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The Power of Video Studies in Investigating Teaching and Learning in the Classroom

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5 Observing Instruction "next-door": A Video Study about Science Teaching and Learning in Germany and Switzerland

Inger Marie Dalehefte, Rolf Rimmele, Manfred Prenzel, Tina Seidel, Peter Labudde, Constanze Herweg[1]

International comparative studies like the Third International Mathematics and Science Study (TIMSS) (Beaton et al., 1996) and the Programme for International Student Assessment (PISA) (OECD, 2001, 2004) made the German students' achievements in mathematics and science appear to be below expectations. The performance in TIMSS was at the level of the international average; in PISA 2000, however, it was below the OECD mean (Baumert et al., 2001). The outcomes of these studies were seriously discussed among German researchers and educational experts and initiated many speculations concerning the reasons for these findings. The TIMSS 1995 Video Study in Mathematics (Stigler, Gonzalez, Kawanaka, Knoll, & Serrano, 1999) indicated that the outcomes could be connected to instructional scripts. For Germany, one concluded that, somehow, an unfavourable instructional script had obviously manifested itself over years and decades.

In this way, the TIMSS 1995 Video Study in Mathematics triggered the drive to know more about instructional problem areas specific to Germany. At the same time, the fact that Swiss students showed a higher performance level in both international studies stood out. These findings raised the question of whether students in Switzerland and Germany experience different conditions in their mathematics and science classrooms. In this chapter, we aim to describe the approach which we took to compare science instruction in the two culturally and linguistically related countries Switzerland and Germany, and to present an overview of the descriptive findings.

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1 Co-researchers: Maja Brückmann, Reinders Duit, Bernhard Gerber, Birte Knierim, Mareike Kobarg, Katharina Schwindt, and Maike Tesch

5.1 Theoretical Background

The TIMSS Video Studies were conducted as large-scale studies in mathematics and science and included countries with different cultures and languages (Roth et al., 2006; Stigler et al., 1999). The study presented in this chapter can be described as a bilateral large-scale study comparing physics instruction in Germany and the German-speaking parts of Switzerland. Physics was of particular interest in this study because this area of science was already known to be a problem domain in German instruction and had already been analysed in a series of pilot studies in Germany (Seidel, 2003) when preparing the IPN Video Study (cf. chapter nine in this volume), which started in 2000 in the context of a DFG (German Research Foundation) Priority Programme (Prenzel, 2007). The first phase of the IPN Video Study was conducted in 13 German classes in the 7th and 8th grade. It was limited to the two topics "electrical circuit" and "concept of force" in order to ensure a certain comparability between the 78 physics lessons videotaped in these classes. Based on a number of theories of cognition and motivation as well as reviews and meta-analyses concerning instructional effectiveness, instruments were developed, tried out and elaborated upon for their use in the second phase of the study (Prenzel et al., 2002). The second phase was conducted in 50 German 9th grade classes from 2002 to 2004. In this period, 100 physics lessons on the "concept of force" or "optical lenses" were videotaped and supplemented with both teacher and student data in the form of interviews and questionnaires/tests (Seidel et al., 2007). A detailed description of the theoretical background and the instruments of the study can be found in the technical report of the IPN Video Study (Seidel, Prenzel, & Kobarg, 2005).

Swiss students have often achieved better results in international comparative studies and seem to have other strengths than German students in their knowledge areas (Labudde, 1999). This fact made Switzerland attractive for a comparative video study. In addition, Switzerland and Germany show differences in teacher education (Herweg, 2008), teacher attitudes, and pedagogical traditions (Klieme & Reusser, 2003). These aspects can play an essential role in instruction and indicate possible reasons for the achievement differences between the students in the two countries. On the other hand, Switzerland and Germany have relatively small geographical, cultural and linguistic differences. In many ways, the similarities facilitate a comparison between the two countries and make the comparison less vulnerable to interpretation biases. In the period of 2003-2004, a video study funded by the Swiss National Science Foundation (NSF) was conducted at the University of Bern (Labudde, 2002). In the Bern Video Study, 64 physics lessons were videotaped in 32 classes in the 9th grade. The Bern Video Study adopted the instruments of the second phase of the IPN Video Study (Seidel, Prenzel, Duit, & Lehrke, 2003) in order to guarantee a common comparable basis for the Bern Video Study and the IPN Video Study.

The aim of the study presented is to analyse physics instruction in Switzerland and in Germany on different levels. In order to capture what actually goes on in the classroom, the use of videos was essential. Videos make repeated observations from different perspectives possible (Jacobs, Kawanaka, & Stigler, 1999) and the data can thus be compared in a variety of ways. In this chapter, we present diverse perspectives on physics instruction and compare the instruction from different points of view.

5.2 Research Questions and Design

Intercultural and international differences in science teaching can become apparent on different levels of analysis. On a first level, the frequencies, duration and sequencing of classroom activities are of interest (Seidel, 2005a). Classroom activities can be more teacher-controlled, for example, in lectures, dictations or class-discussions. Or, they can give students the possibility to influence their learning to a larger degree in group and seatwork phases of instruction. Similar aspects were also investigated in the TIMSS Video Studies (Stigler et al., 1999). Accordingly, the first research question addresses the *surface level* of instruction: What similarities or differences can be identified in the classroom activities of ninth-grade physics teaching?

The study presented goes one step further and takes additional quality aspects at a deeper level into consideration. These quality aspects are often connected to teaching effectiveness and their relevance for learning processes are widely documented in diverse publications, reviews and meta-analyses (Brophy, 2000; Scheerens & Bosker, 1997; Seidel & Shavelson, 2007; Wang, Haertel, & Walberg, 1993). At the same time, these aspects are considered to be problem areas in German instruction (BLK, 1997). The in-depth quality aspects addressed in this chapter are 1) the role and embedding of experiments (Tesch, 2005), 2) goal-directed and structured teaching (Herweg, 2008; Herweg, Seidel, & Dalehefte, 2005), and 3) process-oriented teaching (Knierim, 2008; Kobarg & Seidel, 2005, 2007). Thus, the second research question concerns a *deeper level* of instruction: What similarities or differences can be identified in certain quality characteristics of ninth-grade physics teaching?

All of the research questions in this comparative study aim to disclose the extent to which disparities concerning these aspects can be identified in a Swiss-German sample of physics lessons. In addition, we want to get an impression of how these aspects could perhaps be responsible for the achievement differences found in TIMSS and PISA. For this purpose, a mixed methods design which includes videos, interviews, questionnaires and tests was chosen in order to cover teaching and learning processes in physics instruction.

One benefit of video studies which is often pointed out is the fact that videos provide relatively authentic data and make it possible to apply different perspectives and research questions due to the fact that they can be systematically observed and coded over and over again (Jacobs et al., 1999). However, the explanatory value of video studies also depends on the object of investigation, the design, and the preliminary methodological considerations. A well-conceived design and relevant preliminary methodological considerations strengthen the power of the results.

In this video study, additional assessment, questionnaire and interview data were collected in order to obtain information about the learning outcome of instruction (Figure 5.1). In this way, the design of the video study provides the opportunity to establish a connection between instruction (visible processes) and learning processes (invisible processes).

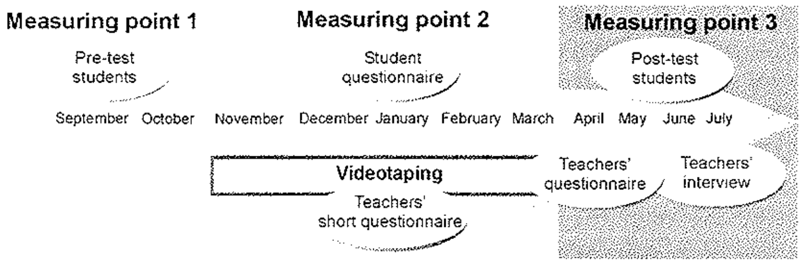

Fig. 5.1: Design of the Swiss-German Video Study in Physics

Sample

The study consists of a stratified random sample of 82 participating schools from the intermediate and the highest teaching level in Germany and Switzerland. Whereas the teachers in the German sample were provided from randomised schools, the teachers in the Swiss study were provided from randomised classes (Gerber, 2007). One teacher participated per school. The study presented comprises 82 (50 German and 32 Swiss) 9th grade classes in which 82 double lessons on the two topics "optics" and "mechanics" were videotaped. This sample size should, first, be large enough to use a quantitative approach and, second, it should provide

the option of adding qualitative case studies for further information. The sample was collected over the course of the school years 2002/2003 (Germany) and 2003/2004 (Switzerland). Though this study compares physics instruction between two countries which share the same language and a similar cultural background, we have to keep the different school systems, the proportional distribution of the participating schools and the pre-selection of upper level school classes in mind. These aspects have to be considered in the interpretation of findings.

Methods

In the study presented, there was a row of decisions to make before the data collection could be realised. It was of great importance to mirror teaching practices in German and Swiss physics lessons as authentically as possible. Videos are a "best-way reproduction" of reality, but can be heavily influenced by the angle of the camera or the interest of the camera person. Therefore, we used standardised guidelines concerning the number and the perspective of the cameras as well as the position of the microphones (Seidel et al., 2005). Similar to the TIMSS 1995 study, we chose a two camera setting, with a lateral "zone of interaction camera perspective" and a frontal "whole class perspective" (Fernandez, Rankin, & Stigler, 1995). In this study, we observed the structure of instruction from two perspectives. We first analysed, along the lines of TIMSS, the so-called surface structure of instruction – the basic organisation of classroom activities. Second, we focused on certain problem areas of physics instruction like experiments, clarity and coherence, and process-oriented teaching. To analyse these in-depth structures, we applied different category systems (high- and low-inference) which had been developed and tested in the IPN Video Study (Seidel et al., 2005). Low-inference coding systems were used similar to the TIMSS Video Study to capture the frequencies and duration of classroom events and experiments (surface structure). These data can be viewed in different ways: They can be observed from a wider angle as general features of teaching or from a closer view as more detailed elements (Hiebert et al., 2003). This form of coding makes it possible not only to determine the differences and similarities on an average level but also to reconstruct the formal structure of the lessons and to chart the instruction from the beginning to the end of the lesson (so-called "lesson signature" (Hiebert et al., 2003)). For certain research purposes, a low-inference coding system is not sufficient. To capture clarity and coherence, for instance, a high frequency of clarifying utterances or a large amount of time allocated for clarification in lessons do not necessarily mirror high quality concerning clarity. In fact, they could mean the opposite due to the fact that things have to be repeated again and again if transparency is not provided. Therefore, high-inference rating systems were chosen for the analyses of the theoretically founded aspects of "clarity & coherence" and "process-oriented teaching". Whereas low-inference coding is considered to be more objective, high-inference coding captures "between the lines" data and can be influenced to a larger degree by the raters' estimations. Nevertheless, these ratings turned out to be very valuable in explaining learning processes (Clausen, Reusser, & Klieme, 2003), which is one of the main aims of this study. The high-inference data, though, is not time-specific and the observed units are more comprehensive. Therefore, a back-coupling with the raw data is more complicated and the attainability of inter-rater agreement becomes more difficult.

Table 5.1 refers to the category systems relevant for this chapter. All category systems presented in this video study were developed in a cyclical process which considered both theoretical and empirical arguments on physics instruction (Seidel, 2005b).

Due to the international design of the study, inter-rater reliability and reliability standards were of essential importance. For instance, we had to consider the fact that the influence of the observers' cultural background can affect cross-country effects regarding video analyses and can also influence the interpretation of the data. All of the systems reported correspond to current international reliability standards (Seidel et al., 2005).

Tab. 5.1: Overview of the coding systems referred to

	Contents, coding strategies & sampling schemes
Surface structure	
Classroom activities (Seidel, 2005a)	Low-inference (10-sec. interval) category system which aims to collect data about sequences of activities over the course of the lesson.
In-depth structures – quality aspects	
Experiments (Tesch, 2005)	Low-inference (10-sec. interval) category system which aims to collect data about the embedding of experiments over the course of the lesson.
Clear and structured teaching (Herweg, 2008; Herweg et al., 2005)	High-inference rating system (4-point Likert scale ranging from 0= does not apply to 3= applies) to gather data about how well goals are clarified, the extent to which the implicit and explicit clarity and coherence of lesson contents is provided, as well as the extent to which anchors are provided.
Process-oriented teaching in: (a) **classwork phases** (b) **seatwork phases** (Kobarg & Seidel, 2005)	High-inference rating system (4-point Likert scale ranging from 0= does not apply to 3= applies) which aims to collect data about teachers' supportive behaviour in class- and seatwork phases.

5.3 Findings from the Swiss-German Video Study

The results presented here refer to the descriptive and comparative part of the study and are limited to a description of the outcomes of the video data. The study takes advantage of the possibility to observe videos over and over again from different theoretical viewpoints. The video data is observed at two levels of instruction (surface and in-depth level). First, we refer to results from the low-inference category systems. Instructional activities and experiments were both coded in a low-inference procedure. Second, we present results from the high-inference analyses which concern theoretically derived rating systems about clarity and coherence as well as process-oriented teaching.

5.3.1 Instructional activities

To investigate the similarities and differences between classroom activities, we first refer to the frequencies and duration of certain activities identified in the sample. In addition, we report on "lesson signatures" (Hiebert et al., 2003) in order to compare the characteristic pattern of instructional activities in both subsamples.

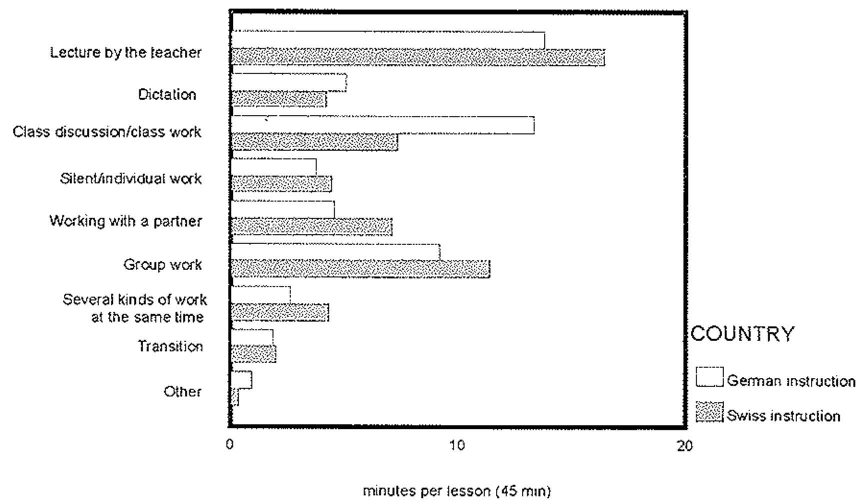

Fig. 5.2: Mean values of instructional activities, by country

The theoretically substantiated category system "instructional activities" can be divided up into teacher-centred categories such as "lecture by the teacher", "dictation", "class discussion/classwork" and student-centred categories like "silent/individual work", "work with a partner", "group work", "several kinds of work at the same time" (Seidel, 2005a). The histogram below shows the cumulated time spent on the different activities in Swiss and German physics instruction.

Figure 5.2 shows some differences between the averages in Swiss and German instruction, but they are all, except for class discussion, relatively small and not significant. Generally, the German teachers hold more classroom discussions in a question-developing style than their Swiss colleagues. Swiss instruction tends to be characterised more often by teachers' lectures. The teacher thereby stands in front of the class and explains contents. No considerable differences were found between the duration of teacher-centred (lecture, dictation, class discussion) and student-centred (social and individual activities) activities in the two countries.

Though these aggregated differences are relatively small, the instructional activities may be distributed differently over the course of the lesson in the two countries. We therefore analysed the country-specific lesson signatures of the frequencies and duration of activities in the two subsamples. The signatures for the German and Swiss lessons are presented in Figures 5.3 and 5.4 (peaks indicate that the activity occurs at that certain time more often).

The lesson signatures for Germany and Switzerland also show a similar picture. The findings from the low-inference category systems "instructional activities" (Seidel, 2005a) indicate that the German and the Swiss lessons only show small differences on an average level as well as on the level of lesson signatures. The German and the Swiss lessons in our sample seem to have similar instruction on the "surface level" of teaching physics.

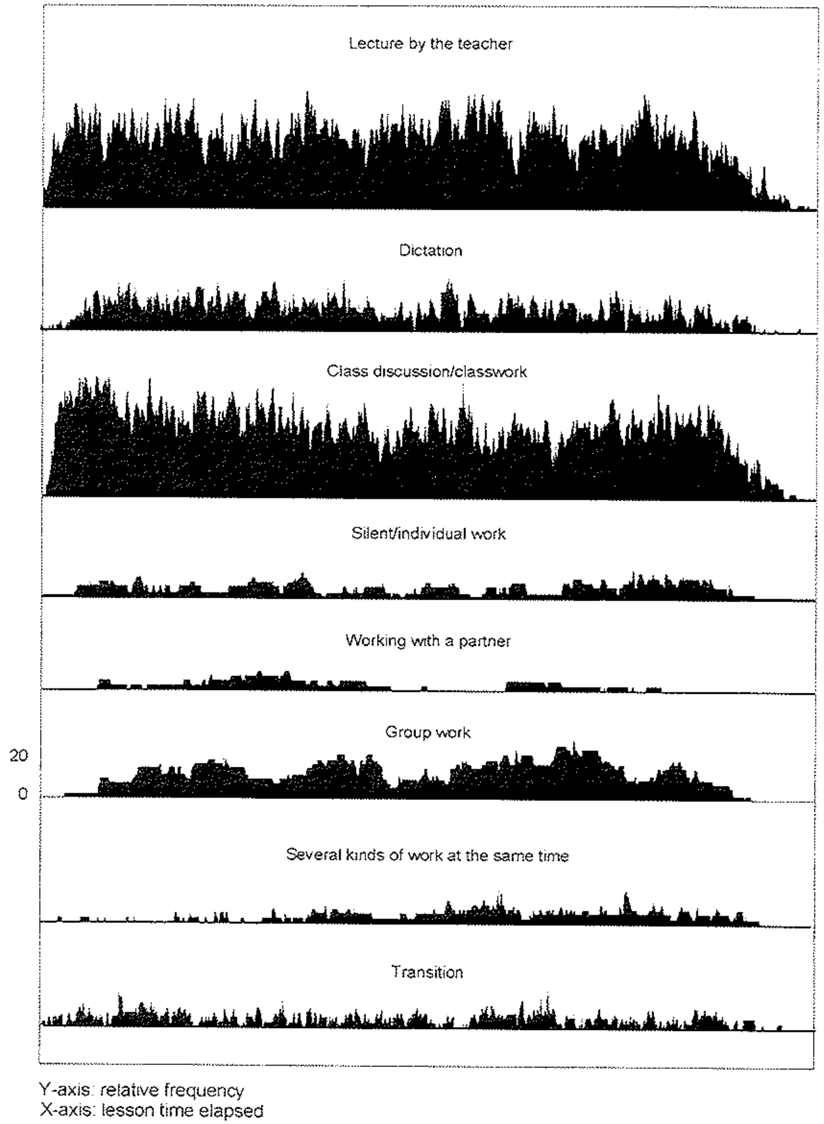

Fig. 5.3: German ninth-grade lesson signature in physics

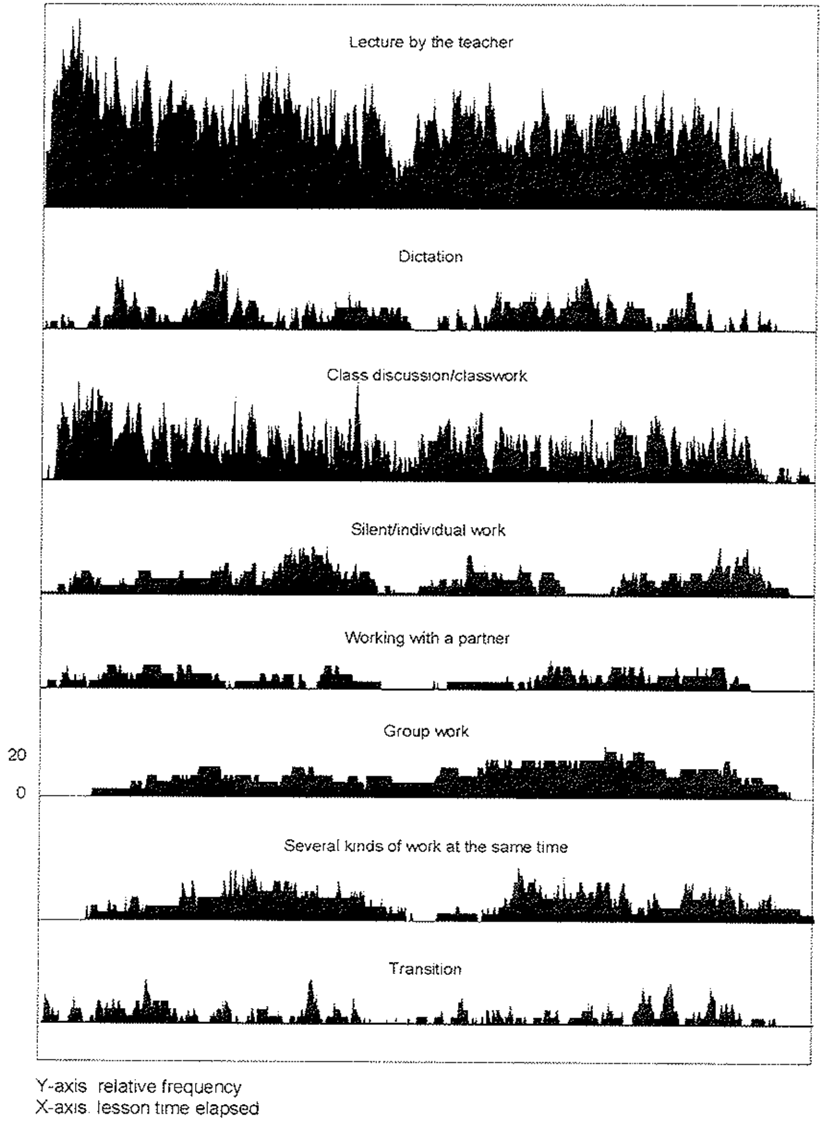

Fig. 5.4: Swiss ninth-grade lesson signature in physics

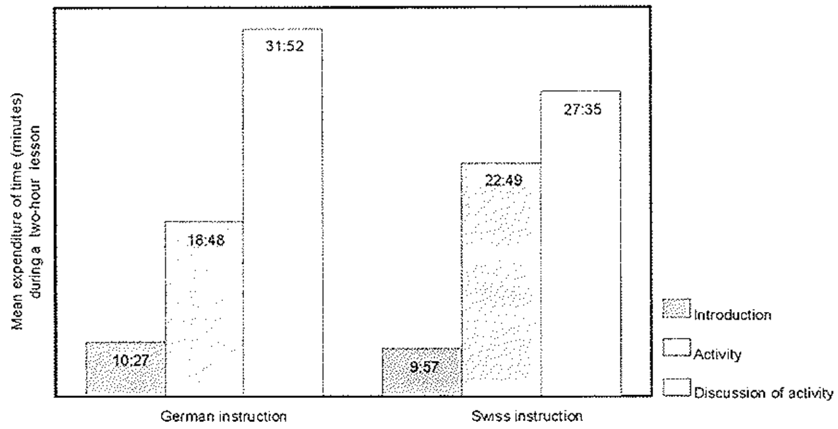

Fig. 5.5: Time spent on experimental activities on average, by country

5.3.2 Experiments

The first in-depth analysis concerns the use and embedding of experiments in physics instruction. The experiment is a basic element in physics instruction and an important tool for communicating physics contents. The low-inference category system "experiments" (Tesch, 2005) mirrors how much time is spent on concrete experimental activities as well as on their preparation and their subsequent work.

In general, no significant differences could be found between the amount of time spent on experimental activities in Swiss and German classrooms. Swiss instruction tends to spend more time on the experimental activity itself and less time on the preparation and subsequent work compared to the instruction in the German subsample (Figure 5.5).

Though the lesson structure in the two countries seems to have many similarities in the instructional and experimental activities registered on a low-inference level, we used further high-inference rating systems to investigate the in-depth structure of instruction connected to some of the problem areas identified in German instruction. The following two coding systems presented aimed to collect data about essential teaching and learning conditions such as "clarity and coherence" (Herweg et al., 2005) and "process-oriented teaching" (Kobarg & Seidel, 2005).

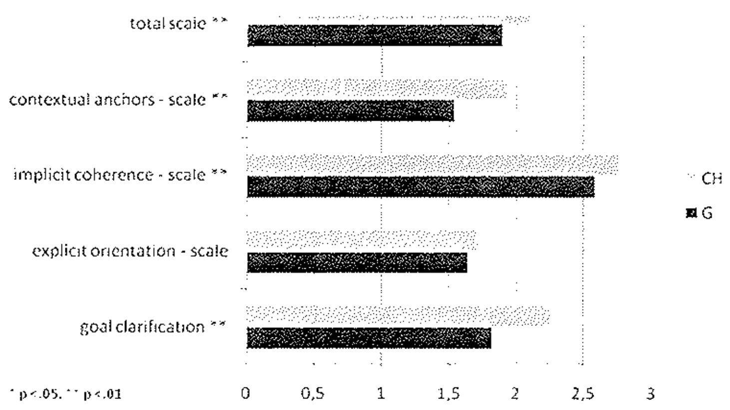

Fig. 5.6: Clarity and coherence on average, by country

5.3.3 Clarity and Coherence

Components of clear and structured teaching have repeatedly been accentuated in educational research. In this study, the videos were analysed with a high-inference category system taking components known from reviews and meta-analyses (Brophy & Good, 1986; Scheerens & Bosker, 1997; Seidel & Shavelson, 2007) into account. These components included, for instance, how well the goals of the instruction are made transparent to the students (explicitly and implicitly) and the extent to which clarifying tools and anchors appear in physics instruction (Herweg et al., 2005).

Overall, clarity and coherence seem to be more salient in the Swiss part of the sample (Figure 5.6). The Swiss sample shows a (not significant) tendency towards a higher mean value in explicit orientation. In the case of goal clarification, implicit coherence and contextual anchors, these distinctions are obvious. Thus, teachers in the Swiss sample seem to foster more clarity than their German colleagues.

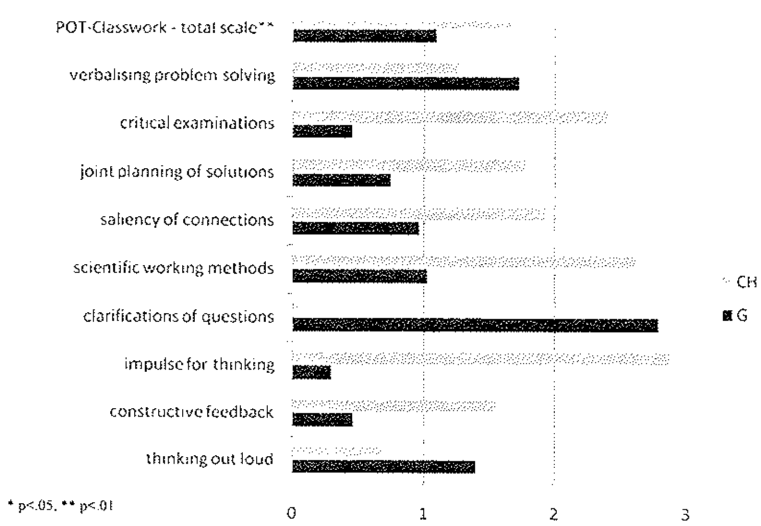

Fig. 5.7: Process-oriented teaching in classwork phases on average, by country

5.3.4 Process-Oriented Teaching

Process-oriented teaching is supposed to support solid and self-regulated learning among students (Bolhuis, 2003; Knierim, 2008; Kobarg & Seidel, 2007) and appears in a variety of ways in class- and seatwork phases of instruction. The class- and seatwork phases of the lessons were analysed with a high-inference category system (Kobarg & Seidel, 2005). Figures 5.7 and 5.8 show the extent to which different process-oriented teaching aspects could be found in the two subsamples on a scale level as well as on an item level. By taking the item level into account, we demonstrate how information becomes more concrete. Thus, individual aspects which make up the distinctions between the learning conditions in the two countries become apparent.

Overall, process-oriented teaching seems to be practised in the Swiss sample more often – both in class- and seatwork phases. However, a look at the item level shows that individual aspects of process-oriented teaching, such as "thinking out loud" or "clarification of questions", appear in the German part of the sample more often. But, all in all, the Swiss teachers obviously use more tools to activate the learning processes of their students. In detail, this means that Swiss teachers in general offer more "constructive feedback" and initiate learning processes through "impulses" more often. Above all, they consider "scientific working methods", "other sources of information", "open-end tasks" and seem to trigger students' "critical examinations" over the course of the lesson.

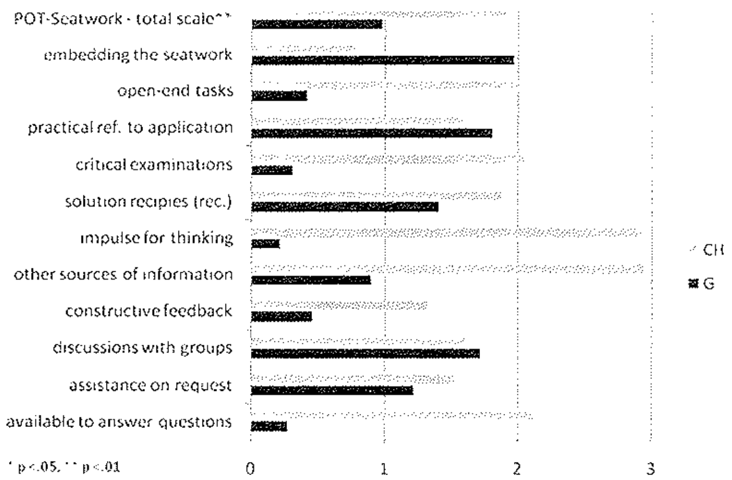

Fig. 5.8: Process-oriented teaching in seatwork phases on average, by country

5.4 Value and Limitations of the Swiss-German Video Study

The data presented here show how international comparisons of instruction can be used to identify distinctions between the learning conditions in different countries which probably can help, in turn, to explain country-specific results. These conditions were observed at two levels of analysis; the *surface level* (instructional activities) and an *in-depth-level* (experiment, clarity and coherence, and process-oriented teaching). In the first case, the findings show that the amount of *instructional activities* does not differ considerably between the German and the Swiss sample. In general (with one exception), no significant differences could be found on the surface level of instruction concerning teacher-centred (lectures, dictation or class discussion) or student-centred (individual, partner- or group work) activities. Also, the lesson signatures showed no remarkable differences over the course of the lessons.

When taking a closer look at the in-depth level of analysis, hardly any distinctions were found between the timeframes of *experimental activities* in the Swiss and the German sample. Further in-depth analyses concerning more detailed information about experimental activities are planned. In the case of *clarity and coherence* and *process-oriented teaching* in class- and seatwork phases, though, differences were observed. It becomes obvious that, in general, teaching in the Swiss lessons shows more clarity and coherence than in the German lessons. Furthermore, Swiss teachers seem to practise more process-oriented teaching in

both seatwork and classwork periods of the lessons. By taking the item level into account, we also throw light upon concrete differences between the use of certain teaching "tools" in the Swiss and the German subsamples.

In summary, concentrating on instructional activities on a surface level offers less convincing reasons to argue for better learning conditions in the Swiss subsample than in the German subsample. We have to keep in mind, though, that this result is based upon a certain topic, a particular sample and a specific observational unit. However, the way in which the instructional activities go along with aspects realised on an in-depth level could make a difference in the quality of teaching. Differences between the two subsamples in this study were primarily found at an in-depth level of instruction. This means that a certain instructional activity can be realised with different levels of quality and the occurrence of the activity cannot be regarded as a quality aspect in itself. Therefore, instructional activities should be connected to further quality aspects when instruction is evaluated.

Video studies take advantage of the possibility to "conserve" instruction so that it can be viewed repeatedly and from different perspectives (Jacobs et al., 1999). Nevertheless, choices concerning the camera perspective and position influence the possibility and the scope of application. In addition, standardised guidelines for the position and handling of the camera equipment are required to make video recordings comparable. An international comparative study has to keep further aspects which are related to the cultural and linguistic background of the conductors of the study in mind. We highly recommend this, even in the case of culturally and linguistically similar countries. The linguistic and cultural understanding of the observer still plays a role when watching and rating instruction. Even nuances can be important.

Furthermore, the explanatory power of videos can be strengthened by adding data from further instruments such as questionnaires, interviews and assessments. This combination of instruments also provides possibilities to make connections between external instructional conditions and internal learning processes. *Section 2* in this book refers to how different sources of data strengthen the explanatory power of a study. The design of the video study presented here is one example for how videos can be combined with further instruments and how quantitative as well as qualitative research questions concerning physics instruction can be realised.

The design and method of this study were carefully elaborated because these aspects were highly relevant for all subsequent analyses and results. Though the design always influences the explanatory value of a study, these aspects are of particular importance in instructional video studies due to the fact that the survey can already be strongly influenced at the data collection stage. The Swiss-German

Video Study presented considered a row of eventualities in the design and methods of the study. Nevertheless, although stratified and random aspects were considered in the data collection, the outcome is still restricted by the make-up of the sample. In principle, the sample size of this study is large enough to allow general conclusions to be made and also offers the possibility to add case studies as supplements for in-depth studies. However, the different school systems in the two countries and the fact that the sample was limited because it only included specific school types at an intermediary and upper level of instruction make it difficult to draw a comparison between the two countries.

The reported comparison of culturally similar countries was fruitful in the identification of classroom conditions relevant to learning. It expands the idea of how instruction can be conducted. Examples from video recordings can support the understanding of instructional elements relevant to learning processes. Different coding systems disclose conditions relevant to learning which can be used in teacher education and training as shown in *Section 3* of this book. International video studies offer the possibility to see beyond one's own four walls and to learn from other teaching cultures. Knowledge about effective elements in instruction can be taken up on and converted into everyday learning practice. Though changing scripts tends to be a long and complex process, integrating instructional elements from culturally related countries perhaps enhances the acceptance among instructors and teachers to accelerate implementation processes.

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