic of this research? One of the most widely reported results from studies of international assessment of student achievement such as the Third International Mathematics and Science Study (TIMSS) (Beaton & Robitaille, 1999) has been the high national mean scores for students from 'Asian' countries. This appears to have triggered the following (naïve) line of reasoning: If Asian countries are consistently successful on international measures of mathematics performance, then less-successful non-Asian countries would do well to adapt for their use the instructional practices of Asian classrooms. Such a line of reasoning is grounded in four key assumptions:

- i that the term 'Asian' identifies a coherent cultural conglomerate with respect to educational practice;
- ii that the performances valued in international tests constitute an adequate model of mathematics, appropriate to the needs of the less-successful country;
- iii that differences in mathematical performance are attributable to differences in instructional practice, such as lesson structure (and not to other differences in culture, societal affluence or aspiration, or curriculum); and
- iv that the distinctive instructional practices of more-successful countries (e.g., norms of lesson structure), should these exist, can be meaningfully adapted for use by less-successful countries. Each of these key assumptions can be problematised on a variety of grounds (e.g., Clarke, 2003; Westbury, 1992).

Such cross-cultural comparisons can also be undertaken in a more introspective manner by individual countries. Wang (2001), in discussing technical concerns with TIMSS, cites Hu (2000, p. 8) as saying, "This study does not break down Americans by race, if they did, Asian Americans would likely score as high as Asians in their home countries, and Whites would rank near top of the European nations." There are several ways to interpret this observation. It is worth comparing this quote with an analogous statement from Berliner (2001).

Which America are we talking about? . . . Average scores mislead completely in a country as heterogeneous as ours . . . The TIMSS-R tells us just what is

happening. In science, for the items common to both the TIMSS and the TIMSS-R, the scores of white students in the United States were exceeded by only three other nations. But black American school children were beaten by every single nation, and Hispanic kids were beaten by all but two nations. A similar pattern was true of mathematics scores . . . The true message of the TIMSS-R and other international assessments is that the United States will not improve in international standings until our terrible inequalities are fixed (David Berliner, *Washington Post*, Sunday, January 28, 2001).

Hu's statement explicitly partitions the American population by race and makes comparisons with the performance of corresponding groups internationally. Berliner also partitions the population of US school students along racial lines and locates each sub-population on an international league table of student achievement. Similar partitioning along socio-economic or gender lines is also possible. In his 2005 address to the annual conference of the American Educational Research Association, Berliner pointed to the connection in the United States between race, socio-economic status and educational access and participation. The essential point that has been made by Clarke (2003) and others is that nationally aggregated data can conceal important differences in educational outcomes, reducing the explanatory potential of international studies and, possibly, producing misleading or erroneous recommendations for the future deployment of (limited) educational resources.

From several perspectives the comparison of national means of student achievement is problematic. Comparisons between sectors of the community within a given country may be more fruitful, even more so within a given state or school system. Such comparisons may at least highlight community groups who are less equal in the benefits they accrue from a school system intended to benefit all students equally. Educational policy can then be framed to address any inequalities.

But, what are the implications from the perspective of cultural traditions? Wang and Lin (2005) reviewed the research literature with respect to the mathematical performance of Chinese, Chinese-American and other US student groups. Their review problematised "ambiguous cross-national categorizations of East Asian students from Japan, China, Korea, and other East Asian regions and countries" (Wang & Lin, 2005, p. 4). The extent to which such culturally-inclusive categorizations can imply possibly misleading similarities can be seen in the accounts of classroom practice provided by Clarke, Keitel, Shimizu and their colleagues in the Learner's Perspective Study (LPS) (Clarke, Keitel & Shimizu, 2006). Elsewhere, Wang and Lin made the point "Although Chinese students showed superiority to U.S. students in symbolic and abstract thinking, Chinese students show no advantage in graphing, understanding tables, or open-process problem solving" (Wang & Lin, 2005, p. 5). This latter statement emphasizes the dangers of over-aggregation for the purpose of cross-cultural comparison, but in this case in relation to the specific mathematical content.

Wang and Lin (2005) note that while there does appear to be a "widening gap between Chinese and U.S. students" (p. 5), "the performance gap between Chinese

Americans and Caucasian Americans also increases as both groups move through U.S. schools" (p. 5). Most importantly, Wang and Lin conclude "whether Chinese students actually outperform Chinese American students is still unresolved" (Wang & Lin, 2005, p. 5). All of which suggests that the cultural affiliation of the learner (whatever their geographical location) is possibly as important as the cultural alignment of the school or school system and certainly should not be simplistically identified with nationality.

The previous remarks are not intended to challenge the premise that school systems enact cultural values. However, they do challenge the simplistic identification of culture with nationality. Once the identification (confusion) of nation with culture has been problematised, then the utility of international comparative research can be considered with greater cultural sensitivity.

Studying Lesson Structure

The analysis of video data collected in the video component of TIMSS, as reported by Stigler and Hiebert (1999), centred on the proposition that the teaching practice of a nation (at least in the case of mathematics) could be explained to a significant extent by the teacher's adherence to a culturally-based "teacher script." Central to the identification of these cultural scripts for teaching were the Lesson Patterns reported by Stigler and Hiebert (1999) for Germany, Japan and the USA. The contention of Stigler and Hiebert was that at the level of the lesson, teaching in each of the three countries could be described by a "simple, common pattern" (Stigler & Hiebert, 1999, p. 82). By contrast, the Learner's Perspective Study analysed sequences of ten lessons, documented using three video cameras, and supplemented by the reconstructive accounts of classroom participants obtained in post-lesson video-stimulated interviews. A fine-grained study of sequences of ten lessons, informed by the reconstructive accounts of the participants, has the potential to identify any recurrent pedagogical elements in a teacher's classroom practice and any evidence of regularity in the sequencing of those elements. Such regularities and recurrent elements have the potential to serve as the basis for comparative analysis.

Lesson structure can be interpreted in three senses:

- i. At the level of the whole lesson – regularity in the presence and sequence of instructional units of which lessons are composed;
- ii. At the level of the topic – regularity in the occurrence of lesson elements at points in the instructional sequence associated with a curriculum topic, typically lasting several lessons;
- iii. At the level of the constituent lesson events – regularity in the form and function of types of lesson events from which lessons are constituted.

In terms of international comparison, it is useful to consider which of these three forms of lesson structure are likely to prove useful as units of comparative analysis. In this regard, it is important to recognize that the most appropriate unit for national typification may not prove useful for international comparison. In terms of national typification, we need to address the question: Is a nation's or a culture's

classroom practice most usefully characterized at the level of the whole lesson, in the manner in which a topic is constructed, delivered and experienced, or in the form and function of the specific activities from which lessons are composed? The same three alternatives are available for the purposes of international comparison, but the optimal unit of international comparison need not be the same as the optimal unit for national typification. We can conceive of the possibility of an idiosyncratic practice that might typify the classrooms of a nation, but be so unusual as to not constitute a legitimate basis for international comparison. There are two quite distinct methodological alternatives:

Alternative 1. If two groups of objects are to be compared, one approach is to consider these two questions:

- i. Difference – What is the characteristic about which the *comparison* is to be made?
- ii. Similarity – How might each group of objects be separately *typified* with respect to that characteristic?

The international comparison of national norms of student achievement could be described as conforming to this approach, mediated by the test instrument employed. As Keitel and Kilpatrick (1999) have pointed out, such a test is the implicit embodiment of an idealised international curriculum taken as common across cultures and school systems. The order in which the two previous questions are posed is a major methodological signature.

Alternative 2. If two groups of objects are to be compared, consider these two questions:

- i. Similarity – Which characteristics appear to *typify* this collection of objects?
- ii. Difference – What *comparisons* can be made between these two groups of objects using the identified characteristics?

Posing the questions as in Alternative 2 reduces the danger of constraining the data to a predetermined structure, but may lead to the typification of the two groups by different emergent characteristics, restricting the common bases on which **comparison** of the two groups might be made. It should be noted also that **Alternative 2** assumes a domain within which comparison is sought, such as **classroom practice** or **curricular policy**.

In terms of lesson structure, it might be that for one nation or culture there is no nationally characteristic structure to the lesson as a whole, but that particular types of idiosyncratic lesson events offer the most appropriate typification. For another nation or culture, there could be a high degree of regularity to the composition of lessons, or in the sequencing of particular types of instructional activity in the delivery of a topic. Such differences in the form of typification provide a basis for international comparison that reflects something more essential to each than the identification (imposition) of the same structural level as the basis for the comparison. The choice of Alternative 1 makes the basis for comparison a matter of prescription based on either theory or on the prevailing educational priorities of the country conducting the study. Choice of Alternative 2 makes the identification of possible bases for comparison an empirical result of the research.

Incommensurability of the emergent typifications becomes relevant if the comparison is intended to be evaluative. However, the identification of idiosyncratic practices, absent entirely in some classrooms, offers the teachers of those classrooms entirely new pedagogical tools, potentially valuable, since they derive from the practices of competent teachers elsewhere.

Lesson Patterns

In the writings of Stigler, Hiebert and their co-workers, we find an interesting shift from discussion (and advocacy) of “lesson scripts” (Stigler & Hiebert, 1998) to “lesson patterns” (Stigler & Hiebert, 1999) and via “hypothesised country models” to “lesson signatures” (Hiebert et al., 2003) as the means by which the classroom practices of countries might be usefully compared. This trend signifies an increasing recognition that meaningful comparison of teaching practice across an international sample requires a multi-dimensional framework and a greater sensitivity to variation than is possible within the confines of a ‘lesson script.’

Givvin et al. (2005) used the TIMSS-R video data to revisit the question: Are there national patterns of teaching? Their approach to the question was handicapped by four key simplifications:

- i. *Lesson Location* – The significance of the location of the lesson within the instructional (topic) sequence as a source of variability was never addressed, either in their analysis nor in the subsequent discussion;
- ii. *Lesson as Unit of Analysis* – The possibility that such teaching patterns might be manifest at a level of an instructional unit other than the lesson was not addressed;
- iii. *Category Independence* – The three dimensions (Purpose, Classroom Interaction and Content Activity)ⁱ are not independent. We would further suggest that it is in the analysis of their interaction and consideration of the participants’ intentions and interpretations that we are most likely to gain insight into the origins of each teacher’s lesson structure and the underlying pedagogical principles.
- iv. *Over-inclusive Codes* – The three dimensions (Purpose, Classroom Interaction and Content Activity) on which the comparative analysis is undertaken were defined in extremely simplistic terms. This had the effect of maximizing the possibility of cross-classroom application of the coding scheme and minimizing variability through lack of sensitivity of the coding scheme to possible variation between classrooms.

Given the breadth of the categories applied, the degree of variability evident in each country’s lesson structure should be seen as quite striking. Our main point is that the inconclusiveness of the findings of Givvin et al. (2005) should not discourage those seeking national teaching patterns. It may reflect no more than the mistake of employing the lesson as the unit of comparison.

In relation to lesson structure and instructional practice as national characteristics, Anderson-Levitt (2002, p. 20) juxtaposed the statement by LeTendre et al. that “Japanese, German and U.S. teachers all appear to be working

from a very similar ‘cultural script’” (2001, p. 9) with the conclusions of Stigler and Hiebert (1999A9) that US and Japanese teachers use different cultural scripts for running lessons. As noted in chapter one, this apparent conflict can be resolved by noting that both US and Japanese teachers draw on the same small repertoire of “whole-class, lecture-recitation and seatwork lessons conducted by one teacher with a group of children isolated in a classroom” (Anderson-Levitt, 2002, p.21), but they utilise their options within this repertoire differently. This interweaving of differences and similarities is an essential characteristic of international comparative research. Policy is best informed by research that examines the nature of the interconnection of the various components of classroom practice rather than simply the frequency of their occurrence (Clarke, 2003).

The identification of national patterns of teaching was not one of the goals of the Learner’s Perspective Study. The research design focused on the classrooms of a small number of competent teachers in each of the participating countries. Because we selected competent teachers according to local criteria, there is a sense in which the practices of these teachers offer a representation of the pedagogical values in operation in that school system. But each teacher’s enactment of any such values would be likely to vary according to the student group, the topic to be taught and the individual teacher’s instructional inclinations. In such a study, it was the similarities and differences in the practices enacted in well-taught classrooms around the world that was of interest, rather than any national characterization of teachers or their classrooms. Nonetheless, given the visibility of the conjectured lesson patterns in various publications relating to international comparative research (see Clarke, 2003, for a more complete discussion), we felt justified in examining the postulated lesson patterns empirically.

There is no logical inconsistency here: Any identified national lesson pattern might be reasonably expected to manifest itself in the set of lessons collected in the LPS project from each of the three countries. The LPS identification of sequences of ten lessons by competent teachers adds interest to this analysis. What use do competent teachers make of the postulated national pattern? And, what consistency of lesson structure is evidenced in a ten lesson sequence by a competent teacher? Our analysis also serves to interrogate the consequences of the four key simplifications listed above. These are simplifications that any study committed to national typification and international comparison will find difficult to avoid. We would argue that it is the combination of such survey-style studies with the in-depth classroom analyses of the LPS project that holds greatest promise both to characterize teaching practice internationally and to inform that practice.

THE LEARNER’S PERSPECTIVE STUDY

As noted earlier, the LPS analysed sequences of ten lessons, documented using three video cameras, and supplemented by the reconstructive accounts of classroom participants obtained in post-lesson video-stimulated interviews. Test, questionnaire, and student written material were also collected. This methodological approach is dealt with in detail in Clarke (1998, 2001, 2003) and

Clarke, Keitel and Shimizu (2006) (see appendix). It offers an informative complement to the survey-style approach of the TIMSS video study.

The research design for the LPS was developed specifically for the purpose of producing a sufficiently complex data set to support the investigation of such interconnections within mathematics classrooms in a wide variety of cultural contexts. In particular, the research design was constructed to complement the approach taken in the TIMSS Video Study by documenting sequences of lessons, rather than single lessons; by recording 'private' (interpersonal) conversations as well as public utterances; and by utilizing the retrospective video-stimulated accounts of classroom participants to determine not just the overt actions documented by the three video cameras, but also the antecedent conditions, motivations and intentions that prompted the observed actions, and the consequent interpretations, meanings and learning outcomes arising from those actions.

In each of the participating countries, three 8th grade classrooms in government schools in major urban settings were chosen according to the common criteria of teacher competence (as locally defined by the community), demographic diversity and the avoidance of atypicality in the student group. Of the eighty-three lessons from nine classrooms across three countries analysed in this chapter, it is useful to note the mathematical content addressed in each classroom, as shown in Table 1.

Table 1. Mathematical Content of Lessons Analysed

Classroom	Number of lessons	Mathematical Content
US 1	10	1. Perimeter, Area and Volume 2. Equations, Inequalities and Formulas 3. Rational Number Concepts
US 2	5 double lessons	1. Functions, Relations and Patterns 2. Equations, Inequalities and Formulas 3. Problem Solving Strategies
US 3	10	Equations, Inequalities and Formulas
Germany 1	10	Integral Rational Terms and their Reformulation and Simplification
Germany 2	10	1. Common and Decimal Fractions 2. Equations of Fractional Terms
Germany 3	8 lessons including 2 doubles	Functions
Japan 1	10	1. Proportionality: Slope, Trigonometry and Interpolation 2. Functions, Relations and Patterns 3. Special Terms Used in Mathematics
Japan 2	10	Geometric Congruence and Similarity
Japan 3	10	System of Linear Equations

We are not claiming that the 30 lessons recorded in Japan (for example) are in any way a nationally representative sample of Japanese eighth grade mathematics classroom practice. The question we addressed in our analysis concerned the extent to which the reported nationally characteristic lesson patterns for eighth grade mathematics teaching in Japan (Stigler & Hiebert, 1999) were evident in the practices of any of the three Japanese teachers' we had studied and what might be learned from the correspondence or inconsistency in the occurrence of these patterns. Similarly, we looked for evidence of the US and German lesson patterns in the practices of the three teachers studied in each of those countries.

It is essential to emphasise that in this chapter we have analysed sequences of ten or more mathematics lessons taught by nine teachers designated as competent in three different countries. We cannot characterize the teaching of a country or a culture on the basis of such a selective sample and this was never our intention. Nor do we claim to compare teaching in one country with teaching in another. The research design was developed to support analyses intended to compare and contrast teachers and their classrooms, not cultures. Of course, the choice of school systems (Germany, Japan and the USA) was not accidental. It was intended to complement any general claims of national typicality by situating identified prevalent practice in relation to the antecedent conditions and consequent outcomes that might transform description into explanation. Also, since it was the specific intention of the TIMSS Video Study (Stigler & Hiebert, 1999) to characterize national practice in mathematics classrooms in the USA, Germany and Japan, it is reasonable to expect any lesson patterns reported as nationally typical to be evident to some extent in the respective LPS data bases of lessons from the USA, Germany and Japan.

The Analytical Approach

The purpose of our initial analysis can be stated simply: To determine whether the sequenced activity categories reported by Stigler and Hiebert (1999) could be identified in an analysis of the corresponding LPS data in the American, German and Japanese classrooms.

Consider first the reported characterisation of mathematics teaching in the United States of America. Based on the analysis of 81 single lessons, Stigler and Hiebert (1999) reported that US lessons could be generally characterized by the recurrence of four distinct classroom activities and that these activities, when placed in a particular sequence, formed the basis of a national lesson pattern.

The lesson pattern for the United States was reported as:

Reviewing previous material;
Demonstrating how to solve problems for the day;
Practicing; and
Correcting seatwork and assigning homework
(Stigler & Hiebert, 1999, p. 80)

Central to any reading of Stigler and Hiebert's lesson patterns is an understanding of the distinction between their activity titles (such as "Demonstrating how to solve problems for the day") and the brief descriptions provided of the most common or typical enactment of that activity.

After homework is checked, the teacher introduces new material, or reviews previous material, by presenting a few sample problems and demonstrating how to solve them. Often the teacher engages the students in a step-by-step demonstration by asking short-answer questions along the way. (Stigler & Hiebert, 1999, p. 80)

These descriptions of typicality do not constitute definitions of the relevant activity, although they did provide useful examples of the type of actions from which the activity category might be constituted. Without strict definitions that distinguished the finer characteristics of one activity from another, we interpreted the four activity categories as liberally as possible. This proved quite challenging. For example, the description of the activity "Demonstrating how to solve problems for the day" (above) includes the phrase "reviews previous material" which is itself the title of the first of the original four activities identified as classifying the structure of US lessons, yet it also appears subsumed within another activity.

A minute by minute analysis was conducted of the video record of all US lessons in the LPS data set in which it was determined which of the four activities best described the classroom behaviour for each minute of every lesson. The analysis was carried out by two researchers working independently and the results were compared and discussed and a consensus coding constructed.

In order to make the structure of individual lessons more readily comparable, a system was devised whereby each activity was allocated a particular colour/shade (see Figure 1) and these colours/shadings used to distinguish between lesson components and to make any structural regularities more readily apparent (see, for example, Figure 2).

	Reviewing previous material
	Demonstrating how to solve problems for the day
	Practicing
	Correcting seatwork and assigning homework

Figure 1. Allocation of colour for coding purposes to each of the classroom activities found in Stigler & Hiebert's (1999) US lesson pattern

The results that follow report the application of this same process of schematic representation to each of the LPS data sets from the USA, Germany and Japan. We begin first with the USA.

RESULTS

Identifying the US Lesson Components within the LPS US Data

Figures 2, 3 and 4 represent the coding of the videotape footage from the LPS data of US Schools 1, 2 and 3 with the classroom activities as described in the US lesson pattern reported by Stigler and Hiebert (1999) and as set out in Figure 1.

Figure 2. US lesson pattern codes as applied to LPS US School 1

The lesson pattern reported in the TIMSS Classroom Videotape Study, namely that a lesson begins with a) reviewing previous material, followed by b) demonstrating how to solve problems for the day, then c) practicing and finally ending with d) correcting seatwork and assigning homework, did not appear as the complete lesson structure in any lesson in US School 1, although it appeared as the first half of Lesson 6. In addition, not all activities were present in every lesson: Lessons 1 to 5 appear radically different in structure from Lessons 7 to 10, while the structure of Lesson 6 appears to be cyclic in nature. This progression in lesson structure across the lesson sequence (that is, across the teaching of one topic) suggests that for this teacher the deployment of the constituent classroom activities was a matter for purposeful choice according to the location of the lesson in the sequence.

Most lessons began with a warm-up activity or by checking homework and this rarely appeared to happen at any other time in the lesson. The progression in lesson structure over the course of the lesson sequence is most evident in the time devoted to teacher demonstration in the early lessons, almost completely replaced by the correction of seatwork in the later lessons. The teacher administered an ungraded, 'conceptual' test in Lesson 7 and the three lessons following this test were spent on explaining and correcting the tasks from the test in order to expand on and develop the students' understanding of the related concepts.

It is important to note that, although the reported characteristics of the constituent activities were fairly vague, it was possible to use these categories for a comprehensive coding of all ten lessons in US School 1. In this sense, the broad categories reported by Stigler and Hiebert (1999) were evident in the LPS US data set. There was no evidence, however, of the reported sequence as a recurrent or regular pattern in the structuring of any of the documented lessons in this teacher's classroom other than the first half of Lesson 6.

If any structural pattern could be said to be evident in this teacher's lessons, it was the progressive shift in dominant activity from demonstration through participation to correction and explanation. This progression was enacted, however, not over the course of a single lesson, but instead over the entire lesson sequence. Prior to this analysis, Shimizu had already observed, "Japanese teachers usually plan a lesson as part of a unit, a sequence of several lessons. This means that each lesson in a unit has a different purpose for attaining the goals of the unit" (Shimizu, 1999, p. 194). The data from US Teacher 1 suggested that this American teacher structured each lesson according to its location within the topic or unit.

Figure 3. US lesson pattern codes as applied to LPS US School 2

The structure of the lessons in School 2 (see Figure 3) appeared to be closest in structure to the pattern reported by Stigler and Hiebert (1999). All School 2 lessons were double lessons taking up two timetable periods. In fact, all the lessons in School 2 began with the reported sequence of classroom activities, while the structure of Lesson 3 is completely described by the Stigler and Hiebert (1999)

pattern. There is no doubt that the pedagogical demands of a double-period lesson influenced the teacher's structuring of each lesson as a whole.

In addition to being the closest in structure to the reported pattern, each classroom activity type appeared in every School 2 lesson. Further, the time allocated to each activity was more evenly distributed than in US School 1.

Figure 4. US lesson pattern codes as applied to LPS US School 3

The US lesson pattern, as described by Stigler and Hiebert (1999), did not appear as the complete lesson structure for any of the lessons from School 3. The earlier portions of Lessons 1 and 7 do resemble the TIMSS lesson pattern, although the lessons themselves in their entirety do not. As for LPS US School 1, not all four activity types appear in every lesson. Lessons 1, 5 and 7 had one similar structural feature: A significant period of each of these three lessons involved the repetitive alternation of student seatwork and the correction of student seatwork. By contrast, several lessons showed little pedagogical sub-structure, with only two or three classroom activities employed (particularly review and practice) and each extending for significant proportions of the lesson's duration.

Almost all the School 3 lessons began with students correcting their homework from a transparency, which the teacher placed on the overhead projector. Any student concerns about the homework were then addressed at this time. Little time was devoted to teacher demonstration, while large portions of the lesson were spent in student practice. The contrast with US Teacher 1 is striking.

A few summative remarks can be made about the coding of the US data as this is displayed in Figures 2, 3 and 4. Firstly, it was possible to interpret the activity categories of the Stigler and Hiebert report sufficiently broadly to accommodate most of the documented activities in all three US classrooms. Secondly, the US lesson pattern reported by Stigler and Hiebert (1999) adequately described only one of the 25 lessons coded (US2-L3) in its entirety, although the lesson pattern appeared within the overall structure of several lessons. Thirdly, the lessons taught by any one teacher showed evidence of purposeful variation across the topic sequence for that classroom. Fourthly, the differences in lesson structure and topic

structure between teachers suggested that each teacher combined and sequenced the various activities in ways that were not only a reflection of the mathematical topic being taught, and of the location of the lesson in the topic sequence, but also of the pedagogical style of the individual teacher.

Identifying the German Lesson Components within the LPS German Data

The same procedure was followed in the case of the German LPS data set. Stigler and Hiebert (1999) reported the lesson pattern shown in Figure 5 and these classroom activity types were used to code the German videotape data. The results for each of the three German schools are shown in Figures 6, 7 and 8.

	Reviewing previous material
	Presenting the topic and the problems for the day
	Developing the procedures to solve the problem
	Practicing

Figure 5. Stigler & Hiebert's (1999) German lesson pattern

Figure 6. German lesson pattern codes as applied to LPS German School 1

Figure 7. German lesson pattern codes as applied to LPS German School 2

Figure 8. German lesson pattern codes as applied to LPS German School 3

Figures 6, 7 and 8 show that there was a much greater variety of lesson structure in the German lessons from the LPS study than the characterisation of a typical German lesson given by Stigler and Hiebert would suggest. As was the case for the US lessons, a generous interpretation of the reported classroom activities allowed most classroom activities to be coded consistently with the four categories shown in Figure 5. However, lessons in all three German schools included classroom activities that fell outside the predicted categories. These uncoded activities are shown in white in each of the three preceding figures. Examples of such uncoded activities included: Organisation of school activities, classroom management and disciplinary control, arranging seating or setting up equipment, getting materials or tools in preparation for the next activity, and conducting a test.

The same four summative points made in relation to the US lessons apply with equal legitimacy to the German lessons: Much of the lessons could be accommodated by the activity codes; however there was no evidence of the German lesson pattern reported by Stigler and Hiebert in any of the twenty-eight lessons analysed, and there was significant variation in lesson structure both within any one teacher's lesson sequence and between teachers.

Identifying the Japanese Lesson Components within the LPS Japanese Data

The same procedure was followed in the case of the Japanese LPS data set. Stigler and Hiebert (1999) reported the lesson pattern shown in Figure 9 and these classroom activity types were used to code the Japanese videotape data. The results for each of the three Japanese schools are shown below (Figures 10, 11 and 12).

Figure 9. Stigler & Hiebert's (1999) Japanese lesson pattern

Figure 10. Japanese lesson pattern codes as applied to LPS Japanese School 1

Figure 11. Japanese lesson pattern codes as applied to LPS Japanese School 2

Figure 12. Japanese lesson pattern codes as applied to LPS Japanese School 3

Many of the Japanese lessons can be characterized as 'structured problem solving' in the sense that the teacher typically intended to have the students work on a problem and discuss solution methods, and then to highlight and summarize the main points in each lesson. But Figures 10, 11 and 12 reveal a rich substructure to each lesson that could not be represented adequately by any single lesson pattern, such as that shown in Figure 9.

As can be seen from Figures 10, 11 and 12, the lesson pattern varied within the instructional sequence for teaching a topic, depending on the teacher's intentions. The coding of the classroom activities for the videotaped sequences of ten consecutive mathematics lessons in Japanese classroom in the Learners' Perspective Study (LPS) data suggests that there are significant variations from the lesson pattern reported by Stigler and Hiebert (1999) and that a more complex categorization of the classroom activities or lesson components of Japanese mathematics lessons is needed than the simple five-component lesson pattern described by Stigler and Hiebert's (1999) analysis of single lessons.

It is interesting to note that Stigler and Hiebert referred specifically to one Japanese lesson in their data, which did not seem to fit their characterization of 'structured problem solving.'

This lesson shows that 'structured problem solving' does not capture the full range of Japanese instruction. Indeed, it seems that the teaching method in this lesson is more like the methods typically used in Germany than the method typically used in Japan. If nothing else, the lesson reminds us that not all teachers within the same country use the same methods (Stigler & Hiebert, 1999, p. 51).

The analysis reported above suggests that even the same teacher teaches mathematics in different ways at different stages in the instructional sequence. This finding has an obvious explanation if we consider that Japanese teachers usually plan a sequence of several lessons as part of the teaching unit (Shimizu, 1999). In other words, each lesson in a unit has a different purpose in relation to attaining the goals of the entire unit. The lesson at the introductory phase of the entire unit, for example, may look like 'structured problem-solving', whereas the lesson at the

final phase of the unit may have an emphasis on practicing what the students have learned.

As was the case with the US and German classrooms, the TIMSS Japanese lesson pattern was not evident in the LPS lessons analysed, except in the first half of Japanese School 1, Lesson 6. The variation between teachers in the constitution of the lessons was significant. One observation, highlighted by the schematic use of colour/shading in Figures 10, 11 and 12, is the preference of each Japanese teacher for a particular activity type. Teacher 1 made much greater use of 'Discussing solution methods' than either of the other two teachers. Teacher 2 devoted more time to 'Highlighting and summarizing the major points' than either of the other two teachers, and Teacher 3 made far more consistent and extensive use of 'Students working individually or in groups.'

LESSON EVENTS AS THE UNIT OF COMPARATIVE ANALYSIS

In coding the lessons displayed in Figures 2, 3, 4, 6, 7, 8, 10, 11 and 12, we applied the activity categories reported by Stigler and Hiebert (1999). We attempted to do this using the broadest possible interpretation of each activity category in order to maximize the capacity of the resultant coding scheme to accommodate the classroom actions documented in the eighty-three lessons analysed. Our relative success overall in this coding exercise highlighted those classroom activities that could not be successfully coded, and these exceptions have been commented upon.

As a result of our analysis, we became convinced of several important points. While we are in sympathy with the goal of finding pattern and structure in teachers' classroom practice, the activity categories employed by Stigler and Hiebert (1999) were too inclusive to usefully represent the richness of the activities we found in the nine classrooms. Shimizu conducted a reclassification of the activities in the Japanese classrooms and found a minimum of thirteen activity codes necessary to accommodate the classroom activities recorded in the three Japanese classrooms. Significant and frequent omissions in the case of the Japanese classrooms included Assigning Homework and Checking Homework.

Table 2 The Thirteen Categories for Coding Japanese Lessons

Reviewing the Previous Lesson (RP)*
Checking Homework (CH)
Presenting the Topic (PT)
Formulating the Problem for the Day (FP)
Presenting the Problems for the Day (PP)*
Working on Sub-problem (WS)
Students Working Individually or in Groups (WP)*
Presentation by Students (PS)
Discussing Solution Methods (DS)*
Practicing (P)
Highlighting and Summarizing the Main Point (HS)*
Assigning Homework (AH)
Announcement of the Next Topic (AN)

* Activity codes from the Japanese lesson pattern reported by Stigler & Hiebert (1999).

Stigler and Hiebert reported that "no homework is typical" (Stigler & Hiebert, 1999, p.30) for Japanese lessons, and contrasted this with Germany and the USA. All the three classrooms in the LPS Japanese data set, however, included both 'assigning homework' and 'checking homework'. In such cases, homework played the role of 'connector' between two lessons (Sekiguchi, 2003). Our analysis of the German and US lessons also strongly supported the need for an expanded categorisation scheme, if the richness and distinctive character of each classroom was to be documented adequately. The increased detail of the codes employed in the later TIMSS-R Video Study (Hiebert et al., 2003) provides further endorsement of this point.

The teachers whose classrooms we had documented showed little evidence of a consistent lesson pattern, but instead appeared to vary the structure of their lessons purposefully across a topic sequence. The challenge for us became to decide how best to represent the teacher's purposeful structuring of their lessons in way that offered greatest insight into the intentions and motivations of the teachers (and their students) and which captured whatever was most distinctive about the practice of each classroom. The question of whether any emergent structures might provide possible contenders as national characteristics was not a question we could address, given the focused nature of our study, but it was here that we hoped the complementarity of the LPS and TIMSS-R projects might prove mutually informing.

The report of the TIMSS-R Video Study (Hiebert et al., 2003) reinterpreted the idea of nationally representative lesson patterns (by implication, if not explicit statement) and reported 'lesson signatures' (Hiebert et al., 2003, pp. 123-151).

If there are features that characterize teaching in a particular country, there should be enough similarities across lessons within the country to reveal a particular pattern to the lessons in each country. If this were the case, then overlaying the features of all of the lessons within a country should reveal a pattern or, as labeled here, a 'lesson signature' (Hiebert et al., 2003, p. 123).

Hiebert and his colleagues constructed an imaginative way of displaying this overlaying of their coding of each country's lessons, representing national practice through an array of parallel bands similar to seismological charts, each band indicating the percentage of lessons that exhibited that feature at that time in the lesson. These displays could support such statements as "For US eighth grade mathematics lessons, while the activity coded as Reviewing was documented at all points in the lesson, it was most frequently recorded during the first 20% of the lesson, with steadily decreasing frequency of occurrence throughout the remainder of the lesson." An alternative reading of these lesson signature displays would be to identify a particular period in the lesson (e.g., when 40% of the lesson time had passed) and to compare the relative frequency of occurrence of the various activity types at that stage of the lesson.

The TIMSS-R lesson signature approach has the advantage of supporting statements of likelihood regarding the occurrence of particular activity types at various points in a lesson for each of the countries studied. The questions which the

LPS sought to address related more to the conditions under which teachers might decide to employ a particular activity and the consequences of that decision for both the teacher's instruction and the students' learning. The analysis of the LPS lessons reported earlier in this chapter suggests that a primary consideration must be where the lesson is situated in the topic sequence. Further, the evident differences in the manner in which teachers structured their lessons, suggested that another unit of analysis was needed: one that corresponded more closely to the decisions made by each teacher regarding the structure of any particular lesson.

Our analysis of the LPS lessons focused therefore on the form and function of recognizable activity conglomerates that we came to call 'lesson events.' The original conception of lesson events was sustained by those features of a country's classroom practice that most attracted the attention of researchers from another country. For example, non-American researchers were struck by consistencies in the way in which the three US teachers commenced each lesson. By contrast, non-Australian researchers commented on the very attenuated content introductions provided in many of the Australian lessons. At the same time, the proportion of time that Australian teachers devoted to moving around the classroom, while their students worked semi-independently on assigned mathematical tasks, also attracted the attention of non-Australian researchers. The evident significance that the Japanese teachers attached to a summative discussion towards the end of each lesson was of interest. The manner in which each teacher posed the first substantive mathematical task, intended to introduce the lesson's content, appeared to vary significantly from teacher to teacher and lesson to lesson. Those moments when a student was called to work on the board at the front of the classroom seemed to serve a distinctive and different purpose from classroom to classroom, and yet such moments were familiar across all participating LPS research groups. Each of these lesson events was recognizable and even familiar to all members of the research group.

As a result, we adopted the lesson event as a unit of comparative analysis. A Lesson Event, as we conceived it, was characterized by a combination of form and function, both of which were subject to local variation, but with an underlying familiarity and frequency of use that suggested both cross-cultural relevance and utility. Each individual Lesson Event had a fundamentally emergent character, suggested by the classroom data as having a *form* (visual features and social participants) sufficiently common to be identifiable within the classroom data from each of the countries studied. In each classroom, both within a culture and between cultures, there were idiosyncratic features that distinguished each teacher's enactment of each Lesson Event, particularly with regard to the *function* of the particular event (intention, action, inferred meaning and outcome). At the same time, common features could be identified in the enactment of Lesson Events across the entire international data set and across the data set specific to a country. The teacher and student post-lesson interviews offered insight into both the teacher's intentions in the enactment of a particular Lesson Event and the significance and the meaning that the students associated with that event type.

Each Lesson Event required separate and distinct identification and definition from within the international data set. Each of the next five chapters addresses one of these Lesson Events. Additional Lesson Events are the focus of current analysis and it is anticipated that future books in this series will report on these.

CONCLUSIONS

One of the most significant challenges confronting international comparative research on classroom practice is the identification of a suitable basis for comparative analysis. Based on the analyses reported earlier in this chapter, it seems likely that, if the goal is to characterise typical national practice at the level of the lesson, in attempting to accommodate the variation evident in a national sample of lessons, the resultant lesson structure and its constituent codes must be so inclusive as to sacrifice the details that might otherwise have facilitated meaningful comparison and informed practice.

An inevitable consequence of any nationally representative sample of individual lessons is to average over the distinctive lesson elements, whose location in the lesson are a direct and informative reflection of the lesson's location in the topic sequence. The 'typical lesson' is consequently no more informative than the 'typical teacher' or 'typical student.' However, statements of national typicality can be a useful reference point when they are expressed as statements of relative frequency or likelihood of occurrence. An example of this can be found in the next chapter on 'Beginning the Lesson.' Particular consistencies of practice were identified among the US lessons analysed, specifically relating to how the teachers began the lesson. The detailed LPS data set supports a fine-grained analysis of both the form and the function of these lesson beginnings as they were enacted in the three US classrooms. It cannot, of course, make any statements regarding the national frequency of occurrence of the review function at the start of mathematics lessons in the US. For this, we can turn to the TIMSS-R data (Hiebert et al., 2003).

If, however, a particular activity were identified by the TIMSS-R Video Study as occurring extremely frequently in the classrooms of a particular country, the TIMSS-R data is unlikely to be able to address such questions as: In response to what antecedent conditions (both immediate and of a more extended nature) was that activity purposefully employed? With what instructional purpose? With what consequent learning outcomes? For the answers to these questions, we require the detail provided by the LPS documentation of lesson sequences, supplemented by the post-lesson interviews with teachers and students.

Another distinguishing characteristic of the LPS is the decision to focus on competent teachers. Elsewhere, Shimizu has contrasted the focus on the typical lesson versus the focus on the well-taught lesson.

Japanese mathematics teachers and educators would believe that studying one excellent lesson intensively is likely to be more beneficial than studying many 'average' lessons. They are interested not in how eighth grade mathematics is taught in Japan but how an excellent teacher, in any one of

three countries, teaches mathematics in her classroom (Shimizu, 1999, p. 191).

The essential point is that the variability in lesson structure documented in this chapter reflects the purposeful decision-making of competent teachers, who structure their lessons in recognition of the needs of their students, their priorities and strengths as teachers, and the situation and consequent purpose of the lesson in the instructional sequence (cf. Givvin et al., 2005, p. 341).

If we are to inform the practices of teachers internationally, our analyses should be focused on that level of activity that is in closest correspondence to the level at which teachers are obliged to make structural instructional decisions. Rather than offering teachers a model lesson, to be universally applied, as has been the case in the past (for example, in the recommendations of the process-product generation of researchers, see Bourke (1985) or Good and Grouws (1979)), our goal is to expand a teacher's repertoire of instructional strategies by reporting the variety of forms and functions in which particular Lesson Events are carried out in the classrooms of competent teachers around the world.

NOTES

- i. Purpose is defined to mean Review, Introducing New Content, Practicing/Applying Content; Classroom Interaction means Public or Private Interactions; Content Activity is defined to include Independent or Concurrent Problems (Givvin et al., 2005).

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