

The Structure of Mathematics Lessons in German Classrooms: Variations on a Theme

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Paper presented as part of the symposium “Mathematics Lessons in Germany, Japan, the USA and Australia: Structure in Diversity and Diversity in Structure” at the Annual Meeting of the American Educational Research Association, Chicago, April 21-25, 2003.

Other papers in the same symposium were:

Clarke, D. & Suri, H. “Issues of Voice and Variation: Developments in International Comparative Research in Mathematics Education.”

Mesiti, C., Clarke, D., & Lobato, J. “The Structure of Mathematics Lessons in the United States.”

Shimizu, Y. “Capturing the Structure of Japanese Mathematics Lessons as Embedded in the Teaching Unit.”

Clarke, D. “The Structure of Mathematics Lessons in Australia.”

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1. Rationales for studying lesson structure

The descriptions of the lesson patterns of German, Japanese and U.S. lessons based on the data from the TIMSS Videotape Classroom Study employ culture specific descriptors of segments of a lesson that are highly interpretive, such as *warm-up*, *reviewing a quiz*, or *seatwork* (Stigler and Hiebert, 1999; Stigler *et al.*, 1999). For the purpose of cross-cultural comparison the use of such terms would be extremely problematic if it served to subsume unfamiliar events under a category that might not be part of the local vocabulary and of the conceptions used to plan and organise lessons. But one rationale for studying lesson structure internationally could be to identify elements of lesson plans and classroom interaction that grew out of local traditions of curriculum and teacher training and are evidenced in distinct organisational forms. It can be assumed that the availability of a repertoire of specific forms of activities shapes the process of learning/teaching in that they constrain the possibilities for interaction.

On the other hand, it is interesting to see how rather cross-national elements of mathematics lessons, such as *practicing*, *reviewing*, or *assigning homework*, turn out to be enacted in distinct ways in different classrooms within and across national traditions. Such a study could offer insights into the extent to which these forms are shaped and changed by teachers and students. In Germany, the intended mathematics curriculum prescribes the goals and the content but assigns the teacher the pedagogical freedom of choosing the methodological arrangements. An empirical investigation into the ways secondary teachers plan their lessons in Germany (Haas, 1998), shows that the content is the most important category on which their lesson plans are based. It is ranked more important than the educational aims. That means that didactical and methodological considerations are subordinated to considerations about the combination and structure of the topics to be taught. As to mathematics, this points to a conception of the content as existing independently from the social practice in the classroom by which it is enacted. However, the students might perceive the structure of the content and the significance of topics in a way that differs considerably from the way the teacher perceives it (see Shimizu, 2003, paper presented at this symposium).

The main goal of this analysis of lesson structure in the three German classrooms from the Learner's Perspective Study (LPS) was to document the different forms by which the teachers intend to realise a didactical purpose, or, conversely, to see the range of functions teachers try to realise by similar forms of physical set-up, interaction and talk.

2. Outline of results

The data from the German classrooms show:

- There is a much bigger variety of lesson patterns in the German lessons from the LPS study than the characterisation of a typical German lesson given by Stigler and Hiebert (1999) suggests;

- There is a variety of forms of interaction, talk and physical set-up by which the teachers realise a distinct function (didactical purpose);
- There is a distinct and detectable repertoire of forms in each of the three classrooms;
- Form and function are linked: Not every form of interaction, talk and physical arrangement is used for any function (didactical purpose) and task structure;
- The teachers are more or less explicit about the purpose of a distinct activity;
- The students are often not aware of the didactical purpose of an activity;
- The extent to which the students shape or acquiesce to the teacher's pre-defined lesson structure varies;
- The degree to which the teacher encourages student-student interaction varies considerably in the classrooms under study.

3. Descriptors of lesson structure

3.1 Physical actions of teacher and students

One goal of this analysis was to document the different forms of physical set-up, interaction and talk by which the teachers intend to realise a didactical purpose.

In order to achieve this, possible combinations of physical actions of the teacher and the students were identified, as shown in the table below. These combinations were used as coverage codes. That means, the descriptors are mutually exclusive, the beginning and ending points could be marked reliably, and the whole lesson could be covered. All 30 lessons, that is, ten consecutive lessons in each of the three classrooms under study, were coded.

These actions were further differentiated empirically from the classroom videos. Both the mixed image of the teacher and a group of focus students and the whole class image were used. For example, when the teacher sits at the teacher's desk, she or he might observe the students' activity, be engaged in public talk or deal with administrative work. When the teacher stands in front of the classroom, she or he might write or produce a drawing at the board or/and talk publicly addressing the whole class. The same applies to students, though it never occurred that a student, when standing in front of the class, happened to talk to the whole class without at the same time using the board or a model.

Combinations of teacher's and students' physical actions in the German LPS classrooms:

	One student sits at teacher's desk	One/ some student(s) stand(s) at front	One/ some student(s) walks(s) between desks	All students sit at their desks
Teacher sits at teacher's desk	Does not occur	Does not occur	Does not occur	Written test
Teacher stands in front	Does not occur	Student Presentation	Setting up task	Most of the time
Teacher walks between desks	Does not occur	Students preparing presentation	Does not occur	Most of the time
Teacher sits at students' desks	Does not occur	Student presentation	Does not occur	Does not occur

It turned out that not all possible combinations occur, and some are only present occasionally. Most of the learning and teaching in the German LPS classrooms takes place when all students sit at their desks and the teacher stands in front of the class or walks between the

students' desks. As an example of variations of a form of physical set-up with different functions, the event "students at the board" was further investigated (see section 4).

3.2 Interaction and forms of talk:

In a second step, relatively simple labels for the forms of interaction and talk were attached to lesson episodes according to what the teacher and/ or the majority of the students are doing. These codes were not used as a system of coverage codes because the beginning and ending points could not be marked reliably. This is mainly due to the fact that different forms of interaction and public and private discourse are occurring parallel in the classrooms and seamlessly shade off into each other. For example, when the teacher talks to individual students while walking between the desks, this frequently changes to public talk addressing the whole class because more and more students start listening to what the teacher says to a group of students, and the teacher, in return, talks more loudly while slowly walking back to the front of the classroom. Or, when students are presenting at the board to the whole class, this often changes to a whole class discussion guided by the teacher who interrupts the students. In addition, depending on the level of description, the interactional categories might be confounded. However, these descriptors show the repertoire of the forms of interaction and talk observed in the three German classrooms:

- Students working individually while talking on and off to the students sitting next to them
- Students working individually without talking
- Students working in pairs
- Students working in groups of more than two
- Teacher addressing the whole class by asking isolated questions
- Teacher addressing the whole class by asking a series of connected questions (fragend-entwickelndes Unterrichtsgespräch)
- Teacher moderating a whole class discussion
- Teacher addressing the whole class by a presentation or demonstration
- Teacher talking to single students or a group of students
- Teacher dictating
- Students copying text or drawings from the board
- Students reading out passages from the textbook or other materials
- Students solving tasks orally (by reporting each step and addressing the whole class)
- Student(s) orally publicising results of previous work (addressing the whole class)
- Students addressing the whole class by a presentation or demonstration

As an example of variations of a form of interaction with different functions, episodes in which the teacher uses the form "fragend-entwickelndes Unterrichtsgespräch" were further investigated (see section 4).

3.3 Function

In a third step, the function the teachers seemed to attribute to the lesson elements that were identified in terms of interaction and forms of talk was taken into account. Most of these descriptors are highly interpretive. In some cases the teacher explicitly announced the purpose of an activity. However, in most of the lessons the function of an episode in terms of the teacher's intention could only be identified by assigning a range of possible functions and then choosing the one that fitted best to a reasonable lesson plan and to the function of a similar lesson element in other lessons of the same teacher. If available, data from the teacher questionnaire were taken into account. For example, in order to see whether an episode was meant to introduce new content, it was looked up in the questionnaire whether the teacher believed that the content was new to most of the students in the class. The function according to the teacher's intention does not necessarily match the function the majority of students or an observer would accredit to an activity. In addition, without further analysis, nothing can be said about the extent to which the purpose of the activity is achieved. The main goal of this step in the analysis was to compare the lessons of the three German classrooms to the German lesson pattern reported by Stigler and Hiebert (1999), which categorises lesson elements in terms of four main functions.

The functions of lesson episodes identified in the three German classrooms comprise:

- Greeting and/ or announcement to start or finish the lesson
- Organization of school activities, classroom management and disciplinary control
- Getting settled: students or/and teacher arrange seats, desks or/and set up equipment or/and get materials or tools in order to start a new activity or the lesson
- Introducing tasks: physical, directional instructions and mathematical activities in order to be able to start working on a task. This might be a task the students are supposed to work on in the lesson or as homework
- Outline of a new topic (advanced organiser)
- Introducing or developing content (definition, terminology, formula, procedure or solution method) that is supposed to be new to the majority of the students
- Practicing: a definition, terminology, formula, procedure or solution method that is supposed to be shared knowledge in the classroom is to be applied in a familiar or new situation for the purpose of familiarisation or re-familiarisation
- Commencing homework: the teacher allows or wants the students to start their homework
- Checking results of students' work, including homework
- Summarising previous work
- Review before a test
- Conducting a test

Stigler and Hiebert (1999) argue that there are recurring features of lesson structure that are typical for many lessons within a country and distinguish the lessons among countries. The hypothesis is that there is a detectable pattern of mathematics lessons characteristic for each country. The implicit assumption of the existence of a script that is nationally representative obviously lead to development of very general descriptors that subsume a diversity of forms. The typical pattern reported for the German classrooms consists of a sequence of four phases:

1. Reviewing previous material, commonly by checking homework or by a brief lecture.
2. Presenting the topic and the problems (for the day).

3. Developing the procedures to solve the problem, typically in a whole class activity guided by the teacher.
4. Practicing, usually by the assignment of a set of problems similar to those in the previous phase, which are solved by the students in seatwork. If not finished it can become homework to finish the problems.

In order to subsume the lesson episodes identified in the three German LPS classrooms under these four activities, the functions identified in the data were grouped under the four headings “Reviewing”, “Presenting the topic/ problems”, “Developing” and “Practicing”. The descriptions of the forms by which, according to Stigler and Hiebert (1999), the described functions are ‘typically’ realised were not taken into account in this analysis because the classroom activities that served these functions showed a much bigger variety than those descriptions suggest. The title “Developing the Procedures to Solve the Problems” turned out to be the most problematic one and had to be interpreted very generously because the new knowledge developed in the classrooms is not necessarily a procedure to solve a problem. Similarly, “Presenting the Topic and the Problems” had to be interpreted very flexibly. In many lessons the problems or the topic was not simply presented to the students by the teacher. In some episodes the students’ interpretation of the tasks was discussed extensively, sometimes the students were asked to read out and comment on the tasks to be solved. Or the problem was specified in a whole class discussion.

Some of the activities observed in the classrooms could not be characterised as part of one of the four components. These are:

- Greeting and/ or announcement to start or finish the lesson;
- Organization of school activities, classroom management and disciplinary control;
- Getting settled: students or/and teacher arrange seats, desks or/and set up equipment or/and get materials or tools in order to start a new activity or the lesson;
- Conducting a test.

“Reviewing” comprises:

- Checking results of students’ work, including homework;
- Summarising previous work (also if from the same lesson);
- Review before a test.

“Presenting the Topic and the Problems” was taken to subsume:

- All physical, directional instructions and all mathematical activities necessary for being able to start working on a task. The task might be a new one on which the students are supposed to work in order to develop a new procedure or an explanation, or a task for practicing in the lesson or as homework.

The following lesson components were classified as “Developing new Procedures”:

- Outline of a new topic (advanced organiser);
- Introducing or developing content (definition, terminology, formula, procedure or solution method) that is supposed to be new to the majority of the students.

The title “Practicing” was applied to lesson components:

- In which the students had to apply a definition, terminology, formula, procedure or solution method that was supposed to be shared knowledge in the classroom in a familiar or new situation for the purpose of familiarisation or re-familiarisation;
- In which the students were commencing their homework in the lesson.

The following figures show the results of the application of the categories provided by Stigler and Hiebert (1999) in this interpretation to the three German Classrooms from the LPS. The

modes of interaction and talk (see section 3.2) by which the components are enacted are also shown. These are:

- FeU: Teacher addressing the whole class by asking a series of connected questions (fragend-entwickelndes Unterrichtsgespräch)
- Pr: Student(s) publicising results of previous work (addressing the whole class)
- RoB: Students reading out passages from the textbook or other materials
- Sc: Students copying text or drawings from the board
- Sd: Students addressing the whole class by a demonstration
- So: Students solving tasks orally (by reporting each step and addressing the whole class)
- Sp: Students addressing the whole class by a presentation
- Tp: Teacher addressing the whole class by a presentation or demonstration
- Wcd: Whole class discussion moderated by the teacher.
- Wg: Students working in groups of more than two.
- Wi: Students working individually while talking on and off to the students sitting next to them or without talking.
- Wp: Students working in pairs

The additional categories “Teacher addressing the whole class by asking isolated questions” and “Teacher dictating” reported in section 3.2 of this paper are not included because the episodes were too short to be represented accurately in this diagram. The category “Teacher talking to single students or a group of students” is not included because these form of interaction occurs at the same time when the students work individually, in pairs or in groups time span which this was the case. For the title “Presenting the Topic and the Problems” the interaction categories were only included if the characterisation “Presentation” did not apply. The white stripes represent the lesson components to which none of the four titles applied. In some instances of group work or individual seatwork the teacher split the class into groups of students who had to work on essentially different tasks. This set-up is called “Division of Labour (DI)” in this analysis.

(The time devoted to the components was rounded to full minutes; the smallest unit represents one minute.)