





# Center for Educational Research

## Contents

Introductory Overview .....	61
Research Area I Opportunity Structures of School and Individual Development in Adolescence and Young Adulthood .....	64
Research Area II Establishing a Monitoring System for Educational Performance: Foundational Studies .....	73
Research Area III Learning and Instruction: Cognitive Activation and Cognitive Tools .....	89
Research Projects of the Director Emeritus Wolfgang Edelstein .....	106
Publications 1998–2000 .....	110

## Scientific Staff 1998–2000

Cordula Artelt, **Jürgen Baumert**, Wilfried Bos (as of 2000: Universität Hamburg), Sabine Gruehn (as of 1998: Humboldt-Universität zu Berlin), Christa Händle, Ilonca Hardy, Susanne Heyn (as of 1998: Forsa Institut, Berlin), Eckhard Klieme, Helmut Köhler, Olaf Köller, Detlef Oesterreich, Kai Schnabel (as of 2000: University of Michigan, Ann Arbor), Gundel Schümer, Knut Schwippert (as of 2000: IEA Data Processing Center, Hamburg), Petra Stanat, Elsbeth Stern, Claudia Thußbas, Luitgard Trommer, Ulrike Wehrhahn

### *Postdoctoral Research Fellows*

Corinne Alfeld-Liro (as of 2000: National Science Foundation, Arlington), Patricia Hawley (as of 1998: Yale University), Catrin Rode (as of 2000: University of Oregon), Elwin Savelsbergh (as of 1999: University of Utrecht), Zhu Liqi (as of 1999: Chinese Academy of Science, Peking)

### *Predocctoral Research Fellows*

Marten Clausen (as of 2000: Universität Mannheim), Zoe Daniels, Anke Demmrich, Anja Felbrich, Ingmar Hosenfeld (as of 2000: Universität Koblenz-Landau), Steffen Knoll (as of 1999: IEA Data Processing Center, Hamburg), Susanne Koerber (as of 2000: Institute for Science Education at the University of Kiel), Mareike Kunter, Oliver Lüdtke, Ulrich Trautwein, Rainer Watermann, Joachim Wirth, Regina Wolf

## Introductory Overview

The Center for Educational Research was restructured in 1996 when Jürgen Baumert was appointed director. The Center's specific concern is research on development and learning from the perspective of institutionalized education. Educational settings such as schools are conceived as providing a specific structure of opportunities and constraints for learning and development. This structure offers a variety of developmental opportunities, but at the same time excludes others. How do aspects of schooling affect learning within and across subject domains, impact on the intra- and interindividual differentiation of personality traits, and guide career-forming processes? Such questions are explored by a multidisciplinary team which includes educational scientists, psychologists, mathematicians, and sociologists. A strong theoretical focus is combined with an applied approach in the fields of system monitoring, professionalization of teaching, and improvement of learning and instruction.

### **Conceptual Orientation: Schooling as a Cultural Artifact and an Authentic Part of Life**

The Center's research program is institutional as well as developmental in orientation. This calls for a multilevel research perspective:

1. With regard to the social structure of societies, formal education can be conceived as a career-forming process, even in its initial stages.
2. From an institutional perspective, the focus is on facilitating and fostering cumulative learning within and

across subject domains.

3. From an individual point of view, learning development can be conceptualized as a process of inter- and intraindividual differentiation. The Center's research agenda is shaped by each of these perspectives.

It is a **structural paradox of formal education** that the experiences made available within institutions of formalized education are always vicarious—selected and prepared with the aim of facilitating learning processes which the learner must nevertheless perceive

as personal and authentic. The more educational institutions try to integrate authentic everyday experiences into their programs, the more obvious the paradox becomes. The acquisition of knowledge in educational institutions is confined by the structural properties of the institution, regardless of whether or not authentic learning is emphasized. This constitutes the difference between learning inside and outside of school-like institutions.

At the same time, however, school is a central part of the student's life, and impacts strongly on cognitive activities, beliefs, and behavior outside of school. Educational institutions command a large part of the time of children, adolescents, and young adults, and thus constitute **social environments in their own right**. The social rules and regulations of educational institutions not only create the conditions for systematic instruction and learning, but provide the setting for immediate everyday experiences. In our research program, this effect of schooling is taken into particular consideration in a longitudinal study exploring individual development in terms of cognitive competencies, motivational and social resources, and value commitment.

The way in which educational institutions have structured content areas into different academic subjects determines the **high domain-specificity of knowledge acquisition**. This is taken into account in our research on the structure of knowledge—including domain-specific epistemological beliefs—acquired in school. In large-scale assessment studies, classroom studies, and experimental training studies, **we focus on domains of knowledge which represent basic cultural tools** and, as such, are critical for individual development in modern societies. **Mathematics and science education and reading comprehension** constitute main areas

of research. Special emphasis is placed on the question of how cognitive activation and self-regulation can be stimulated and supported by instructional environments.

In all our research on the interaction between the individual learner and the institutional educational setting, the learner is perceived as the producer of his or her own development—not only in the constructivist sense of active and idiosyncratic acquisition of knowledge, but also in the sense that he or she proactively selects and shapes the developmental environment.

### Summary Outline

The following summary of the Center's research program is not comprehensive. Rather, research projects have been selected to illustrate the major lines of inquiry pursued in the Center and provide a representative overview of the three areas of our current research.

**Research Area I** focuses on the relationship between the opportunity structure of schools and the optimization of individual development in terms of cognitive competencies, motivational and social resources, and value commitment. The basis for this research program is provided by a multiple-cohort longitudinal study which was initiated in 1991 with a sample of 13-year-olds. These main cohort participants, who are now aged 23, are currently taking part in a sixth wave of measurement (**Learning Processes, Educational Careers, and Psychosocial Development in Adolescence and Young Adulthood [BIJU]**). As far as the transition from school to work is concerned, Research Area I is smoothly interlinked with the project *Regulating Development by Controlling the Environment and the Self* of the **Center for Lifespan Psychology**.

**Research Area II** comprises studies which can be seen as representing the first steps in the establishment of a na-

tional monitoring system to gauge the performance of the German school system. These foundational studies combine basic research and system monitoring in an international comparative perspective. The most important projects in this research area are the **Third International Mathematics and Science Study (TIMSS)**, and the OECD's **Programme for International Student Assessment (PISA)**. These studies are complemented by the second **CIVIC Education Study** initiated by the International Association for the Evaluation of Educational Achievement (IEA). Together with a project on state schooling in the former GDR funded by the German Research Foundation (DFG), these studies provide a firm basis for the Center's **Report on Education (Bildungsbericht)**, which is published in collaboration with the **Center for Sociology and the**

**Study of the Life Course.** The report appears on a regular basis and has become established as a standard work.

**Research Area III** consists of projects on learning and instruction with an experimental or quasi-experimental approach. Most of these studies address research questions that have emerged directly from the first and second areas of research. They are conducted either in the laboratory (**ENTERPRISE**) or as video-based studies in school environments (**TIMSS-Video and Pythagoras**). In the field of mathematics education the Center closely collaborates with the **Center for Adaptive Behavior and Cognition**. Building on a strong theoretical background, these studies have practical implications for the optimization of classroom instruction and teacher training.

---

### The Center for Educational Research 2001



Left to right: (front row) Rainer Watermann, Cordula Artelt, Ilonca Hardy, Ulrich Trautwein, Zoe Daniels, Luitgard Trommer, Mareike Kunter, Anja Felbrich, Anke Demmrich, Gundel Schümer; (back row) Jürgen Baumert, Helmut Köhler, Claudia Thußbas, Eckhard Klieme, Petra Stanat, Olaf Köller, Elsbeth Stern, Joachim Wirth, Oliver Lüdtke, Christa Händle.

## Research Area I

### Opportunity Structures of School and Individual Development in Adolescence and Young Adulthood

**Educational Institutions as Developmental Environments** The successful development of human beings across the entire life span is dependent both on their individual, internal characteristics and on external socializers such as significant others and social institutions. The relative importance of internal and external promoters varies across the life span and between the areas of individual functioning. While parents, for example, play a dominant role for their children's development during infancy, childhood, and early adolescence, their influence decreases during adolescence and often ceases entirely in adulthood. Particularly in the domain of academic learning and, more generally, cognitive development, the social institution of school plays an important role during childhood and adolescence. Furthermore, schools have an impact on the formation or development of motivation, emotions, attitudes, and other personal characteristics.

Inasmuch as the theoretical perspective of the Center for Educational Research highlights the institutional influence on human development, it requires **longitudinal multilevel studies** that collect data at school, class, and individual levels, cover more than one knowledge domain, and allow the investigation of intraindividual change across domains and of interindividual differences in the patterns of intraindividual change. For TIMSS population II (7th and 8th graders), for example, a repeated measurement design was implemented with additional measurement points at the end of grades 7

and 8 (see Research Area II). The national longitudinal project *Learning Processes, Educational Careers, and Psychosocial Development in Adolescence and Young Adulthood (BIJU)* does even more to fulfill the requirements of a multilevel longitudinal design in its investigation of the effects of school and class environments on human development. The **BIJU study** has **four guiding components**, each with specific tasks and addressing specific issues:

(1) provision of institutional and individual baseline data on the integration of the East and West German educational systems; description and analy-

#### The BIJU Team

Jürgen Baumert  
Sabine Gruehn  
(until 1998)  
Susanne Heyn  
(until 1998)  
Olaf Köller  
Kai Schnabel  
(until 2000)

Corinne Alfeld-Liro  
(postdoctoral fellow, until 2000)

Zoe Daniels  
Ingmar Hosenfeld  
(until 2000)  
Ulrich Trautwein  
Rainer Watermann  
(predoctoral fellows)

[www.biju.mpg.de](http://www.biju.mpg.de)

sis of the transformation of the East German educational system and the subsequent impact on system performance;

(2) analysis of domain-specific learning as dependent on social and cognitive resources, prior knowledge, motivational orientation, learning and processing strategies, quantity and quality of instruction, and general institutional conditions;

(3) analysis of long-term trajectories of psychosocial development in adolescence as shaped by varying conditions of schooling and instruction;

(4) analysis of ways of coping with the transition from school to vocational training and working life, taking into account the interplay of personal resources and the conditions of the vocational training system and the labor market.

The BIJU design—a two-cohort longitudinal study supplemented by a cross-sectional survey—makes it possible to simultaneously analyze aspects of individual development, the particular situation of different birth cohorts, and the impact of social change.

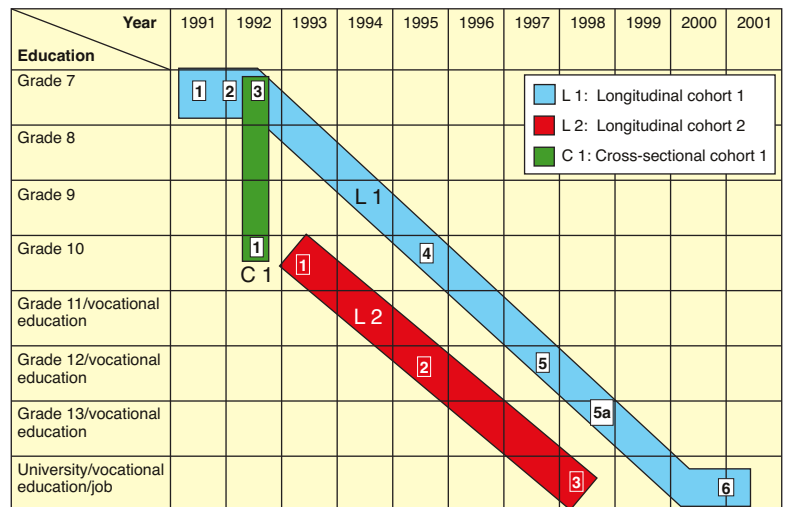


Figure 1. Research design of the BIJU project.

Thus far, research has focused mainly on the first three guiding components of the BIJU project. Because all the students in the sample have now left school, the theoretical focus is currently shifting to the fourth BIJU component, that is, more emphasis is being placed on students' ways of coping with the transition from school to work or university. In the following, two of the current research projects will be described in more detail.

### The BIJU Study Data Collection

The longitudinal study began with a survey of the main cohort during the 1991/92 school year (see Fig. 1). Data was gathered from these 7th graders at three measurement points. The first point of measurement coincided with the transformation of the unitary school system of the former GDR to the tracked system adopted from West Germany. Thus, the first survey provides baseline data for the analysis of the situation at the end of the unitary system and the outset of the transformation process. The fourth wave of data collection was conducted in spring 1995, when the main cohort students were in the final grade of lower secondary school. The next follow-up survey took place in spring 1997, when the participants were either in the vocational education system or the academic track of upper secondary level. A new wave of data collection is currently in progress, focusing on how students have mastered the transition from school to university or from vocational education to the labor market.

The sample of school classes, disproportionately stratified according to state and type of school, comprises some 8,000 students from 212 schools of all secondary school types in the states of Berlin, Mecklenburg-West Pomerania, North Rhine-Westphalia, and Saxony-Anhalt. In order to separate school and classroom effects, two classes per school were included in the sample.

In spring 1993, the sample was supplemented by a second longitudinal cohort of 1,330 students in the final grade of lower secondary level. In order to provide a baseline for an East-West comparison at the end of lower secondary school, a separate cross-sectional study of the 10th grade (involving approximately 1,600 students) was also carried out. This study concentrated on issues of political socialization and the transition to vocational training and working life.



## Key References

Köller, O., Baumert, J., & Schnabel, K. (1999). Wege zur Hochschulreife: Offenheit des Systems und Sicherung vergleichbarer Standards. Analysen am Beispiel der Mathematikleistungen von Oberstufenschülern an Integrierten Gesamtschulen und Gymnasien in Nordrhein-Westfalen. *Zeitschrift für Erziehungswissenschaft*, 2, 385-422.

Köller, O., & Baumert, J. (in press). Leistungsgruppierungen in der Sekundarstufe I und ihre Konsequenzen für die Mathematikleistung und das mathematische Selbstkonzept der Begabung. *Zeitschrift für Pädagogische Psychologie*.

Marsh, H. W., Köller, O., & Baumert, J. (in press). Reunification of East and West German school systems: Longitudinal multilevel modeling study of the big-fish-little-pond effect on academic self-concept. *American Educational Research Journal*.

## Opportunity Structures, Academic Achievement, and Cognitive Development in German Secondary Schools

One of the basic assumptions of our research program is that schools represent learning environments in which cognitive development during adolescence may be promoted more or less successfully. Due to its long-term character, with five measurement points over a period of six years, **the BIJU project enables us to compare the learning trajectories of students in different types of secondary schools from grade 7 to grade 12.** The findings show quite clearly that the transition from elementary school to different types of secondary school has remarkable effects on domain-specific learning processes. The highest achievement gains are reached at the *Gymnasium*, followed by the *Realschule*, the *Gesamtschule* (comprehensive school), and finally the *Hauptschule*. Additional analyses show that learning differences across the school types are not only a consequence of reducing the achievement heterogeneity between students within classes, but are mainly **effects of different learning and teaching cultures in the different school types.** Interestingly, the different types of secondary school do not only influence learning trajectories in curriculum-based knowledge, as measured with standardized achievement tests, but also impact on nonverbal psychometric intelligence.

One guiding idea behind the early assignment to different school types in Germany is that learning and instruction are more effective in relatively homogeneous groups of students, in which teachers can adapt their instructional strategies according to the entry achievement levels of their students. It is, therefore, assumed that school types differ with respect to the demands made by instruction: The higher the track, the more demanding the classes. Being exposed to higher demands in class should lead to higher levels of

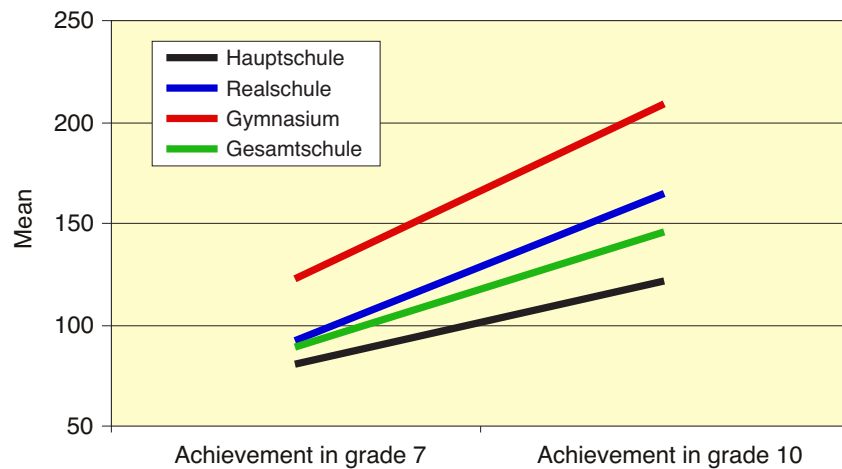
cognitive stimulation and higher gains in achievement. The different types of secondary school are thus assumed to provide specific learning environments that differ with respect to how much they promote the cognitive functioning of their students. However, recent studies from highly selective school systems, for example Hong Kong (see Marsh, Kong, & Hau, 2000), suggest that differences in knowledge acquisition across school types are not a consequence of different learning environments, but can be explained entirely by

### Tracked and Comprehensive System in German Secondary School

Two different approaches have been implemented in the German secondary school system: a tracked and a comprehensive system. The former allocates students completing grade 4 (in most *Länder*, grade 6 in two *Länder*) to three different types of school on the basis of previous achievement: *Hauptschule* is the academically least demanding track, *Realschule* an intermediate track, and *Gymnasium* the highest track. Education at the *Hauptschule* ends after grade 9 or 10, when its graduates enter the dual system, which combines general and vocational education in school with vocational training in companies. Students at the *Realschule* graduate after grade 10, and also enter the dual system, but usually aspire to more highly skilled occupations than *Hauptschule* graduates. Students at the *Gymnasium* graduate after grade 13 (or grade 12 in most of the East German *Länder*). A successful final examination at *Gymnasium* level (*Abitur*) is required for university admission, and some of the more attractive jobs in the dual system (e.g., bank clerk) also ask for this certificate.

The other system consists of the comprehensive school (*Gesamtschule*). Within this type of school, students are generally tracked from grade 7 onward, being allocated to classes according to their subject-specific achievement levels. However, this tracking system is usually only applied in major subjects like mathematics, German (as the mother tongue), English (as a foreign language), and sometimes physics (starting in grade 9). Students can gain the same qualifications as in the tracked system, leaving school at the corresponding grade levels.

Figure 2. Learning trajectories for mathematics according to type of secondary school.



individual achievement differences at the time of secondary school entry. Marsh et al. found that, after controlling for individual entry achievement, no additional effect of school-average ability on mathematics learning was observable. Similar findings were reported by Goldstein and colleagues for the English secondary system. In the BIJU study we tested whether these conclusions also hold for the German school system.

The BIJU project not only allows individual and institutional effects on learning to be disentangled, it also allows institutional effects in different subjects, that is, mathematics, biology, physics, English, and civics, to be investigated. Findings show that institutional effects are particularly apparent in core

subjects like English and mathematics, but that they are smaller in other subjects such as physics, biology, and civics. Figure 2 displays mathematics achievement trajectories for the different school types. The achievement scores in grade 7 are standardized with a mean of 100 and a standard deviation of 30. The largest mean difference (between *Gymnasium* and *Hauptschule*) is 42 points in grade 7, increasing to 87 points in grade 10, thus suggesting that the school-type variable is a very important predictor for learning rates in mathematics.

In order to disentangle the effects of prior individual achievement, school-average achievement, and type of secondary school on later achievement, multilevel analyses of the BIJU data

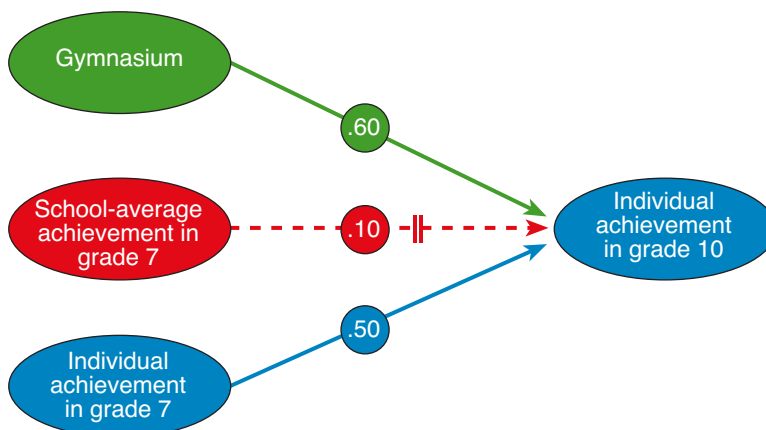
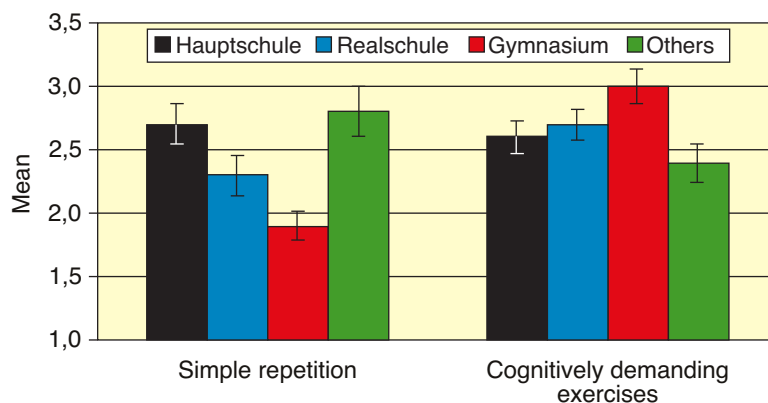


Figure 3. Effects of prior individual achievement, school-average achievement, and type of secondary school (1 = *Gymnasium* vs. 0 = others) on grade 10 mathematics achievement.

Figure 4. Quality of mathematics exercises according to type of secondary school (findings from TIMSS-Video).



were carried out. The findings of these analyses are presented in Figure 3 (note that there are usually large achievement differences between individual schools within one school type).

Obviously, the school type matters. That is, even after controlling for prior knowledge on the individual level and school-average achievement, **the type of secondary school has a substantial effect on later achievement.** Note that the effect of school type on achievement in grade 10 can be interpreted as an effect on *change* in achievement, because achievement in grade 7 is controlled. The nonsignificant effect of school-average achievement suggests that it is not the ability-grouping *per se*, but the learning climate of the *Gymnasium* that leads to higher learning rates. This assumption is supported by the findings of TIMSS-Video (see Research Area III), in which mathematics lessons in German schools were rated by experts on various instruction variables. Figure 4, showing the quality of exercises on two different dimensions, gives a good insight into why the *Gymnasium* is more effective at enhancing learning in mathematics. Relative to students' prior knowledge, the exercises used at the *Gymnasium* are cognitively more demanding than in other school types, thus helping students to learn in a more effective manner. These results thus provide empirical support for the as-

sumption that **different school types in Germany represent different learning environments**, in which the given opportunity structures have a substantial influence on the development of achievement. This effect is not restricted to curriculum-based tests, but also emerges from the psychometric intelligence tests administered in BIJU in grades 7 and 10. Here, longitudinal multilevel analyses show that the type of secondary school (1 = *Gymnasium* vs. 0 = others) has a substantial impact on **nonverbal intelligence** (standardized regression coefficient  $\beta = .43$ ,  $p < .001$ ), even after controlling for individual and class-average intelligence in grade 7. This last result is of paramount importance as it shows that the substantial effect of schools or school types on cognitive development reaches beyond the confines of curriculum-based knowledge. *Possible pedagogical implications of these findings include the provision of more favorable opportunity structures in schools other than the Gymnasium in order to optimize the cognitive development of the students in these schools.*

## Opportunity Structures and the Formation of Academic Interests in Schools

Previous research on students' academic interests, particularly in science, has shown a dramatic decrease in mean interest over adolescence. Explanations for this phenomenon have usually referred to the predominantly scientific orientation of science instruction, which ignores the everyday experiences of students. Special instructional programs were, therefore, developed to encourage science teachers to build on student experiences, assuming that students will be more interested in and learn best from their own experiences. More psychologically-driven models, for example, the stage-environment-fit model proposed by Eccles and colleagues, suggest that the decline in interests could reflect a mismatch between individual needs in early adolescence and the opportunity structures typically provided by secondary schools. **Our theoretical approach to interest development** offers additional explanations for decreasing interests. Instead of stressing the negative role of class and school environments, our assumptions turn to individual developmental processes in adolescence.

Although traditional research on school effects on individual development has primarily focused on cognitive outcomes, especially language, mathematics, and science achievement, non-cognitive outcomes have also been investigated. These outcomes (e.g., self-esteem, academic self-concepts, and interests) are often seen as educational aims in themselves, and modern schools always strive to enhance students' development in these areas. Research on the development of academic interests, however, often suggests that schools are very ineffective in achieving non-cognitive goals in terms of increasing interests over time. In fact, previous research has shown a dramatic decrease in mean interest in adolescence, partic-

ularly in science. This development was replicated in the BIJU project. Figure 5 shows the development of interest in mathematics and physics during lower secondary school (from grade 7 to 10).

Interest values greater than 50 at grade 7 indicate positive interest, whereas values less than 50 indicate a lack of interest in the subject. There is a substantial decline for both girls and boys in both subjects suggesting that the developmental process is quite similar for both genders.

This general decline in academic interest, particularly in science and mathematics, has often been shown (for an overview see Baumert & Köller, 1998). One attempt to explain this trend assumes a mismatch between instruction-

### Key References

**Baumert, J., & Köller, O.** (1998). Interest research concerning secondary level I: An overview. In L. Hoffmann, A. Krapp, K. A. Renninger, & J. Baumert (Eds.), *Interest and learning: Proceedings of the Seon Conference on Interest and Gender* (pp. 241–256). Kiel: Institut für die Pädagogik der Naturwissenschaften.

**Köller, O., Baumert, J., & Schnabel, K.** (2000). Zum Zusammenspiel von schulischem Interesse und Lernen im Fach Mathematik. Längsschnittanalysen in den Sekundarstufen I und II. In U. Schiefele & K. Wild (Eds.), *Interesse und Lernmotivation—Untersuchungen zu Entwicklung, Förderung und Wirkung* (pp. 163–183). Münster: Waxmann.

**Köller, O., Schnabel, K., & Baumert, J.** (in press). Does interest matter? The relationship between academic interest and achievement in mathematics. *Journal for Research in Mathematics Education*.

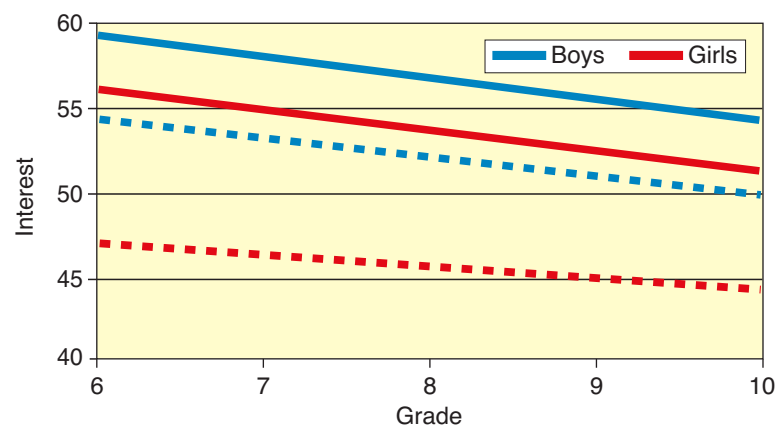


Figure 5. Development of academic interest in mathematics (bold lines) and physics (broken lines) in lower secondary schools.

al practice in classrooms and the general interests of adolescents. More specifically, it has been argued that teaching often fails to tie into students' everyday experiences. In fact, Schoenfeld (1988) shows that direct instruction in mathematics, which is usually regarded to be a quite successful approach, leads students to believe that mathematics has nothing to do with their everyday experiences and, as a consequence, they lose interest. Travers (1978) argues that *"the school is more likely to be a killer of interest than the developer."*

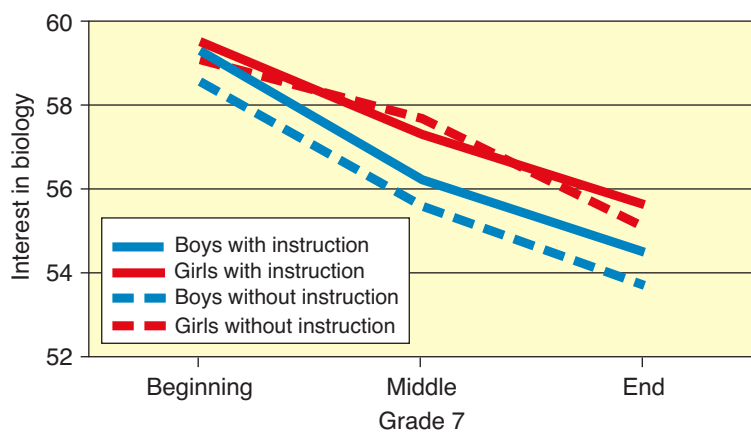
Viewing schools or traditional instruction as killers of academic interest suggests that no instruction would probably be a better way of promoting students' interests. The BIJU project allows for an analysis of the development of interest with instruction and without instruction. Following a resolution passed by the state government, no 7th graders in Mecklenburg-West Pomerania were taught **biology** during the 1991/1992 school year. This "natural experiment" allows us to compare changes in students' interest in biology under conditions in which biology was taught or not taught. Figure 6 presents the findings of this analysis. Here, the groups are additionally broken down according to gender. There is clearly no empirical evidence for any differences between the two instructional conditions. Only the time effect and the gen-

der effect were statistically significant, with girls displaying more interest in biology than boys. In sum, these findings do not support the frequent claims that lack of interest stems only from poor instruction.

An alternative explanation for the unfavorable interest trajectories observed during lower secondary school—and not only in the sciences—has been put forward by Eccles and colleagues. They point out that the field of experience outside of school broadens considerably during adolescence, providing competing opportunities for interest development. At the same time, the authors identify an institutionalized mismatch between the students' increasing desire for self-determination and the sometimes restrictive learning environments of schools. According to this view, the restrictive learning environments of lower secondary schools cause the typical decrease in interest over time.

A further explanation for the decline in academic interest during adolescence has been proposed by our research group (e.g., Köller, Schnabel, & Baumert, 1998), both supporting and expanding upon the argument made by Eccles and colleagues. Instead of stressing the role of curriculum and instruction, we turn to basic developmental processes occurring in adolescence. Following Deci and Ryan (1985), we start from the basic idea that students have an innate need to autonomously explore new fields of knowledge and action where they can develop a feeling of self-determination and experience competence and personal control. **In adolescence, students develop more realistic self-concepts of their own abilities** and become more and more aware of their **specific strengths and weaknesses** in various fields of knowledge and action. This **intraindividual comparison** is a central mechanism in

Figure 6. The development of interest in biology in classes with and without biology instruction.



the construction of personal identity and the development of personal interests. Coping with developmental tasks such as the transition from school to vocational education and the labor market exerts pressure on students to select and reinforce specific fields of interest, while giving up others. This **process of selection and optimization** technically results in decreasing mean values of interest across students during lower secondary grades. The logical consequence of this argument would be that a decrease in interest would not only be expected in mathematics and science, but in other key subjects such as German (as the mother tongue) and English (as a foreign language) as well. Empirical support for this assumption is presented in Figure 7 showing data from the BIJU project. As expected, the average interest in German and English decreased during grade 7.

In order to gather further empirical support for our assumption that interest development is affected by perceived competence in personally important domains, we investigated the relations between academic self-concepts and interest, hypothesizing that self-concepts would influence change in interest. Longitudinal structural equation modeling indeed provided evidence for the assumption that **self-concepts are important antecedents of academic interests**.

In order to investigate the role interest development plays in the processes of selection and optimization in specific academic fields, we explored the **relation between academic interest and course selection** in German upper secondary schools. At grade 11, German *Gymnasium* students have to choose advanced courses in two or three domains and basic courses in the remaining domains. Advanced courses usually comprise five to six lessons per week, whereas basic courses involve two to

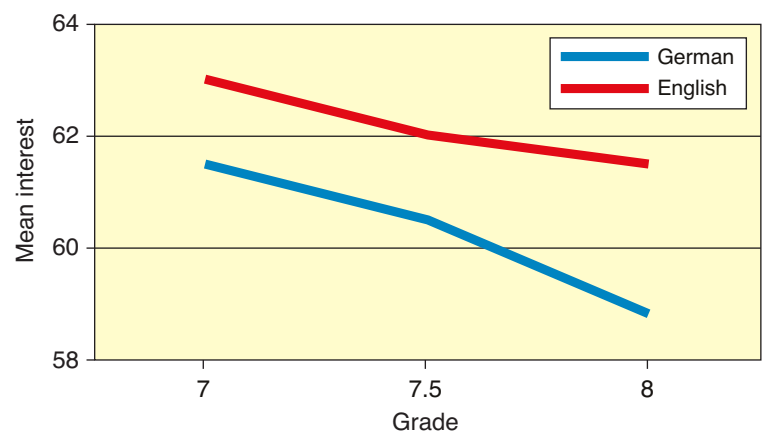


Figure 7. Development of academic interest in German (as the mother tongue) and English during grade 7; findings from the BIJU project.

three lessons per week. From our theoretical perspective, we predicted that students who later choose a basic course in mathematics would show decreasing interest in the subject during lower secondary school, while students later choosing an advanced course would show consistently high levels of interest.

The findings displayed in Figure 8 show that the one-third of the sample who opted for an advanced course in grade 11 indeed expressed high academic interest during lower secondary school. In contrast, the two-thirds of the students who opted for a basic course displayed a decrease in interest, resulting in a total decline for the whole sample. Therefore, the data portrayed in Figure 8 provide strong evidence for our assumption that the frequently reported decline in academic interest reflects a **process of differentiation** with students reinforcing specific fields of interest while giving up others and trying to optimize domains of high interest.

In our framework we propose that competing interests are not only to be expected in the academic field, but also between academic and nonacademic domains. Particularly in early adolescence, students have a strong tendency to prefer nonacademic contexts. At this time, children experience dramatic bio-

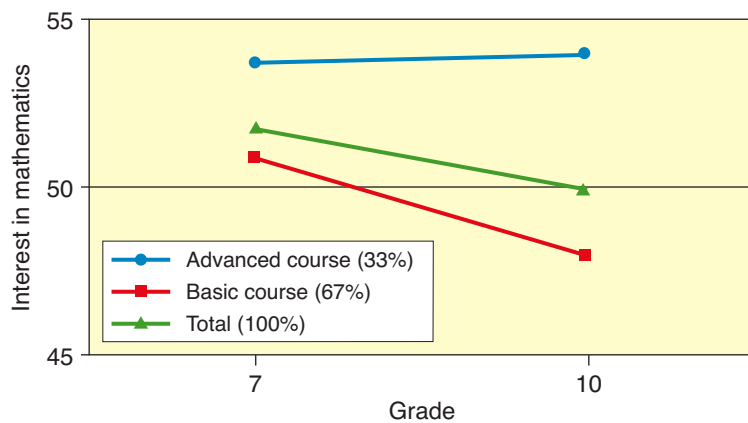


Figure 8. Development of interest in mathematics of students opting for an advanced or a basic mathematics course at grade 11.

logical and social changes associated with puberty. Peer groups become more and more important, while the parents' influence decreases and school often becomes a context which does not correspond to students' interests. Of particular interest are nonschool domains that compete with school in terms of attitudes, interests, and time investment. We thus hypothesized that the decline in academic interests during secondary school might also be a consequence of the increase in nonacademic interests and activities during adolescence. Contrary to expectations, however, none of the longitudinal analyses carried out so far have provided evidence for this hypothesis, thus indicating that the school context is less influenced by students' out-of-school experiences than suggested by prior re-

search. For German students at least, it seems that the academic world (school) and the nonacademic world (home, friends, clubs, teams, etc.) form two more or less independent domains that do not substantially influence one another. As a result, out-of-school variables and experiences have barely any impact on the development of academic interests.

## Research Area II

### Establishing a Monitoring System for Educational Performance: Foundational Studies

Despite the complex system of governance and federal cooperation which has been developed in the German educational system, Germany is one of the few industrial states which long had no national system of quality control to monitor the outcomes of educational processes and provide a framework for international comparison. With its participation in TIMSS, reliable data on the levels of performance of selected cohorts of students in mathematics and science have become available for the first time.

The Organization for Economic Co-operation and Development (OECD) uses the results of the TIMSS 7th- and 8th-grade assessment as performance indicators for the comparison of the educational systems in its member states. Data on mathematics and science performance are a regular feature of the OECD's annual publication "Education at a Glance" (OECD, 2000). The OECD has now launched its own program to monitor the outcomes of education systems in terms of student achievement, and to provide internationally comparable indicators for central domains of the edu-

cation system on a regular basis. All 16 of the German *Länder* are participating in this Programme for International Student Assessment (PISA), which builds on the experiences of TIMSS, but seeks to achieve qualitative improvement in many respects. A national consortium under the leadership of the Center for Educational Research is responsible for the national project management.



### The TIMSS Team

Jürgen Baumert  
 Wilfried Bos  
 (until 2000)  
 Eckhard Klieme  
 Olaf Köller  
 Kai Schnabel  
 (until 2000)  
 Knut Schwippert  
 (until 2000)

Associated scientists:  
 Rainer Lehmann  
 (Humboldt-Universität zu Berlin)  
 Manfred Lehrke  
 (Institute for Science Education, Kiel)

[www.mpib-berlin.mpg.de/TIMSS-Germany/](http://www.mpib-berlin.mpg.de/TIMSS-Germany/)

### The Third International Mathematics and Science Study (TIMSS)

The Third International Mathematics and Science Study (TIMSS) is the latest in a series of international comparative studies on mathematics and science teaching initiated by the International Association for the Evaluation of Educational Achievement (IEA). TIMSS integrates the two domains in a single study, thus providing basic information on system performance in a core area of modern education in the 45 participating countries. The German research group consists of three partners: the Max Planck Institute for Human Development (MPIB), the Institute for Science Education at the University of Kiel (IPN), and the Humboldt University of Berlin (HUB). The national consortium is headed by the Max Planck Institute for Human Development.

The goal of TIMSS is to investigate achievement in mathematics and science from a cross-cultural perspective.

The international study is based on a cross-sectional sample of three age groups: (I) students from the two adjacent grades with the largest proportion of 9-year-olds, (II) students from the two adjacent grades with the largest proportion of 13-year-olds, and (III) students in the final grade of upper secondary school in the general and vocational education system. In Germany, age groups II and III were investigated. As an enhancement of the international design, the **TIMSS-Germany** design for age group II was longitudinal. Additionally, an international Videotape Study (TIMSS-Video) comparing mathematics instruction in Germany, Japan, and the United States has been interlinked with the panel study in Germany (see Fig. 1; see also Research Area III for a more detailed description of TIMSS-Video).

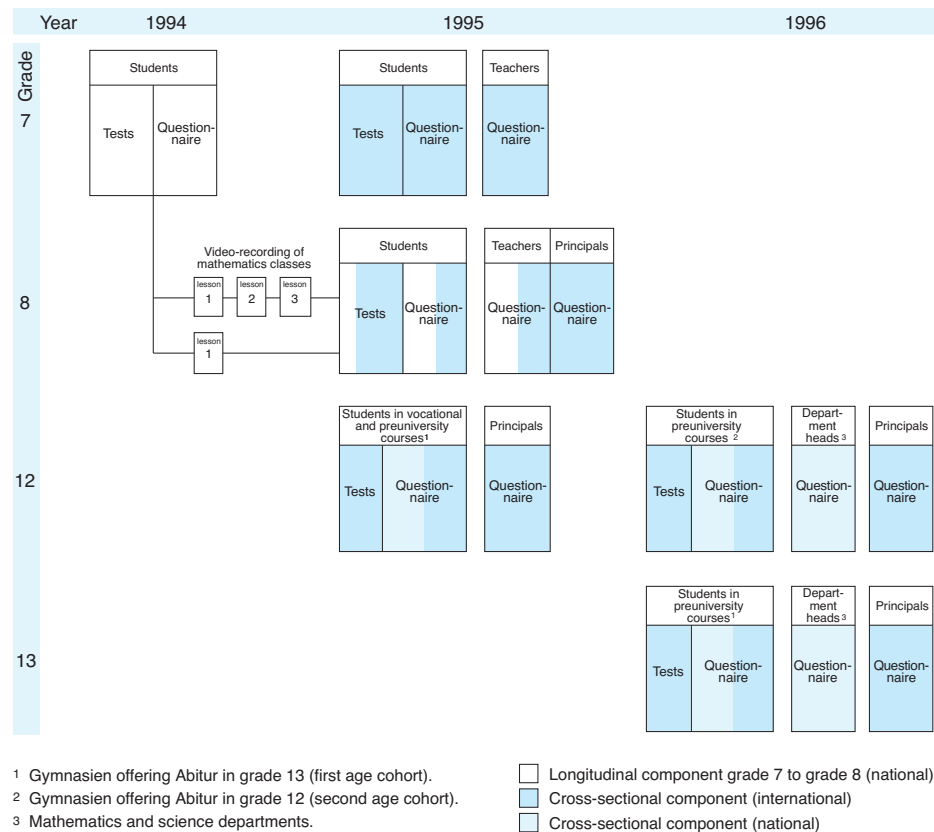


Figure 1. Design for TIMSS/II, TIMSS-Video, and TIMSS/III.

### Research Questions

Since the publication of the reports on Population II, our investigations have focused on the analysis of Population III—the final grade of upper secondary education in vocational and preuniversity courses. The results of these analyses are presented in two recently published volumes.

The main foci of research were as follows:

- the structure and level of the mathematics and physics competencies acquired at school,
- epistemological beliefs about mathematics and physics,
- the relationship between motivation, learning strategies, and domain-specific knowledge,
- instructional strategies in mathematics and physics classrooms and the implications of these for the acquisition of domain-specific knowledge, and
- the relationship between course selection and domain-specific achievement, on the one hand, and career prospects and choice of university course, on the other.

### Knowledge Structures in the Domain of Mathematical Literacy

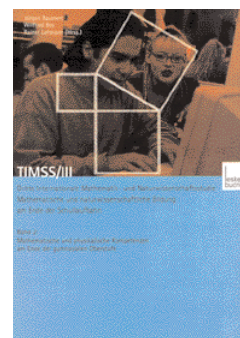
To analyze students' knowledge structures in a given domain such as mathematics, analysis has to go beyond the broad unidimensional achievement scores regularly established in educational measurement. Instead, students' understanding of the domain needs to be elaborated by means of qualitative categories derived from research on mathematics education and cognitive psychology. Therefore, test scores are anchored within the given content areas, and score levels are associated with cognitive demands mastered by students reaching the respective level. These *proficiency levels* also help to interpret research findings in a way that

is easily understood by teachers and educational researchers in the field.

Technically, proficiency levels can be described as critical thresholds in achievement, above which there is sufficient probability that students will provide the correct response to mathematics and science questions which call for particular knowledge or skills. Here, sufficient probability is defined as a 65% probability that the correct answer will be given. **Four proficiency levels** were defined for the domain of mathematical literacy, ranging from everyday reasoning to the application of basic mathematical routines, and on to mathematical modeling and argumentation. When the distribution of students across these proficiency levels is viewed in international comparison, qualitative differences in the structure of mathematical knowledge acquired become apparent. Table 1 illustrates the literacy profiles of school leavers in five European countries. For German mathematics instruction, the proficiency levels reveal an alarmingly high proportion of students who are unable to reliably apply basic mathematical routines—a necessary condition for successful transfer from school to vocational training. By the same token, the proportion of students who have attained the level of mathematical argumentation by the end of compulsory schooling is conspicuously low. The discrepancy between results in Germany and the Netherlands is striking. The finding that one third of the Dutch students in their final year of schooling do reach the highest level of mathematical literacy seems to provide convincing evidence for the success of **the realistic mathematics concept** developed by the Freudenthal Institute and implemented in the Netherlands.

### Key References

Baumert, J., Bos, W., & Lehmann, R. (Eds.). (2000). *TIMSS/III. Dritte Internationale Mathematik- und Naturwissenschaftsstudie—Mathematische und naturwissenschaftliche Bildung am Ende der Schullaufbahn: Vol. 1. Mathematische und naturwissenschaftliche Grundbildung am Ende der Pflichtschulzeit*. Opladen: Leske + Budrich (362 p.).



Baumert, J., Bos, W., & Lehmann, R. (Eds.). (2000). *TIMSS/III. Dritte Internationale Mathematik- und Naturwissenschaftsstudie—Mathematische und naturwissenschaftliche Bildung am Ende der Schullaufbahn: Vol. 2. Mathematische und physikalische Kompetenzen am Ende der gymnasialen Oberstufe*. Opladen: Leske + Budrich (466 p.).

Baumert, J., Klieme, E., Lehrke, M., & Savelsbergh, E. R. (2000). Konzeption und Aussagekraft der TIMSS-Leistungstests. Zur Diskussion um TIMSS-Aufgaben aus der Mittelstufenphysik (part 1). *Die Deutsche Schule*, 92, 102–115; (part 2). *Die Deutsche Schule*, 92, 196–217.

Table 1  
Distribution of students across levels of mathematical proficiency at the end of full-time schooling (in %)

Proficiency level	Germany (TCI <sup>1</sup> = 78)	France (TCI = 84)	Netherlands (TCI = 78)	Norway (TCI = 84)	Switzerland (TCI = 82)
Everyday reasoning	15.4	5.5	3.7	7.6	5.7
Application of basic routines	36.6	33.4	21.5	32.5	27.8
Modeling and mathematization	34.1	44.3	41.3	37.4	40.9
Mathematical argumentation	13.9	16.8	33.4	22.5	25.6
Total	100.0	100.0	100.0	100.0	100.0

<sup>1</sup> TIMSS Coverage Index: Percentage of the age cohort covered by the TIMSS sample.

### Key References

**Klieme, E.** (2000). Fachleistungen im voruniversitären Mathematik- und Physikunterricht: Theoretische Grundlagen, Kompetenzstufen und Unterrichtsschwerpunkte. In J. Baumert, W. Bos, & R. Lehmann (Eds.), *TIMSS/III. Dritte Internationale Mathematik- und Naturwissenschaftsstudie—Mathematische und naturwissenschaftliche Bildung am Ende der Schullaufbahn: Vol. 2. Mathematische und physikalische Kompetenzen am Ende der gymnasialen Oberstufe* (pp. 57–72). Opladen: Leske + Budrich.

**Baumert, J., Bos, W., & Watermann, R.** (2000). Fachleistungen im voruniversitären Mathematik- und Physikunterricht im internationalen Vergleich. In J. Baumert, W. Bos, & R. Lehmann (Eds.), *TIMSS/III. Dritte Internationale Mathematik- und Naturwissenschaftsstudie—Mathematische und naturwissenschaftliche Bildung am Ende der Schullaufbahn: Vol. 2. Mathematische und physikalische Kompetenzen am Ende der gymnasialen Oberstufe* (pp. 129–180). Opladen: Leske + Budrich.

**The Structure of Knowledge Acquired in Preuniversity Mathematics and Physics Courses: Strengths and Weaknesses of Students in Academic Tracks**  
Previous comparative educational research has shown that didactical traditions vary between countries. For example, the realistic mathematics approach implemented in the Netherlands as well as the problem-oriented approaches taken in the Scandinavian countries highlight the linking of mathematical concepts to authentic problem situations, while mathematics education in France and Japan stresses the systematic structure of mathematical concepts and inner-mathematical reasoning.

These observations lead to theoretical hypotheses on relative strengths and weaknesses of students from different countries. Within **TIMSS-Germany**, we tested these hypotheses by categorizing the cognitive demands of TIMSS test items and examining their differential functioning in international comparison.

The difficulty parameter describing each item's position on the proficiency scale was broken down into two components: (a) a component that covers the overall difficulty of the item on the international level and (b) a country-specific component indicating differential item functioning (DIF) between

countries. We made systematic use of such differential item functioning in pairwise comparisons of the countries participating in TIMSS. Furthermore, we are able to refer to the additional information provided by the proficiency scales, on the one hand, and expert ratings of the cognitive demands of the items, on the other. Statistical methods can be used to test which of these cognitive demands are related to the DIF parameters. The patterns of results indicate **systematic differences in the structure of knowledge acquired in the various countries**, and thus reveal the effects of the differing didactic traditions.

The German students' **mathematics performance at the preuniversity level** was not only generally weaker than that of many of their European counterparts, these weaknesses were particularly pronounced in the more advanced domains of mathematical reasoning (see Table 2). The relative weaknesses of the German upper secondary students lie in the domains of conceptual and procedural mathematical knowledge. The German students also underperformed in tasks requiring mathematical modeling, application, and problem solving, however. A certain strength of German mathematics instruction was found in the German stu-

Table 2  
Relation between cognitive demands of advanced mathematics items and differential item functioning in various countries in comparison to Germany<sup>1</sup>

Cognitive demands	Comparison country					All countries
	Austria	Switzerland	France	Sweden	USA	
Mathematical knowledge	-.22	-.31	-.28		-.32	-.38
Conceptual understanding	-.35			-.25	-.25	-.37
Algebra			-.29	-.36	-.34	-.28
Text comprehension			.35	-.23		
Modeling			.40	-.24		
Application				-.32		
Problem solving			.22	-.22		-.20
Visualization and using graphic material			.45	.25	.46	.32

<sup>1</sup> The values given are correlations between the cognitive demands (as rated by experts) and the differential item parameters across 66 TIMSS test items. Positive values indicate relative strengths of German students compared to students from the comparison country, while negative values indicate relative weaknesses. Only significant correlations ( $p < 0.05$ ) are given.

dents' ability to visualize and use graphic material, but this was the only strength that could be identified. The pairwise international comparisons reveal some highly interesting variations in the country-specific cultures of pre-university mathematics. There is little deviation in the DIF parameters of the three German-speaking countries (Germany, Austria, and Switzerland). In other words, although the Swiss students far outperformed their peers in Germany and Austria, the didactic cultures of the three countries seem to be rather similar. These findings imply scope for optimization within one and the same didactic tradition.

The U.S. students' performance in the advanced mathematics test—though very low overall—was relatively high in tasks requiring conceptual and procedural knowledge. This indicates that high school lessons in Germany follow the same kind of lesson script that was also observed in the 7th and 8th grades, emphasizing the use of repetitive exercises and the rote learning of mathematical concepts (Baumert, Lehmann et al., 1997).

Students attending the mathematical and scientific track of the French *Lycée d'Enseignement Général* generally attain an extraordinarily high level of mathematics achievement. Their particular strengths lie in advanced mathematics and algebra skills. At the same time, the relations between the DIF parameters and the strategic demands of the tasks such as problem solving, restructuring, and spatial visualization show that—in comparison to their extremely high performance overall—French students are relatively weak in these areas. French instructional practice is obviously geared to the traditional approach of imparting systematic domain-specific knowledge.

As expected, the Swedish students' profile is complementary to that of their French peers. Compared to both German students and students in the other participating countries, the particular strengths of the Swedish students lie in the domains of application and problem solving, as well as in procedural knowledge and the qualitative understanding of mathematical concepts. This confirms that Swedish mathematics instruction

#### Key Reference

Baumert, J., Lehmann, R., et al. (1997). *TIMSS—Mathematisch-naturwissenschaftlicher Unterricht im internationalen Vergleich. Deskriptive Befunde*. Opladen: Leske + Budrich (242 p.).

indeed focuses more on problem solving and understanding than is the case in the other countries under investigation. Moreover, the level of competence achieved by the Swedish students was generally high.

The task shown in Figure 2 is a good illustration of differing knowledge profiles. The item, in which compulsory material from lower secondary education is embedded in an unfamiliar context, was administered to preuniversity students taking advanced courses in mathematics.

Country-specific profiles also emerge for the knowledge acquired in **preuniversity physics courses**. By in-

ternational comparison, the relative strengths of German upper secondary students lie in the formal, quantitative approach to physics. In contrast, German academic-track students have particular difficulty with tasks that require either a clear conceptual understanding or the overcoming of misconceptions (see Fig. 3). This finding shows that the results of intensive research into conceptual change have not been successfully transferred to instructional practice in Germany. This indicates a serious shortcoming in the implementation of research findings in in-service teacher training.

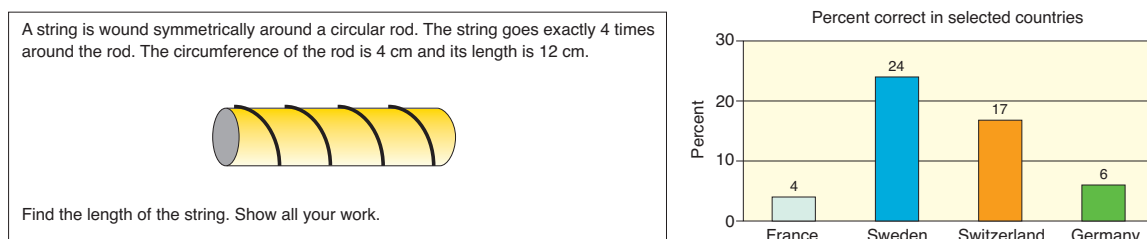


Figure 2. TIMSS item on problem solving in advanced mathematics.

#### Key Reference

Köller, O., Baumert, J., & Neubrand, J. (2000). Epistemologische Überzeugungen und Fachverständnis im Mathematik- und Physikunterricht. In J. Baumert, W. Bos, & R. Lehmann (Eds.), *TIMSS/III. Dritte Internationale Mathematik- und Naturwissenschaftsstudie—Mathematische und naturwissenschaftliche Bildung am Ende der Schullaufbahn: Vol. 2. Mathematische und physikalische Kompetenzen am Ende der gymnasialen Oberstufe* (pp. 229–269). Opladen: Leske + Budrich.

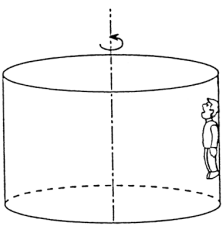
#### Epistemological Beliefs about Mathematics and Physics

The terms "epistemological beliefs" and "worldviews" cover all beliefs and subjective theories that individuals develop about knowledge and knowledge acquisition, either in general or in specific domains. The starting point for all research on epistemological beliefs is the assumption that these intuitive theories predetermine how the individual encounters and interacts with the discernible world. They impact on thought and reasoning, information processing, learning, motivation, and—ultimately—academic achievement. As a rule, analyses of epistemological beliefs take a developmental approach and assume an

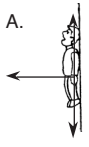

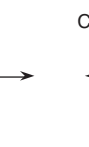
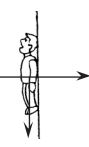
age-graded increase in the complexity of the worldviews. This process can either be fostered or obstructed by school instruction.

When epistemological beliefs are studied within the framework of research on mathematics and science education, the aim is not only to optimize the learning process. More importantly, **epistemological beliefs are perceived as an integral component of mathematical and scientific knowledge**. They provide implicit conceptual frameworks, indicating which questions can legitimately be posed in a specific domain, which methods can be used to solve them, and with what degree of certainty. The elaboration of students' intuitive

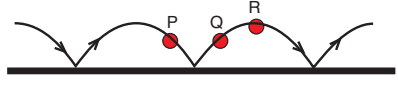
The figure below shows a special sort of amusement park ride. As the ride starts to rotate about its central vertical axis the floor drops slowly but the rider does not. The rider is pressed against the rough inside wall of the rotating cylinder and remains at rest with respect to the wall. The rider's feet are not in contact with the floor.



Which one of the following diagrams best represents the real forces acting on the rider?

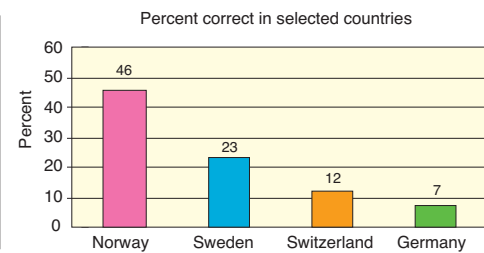
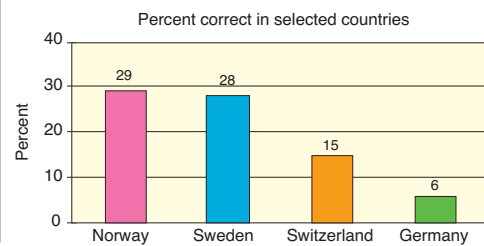
A.  B.  C.  D. 

The figure shows the trajectory of a ball bouncing on a floor, with negligible air resistance.



Draw arrows on the figure showing the direction of the acceleration of the ball at points P, Q, and R.

Figure 3. Two TIMSS items on misconceptions in advanced physics.



theories is therefore a goal in its own right in mathematics and science education, and epistemological beliefs are considered to be a core element of mathematical and scientific literacy. At the same time, typically occurring students' beliefs about mathematics and physics allow inferences to be drawn about the students' previous instruction in these domains (see Tables 3 and 4).

In **TIMSS-Germany**, epistemological beliefs about mathematics and physics were explored in a **supplementary national investigation**. The **key findings** can be summarized as follows: The mathematical worldview of upper secondary students in the academic track is typically a schematic and algorithmic perception of **mathematics** and mathematics instruction. A clear majority of respondents agreed with statements such as: "mathematics implies remem-

bering and applying definitions, formulas, mathematical facts, and procedures" or "doing mathematics means applying general rules and procedures to specific tasks." Accordingly, upper secondary students are not familiar with the constructivist approach to mathematics taken in the philosophy of science. This approach emphasizes the

Table 3  
Students' beliefs about mathematics and learning mathematics

- Math problems have one, and only one, correct answer.
- There is only one approach to solving any given math problem—usually the method recently demonstrated by the teacher.
- Normal students can't expect to understand math; they have to learn methods off by heart and apply them mechanically.
- Students who have understood mathematical concepts and methods are able to solve any math problem in a matter of minutes.
- School math has little or nothing to do with the real world.
- Doing math is a solitary activity that individuals engage in on their own.
- Math is a formal system, and has nothing to do with intuition or creativity.

Table 4  
Students' beliefs about science and learning science

- A logico-empiricist view of the world is predominant, according to which scientific theories are derived from observations and experiments.
- An adequate understanding of the relationship between models and reality is lacking. Models are viewed as a direct reflection of reality.
- Scientific knowledge is the result of human beings discovering objective, permanent natural laws (reification of discovery).
- In contrast to other forms of discovery, science knowledge entails a claim of absolute truth; the distinction between true and false is independent of theory and context.
- The notion that scientific discoveries are the result of interactive validation processes is lacking.
- The sciences represent the definitive way of understanding the world in modern societies.
- The sciences are the basis for modern technology and the engine driving progress.

#### Key Reference

Baumert, J., & Köller, O. (2000). Unterrichtsgestaltung, verständnisvolles Lernen und multiple Zielerreichung im Mathematik- und Physikunterricht der gymnasialen Oberstufe. In J. Baumert, W. Bos, & R. Lehmann (Eds.), *TIMSS/III. Dritte Internationale Mathematik- und Naturwissenschaftsstudie—Mathematische und naturwissenschaftliche Bildung am Ende der Schullaufbahn: Vol. 2. Mathematische und physikalische Kompetenzen am Ende der gymnasialen Oberstufe* (pp. 271–315). Opladen: Leske + Budrich.

constructive and dynamic nature of mathematics, and the fact that mathematical innovation is dependent on creativity and imagination. Nevertheless, almost all *Gymnasium* students are aware of the importance of mathematics in the modern world. Rigid schematic perceptions, such as there only being one approach to solving any given mathematics problem—still a typical belief among 14-year-olds—are no longer found in preuniversity mathematics courses. In contrast to physics, Platonist perceptions play practically no role in the domain of mathematics.

A predominant worldview among academic-track students in upper secondary education can also be identified for the domain of **physics**. This perception couples the ontological belief that physics consists in the gradual discovery of a construction plan for the universe with the view that physics-related knowledge has system character. According to this view, the natural laws of physics are discovered by physicists on a step-by-step basis. The theories of physics systematize human experience, most of which is gained from experiments. In the international research literature, this basic perception is defined as a logico-empiricist view of science. An understanding of the constructive

nature of scientific theories is alien to this worldview.

As is also the case in mathematics, the societal relevance of physics is undisputed. The great majority of upper secondary students believe physics to be the driving force behind technological progress, its aim being to solve the practical problems encountered by humanity. However, there is a systematic difference in the physics-related worldviews of students enrolled in basic and advanced courses, the direction of which is worthy of note: The longer and more intense the students' involvement with physics in school, the more pronounced their empiricist beliefs about science, and the greater the claims of certainty that they associate with knowledge in physics. This finding clearly contradicts the normative expectations guiding physics education.

The development of epistemological beliefs about mathematics and physics during adolescence can be described as a process of differentiation. During adolescence, different aspects of beliefs, which are by no means always logically compatible, become more distinct from one another and thus more clearly defined. Where mathematics is concerned, a clear polarization of epistemological beliefs occurs over the course of this development—either in the direction of a static schema-oriented view or in that of a dynamic application-oriented position. Where physics is concerned, a similar differentiation of epistemological beliefs can be observed over the course of development. This has little effect on the empiricist view of the world that predominates in this domain, however. The main change here lies in the rejection of schematic perceptions of physics. Figure 4 shows the results of a latent class analysis for mathematics from a developmental perspective.

Epistemological beliefs are intuitive theories which represent an integral el-

ement of domain-specific knowledge and, at the same time, impact on motivation, learning processes, and ultimately academic achievement in the domain in question. In TIMSS, structural equation modeling was used to analyze the relationship between epistemological beliefs, on the one hand, and motivational orientations, use of learning strategies, and achievement in the given subject, on the other. It emerged that there was a high degree of comparability between the two subjects. The analyses of the **mathematical worldviews**—as shown in Figure 5—indicate that these beliefs **have direct or indirect**—that is, mediated by other factors—**effects on achievement in mathematics**. As expected, the effects of Platonist and **schematic perceptions** of mathematics are negative. The effect of schematic perceptions is mediated by interest in the subject and rehearsal strategies. Students who believe that mathematics consists merely in the application of particular algorithms to given tasks are less interested, more likely to use surface strategies when studying, and perform less well than their peers. As was also predicted, the other two dimensions of the mathematical worldview proved to have positive effects on achievement. Those students with a **constructivist perception** express great interest in mathematics and perform better than their peers.

### Summary

In Germany, the TIMSS findings on the structure of knowledge in mathematics and physics synthesize with the students' modal epistemological beliefs to form a relatively homogeneous pattern and reflect a form of instruction which is fundamentally schematic and often

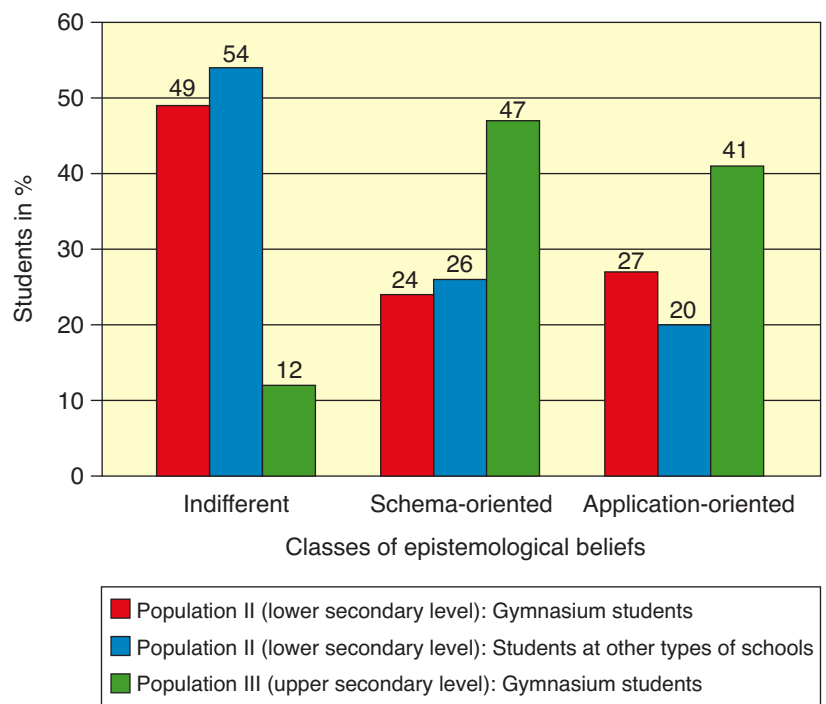


Figure 4. Students' epistemological beliefs about mathematics according to age cohort and school type (in %).

repetitive, involves relatively little variation, and does not have the primary aim of stimulating and fostering cognitive activity, intellectual autonomy, and self-regulated learning. This conclusion is confirmed by the TIMSS data on the structure and delivery of lessons (see below: *The Orchestration of Students' Learning Activities*). At the same time, the TIMSS results also reveal considerable variation in knowledge profiles according to the country, its didactic tradition, and the subject in question.

This convergence of results in the in-depth analyses conducted in Germany may well explain the far-reaching impact of the study. It seems fair to draw attention to the considerable political, practical, and scientific impact that TIMSS has had in this country. The findings have led to marked changes in the political agenda, inasmuch as the *Länder* have begun to establish a national monitoring system focusing on educational outcomes. From the practical



point of view, the federal and *Länder* governments have reacted with a well-equipped development program to improve instruction in individual schools and professionalize teaching in the domains of mathematics and sciences. From the scientific point of view, the findings of TIMSS and TIMSS-Video

have led to the **German Research Foundation (DFG)** funding a **new program** to further research on learning and instruction in mathematics and science, taking into account support systems existing both inside and outside of school.

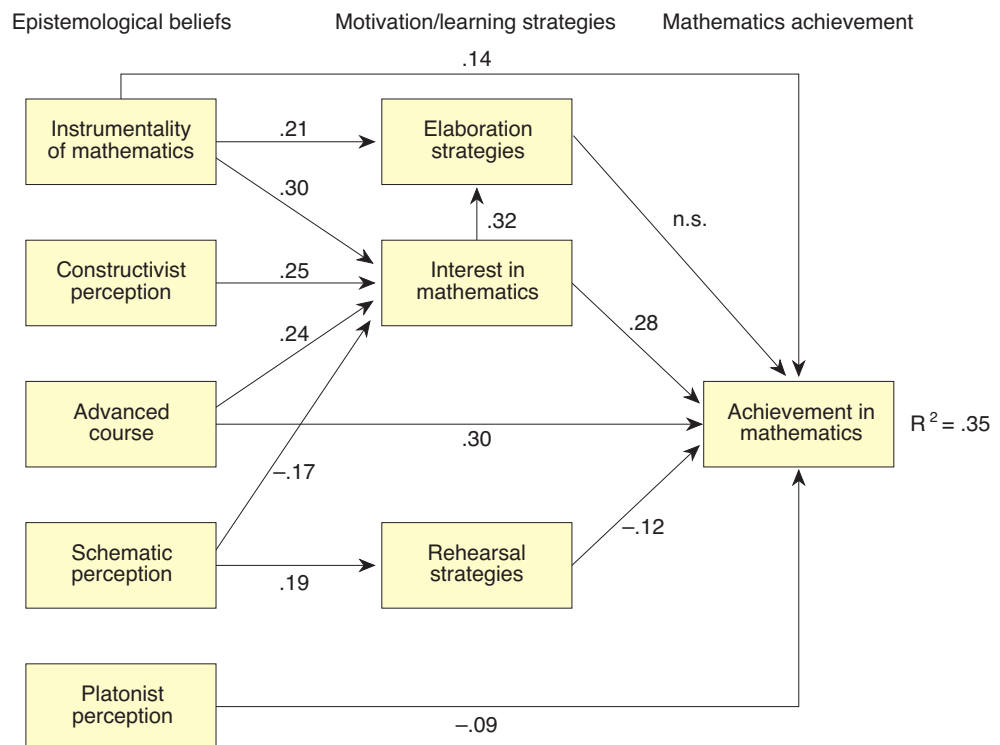


Figure 5. Epistemological beliefs, motivation, learning strategies, and performance in mathematics: Structural equation model.

## Programme for International Student Assessment (OECD-PISA)

As projects like the Third International Mathematics and Science Study (TIMSS) have shown, large-scale assessments of student performance can provide valuable information for policy-makers, teacher trainers, and educators. The German ministers of education in the 16 German *Länder* have, therefore, resolved to monitor outcomes of schooling on a regular basis. The Programme for International Student Assessment (PISA) that was initiated by the member countries of the Organisation for Economic Cooperation and Development (OECD) provides an excellent basis for the establishment of such a monitoring system. This project assesses knowledge, skills, and competencies of 15-year-old students in reading, mathematics, and science, as well as in cross-curricular domains. Because the assessments take place on a regular basis, with updates every three years, the study presents a tool for monitoring changes in the performance of the participating countries' education systems and for gauging the effects of measures taken to improve

learning outcomes.

Another important feature of the PISA project is that it allows for national additions to the international design. This gives national committees the opportunity to address research questions that are of particular interest to them. The German PISA consortium has made extensive use of this opportunity and supplemented the program such that central research questions in education and educational psychology can be addressed. One main focus of these foundational studies is the explication of structures of knowledge and competencies in curricular and cross-curricular domains. In addition, an attempt is made to gauge the importance of individual-level and school-level factors, as well as curricular and didactical traditions affecting the development of these knowledge structures and competencies. Some of the national additions to the international PISA design and the research questions they aim at addressing are listed in Table 5.

## The PISA Team

Cordula Artelt  
Jürgen Baumert  
Eckhard Klieme  
Gundel Schümer  
Petra Stanat

Anke Demmrich  
Mareike Kunter  
Joachim Wirth  
(predoctoral fellows)

Associated scientists:  
Helmut Heid (Universität Regensburg)  
Michael Neubrand (Bildungswissenschaftliche Hochschule Flensburg)  
Manfred Prenzel (Institute for Science Education, Kiel)  
Ulrich Schiefele (Universität Bielefeld)  
Wolfgang Schneider (Universität Würzburg)  
Klaus-Jürgen Tillmann (Universität Bielefeld)  
Manfred Weiß (DIPF, Frankfurt a.M.)

Table 5  
National supplements to the international PISA design for analyses of knowledge structures and their determinants

Reading	Mathematics	Science	Cross-curricular competencies
<ul style="list-style-type: none"> <li>Assessment of learning from texts as a component of reading literacy distinct from working with texts</li> <li>Assessment of proximal antecedents of text comprehension to identify possible points for intervention</li> </ul>	<ul style="list-style-type: none"> <li>Fine-grained differentiation and description of competency classes</li> <li>Addition of broader range of items assessing aspects of mathematical literacy not covered by the international test</li> <li>Ratings of items based on a theory of cognitive demands</li> <li>Identification of effects of curricular and didactical traditions on knowledge structures</li> </ul>	<ul style="list-style-type: none"> <li>More comprehensive assessment of understanding of scientific concepts to test the distinction between concept and process components of scientific literacy</li> <li>Identification and description of competency levels for the concept and the process dimensions</li> </ul>	<ul style="list-style-type: none"> <li>Assessment of general problem-solving skills and validation of the construct</li> <li>Assessment of aspects of social competence and cooperative behavior</li> <li>Exploration of the role schools play in the development of CCCs</li> </ul>

## Analyses of Knowledge Structures

**Reading literacy** Each cycle of the international PISA program will focus on one of the three assessment domains. In the first cycle, this major domain is reading. The international framework for the assessment of reading literacy is largely based on a structural model developed by Kirsch and Mosenthal (1998), which strongly influenced both the U.S. National Assessment of Educational Progress (NAEP) and the OECD's International Adult Literacy Study (IALS). At a general level, this model distinguishes between a primarily text-based and a more knowledge-based aspect of reading comprehension. Whereas the former relies almost exclusively on information provided in the text, the latter also draws on prior knowledge. These two aspects are further broken down into five types of demands that readers encounter when working with texts, namely retrieving information, developing a broad understanding, and developing an interpretation, on the one hand (representing text-based comprehension), as well as reflecting on the content of the text and reflecting on the form of the text, on the other (representing more knowledge-based comprehension).

The international approach examines reading comprehension in the context of *working with texts*. In the test, students were allowed to refer back to the text while answering questions about it. This approach clearly captures an important aspect of reading literacy. Yet, reading literacy also encompasses the ability to generate mental representations of a text such that the information can be used at a later point in time, without having to consult the document again. This aspect, which can be described as *learning from texts*, was assessed in the national extension of the international PISA design. The na-

tional test is based on the psychological theory of text comprehension developed by Kintsch (1998) and van Dijk and Kintsch (1983). This theory differentiates three types of text representations: verbatim representations, which result from basic processing of a text's surface; propositional representations, which capture the meaning of texts; and situational representations, which integrate the information from the text with prior knowledge. By separating the reading or learning phase from the test phase, the national test assesses each of these representations. More specifically, students answered questions about a text they had read without being able to refer back to it.

According to Kintsch (1998), text comprehension encompasses text-driven construction processes and knowledge-driven integration processes. Idea units or propositions, on the one hand, and the reader's goals, on the other, lead to the retrieval and activation of associated elements (knowledge, experience) from long-term memory and the formation of an interrelated network. At the lowest level of comprehension, a person may be able to reproduce a text from memory without being able to use it for any other purpose; in that case, the information provided by the text remains inert knowledge. The most elaborated form of text processing, on the other hand, is the situational representation. Here, the contents of the text and the reader's current knowledge are interconnected and additional information stemming from inferences is incorporated, thus reflecting the deepest level of learning from the text. In generating situational representations, deliberate control becomes necessary when the textual information interferes with the knowledge base or when not enough knowledge is available for an orderly mental representation of the text to be constructed.

Large-scale assessment studies (e.g., IEA, NAEP) have recently begun to try to explain observed differences in text comprehension skills or reading literacy by reference to structural and individual features. Among other things, they examined the role of such factors as school characteristics, class size, and students' socio-economic background (SES). One of the main findings of these studies was that, compared to SES, school variables seem to have relatively little impact on text comprehension skills. However, the analyses did not take into account more proximal antecedents of reading comprehension that have been identified in the psychological literature on the processes operating during the construction of mental representations, on the one hand, and on individual predictors of comprehension and memory skills, on the other. Here, decoding skills, knowledge about language, domain-specific knowledge, basic cognitive capacities (working memory, mental ability), learning strategies, and metacognitive knowledge are described as major predictors of text comprehension. In addition, the construction of a coherent situational representation of a text may also depend on the reader's goals and motivation. The importance of motivational variables has repeatedly been shown in research on learning strategies.

Rather than concluding that schools do not make a difference, the national PISA consortium added an assessment of several proximal antecedents of text comprehension which could represent potential points of intervention, particularly in schools. The national additions include reading and learning strategies, thematic interest, and prior knowledge about the topic of each text. A reading speed test was also administered, allowing for the measurement of basic reading skills (decoding speed). Furthermore, students' knowledge of learning strate-

gies was assessed. That is, students were asked to rate a series of learning strategies in terms of how effective they would be for attaining a stated goal in six different scenarios, and their ratings were subsequently compared with corresponding judgments by experts.

As described above, the national design includes a second text comprehension test, differing from the international reading literacy test in several respects. Whereas the international assessment examines reading comprehension in the context of working with texts, the national test requires students to read each text within a limited period of time and to subsequently answer comprehension-based and knowledge-based questions from memory without being able to consult the text again. The extent to which students have developed a situational representation of the information provided is regarded as an indicator of learning from texts. On the basis of the different assumptions about text comprehension and literacy underlying the national and the international theoretical frameworks, we expect that different predictors will be identified for the aspects captured with the two tests. More specifically, the theoretical assumptions depicted in Figure 6 will be tested systematically by comparing structural equation models with varying constraints.

Based on the models by Kirsch and Mosenthal and van Dijk and Kintsch, we expect to find substantial effects of mental ability, decoding speed, knowledge about learning strategies, and interest, as well as of parents' socio-economic status (SES) on both aspects of text comprehension. Other predictors are expected to influence only one of the measures. For example, the theoretical assumptions suggest that prior knowledge and use of deep-level learning strategies (elaborations) will only

#### Key References

- Baumert, J., Artelt, C., Klieme, E., & Stanat, P.** (in press). PISA (Programme for International Student Assessment)—Zielsetzung, theoretische Konzeption und Entwicklung von Messverfahren. In F. E. Weinert (Ed.), *Leistungsmessung in Schulen—Eine Zwischenbilanz*. Weinheim: Beltz.
- Klieme, E., Köller, O., & Stanat, P.** (in press). TIMSS und PISA: Von der Untersuchung fachlichen Lernens zur Analyse allgemeiner Kompetenzentwicklung. *Journal für Schulentwicklung*.
- Klieme, E., Funke, J., Leutner, D., Reimann, P., & Wirth, J.** (in press). Problemlösen als fächerübergreifende Kompetenz. Konzeption und erste Resultate aus einer Schulleistungsstudie. *Zeitschrift für Pädagogik*.

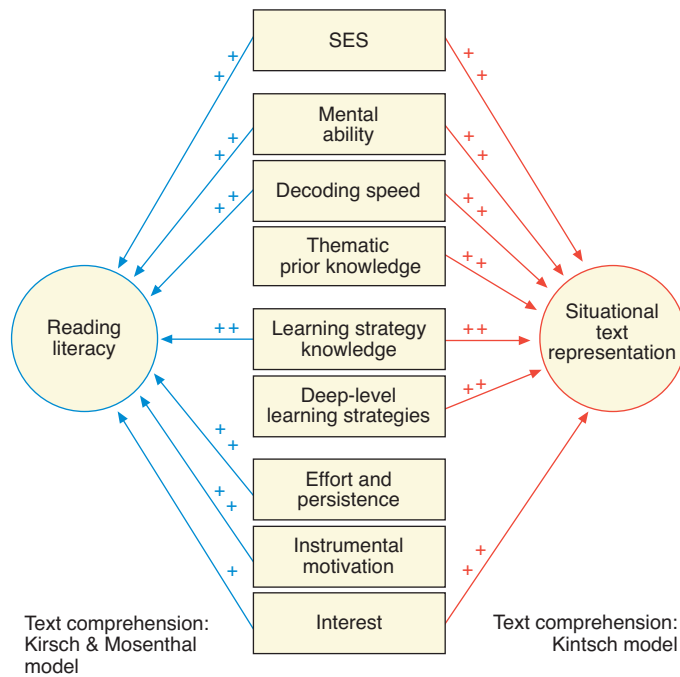


Figure 6. Theoretical assumptions about variables predicting the two facets of text comprehension.

have a positive effect on the development of situational text representations, whereas instrumental motivation and effort and persistence when studying should primarily be associated with higher levels of performance in the international reading literacy test.

Analyses of data from a field trial show that the international assessment (working with texts) and the national assessment (learning from texts) do, in fact, capture different aspects of reading literacy. A two-dimensional Rasch model was shown to represent the data better than a one-dimensional model. Owing to design restrictions in the field trial, however, we have not yet been able to test the complete model depicted in Figure 6 by considering both criterion variables simultaneously. Nevertheless, in line with our theoretical assumptions, partial models provided strong evidence to show that learning strategy knowledge and text-related prior knowledge have the highest predictive power, particularly where learning from texts is concerned. Most importantly, this conclusion holds even when SES is included as a predictor.

These findings suggest that metacognitive skills may present an appropriate point of intervention when it comes to fostering reading literacy in schools. To test this idea, an experimental training study has been designed. Based on the concept of reciprocal instruction, students will be trained in the use of metacognitive strategies, and the longer-term effects of this training program on text comprehension will be explored.

**Mathematical literacy** The international framework for the assessment of mathematical literacy is strongly influenced by the "realistic mathematics" approach introduced by Hans Freudenthal. This approach starts with the assumption that mathematical concepts and ideas have primarily been developed as tools for grasping and structuring phenomena of the physical, social, and mental world. In line with this assumption, the international PISA test consists mainly of items that require students to apply their knowledge and skills in authentic situations. Moreover, the composition of the test reflects the idea that problems involving modeling and application present the best indicators for mathematical understanding.

The "realistic mathematics" approach reflects current ideas on constructivist teaching and situated learning that are quite popular in didactics and educational research (see below: Research Area III). However, these conceptualizations leave unanswered such important questions about the nature and structure of mathematical competencies as the following:

(1) What is the relationship between modeling-and-application kinds of tasks, on the one hand, and inner-mathematical problem solving and technical skills, on the other? Do these competencies constitute different dimensions of mathematical literacy or do

they represent hierarchical levels of mathematical understanding that may be positioned on a singular latent dimension?

(2) Can different levels of mathematical modeling be distinguished?

To address these and other questions, the German PISA consortium has extended the international approach in terms of theory, design, and methodology:

(1) Further breaking down two of the three competency classes defined in the international framework, the national approach establishes a more fine-grained theory of mathematical competencies. More specifically, the model distinguishes the following competency classes: (1a) application of technical skills or recall of facts, (1b) modeling based on a single algorithm, (2a) single-step modeling that is primarily conceptual in nature, (2b) multi-step modeling that requires either the combination of several similar steps or knowledge from several mathematical domains, and (3) mathematical thinking, generalization, and insight.

(2) Based on mathematical and didactical conceptualizations as well as psychological approaches, a theoretical model of cognitive demands has been developed. Using this model, trained experts rated the cognitive demands of each item used in PISA.

(3) The test design was extended by adding a broader range of items. These items cover a wide variety of mathematical themes and a broad range of technical skills.

The structure of mathematical competence will be explored and compared across student groups and countries. Based on the theory of item demands and difficulty mentioned above, levels of proficiency will be described in detail for the dimensions and sub-dimensions identified in the structural analyses. In addition to providing further informa-

tion on structural aspects of the domain, these proficiency scales will allow for criterion-referenced interpretations of test scores. In order to gauge the effects of didactical and curricular traditions on structures of mathematical knowledge and skills, moreover, differential strengths and weaknesses across countries as well as regions and school types will be examined.

Taken together, the theoretical, empirical, and analytical power of the extended PISA mathematics study will provide important insights into the nature of mathematical literacy and into specific strengths and weaknesses in students' knowledge and skills. Such results represent valuable information for curriculum development, teacher training, and textbook writing.

**Scientific literacy** As is the case with mathematics, the first cycle of PISA assesses scientific literacy as a minor component. In line with the Anglo-Saxon notion of scientific literacy, as described in the *Benchmarks for Science Literacy* published by the American Association for the Advancement of Science, for example, the international PISA framework emphasizes process skills. The framework defines processes as "mental (and sometimes physical) actions used in conceiving, obtaining, interpreting, and using evidence or data to gain knowledge or understanding" (OECD, 1999, p. 61), and distinguishes five such processes: (1) recognizing scientifically investigable questions, (2) identifying evidence needed in a scientific investigation, (3) drawing or evaluating conclusions, (4) communicating valid conclusions, and (5) demonstrating understanding of scientific concepts. Although some scientific knowledge is needed for all five processes, only the fifth primarily focuses on this aspect of scientific literacy. In other words, understanding of scientific concepts is not

intended to be the main challenge in solving items designed to assess the first four of the processes covered in the international PISA test.

The national extension in science adds a more comprehensive assessment of conceptual understanding to the international design. This addition covers concepts from biology, physics, and chemistry. The data collected with both the international and national items will be used to test the distinction between concept and process components of scientific literacy. If, as expected, the distinction holds, competency levels will be determined and described for each of the two dimensions. Again, on the basis of such structural analyses, specific strengths and weaknesses of the students can be identified.

#### **Cross-curricular competencies**

PISA is the first international assessment study that goes beyond the measurement of knowledge and skills in curricular domains and attempts to capture so-called cross-curricular competencies (CCCs) that can be applied in a broad range of situations. This approach follows the central idea that the goals of formal education are not restricted to maximizing curriculum-based knowledge. In the first cycle of PISA, cognitive, metacognitive, and motivational prerequisites for self-regulated learning were assessed in most participating countries. The instrument for this part of the assessment was developed by PISA-Germany in collaboration with the OECD and the University of Groningen.

In Germany, a problem-solving component has been added to the design. Based on different psychological approaches to studying problem solving, both paper-and-pencil instruments and computer-based assessment procedures have been developed. A main goal of this part of the study is to determine the extent to which problem-solving

skills can be defined and measured at a domain-independent level and distinguished from general intelligence.

Analyses of the field-trial data identified two aspects of problem solving. The first was primarily picked up by the paper-and-pencil tasks, and reflects an abstract component that is closely related to general reasoning ability. Performance in the more complex, dynamic, and realistic computer-based tasks, on the other hand, seems to constitute a distinct factor. The data from the main study will be used to explore further the structure of the problem-solving construct and its relationship with other competencies and skills. Moreover, relationships between the CCCs, students' sociocultural background, and school-level variables will be analyzed to gauge the extent to which schools can promote the development of such general competencies.

Another national extension in the CCC domain aimed at assessing aspects of social competence. Particularly in the German debate about educational goals, social learning and social competencies play an important role. Protagonists of progressive education (*Reformpädagogik*) have placed special emphasis on social skills as paramount outcomes of schools. However, while it is relatively easy to capture academic achievement reliably and validly in large-scale assessments, the measurement of social behavior or social competencies in such studies poses more difficult problems. Most of the measures applied in previous research have been based on self-reports that tend to be affected by a tendency toward socially desirable responses. In addition to employing existing self-report scales measuring cognitive, emotional, and motivational antecedents of interpersonal behavior (e.g., perspective taking, social orientations), a group-task was, therefore, developed to assess cooperative behavior.

This task requires three students to work together on a problem and to pool the various pieces of information given to each group member in order to come up with a joint solution. Results from a validation study show that the joint solution represents a combination of the students' problem-solving abilities and aspects of social competence. The rela-

tionships between cognitive competencies, social skills, and cooperative problem solving will be further investigated with the data from the main study. Moreover, the assumption that cognitive and social outcomes of schooling show a positive rather than compensatory relationship will be tested.

## Research Area III

### Learning and Instruction: Cognitive Activation and Cognitive Tools

Three cornerstones of competence acquisition have to be integrated into research on learning and instruction: the tasks to be mastered, the students (who have to be engaged in meaningful learning activities), and the teachers (whose task it is to facilitate students' learning). Each cornerstone highlights different aspects of the learning process. Focusing on the tasks means asking what kinds of knowledge structures and more general cognitive preconditions have to be accessible in order for certain tasks to be mastered. Switching to the students' perspective leads to the question of how the learners' existing knowledge can be modified, extended, cross-linked, hierarchically ordered, or how new knowledge can be generated, in order to master the tasks. The teacher's role is to mediate between the tasks and the students. By selecting learning materials, giving appropriate feedback, and involving students in meaningful learning activities, teachers can support learners in closing the gap between prior knowledge and the knowledge needed to master the tasks in question.

#### **Insightful Learning: A Challenge for Teachers as well as for Scientists**

In comparison to the acquisition of facts, skills, and routines, insightful conceptual understanding—a central aim of science and mathematics instruction, in particular—is still a puzzle,

for teachers as well as for researchers. Nonetheless, scientific progress in modeling and explaining the emergence of insights and conceptual understanding is evident.

It is now widely accepted that new concepts and insights are not acquired through passive transmission of the ex-



pert's knowledge to the learner's mind, but rather that they are the result of the learner's active process of constructing increasingly complex and elaborated cognitive structures. Powerful learning environments stimulate students' cognitive activation, that is, students' mental involvement in the tasks to be mastered. In so doing, learners have to make use of, and are constrained by, the knowledge already available to them. Particularly for science and mathematics, it has been widely shown that **students** enter classrooms with intuitive concepts and belief systems which are partly based on universal conceptual primitives. These may have innate roots, but are also shaped by schooling. The negative consequences of ignoring this kind of prior knowledge have been demonstrated, particularly for physics education. Students often only adopt the knowledge taught at school at a superficial level, and therefore can only use it when faced with problems that have already been dealt with at school. Data from the TIMS advanced physics study show that overcoming certain misconceptions that are deeply rooted in everyday experience is the most difficult task of science education (see above *The Structure of Knowledge Acquired in Preuniversity Mathematics and Physics Courses*).

To effectively initiate and assist student learning, **teachers** need to take into account students' specific prior knowledge and understanding, and they need to design and organize lessons and classroom discourse in a way that closely attend to the curriculum as well as to the social construction of meaning in classrooms. Teachers can only do a good job if they know what makes certain tasks particularly difficult, on the one hand, and are aware of the way their students learn, on the other. For instance, they have to know what kinds of mistakes and obstacles typically oc-

cur during the learning process and whether students need special support to overcome these. In order to combine the task perspective and the student perspective, teachers need pedagogical content knowledge in the sense of Schulman (1987). This means that teachers have to know how particular topics, problems, or issues are organized, represented, and adapted to meet the diverse interests and abilities of learners and how they should be presented during instruction. Teachers' classroom behavior thus needs to be based on an understanding of how students learn in the respective academic domains.

In order to provide teachers with appropriate pedagogical content knowledge, research on learning and instruction has to focus on students' insightful learning. **Important questions to be addressed** include the following: What is the structure of the knowledge to be acquired? What prior knowledge does the learner have to build on? What particular tasks, explanations, and interactive discourse will assist students' construction of intelligent knowledge? Is the understanding of certain concepts subject to conscious or unconscious processes? At what stage of the learning process are feedback and direct instruction helpful? At what age can students make sense of certain forms of visual-spatial representation? What kind of practice do students need for the application of such tools in new content domains? Which tool is most appropriate for reasoning in a given content domain? What kinds of misconceptions can arise from using a tool that has not yet been fully understood?

Questions such as these are addressed in **quasi-experimental and experimental classroom studies** as well as in **training studies run in the laboratory**. Laboratory studies are a comparably cheap and particularly appropriate

method for researching certain aspects of students' learning. They allow factors of instructional input to be disentangled from factors related to teacher personality and the management and organization of classrooms and schools. Moreover, running studies with small groups in the laboratory allows for detailed video-based monitoring of learner activities, and leaves room for additional achievement measures to be gathered during the learning process. Although learning programs and training sessions developed for the laboratory can hardly be directly transferred to schools, they provide insights into particular effects of the presentation of information and learning materials that are of central importance for teacher education. We, therefore, consider them a very useful supplement to studies carried out in schools, particularly when linked to each other.

### **The Orchestration of Students' Learning Activities**

Classroom instruction is not the only factor that determines the knowledge structures and epistemological beliefs acquired by students. It is, however, the factor that is most likely to be affected by the institutions of the education system and the professional activity of teachers. Recent findings emphasize that **classroom instruction**, rather than the school environment or management structures, has the **main impact on school effectiveness in terms of learning outcomes**. As such, the question of what actually determines good instructional practice is central to the success of formal education and the functionality of the education system. For this question to be addressed, pedagogical concepts of instructional quality need to be combined with the analysis of individual and collective processes of knowledge acquisition in specific domains.

### **From Educational Productivity to Cognitive Activation**

In general, models of educational productivity (such as those devised by Walberg and colleagues), the quantity and quality of instruction are deemed to be productivity factors that cannot be compensated by other components, such as the home and classroom environment or individual abilities and motivation. There is a high level of consensus in the description of "instructional quality" in the international research community. **High quality instruction** is typically described by a set of basic properties that combine aspects of direct instruction with adaptivity and affective quality:

- good classroom management and effective responses to interruption,
- appropriate pacing and moderate speed of interactional exchange, allowing for a high level of student attentiveness and participation,
- clear and well-structured presentation of material and setting of tasks,
- adaptivity of task selection and feedback given by the teacher, based on his/her diagnostic understanding of the ability and learning progress of individual students, and
- affective quality of the teacher-student relations.

This concept describes the basic requirements of "instructional quality," the conditions which have to be met to allow for successful knowledge acquisition in the classroom. However, this concept of instructional quality is limited by that fact that (a) it does not show how teachers implement each of its elements in the structure and delivery of their lessons, (b) it has a distal relationship to the students' actual learning processes, and (c) it overlooks subject content, and thus, cannot adequately reflect the structure and quality of the knowledge acquired.

In the approach taken by the Center for Educational Research, the concept of instructional quality is extended by **adding specific didactic aspects** that (a) describe how basic elements of the productivity model are implemented in the setting of tasks and in instructional interaction processes, (b) have a more proximal relationship to the psychological processes of insightful learning, and

(c) take domain-specific criteria of knowledge acquisition into consideration. Linking up with the investigations of knowledge structures in mathematics and science described above, we ask the following question: How should instruction be shaped to allow students to gain a deep understanding of domain-specific concepts and develop adequate, nonschematic epistemological beliefs?

### The Research Team

Jürgen Baumert  
 Sabine Gruehn (until 1998)  
 Eckhard Klieme  
 Olaf Köller  
 Gundel Schümer  
  
 Marten Clausen (until 2000)  
 Steffen Knoll (until 1999)  
 Oliver Lüdtke (predoctoral fellows)

### Teaching for Understanding: Linking BIJU and TIMSS to Research on Learning and Instruction

**TIMSS/III** In the TIMS study on advanced mathematics and physics instruction at the end of compulsory schooling, students were asked to rate their instruction in each subject domain in terms of a given list of properties. It was possible to reduce these ratings to 4 or 5 scales (Baumert & Köller, 2000). In both domains, the first factor clearly represented understanding-oriented instruction. The three most important items were as follows: "Explaining the reasoning behind an idea," "describing and analyzing relations," and "working on tasks and problems with no immediate solution." The corresponding scales provide first indications of ways in which cognitive activation can be achieved in the classroom environment.

As shown in Figure 1, even in pre-university mathematics courses, under-

standing-oriented mathematics instruction is much less prevalent in everyday instructional practice than procedural drills (mostly solving equations) or a receptive instructional style, with the teacher demonstrating procedures and the students taking notes from the blackboard. It is even rarer for mathematics to be applied to everyday problems—a characteristic which is closely related to insightful learning. If these four instructional characteristics are placed in relation to the level of achievement in the course attended teaching for understanding emerges as a positive predictor and teacher demonstration as a negative predictor. This is a first indication that cognitively activating instruction is associated with higher levels of mathematics knowledge—be it that this type of instruction better fos-

[www.mpib-berlin.mpg.de/TIMSS-Video/](http://www.mpib-berlin.mpg.de/TIMSS-Video/)

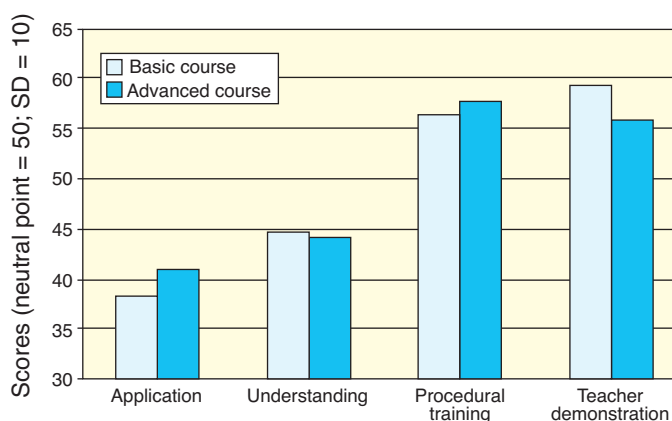


Figure 1. Instructional approaches in advanced mathematics courses as perceived by students.

ters student achievement or that it is more often practiced in high performing classes.

**BIJU** The cross-sectional design of the TIMS upper secondary study did not allow for a distinction to be made between the preconditions and the outcomes of lesson structure and delivery. This is possible within the longitudinal framework of the BIJU study, however. Gruehn (2000) used a multilevel approach to investigate the impact of instructional properties on performance gains in mathematics and science over the course of the 7th grade. Gruehn also surveyed the students' perception of their instruction, but here on a total of 21 scales. She was, thus, able to cover each of the above mentioned classical dimensions of instructional quality by several scales. Furthermore, two aspects of cognitively activating instruction were tapped in BIJU: First, "cognitively demanding exercises," that is, the use of tasks which restructure and contextualize subject content, thus, resulting in the reconstruction of knowledge; second, the "Socratic approach to mistakes." Gruehn (2000) was able to show that **cognitive activation has a positive effect on performance gains in both mathematics and physics**. A dominance of simple repetition tasks, in contrast, had a marked negative effect in all school types. When classes with cognitively activating instruction are identified and compared to classes in the same school type where instruction is more repetitive, the effects of cognitive activation on performance gains are striking (see Fig. 2).

**TIMSS-Video** The BIJU scales describing the instructional approach were also implemented in the TIMSS-Germany 8th-grade study (Baumert, Lehmann et al., 1997). Combining the data gathered by these scales with the

results of the **videotape study conducted in Germany, Japan, and the USA** (international coordination: James W. Stigler) allows a multi-perspective approach to be taken to the investigation of instructional quality. As part of an extension of this study at the Max Planck Institute for Human Development (Klieme, Knoll, & Schümer, 1999; Klieme & Bos, 2000), the scales from the student questionnaires were both presented to the teacher in question, and used as high-inference ratings by trained video viewers (Clausen, in press). On the basis of video analyses, it was possible to validate the "cognitive activation" construct and delimit it from other dimensions of instructional quality.

The 21 rating scale scores of the video viewers allow three superordinal dimensions of quality to be reconstructed: (a) effectiveness of classroom management, (b) individualization and positive climate of teacher-student relations, and (c) cognitive activation. The first two dimensions correspond with classical concepts of instructional quality. Interestingly, it emerged that instructional adaptivity and the affective quality of teacher-student relations

#### Key References

Baumert, J., & Köller, O. (2000). Unterrichtsgestaltung, verständnisvolles Lernen und multiple Zielerreichung im Mathematik- und Physikunterricht der gymnasialen Oberstufe. In J. Baumert, W. Bos, & R. Lehmann (Eds.), *TIMSS/III. Dritte Internationale Mathematik- und Naturwissenschaftsstudie—Mathematische und naturwissenschaftliche Bildung am Ende der Schullaufbahn: Vol. 2. Mathematische und physikalische Kompetenzen am Ende der gymnasialen Oberstufe* (pp. 271–315). Opladen: Leske + Budrich.

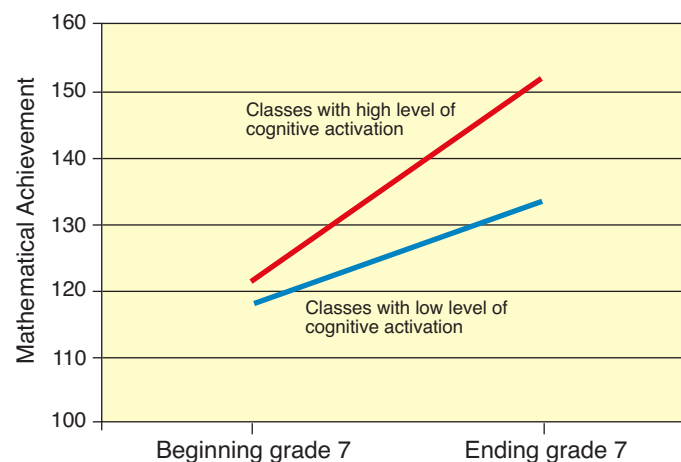


Figure 2. Achievement gain of *Gymnasium* students dependent on the level of cognitive activation (findings from BIJU, adapted from Gruehn, 2000). Metric defined across all school types with  $m = 100$ ,  $SD = 30$ .

**Key References**

**Gruehn, S.** (2000). *Unterricht und schulisches Lernen: Schüler als Quellen der Unterrichtsbeschreibung*. Münster: Waxmann (252 p.).

**Klieme, E., & Bos, W.** (2000). *Mathematikleistungen und mathematischer Unterricht in Deutschland und Japan. Triangulation qualitativer und quantitativer Forschungsansätze im Rahmen der TIMSS-Studie. Zeitschrift für Erziehungswissenschaft, 3*, 359–379.

**Klieme, E., Knoll, S., & Schümer, G.** (1999). *Mathematikunterricht der Sekundarstufe I in Deutschland, Japan und den USA. CD-Rom-Dokumentation der TIMSS-Videostudie*. Berlin: Max-Planck-Institut für Bildungsforschung and Stuttgart: Klett.

were confounded. The additional didactic properties introduced by BIJU and TIMSS allow the third, more content-related dimension to be identified. **Performance gains** on the class level are predicted by the "cognitive activation" dimension, whereas **interest gains** are predicted by individualization and the quality of teacher-student relations.

In this extended model of instructional quality, classroom management is no longer the central component explaining performance gains. This does not imply that it is irrelevant, however. As shown in Figure 3, a high level of cognitive activation can only be achieved in a well-managed classroom. In other words, efficient classroom management is a necessary condition of good instruction, but not a sufficient one.

Based on discourse analyses of the videotapes by Schümer, it was shown that high levels of cognitive activation are associated with changes in the **verbal behavior patterns of teachers**: Teachers in cognitively activating classrooms make more content-related, but fewer discipline- and management-related statements; they pose more questions asking students to describe or explain something and fewer factual questions. From independent high-inference ratings of problem solving processes, we can infer that cognitive activation is associated with a new role for the teacher: Teachers

whose classes show higher levels of cognitive activation seem to act as mediators facilitating the students' own learning activities and argumentation, and not as providers of rules and facts.

**Summary** The various studies conducted within the framework of TIMSS/III, BIJU, and TIMSS-Video can be summarized as follows: In addition to the classic elements of good instruction—efficient classroom management, adaptivity of instruction, and quality of teacher-student relations—student surveys and video-based observations allow the identification of a further dimension of instructional quality, which can be termed **"cognitive activation."** This refers to teaching strategies, task settings, and patterns of interaction which allow students to **actively construct and cross-link knowledge**. Although—as assumed in educational productivity models—efficient classroom management is a necessary condition for instructional effectiveness in terms of learning outcomes, the level of cognitive activation, and hence the didactic quality of instruction, is of critical importance for performance gains. This forges a link between instructional quality research, psychological theories of insightful learning, and research on mathematics and science education.

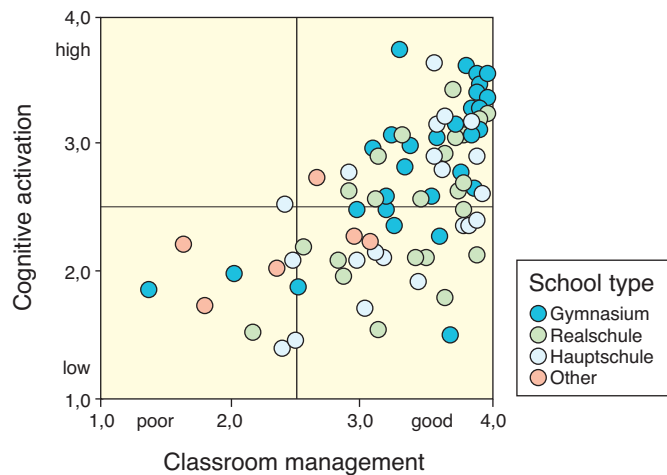


Figure 3. Relation between classroom management and cognitive activation (findings from TIMSS-Video).

## Teacher Beliefs and the Orchestration of Learning Activities: From TIMSS-Video to the "Pythagoras" Project

As shown by studies such as TIMSS-Video, cognitive activation of students requires a certain type of teaching, where teachers act as facilitators for students' learning activities and guide them toward an in-depth understanding of the subject domain. This type of teaching behavior is dependent on the teacher having adequate understanding of his or her role, based on beliefs about the epistemological nature of the domain, learning, and instruction. With this in mind, the TIMSS teachers of lower secondary schools were asked to comment on the following statement: "Basic computational skills on the part of the teacher are sufficient for teaching primary school mathematics." The more strongly the teachers agreed with this statement and the more explicitly they thus reduced the teacher's role to the imparting of procedural skills, the lower the level of cognitive activation to be observed in the videos (cf. Fig. 4). In other words, a relationship could be identified between teacher beliefs and instructional quality in the sense of cognitive activation.

A new study, funded by the **German Research Foundation (DFG)** as part of its program on educational quality in

schools and carried out in the Center for Educational Research, links up with these findings from TIMSS-Video. The aim of the "Pythagoras" project, directed by Eckhard Klieme, is to investigate instructional quality and mathematical understanding in Germany and—in collaboration with the University of Zurich—in Switzerland. In the first stage of the project, mathematics teachers from the two countries will be surveyed about perceived instructional conditions, teacher beliefs, and instructional practice in two specific topics: algebraic word problems and the Pythagorean theorem.

Instructional practice on the Pythagorean theorem was surveyed with reference to the kind of mathematical tasks set. The teachers were asked to what extent certain types of tasks—procedural tasks, tasks requiring a qualitative understanding of mathematical concepts, proofs, inner-mathematical transfer tasks, and application tasks—were used in their lessons. On the basis of these data, the teachers participating in a pilot study in Germany could be grouped into two latent classes (cf. Fig. 5a): one group that used a higher total number of tasks, a broad-

## The Pythagoras Team

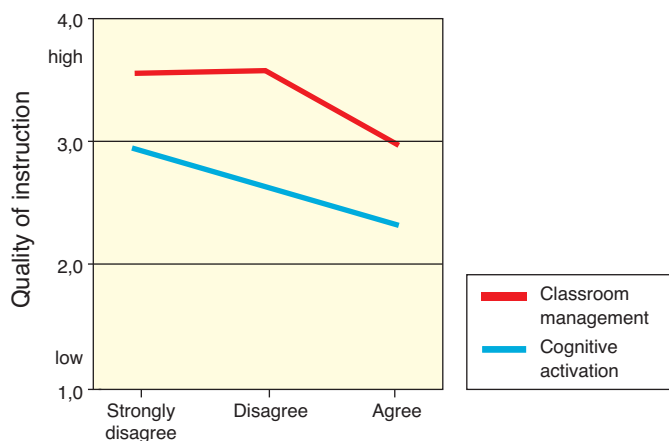
Eckhard Klieme  
Claudia Thußbas

Associated scientists:  
Kurt Reusser  
Christine Pauli  
(University of Zurich)

[www.mpib-berlin.mpg.de/Pythagoras/](http://www.mpib-berlin.mpg.de/Pythagoras/)

### Key Reference

Klieme, E., & Thußbas, C. (in press). Kontextbedingungen und Verständigungsprozesse im Geometrieunterricht. Eine Fallstudie. In S. von Aufschnaiter & M. Welzel (Eds.), *Nutzung von Videodaten zur Untersuchung von Lehr-Lernprozessen*. Münster: Waxmann.



"Basic computational skills are sufficient"

Figure 4. Instructional quality—rated by observers dependent on teacher's belief about the importance of basic computational skills for teaching at primary school (findings from TIMSS-Video).

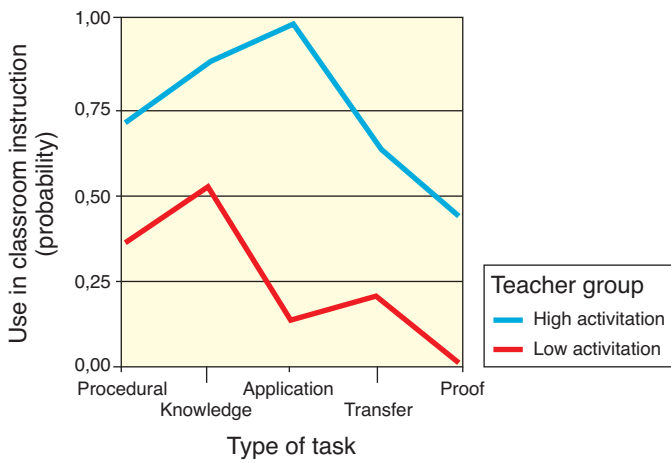


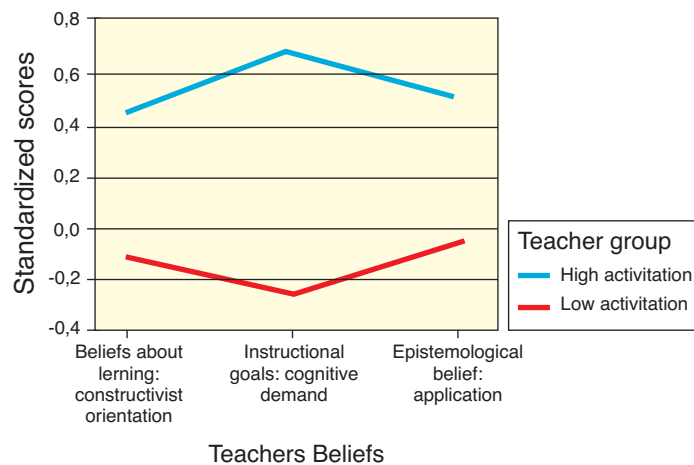
Figure 5a. Use at mathematical tasks in teaching the Pythagorean theorem by two groups of teachers.

er variation of task types, and emphasized application (high activation group), and a second group that limited its lessons to drilling routine knowledge and procedural skills (low activation group). When these two groups are compared in terms of their beliefs, considerable differences emerge (cf. Fig. 5b): Teachers with a cognitively activating instructional approach set themselves more demanding instructional goals. Their epistemological beliefs stress the application of mathematical models in real-world problem solving

and their beliefs about the learning processes (questionnaire developed by Fennema, Carpenter, & Loef and adapted by Staub & Stern) are in accordance with constructivist ideas of knowledge acquisition. This represents first empirical evidence confirming the existence of a **relationship between constructivist beliefs and instructional practice**. It is a telling result that cognitive activation was found to be associated with application-oriented instruction among the teachers surveyed. Although the German-Japanese comparison in TIMSS-Video revealed that inner-mathematical tasks are of particular value in cognitively activating instruction, German teachers are still unfamiliar with this approach (Klieme & Bos, 2000).

Within the framework of a longitudinal videotape study, the "Pythagoras" project will continue to explore the effects of teacher beliefs on instructional quality and student understanding, using methods including the quasi-experimental variation of instructional settings to provide for higher or lower levels of cognitive activation.

Figure 5b. Relation between instructional approach (high vs. low cognitive activation) and teacher beliefs.



## Cognitive Activation by Means of Diagrammatic Tools

Knowledge dealt with in academic contexts is based on symbolic systems such as script, formal mathematical language, pictures, and diagrammatic representations. Symbols can be understood as *mental tools* that provide a basis for the construction of meaning in concepts, ideas, or plans. In order to successfully employ such tools, it is important to know which affordances and constraints different mental tools provide. For instance, both language and numbers provide affordances for constructing the concept of infinity, even though this concept has no direct relation to the perceivable world. Language allows prefixes such as "in-" to be added to words, thus reversing their meaning. Numbers provide the means for addition and allow quantities to be enlarged ad infinitum by adding a number to any given number. Following this line of argumentation, which is based on the core ideas of Vygotski, cognitive development and learning can be understood as a process of extending the use of mental tools. In this sense, symbols not only represent parts of the perceivable world, but themselves become objects of reasoning, thus allowing the construction of concepts which have no direct relation to the perceivable world. Within this framework, understanding can be conceptualized as the ability to use representations in a flexible manner.

While pictures, number systems, and written language have a long tradition of use in human culture, **visual-spatial tools such as graphs and diagrams** were only devised as tools for knowledge representation about two centuries ago. Since then, space has been used to represent nonspatial information, particularly in formal domains such as science and economics. Because computers have made the construction

and modification of graphs and diagrams so easy, the frequency with which individuals encounter such representations has increased markedly over the past decades. In view of this trend, cognitive science has put a great deal of effort into researching diagrammatic literacy. Beyond the function of depicting information, however, diagrams and graphs can also serve as **active reasoning tools**. Drawing diagrams may help to integrate complex information or provide a basis upon which inferences can be drawn. It has been demonstrated that experts in domains such as science, mathematics, and formal logic make extensive use of graphs and diagrams as reasoning tools. Apart from this rather small group of people, however, the active use of visual-spatial tools is not very common, neither inside nor outside of school.

With this in mind, the ENTERPRISE project (**Enhancing Knowledge Transfer and Efficient Reasoning by Practicing Representation In Science Education**) directed by Elsbeth Stern aims to explore the conditions under which graphs and diagrams can serve as tools for structuring learning environments, and thus foster conceptual understanding in science as well as other content areas.

## The ENTERPRISE Team

Ilonca Hardy  
Elsbeth Stern

Zhu Liqi  
(until 1999)  
Catrin Rode  
(until 2000)  
Elwin Savelsbergh  
(until 1999)  
(postdoctoral fellows)

Anja Felbrich  
Susanne Koerber  
(until 2000)  
(predoctoral fellows)

### Key References

**Hardy, I.** (1999). Wie Kinder lernen: Von der Bedeutung soziokultureller Lernerfahrungen für die Denkentwicklung. *Grundschulmagazin*, 72, 4-7.

**Stern, E., Aprea, C., & Ebner, H.** (in press). Improving cross-content transfer in text processing by means of active graphical representation. *Learning and Instruction*.

**Stern, E., Hardy, I., & Koerber, S.** (in press). Die Nutzung graphisch-visueller Repräsentationsformen im Sachunterricht. In K. Spreckelsen, A. Hartinger, & K. Möller (Eds.), *Ansätze und Methoden empirischer Forschung zum Sachunterricht*. Bad Heilbrunn: Klinkhardt.

**Stern, E.** (in press). Wie abstrakt lernt das Grundschulkind? Neuere Ergebnisse der entwicklungspsychologischen Forschung. In H. Petillon (Ed.), *Handbuch Grundschulforschung: Vol. 5. Individuelles und soziales Lernen—Kindperspektive und pädagogische Konzepte*. Leverkusen: Leske + Budrich.



"One picture can be worth ten thousand words."

### The Cognitive Potential of Graphs and Diagrams

The old adage that one picture can be worth ten thousand words has been confirmed by cognitive science research. Diagrams support a large number of perceptual inferences, which are extremely easy for humans to process. They group together all related information, thus making extensive searches for elements needed in a problem-solving inference superfluous. Indeed, visualization may lead to new insights into the formal structures of a problem. We will come back to this aspect when presenting a study which shows that elementary school children can already overcome misconceptions about proportional reasoning with the help of external representations.

Diagrammatic tools not only support the emergence of **conceptual knowledge**, they also offer efficient approaches to **solving formal problems**, for example, by comparing two slopes in a linear graph to infer information about different rates of change. Cross-tabulation can also be employed as a procedure allowing the effects of more than one variable to be disentangled.

It is widely accepted that diagrammatic representations also **foster analogical transfer**. Because the constraints to be considered when drawing graphs and diagrams are the same in different domains and content areas, learners using external representations may be able to identify previously imperceptible commonalities between domains. For instance, interpreting the slope of a graph as the rate of change requires the axes to be labeled in increasing units. Core concepts from different content domains, for example, price per unit, speed, density, reproduction rate, or concentration of acid can be represented by the slope of a linear graph. Such commonalities may bridge the gaps between different content ar-

reas (Stern, Aprea, & Ebner, in press). The first results of a **collaborative study** between the ENTERPRISE group and Reinhard Demuth, Institute for Science Education at the University of Kiel (IPN), indicate that graphs can be used as transfer tools. In four 10th-grade *Realschule* classrooms in the Kiel area, the concept of equilibrium was introduced as a new topic by means of a computer animation showing the varying relations of sharks and herrings in a marine ecosystem. In two of the classrooms, the animation was supplemented by line graphs demonstrating the regular fluctuations of the two species over time. Results revealed that all four classrooms improved their understanding of the equilibrium, but that only students in the classrooms using graphs were able to transfer their knowledge about the equilibrium to economics-related contents. This promising result supports **the core assumption of the ENTERPRISE project** that the competent use of graphs and diagrams is crucial for advanced reasoning and knowledge transfer in formal content areas such as science and economics.

### Why Diagrammatic Tools are Particularly Appropriate for Stimulating Cognitive Activation in Classrooms

We assume that forms of external representation not only support individuals' cognitive functioning, but that they are particularly appropriate for classroom use. The major challenge for teachers is to orchestrate students' learning behavior by presenting problems and learning material which leave room for self-regulated activities. External representations are clearly one way of achieving this goal. From a socio-constructivist point of view, it can be postulated that external representations such as graphs will support high-quality discourse in the classroom as well as in small groups by offering stu-

dents an anchor for their reasoning processes.

Moreover, the **use of external representations** may be particularly appropriate for classrooms because the construction of graphs and diagrams leaves learners with various degrees of freedom. Depending on the learner's preferences, for example, diagrams can either be constructed in a sparse way, or they can be enriched with concrete pictures of the situation to be represented. In this respect, external representations allow **an element of freedom** and leave room for the introduction of the learner's own interests. As has been demonstrated in the BIJU study, this is otherwise quite rare. The use of diagrammatic tools may be particularly helpful in **coping with large interindividual differences in prior knowledge and general cognitive capabilities**. Each individual student can use and construct visual-spatial representations in the way that is most appropriate for his or her conceptual understanding of the given situation. Particularly if teachers offer a broad variety of diagrammatic tools, they can ensure that students are neither bored nor overtaxed.

Last but not least, the use of diagrammatic tools can also stimulate students' metacognitive activities, especially with respect to **self-monitoring**. Dealing with complex tasks requires particularly extensive planning and goal setting. Difficulties may occur because a learner does not know how to begin structuring the problem. In this case, familiarity with certain forms of external representation, such as the construction of concept maps, may help him or her to access an appropriate solution process. Moreover, by trying to map a certain concept or situation onto space, students may become aware of which particular aspects of the content area and the problem they do not yet understand. In this respect, the use of

external representations may relieve the teacher of close supervision, in that students can work independently in a meaningful way. The wider use of graphs and diagrams in classrooms may also improve students' metacognitive knowledge and learning strategies, which many studies—including TIMSS and PISA—have shown to be important.

### Current Deficits in the Use of Graphs and Diagrams Inside and Outside School

Despite the value of graphs and diagrams as tools for knowledge structuring, reasoning, and problem solving, the competent use of such tools is not as widespread as would be desirable. Several studies conducted by the ENTERPRISE group have revealed that there is room for improvement in diagrammatic competencies, not only in students of all ages, but also in their teachers.

For instance, Elwin Savelsbergh developed a training program which used vector diagrams to support secondary school students' understanding of central concepts in mechanics, for example, pivots and levers. However, it emerged that the students could not take advantage of this training program because of their weaknesses in the sphere of graphical representation. A study on the graph-based reasoning of university students reading mathematics and economics (Stern, Aprea, & Ebner, in press) showed that such deficits are not rectified after leaving school. Participants in this study answered questions on a text dealing with the break-even point. Undoubtedly, the best way to infer the necessary information from the text was to construct hand-drawn graphs. Without an obvious hint, however, very few students did so.

A study with 5th-, 7th-, and 9th-grade students from Berlin *Gymnasium* schools showed that students even have difficulty in constructing qualitative di-

**Key Reference**

**Stern, E.,** & Staub, F. (2000). Mathematik lernen und verstehen: Anforderungen an die Gestaltung des Mathematikunterrichts. In E. Inckermann, J. Kahlert, & A. Speck-Hamdan (Eds.), *Sich Lernen leisten. Grundschule vor den Herausforderungen der Wissenschaft* (pp. 90–100). Neuwied: Luchterhand.

agrams. Students were presented with short texts such as the following: "On the faraway planet of Urx, living beings are called pings. There are two kinds of pings—spotted pings and striped pings. There are also two kinds of spotted pings—laughing pings and crying pings. Among the striped pings, there are noisy ones and quiet ones. Tip is a crying ping." The best way to answer the subsequent inference question "Is Tip spotted or striped?" is by drawing a tree-diagram. However, even in 9th grade, only very few students took advantage of this form of representation although they had encountered it previously, both inside and outside of school. By varying the instruction in an experimental design, we tested whether students had diagrammatic methods at their disposal but were simply unable to access them. In fact, it emerged that students lack an understanding of the potential of diagrammatic representations. The large majority of students preferred propositional representations, although these were less appropriate for answering the questions posed at the end of the text. As shown by a **collaborative study with Zhu Liqi and Fang Ge from the Chinese Academy of Science**, however, the use of diagrams was quite natural for the majority of Beijing students of the same age. The superior performance of the Chinese students may be due to frequent practice of diagrams in mathematics lessons, as well as to indirect effects of their symbol-based writing system.

In sum, these findings suggest that *schools should provide more opportunities for students to practice graph- and diagram-based reasoning*. Teachers need to learn more about the potential of graphs and diagrams and to find ways of using them appropriately. German elementary school teachers currently lack training in ways of providing appropriate visualizations of arithmetical word

problems (Stern & Staub, 2000). Analyzing the use of representations in 8th-grade mathematics classrooms of the TIMSS-Video sample, Ilonca Hardy found that only 2.8% of introductory tasks were based on visual representations. Although representation tasks which demand a switch between symbolic systems are associated with high-quality instructional discourse, teachers rarely employ them as a basis for student activity.

#### **Experimental Training Studies on Elementary School Students' Use of External Representations**

In exploring the ways in which diagrammatic tools can best be implemented in science and mathematics instruction, the ENTERPRISE project concentrates mainly on elementary school children. Investigations of this age group provide valuable insights into human development, particularly because elementary school children's cognitive potential has long been underestimated. A widespread assumption is that students of this age group are "concrete" thinkers and this, in turn, has had a limiting effect on the design of elementary school science and mathematics curricula. This assumption has been fundamentally challenged by findings showing that elementary school children can have profound domain-specific expertise in several areas. There is good reason to assume that presenting elementary school children with more demanding learning material will better prepare them for the mathematics and science lessons in secondary schools. The extent to which elementary school children can already make use of graphs, diagrams, and other forms of external representation is investigated in experimental training studies.

**Study I: How Linear Graphs can Help 4th Graders to Overcome Mathematical Misconceptions**

In the left-hand pitcher there is a mixture of 5 glasses of orange juice and 9 glasses of lemon juice. In the right-hand pitcher there is a mixture of 8 glasses of orange juice and 12 glasses of lemon juice. Which mixture tastes more orangy or do both mixtures taste the same?

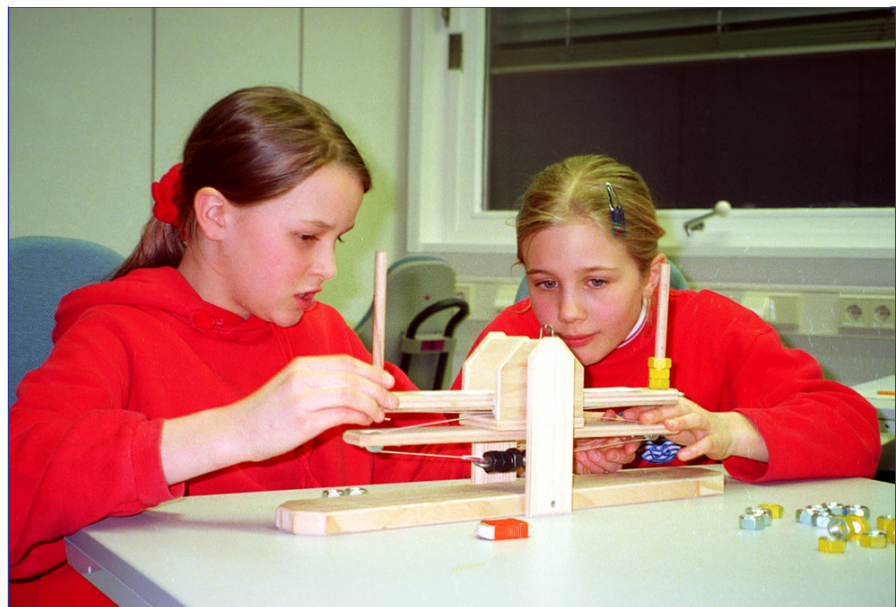
The majority of elementary school children, and even many adults, will erroneously answer that both mixtures taste "the same." The so-called additive misconception, according to which the difference between quantities rather than their ratio is considered, often prevails until students have acquired advanced competencies in using fractions and decimals.

A study with 67 4th graders (Koerber, 2000) revealed that additive misconceptions in proportional reasoning can be overcome with the help of external representations, as depicted in Figure 6. In order to fully exploit a representation and foster in-depth understanding of a quantitative concept, a meaningful integration of the symbolic understanding of the representation, on the one hand, and the quantitative understanding of the

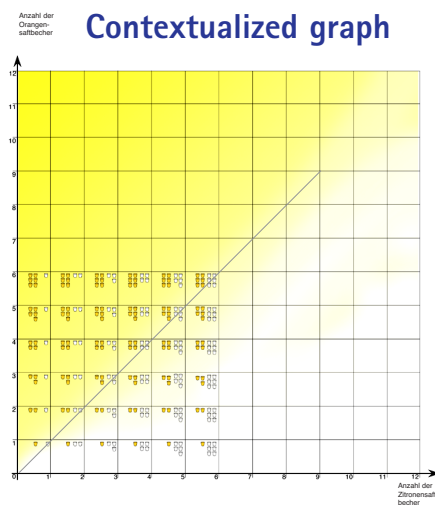
situation, on the other, has to be achieved. Different representations may meet these requirements in different ways, depending on their structural characteristics and the agents' prior experiences. One difference between forms of representation is their degree of intuitive interpretability. The functioning of the balance beam, for example, is understood comparatively easily by children. For instance, when children put different weights on each side of

Figure 6. The three forms of representation used in the training study.

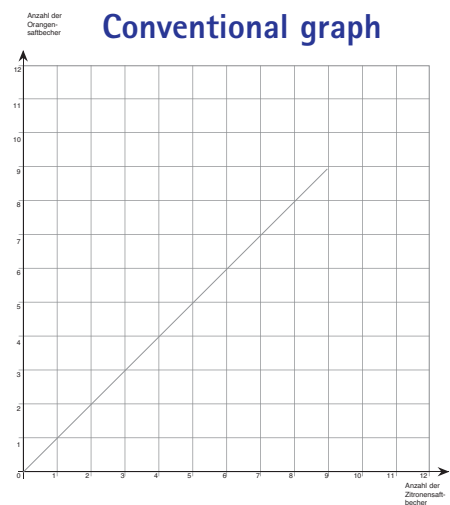
**Balance beam**



**Contextualized graph**



**Conventional graph**



## Key Reference

Koerber, S. (2000). *Der Einfluss externer Repräsentationsformen auf proportionales Denken im Grundschulalter*. Doctoral dissertation, Technische Universität Berlin.

the beam, they intuitively interpret the side going downward as bearing more weight, owing to their experience with seesaws. Moreover, external representations may differ in their degree of abstraction with respect to the quantities involved (e.g., numbers on axes vs. weights which can be put on the balance beam, both representing quantities). With increasing abstraction, a definition of the relationship between the symbols used and the quantities represented becomes ever more important for interpretation.

The **balance beam** and the **Cartesian graph** both allow the representation of quantitative information on their levers or axes, respectively, and enable the integration of two quantities forming a **ratio** to be visualized. By taking a balance beam, where balance can be maintained by changing the arm length of a movable beam, two ratios can be compared and a conclusion drawn

about which mixture tastes more orangy, for example. The same conclusion can be drawn by comparing the slopes of two graphs in a Cartesian coordinate system representing the two mixtures. Such coordinate systems can be either designed in a purely numerical way (conventional graph), or they can be adapted to include elements of the context in question (contextualized graph). In the contextualized graph, the glasses of orange and lemon juice were depicted at the respective coordinates, and the background was colored with orange of increasing intensity moving from the x-axis (number of glasses of lemon juice) to the y-axis (number of glasses of orange juice). The inclusion of these two elements was intended to foster a meaningful relation between the unfamiliar representational format of graphs and the mixture context, thus facilitating the interpretation of the graph's properties (e.g., numbers at the

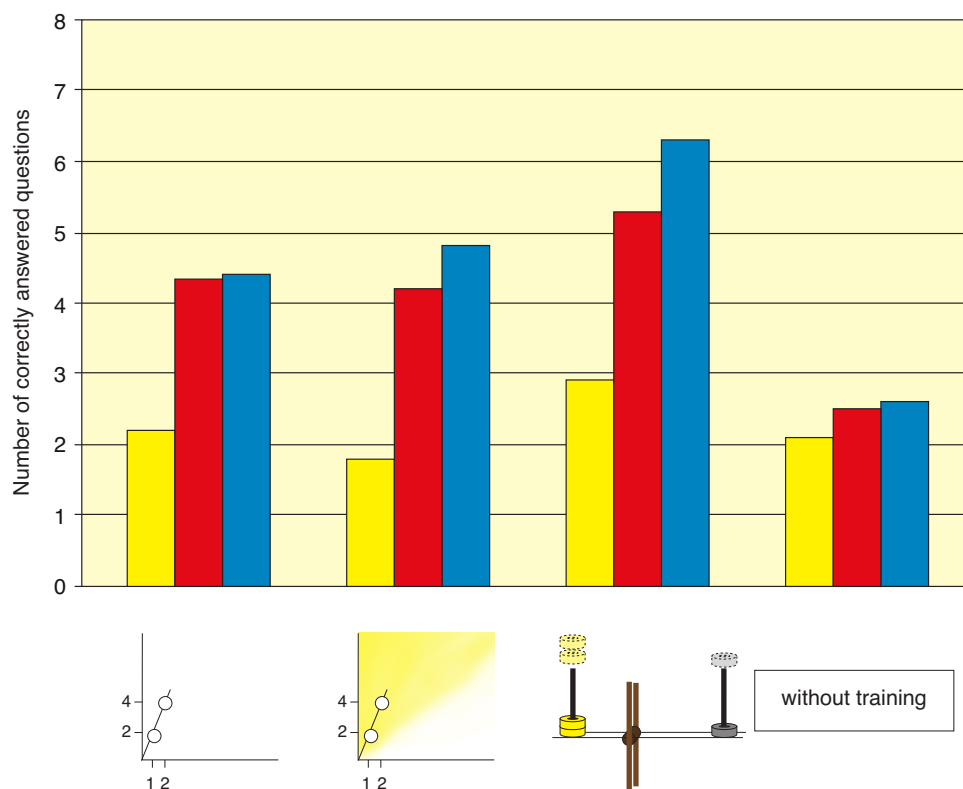


Figure 7. Mean performance of the three different training groups (abstract graph, contextualized graph, balance beam) and of a group, that did not receive any training on the proportional reasoning test (maximum score: 8 points) in the pretest (yellow column), posttest 1 (red column), and posttest 2 (blue column).

axes) and its principles (e.g., the steeper the slope, the more intense the orange taste).

The balance beam affords hands-on experience and thus the witnessing of cause-and-effect relationships. This helps children to interpret the balance beam intuitively without having been explicitly exposed to its rules. In contrast, any meaningful use of the Cartesian graph requires the knowledge and correct application of its rules (e.g., the steeper the slope, the faster or more intense the rate of change).

Tests were administered before the training (pretest), after the first half (posttest 1) and after the entire training (posttest 2). Figure 7 shows that performance in a proportional reasoning test increased under all three training conditions, but that **the group exposed to the balance beam gained the most from the training program**. Apart from this posttest evidence for the students' acquisition of proportional reasoning, student activity during the training process indicates that working with external representations leads to different degrees of insight into new mathematical concepts and different levels of conceptual change. In the balance beam condition, in particular, "eureka experiences" were observed when students used the balance to explain their reasoning. The posttest results of children who worked with the contextualized graph did not differ from those of children who worked with the conventional, rather abstract graph. The added contextualization apparently did not foster a meaningful connection between the symbols used and the proportional properties of the situation, thus resulting in proportional knowledge with a high level of situational specificity. This result qualifies the widely held view that embedding complex ideas and concepts within concrete contexts is particularly helpful for elementary school children.

In sum, results of this study are a promising indication that representations—once meaningfully related to the problem context—are not only beneficial for representing and communicating information about concepts that have already been acquired, but can be used as scaffolding tools for the **acquisition of new concepts, and thus aid conceptual change**. Combining the "natural" persuasiveness of the balance beam with the broad applicability of the abstract graph can be recommended as an instructional approach for elementary school.

### Study 2: The Value of Self-Constructed Representations for Deeper Mathematical Understanding

Assuming that conceptual understanding is supported by transforming one representation into another, the tank system depicted in Figure 8 may be particularly suitable as a way of laying the foundations for an understanding of linear graphs (Hardy, in press). By pouring water into tanks using differently sized cups, both the y-intercept and the slope of a graph can be visualized. Although some elementary school children spontaneously see the connection between the tank system and the graph, an additional representation that mediates between the concrete and the abstract representational forms may be beneficial. In a study with 68 4th graders, Hardy found that a group who represented the tank quantities in tables before interpreting Cartesian graphs were more likely to show two-dimensional understanding of Cartesian graphs than a group who represented the tank quantities in self-constructed representations. Interestingly, the level of proportional understanding, as evidenced by the students' problem-solving activities with the tank system, was higher in the group with self-constructed representations. While tables represented the

#### Key Reference

Hardy, I. (in press). Repräsentationsaktivitäten zur Förderung proportionalen und graphisch visuellen Verständnisses im Grundschulalter. In H. Petillon (Ed.), *Handbuch Grundschulforschung: Vol. 5. Individuelles und soziales Lernen—Kindperspektive und pädagogische Konzepte*. Leverkusen: Leske + Budrich.

two dimensions of number of pours and corresponding water level particularly well, thus enabling transfer to Cartesian graphs, self-constructed representations did more to further students' perceptions of mathematical relationships in the problem-solving situation.

Graphs, diagrams, tables, or other forms of external representation are culturally-developed tools which summarize the agreed-upon understanding of a mathematical community. However, they may vary in their initial degree of meaningfulness to novices. Such representations often need to be introduced by teachers, and only after a period of familiarization will students be able to use these tools in a self-determined manner for structuring their knowledge and reasoning. In contrast, self-constructed representations explicate an individual's mathematical understanding of a situation and, as such, are inherently meaningful to the constructor.

**Self-constructed and predetermined visual representations** may fulfill different purposes in students' development of proportional reasoning. This was explored in a study conducted by Ilonca Hardy with 27 12-year-old students who took part in a training session with either a predetermined form of representation or a self-constructed form. Effects of the one-hour training session were assessed by achievement gains in a proportional reasoning test closely related to the training domain, as well as by a transfer test involving a structurally dissimilar problem. In order to assess the students' ability to use visual representations in solving proportional problems, they were asked to visualize if they thought this would help their problem solving. Results showed that both groups achieved similar gains in performance after the intervention, but that the group using a predetermined form of representation was able to visualize

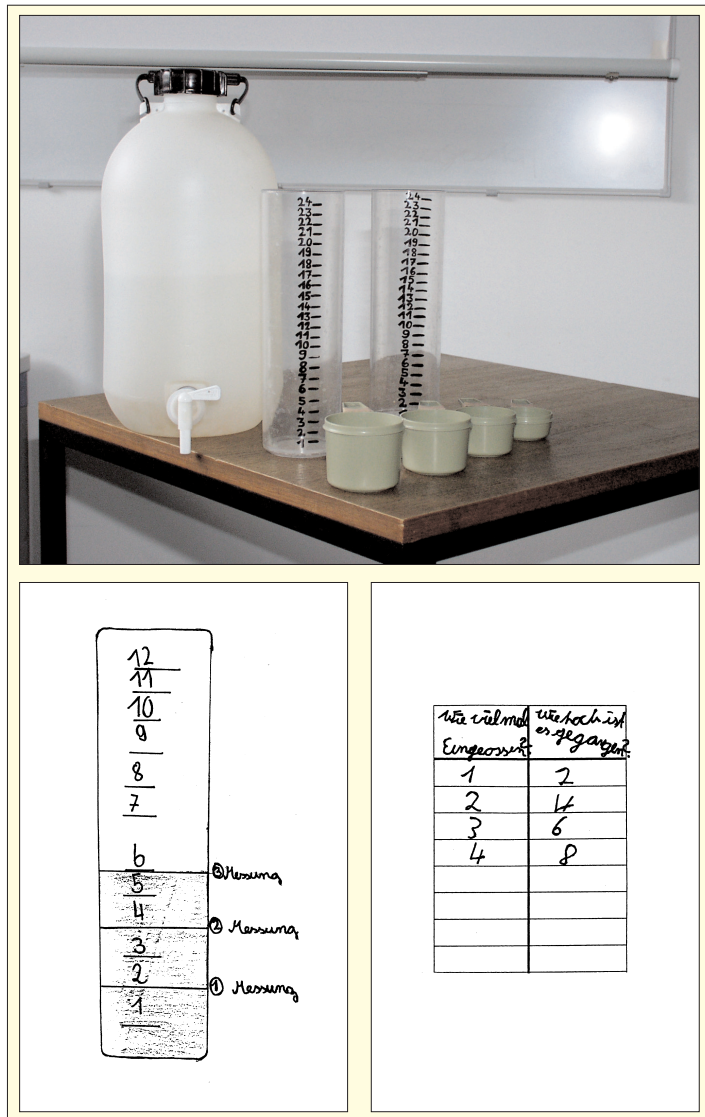


Figure 8. The tank system with differently sized cups (upper picture) and its transformation into a self-constructed representation (bottom left) and a table (bottom right).

their solutions significantly better than the group using self-constructed representations. In the transfer problem, however, the group using self-constructed representations outperformed the other group where both visualizing the problem structure and solving the problem were concerned. It seems that the process of devising a representation furthered students' perception of representations as flexible tools for problem solving, whereas instruction with a predetermined form of representation led

students to restrict the usefulness of the representation to the training domain. In further studies, we explore whether presenting students with pre-determined representations only *after* they have used self-constructed ones supports flexibility in dealing with representations.

#### Outlook on Further Research

The studies conducted thus far have shown that elementary school children are already able to map visual-spatial representations of quite demanding concepts and that this helps them to overcome misconceptions which can otherwise be quite persistent. In further experiments, we explore what kind of practice helps students best to use graphs and diagrams as tools for knowledge acquisition and transfer. Moreover, in a **collaborative project** funded by the German Science Foundation with Kornelia Möller, University of Münster, Ilonca Hardy and Elsbeth Stern are investigating how graphs can be implemented in an elementary school curriculum on "swimming and sinking."

These classroom studies are based on the assumption that graphs and diagrams can serve as instruments to structure learning environments, thus allowing a practicable mode of instruction based on constructivist views of learning.



## Research Projects of the Director Emeritus

**Experiential Learning and the Lifeworld of the School** Since the mid-century criticism of the school had focused on problems of justice and functionality, the fairness of school organization to the different social classes and on acceptable relations of outcomes to input. However, until the nineties, the basic fit between the educational system and the manpower needs of the economic system was never called into question. However problematic their relationship, in a fairweather society with an expanding economy schools continued to prepare for "life" and to guarantee the social inclusion of their graduates.

Wolfgang Edelstein

In the last decade of the century the balanced relationship between school and life was being upset. An incipient imbalance in the relation between the school and the globalizing economy would lead to the potential exclusion of a sizeable segment of young people of school leaving age. Although a vast majority, especially of the better students, was not threatened, the relative shrinkage of opportunities was bound to affect the perspectives of everyone in some way or to some extent. Increased pressure not only derives from the stiffer competition for economic and social inclusion, but from the concomitant imperatives of compliance and submission to standards, the insistence on increased speed and compression of educational careers, and even from perceived threats of a departure from conventional pathways—both for individuals and schools.

Simultaneously with the onset of globalization-related risks and setbacks the unification of Germany produced a

set of problems more specifically felt in the Eastern provinces of the country. The unitary school system of the socialist GDR had been abolished, and a system akin to the threepronged Western system introduced; the job security of the graduates which had been part of an institutional patronage system linking schools to industries and workplaces dissolved, decreasing birth rates decimated the school population, and threatened school sites and teaching positions. And in the financially demanding reconstruction of the infrastructure in the Eastern provinces the needs of a renovated school system did not top the rank. In fact there is empirical evidence for alienation and disaffection of school in large portions of the population of secondary schools in the East. It is also quite clear that the alarming increase of right-wing extremism, xenophobia, cynicism and violence among secondary school students in East Germany largely occurs among those who are alienated by the school

and dissatisfied with their teachers.

In sum, the transformation of the economy and the needs generated by German unification have produced a fiscal crisis which, combined with the political goal of a lean state have deprived schools both in the old and the new federal states of essential funds, restricted the number of available teaching positions and thus the access of younger teachers to schools, a fact leading to diminishing expectations and decreasing professional aspirations as well as increasing burnout, as the average age of the teaching force increases. On the local level, this may result in growing numbers of cancelled lessons and extra-curricular projects—with the double-edged consequence of diminished discipline and increased achievement pressure. These problems, of course, vary across the states, hitting the poorest states like Berlin or Mecklenburg-West Pommern harder than the wealthier ones.

---

On the background of this picture of widespread dysfunction it appears reasonable to not only critically evaluate the outcomes of schooling and to initiate programs of curricular innovation, but to give special attention to social psychological processes in school—the quality of teacher/student interaction and of the school as a setting for life experience and moral growth in childhood and adolescence:

**"Coalition of Self-Efficacious Schools"** (Verbund Selbstwirksamer Schulen). In the aftermath of a conference on applications of A. Bandura's theory of self-efficacy sponsored by the Jacobs Foundation in 1994, R. Brockmeyer and W. Edelstein designed a project targeting teacher self-organization and students' enhanced wellbeing and achievement in secondary schools (ages 12–18). This was an attempt to respond

to the predicament of adolescents and schools as described above. The project was submitted to the Federal Commission on Educational Research and Planning (BLK), which after yearlong negotiations accepted to sponsor the project, and appropriate funds and teacher hours for project activities. Ten German states decided to participate, with one school each. For a period of three years, schools participating in the Coalition were to receive support for their self-designed self-efficacy projects. The support consisted in a half extra position for each school, federal money for central activities and foundation funding for the support for common development activities, conferences and teacher training endeavors, as well as school-based consultancies, training and evaluation activities. This model of mixed public and private appropriations was new and opened up a window of opportunities for support of individual programs not available to previous projects. No common treatment condition was designed for the participating schools. In line with the philosophy of self-efficacy as applied to organizational behavior the project was to rely maximally on the school's own proposals and preferences negotiated between teachers and the leadership of the institution. This decision made the evaluation of the project a much more complicated affair. While assessing overall effects of the intervention, each individual school had to be evaluated, at least in part, in terms of its own program.

The program was targeted on three sets of objectives: the students, the teachers, and the school. Student change was measured through a battery of self-efficacy scales relating to learning in various subjects, satisfaction with school, learning climate in the classroom, health, anxiety and control beliefs, and a variety of other variables. Teacher measures related to several

#### Key Reference

Brockmeyer, R., & Edelstein, W. (Eds.). (1997). *Selbstwirksame Schulen. Wege pädagogischer Innovation*. Oberhausen: Verlag Karl Maria Laufen (168 p.).

burnout dimensions, professional involvement, collegial effectiveness, and individual professional efficacy, among others (Edelstein & Brockmeyer, 1997).

Change of the school as an organization was assessed by narrative accounts and day-to-day documentation of school events and decision making at various levels. An important dimension of the project was the establishment of a complementary network of schools to cooperate with each school in the Coalition, comparing and contrasting experience, and communicating through internet messages. The evaluation process is still under way, but major results show, on the average, slight progress in self-efficacy of teachers, lowered burnout scores, and, contrary to the overall trend in the corresponding population, arrested decrease in self-efficacy scores and interest in school for students with large within-school and between-school variations. On the average, scores rose significantly during the early phase of the project to remain stable or decrease somewhat in the later phase. The major effects were seen in the organizational progress of (most) schools, and important changes in attitudes towards school, school reform, and collegial cooperation among teachers.

The major weakness proved to be the following: Teachers were expected to enhance the growth of self-efficacy in students through changing their instructional strategies towards self-efficacy generating interactions and constructive individualizing feedback to students. This strategy, however, failed to produce effects as teachers rarely modified their didactic strategies and tactical moves with this goal in mind. Teachers need much more training, support, and cooperation to achieve goals involving changes in basic professional know-how and pedagogical attitude. For students to develop positive expect-

tations of success and motivation to invest effort in learning, as well as optimistic confidence in their competence to achieve, teachers need to be able to implement error friendly questioning strategies, inductive discourse, and evaluation methods that stress individual progress (e.g., portfolio methods). Quality of instruction and pedagogy consequently is the focus of the successor program "Quality in Schools and School Systems" (QuiSS) which the Federal Commission initiated to succeed the Coalition for the next five years. It has also influenced the preparation for yet another program sponsored by the Federal Commission provisionally named "Learning Democracy in Schools and Communities"—a program designed to fight the right-wing extremist youth culture to which adolescent dissatisfaction with school experience and with the lifeworld of the schools (Edelstein, 2000a, in press) appears to be a contributing factor.

It is a sign of success and of organizational self-efficacy that, when the project ended in 1999, the Coalition continued its activity even without external support, maintaining internal cooperation, conferences, and the external networks, now encompassing 60 schools. A grant has been ascertained to continue and to extend these activities for another three years, and new member schools are being recruited to join the Coalition.

Program "**Youth Take Responsibility**" (Jugend übernimmt Verantwortung) established through the Brandenburger Tor Foundation of the Berlin Bank Company.

Whereas the concept of the "self-efficacious school" targeted the social psychology of educational goals pursued to enhance student optimism and effort and to decrease teacher burnout through student-oriented instruction, communicative collegial interaction and

#### Key References

- Edelstein, W. (in press). Zur Genese des rechts-extremen Potentials in Deutschland und mögliche Antworten seitens der Schule. In C. Petry & E. Welz (Eds.), *Demokratie lernen und leben—Eine Initiative gegen Rechtsextremismus, Rassismus, Antisemitismus, Fremdenfeindlichkeit und Gewalt. Gutachten und Empfehlungen: Vol. I. Probleme—Voraussetzungen—Möglichkeiten*. Weinheim: Beltz.
- Edelstein, W. (1999). Das Stiftungsprogramm "Jugend übernimmt Verantwortung." In Stiftung Brandenburger Tor (Ed.), *Jugend übernimmt Verantwortung* (pp. 44-55). Berlin.

co-constructive organizational process, the focus of the responsibility program is both more limited and more precise: The aim is to fuse the abstract characteristics of self-efficacy beliefs with the concrete experience of responsibility for cooperative action in a circumscribed project based in a school or community. Again, the basic idea is to counteract the sense of helplessness, heteronomy and alienation affecting many students in the secondary school (especially, but not only, low-achieving students) and to activate them through a sense of achievement with a self-chosen task undertaken in cooperation with others. A project in the program represents an experience of cooperation and democratic exercise of control in the context of collective goalsetting and decision making about a common task. It implies responsibility taken for action and responsibility shared with others. It also implies didactic and management shifts that teachers have to acquire (Edelstein, 1999f).

A first expert workshop on responsibility learning was held in May 2000 (Edelstein, 2000c). A conference on the learning of responsibility in various domains (schools, ecological projects, international youth programs, reeducation of adolescent delinquents) will take place in May 2001, and a summer school for teachers on responsibility learning in projects is in preparation for July 2001.

#### Key References

- Edelstein, W. (2000). Verantwortung lernen, Verantwortung lehren, Verantwortung lehren lernen. In Stiftung Brandenburg Tor (Ed.), *Jugend übernimmt Verantwortung—Verantwortung lernen* (pp. 68–76). Berlin.
- Edelstein, W. (2000). Lernwelt und Lebenswelt. Überlegungen zur Schulreform. *Neue Sammlung*, 40, 369–382.

[www.stiftung.brandenburgertor.de](http://www.stiftung.brandenburgertor.de)

## Publications 1998–2000

Achtenhagen, F., & Baumert, J. (Eds.). (1999). Alternative Evaluationsverfahren. *Unterrichtswissenschaft, 27*, 97–191.

Arnold, E., Bos, W., Koch, M., Koller, H.-C., & Leutner-Ramme, S. (1998). Selbstbestimmt lehren lernen. Ein Konzept zur hochschuldidaktischen Qualifizierung des akademischen Mittelbaus. *Das Hochschulwesen, 46*, 147–152.

Artelt, C. (2000a). Wie prädiktiv sind retrospektive Selbstberichte über den Gebrauch von Lernstrategien für strategisches Lernen? *Zeitschrift für Pädagogische Psychologie, 14*, 72–84.  
– (2000b). *Strategisches Lernen*. Münster: Waxmann (Pädagogische Psychologie und Entwicklungspsychologie, Vol. 18.) (303 p.).



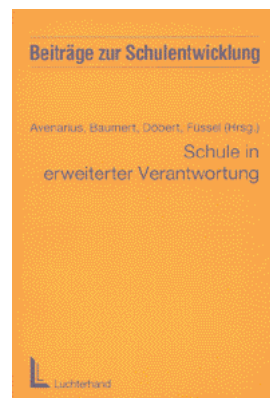
– (1999). Lernstrategien und Lernerfolg—Eine handlungsnahe Studie. *Zeitschrift für Entwicklungspsychologie und Pädagogische Psychologie, 31*, 86–96.

Artelt, C., & Stanat, P. (1999). Schülerleistungen im internationalen Vergleich: Die OECD-Studie PISA (Programme for International Student Assessment). *Erziehungswissenschaft, 10*, 8–14.

Avenarius, H., Baumert, J., Döbert, H., & Füssell, H.-P. (Eds.). (1998). *Schule in erweiterter Verantwortung: Positionsbestimmungen aus erziehungswissenschaftlicher, bildungspolitischer und verfassungsrechtlicher Sicht*. Neuwied: Luchterhand (166 p.).

Averill, J. R., Stanat, P., & More, T. (1998). Aesthetics and the environment. *Review of General Psychology, 2*, 1–22.

Baumert, J. (2000). Lebenslanges Lernen und internationale Dauerbeobachtung der Ergebnisse von institutionalisierten Bildungsprozessen. In F. Achtenhagen & W. Lempert (Eds.), *Lebenslanges Lernen im Beruf. Seine Grundlegung im Kindes- und Jugendalter: Vol. 5. Erziehungstheorie und Bildungsforschung* (pp. 121–127). Opladen: Leske + Budrich.  
– (1999a). Befunde der internationalen Leistungsvergleiche zum mathematisch-naturwissenschaftlichen Unterricht und fachdidaktische Konsequenzen. In *Weiterentwicklung des mathematisch-naturwissenschaftlichen Unterrichts* (pp. 11–20). Stuttgart: Ministerium für Kultus, Jugend und Sport.  
– (1999b). Mathematisch-naturwissenschaftliche Bildung am Ende der Schullaufbahn. In J. List (Ed.), *Mathematik, Naturwissenschaften und Technik* (pp. 64–85). Köln: Deutscher Instituts-Verlag.  
– (1999c). Die Rolle standardisierter Vergleichsuntersuchungen in einem System der Qualitätssicherung und Qualitätsentwicklung. In G. Grogger & W. Specht (Eds.), *Evaluation und Qualität im Bildungswesen* (pp. 72–79). Graz: Zentrum für Schulentwicklung, Bereich II.  
– (1998a). Fachbezogenes/fachübergreifendes Lernen/Erweiterte Lern- und Denkstrategien. *Leitung Forum 5*. In Bayerisches Staatsministerium für Unter-



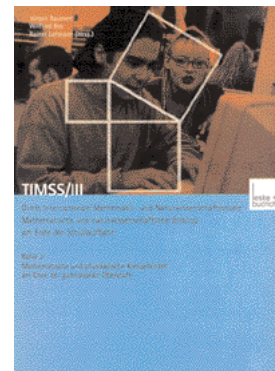
richt, Kultus, Wissenschaft und Kunst (Ed.), *Wissen und Werte für die Welt von morgen. Dokumentation zum Bildungskongreß des Bayerischen Staatsministeriums für Unterricht, Kultus, Wissenschaft und Kunst am 29./30. April 1998 in der Ludwig-Maximilians-Universität München* (pp. 213–231). München: Bayerisches Staatsministerium für Unterricht, Kultus, Wissenschaft und Kunst.  
– (1998b). Internationale Schulleistungsvergleiche. In D. H. Rost (Ed.), *Handwörterbuch Pädagogische Psychologie* (pp. 219–225). Weinheim: Beltz.  
– (1998c). Physikleistungen am Ende der Schullaufbahn im inter- und intranationalen Vergleich. In Fachverband Didaktik (Ed.), *Didaktik der Physik: Vorträge zur 62. Physikertagung 1998* (pp. 22–32). Regensburg: Deutsche Physikalische Gesellschaft.  
– (1998d). TIMSS—Mathematisch-naturwissenschaftlicher Unterricht im internationalen Vergleich. In Gewerkschaft Erziehung und Wissenschaft Nordrhein-Westfalen (Ed.), *Eintrichtern + Pauken = Mathe Mangelhaft. Ergebnisse der TIMS-Studie und Konsequenzen für den Unterricht an deutschen Schulen* (pp. 13–50). Essen: Neue deutsche Schule Verlagsgesellschaft.  
– (1998e). TIMSS—Mathematisch-naturwissenschaftlicher Unterricht im internationalen Vergleich—Anlage der Studie und ausgewählte Befunde. In J. List (Ed.), *TIMSS: Mathematisch-naturwissenschaftliche Kenntnisse deutscher Schüler auf dem Prüfstand* (pp. 13–65). Köln: Deutscher Instituts-Verlag.

Baumert, J., Artelt, C., Klieme, E., & Stanat, P. (in press). PISA (Programme for International Student Assessment)—Zielsetzung, theoretische Konzeption und Entwicklung von Messverfahren. In F. E. Weinert (Ed.), *Leistungsmessung in Schulen—Eine Zwischenbilanz*. Weinheim: Beltz.

Baumert, J., Bos, W., Klieme, E., Lehmann, R., Lehrke, M., Hosenfeld, I., Neubrand, J., & Watermann, R. (Eds.). (1999).

*Testaufgaben zu TIMSS/III. Mathematisch-naturwissenschaftliche Grundbildung und voruniversitäre Mathematik und Physik der Abschlussklassen der Sekundarstufe II (Population 3)*. Berlin: Max-Planck-Institut für Bildungsforschung (Materialien aus der Bildungsforschung, Vol. 62).

Baumert, J., Bos, W., & Lehmann, R. (Eds.). (2000a). *TIMSS/III. Dritte Internationale Mathematik- und Naturwissenschaftsstudie—Mathematische und naturwissenschaftliche Bildung am Ende der Schullaufbahn: Vol. 1. Mathematische und naturwissenschaftliche Grundbildung am Ende der Pflichtschulzeit*. Opladen: Leske + Budrich (362 p.).  
– (Eds.). (2000b). *TIMSS/III. Dritte Internationale Mathematik- und Naturwissenschaftsstudie—Mathematische und naturwissenschaftliche Bildung am Ende der Schullaufbahn: Vol. 2. Mathematische und physikalische Kompetenzen am Ende der gymnasialen Oberstufe*. Opladen: Leske + Budrich (466 p.).



– (2000c). Untersuchungsgegenstand und Fragestellungen. In J. Baumert, W. Bos, & R. Lehmann (Eds.), *TIMSS/III. Dritte Internationale Mathematik- und Naturwissenschaftsstudie—Mathematische und naturwissenschaftliche Bildung am Ende der Schullaufbahn: Vol. 1. Mathematische und naturwissenschaftliche Grundbildung am Ende der Pflichtschulzeit* (pp. 19–30). Opladen: Leske + Budrich.

- Baumert, J., Bos, W., & Watermann, R.** (2000a). Fachleistungen im voruniversitären Mathematik- und Physikunterricht im internationalen Vergleich. In J. Baumert, W. Bos, & R. Lehmann (Eds.), *TIMSS/III. Dritte Internationale Mathematik- und Naturwissenschaftsstudie—Mathematische und naturwissenschaftliche Bildung am Ende der Schullaufbahn: Vol. 2. Mathematische und physikalische Kompetenzen am Ende der gymnasialen Oberstufe* (pp. 129–180). Opladen: Leske + Budrich.
- (2000b). Mathematische und naturwissenschaftliche Grundbildung im internationalen Vergleich. In J. Baumert, W. Bos, & R. Lehmann (Eds.), *TIMSS/III. Dritte Internationale Mathematik- und Naturwissenschaftsstudie—Mathematische und naturwissenschaftliche Bildung am Ende der Schullaufbahn: Vol. 1. Mathematische und naturwissenschaftliche Grundbildung am Ende der Pflichtschulzeit* (pp. 135–197). Opladen: Leske + Budrich.
- (1998). *TIMSS/III: Schülerleistungen in Mathematik und den Naturwissenschaften am Ende der Sekundarstufe II im internationalen Vergleich. Zusammenfassung deskriptiver Ergebnisse*. Berlin: Max-Planck-Institut für Bildungsforschung (Studien und Berichte, Vol. 64).
- Baumert, J., Evans, R. H., & Geiser, H.** (1998). Technical problem solving among 10-year-old students as related to science achievement, out-of-school experience, domain-specific control beliefs, and attribution patterns. *Journal of Research in Science Teaching*, 35, 987–1013.
- Baumert, J., Fend, H., O'Neil, H. F., & Peschar, J. L.** (1998). *Prepared for life-long learning*. Paris: OECD.
- Baumert, J., Klieme, E., Lehrke, M., & Savelbergh, E. R.** (2000). Konzeption und Aussagekraft der TIMSS-Leistungstests. Zur Diskussion um TIMSS-Aufgaben aus der Mittelstufenphysik (part 1). *Die Deutsche Schule*, 92, 102–115; (part 2). *Die Deutsche Schule*, 92, 196–217.
- Baumert, J., Klieme, E., & Watermann, R.** (1998). Jenseits von Gesamttest- und Untertestwerten: Analyse differenzieller Itemfunktionen am Beispiel des mathematischen Grundbildungstests der Dritten Internationalen Mathematik- und Naturwissenschaftsstudie der IEA (TIMSS). In H.-J. Herber & F. Hofmann (Eds.), *Schulpädagogik und Lehrerbildung* (pp. 301–324). Innsbruck: Studien Verlag.
- Baumert, J., & Köller, O.** (2000a). Motivation, Fachwahlen, selbstreguliertes Lernen und Fachleistungen im Mathematik- und Physikunterricht der gymnasialen Oberstufe. In J. Baumert, W. Bos, & R. Lehmann (Eds.), *TIMSS/III. Dritte Internationale Mathematik- und Naturwissenschaftsstudie—Mathematische und naturwissenschaftliche Bildung am Ende der gymnasialen Oberstufe* (pp. 181–213). Opladen: Leske + Budrich.
- (2000b). Unterrichtsgestaltung, verständnisvolles Lernen und multiple Zielerreichung im Mathematik- und Physikunterricht der gymnasialen Oberstufe. In J. Baumert, W. Bos, & R. Lehmann (Eds.), *TIMSS/III. Dritte Internationale Mathematik- und Naturwissenschaftsstudie—Mathematische und naturwissenschaftliche Bildung am Ende der Schullaufbahn: Vol. 2. Mathematische und physikalische Kompetenzen am Ende der gymnasialen Oberstufe* (pp. 181–213). Opladen: Leske + Budrich.
- (1998a). Interest research concerning secondary level I: An overview. In L. Hoffmann, A. Krapp, K. A. Renninger, & J. Baumert (Eds.), *Interest and learning: Proceedings of the Seon Conference on Interest and Gender* (pp. 241–256). Kiel: Institut für die Pädagogik der Naturwissenschaften.
- (1998b). Nationale und internationale Schulleistungstudien: Was können sie leisten, wo sind ihre Grenzen? *Pädagogik*, 50, 12–18.
- Baumert, J., Köller, O., Lehrke, M., & Brockmann, J.** (2000a). Anlage und Durchführung der Dritten Internationalen Mathematik- und Naturwissenschaftsstudie zur Sekundarstufe II (TIMSS/III)—Technische Grundlagen. In J. Baumert, W. Bos, & R. Lehmann (Eds.), *TIMSS/III. Dritte Internationale Mathematik- und Naturwissenschaftsstudie—Mathematische und naturwissenschaftliche Bildung am Ende der Schullaufbahn: Vol. 1. Mathematische und naturwissenschaftliche Grundbildung am Ende der Pflichtschulzeit* (pp. 31–84). Opladen: Leske + Budrich.
- (2000b). Untersuchungsgegenstand, allgemeine Fragestellungen, Entwicklung der Untersuchungsinstrumente und technische Grundlagen der Studie. In J. Baumert, W. Bos, & R. Lehmann (Eds.), *TIMSS/III. Dritte Internationale Mathematik- und Naturwissenschaftsstudie—Mathematische und naturwissenschaftliche Bildung am Ende der Schullaufbahn: Vol. 2. Mathematische und physikalische Kompetenzen am Ende der gymnasialen Oberstufe* (pp. 27–56). Opladen: Leske + Budrich.
- Baumert, J., Köller, O., & Schnabel, K.** (2000). Schulformen als differentielle Entwicklungsmilieus—Eine ungehörige Fragestellung? In Gewerkschaft Erziehung und Wissenschaft GEW (Ed.), *Messung sozialer Motivation. Eine Kontroverse* (pp. 28–68). Frankfurt a.M.: Bildungs- und Förderungswerk der GEW (Schriftenreihe des Bildungs- und Förderungswerks der GEW, Vol. 14).
- Baumert, J., Lehmann, R., Lehrke, M., Clausen, M., Hosenfeld, I., Neubrand, J., Patjens, S., Jungclaus, H., & Günther, W.** (Eds.). (1998a). *Testaufgaben Mathematik TIMSS 7./8. Klasse (Population 2)*. Berlin: Max-Planck-Institut für Bildungsforschung (Materialien aus der Bildungsforschung, Vol. 60).
- (1998b). *Testaufgaben Naturwissenschaften TIMSS 7./8. Klasse (Population 2)*. Berlin: Max-Planck-Institut für Bildungsforschung (Materialien aus der Bildungsforschung, Vol. 61).
- Baumert, J., Schnabel, K., & Lehrke, M.** (1998). Learning math in school: Does interest really matter? In L. Hoffmann, A. Krapp, K. A. Renninger, & J. Baumert (Eds.), *Interest and learning: Proceedings of the Seon Conference on Interest and Gender* (pp. 327–336). Kiel: Institut für die Pädagogik der Naturwissenschaften.
- Baumert, J., & Watermann, R.** (2000). Institutionelle und regionale Variabilität und die Sicherung gemeinsamer Standards in der gymnasialen Oberstufe. In J. Baumert, W. Bos, & R. Lehmann (Eds.), *TIMSS/III. Dritte Internationale Mathematik- und Naturwissenschaftsstudie—Mathematische und naturwissenschaftliche Bildung am Ende der Schullaufbahn: Vol. 2. Mathematische und physikalische Kompetenzen am Ende der gymnasialen Oberstufe* (pp. 317–372). Opladen: Leske + Budrich.
- Bos, W., & Baumert, J.** (1999a). Internationale Schulleistungsforschung als Instrument externer Evaluation des Bildungswesens in Deutschland am Beispiel von TIMSS/III. In B. von Rosenblatt (Ed.), *Bildung in der Wissensgesellschaft* (pp. 63–92). Münster: Waxmann.
- (1999b). Möglichkeiten, Grenzen und Perspektiven internationaler Bildungsforschung: Das Beispiel TIMSS/III. *Aus Politik und Zeitgeschichte*, 49, 3–15.
- (1998a). Erste Ergebnisse der TIMSS-Studie für den oberen Sekundarbereich. *Mathematik Lehren*, 90, 56–60.
- (1998b). Fachleistungen in voruniversitärer Mathematik im internationalen Vergleich—Ergebnisse aus der TIMS-Studie für die gymnasiale Oberstufe. *Lehrerbildung und Schule*, 4, 58–69.
- Bos, W., & Köller, O.** (1998). TIMSS—Mathematics and science achievement in international comparison: Goals, design, and research questions. *Newsletter of the International Society for the Study of Behavioural Development*, 33, 1–3.
- Bos, W., & Tarnai, C.** (1999a). Content analysis in educational research. *International Journal of Educational Research*, 31, 656–734.
- (1999b). Content analysis in empirical social research. *International Journal of Educational Research*, 31, 659–671.
- (1999c). University faculty members' and students' perceptions of university academic systems. *International Journal of Educational Research*, 31, 699–715.
- Brockmann, J., Bos, W., & Gruehn, S.** (1999). Methoden- ausbildung und Berufspirationen Studierender im Diplom-

- Studiengang Erziehungswissenschaft. *Empirische Pädagogik*, 13, 333–352.
- Bullock, M., Nunner-Winkler, G., Stern, E., Lopez, A., & Ziegler, A. (in press). Using a complex rule in different domains: When familiar schemes don't help. In D. Fasko (Ed.), *Critical thinking and reasoning: Current theory, research, and practice*. Cresskill, NJ: Hampton Press.
- Chourdakis, D., & Thußbas, C. (2000). Der Aufbau inhaltsspezifischer Wissensstrukturen in der Mathematik im Rahmen analoger Problemlöseanforderungen (Abstract). In D. Vorberg, A. Fuchs, T. Futterer, A. Heinicke, U. Mattler, & U. Heinrich (Eds.), *Tagungsband zur 42. Tagung experimentell arbeitender Psychologen* (p. 187). Lengerich: Pabst.
- Clausen, M., & Meyer, T. (1999). Konfigurationsfrequenzanalyse und log-lineare Modelle als Verfahren zur Analyse von Häufigkeitstabellen. In B. Strauß, M. Kolb, & H. Haag (Eds.), *Datenanalyse in der Sportwissenschaft* (pp. 337–357). Schorndorf: Hofmann.
- Clausen, M., Möller, J., & Strauß, B. (2000). Einflüsse auf das Ankreuzverhalten bei der Self-Monitoring-Skala. In J. L. Patry (Ed.), *Situationspezifität in pädagogischen Handlungsfeldern* (pp. 81–100). Innsbruck: Studien-Verlag.
- Cohors-Fresenborg, E., & Klieme, E. (2000). Mathematik als Werkzeug zur Wissensrepräsentation—Eine Evaluationsstudie auf der Basis von TIMSS-Instrumenten. In M. Neubrand (Ed.), *Beiträge zum Mathematikunterricht 2000* (pp. 149–152). Hildesheim: Franzbecker.
- Dossey, J., Klieme, E., Csapo, B., & Vosniadou, S. (2000). *Framework for the assessment of problem solving skills in the second international PISA survey cycle*. Paris: OECD (74 p.).
- Edelstein, W. (in press-a). Gesellschaftliche Anomie und moralpädagogische Intervention: Moral im Zeitalter individueller Wirksamkeitserwartungen. In W. Edelstein, F. Oser, & P. Schuster (Eds.), *Moralische Erziehung in der Schule. Beiträge zur Entwicklungspsychologie und pädagogischen Praxis*. Weinheim: Beltz.
- (in press-b). Lernwelt und Lebenswelt. Überlegungen zur Schulreform. In W. Beutel & P. Fauser (Eds.), *Erfahrene Demokratie*. Opladen: Leske + Budrich.
- (in press-c). Mediation als sozialkognitiver Entwicklungsprozess. In Evangelische Akademie Bad Boll (Ed.), *Abgründe und Schätze der Mediation*.
- (in press-d). Verantwortlich handeln lernen. In Stiftung Brandenburger Tor (Ed.), *Jugend übernimmt Verantwortung*. Berlin: H&P Druck Berlin.
- (in press-e). Verantwortung—Initiative—Selbstwirksamkeit. Skizze eines Programms zur Förderung situierter Lernens und nachhaltiger Lernmotivation Jugendlicher. In F. Achtenhagen & W. Lempert (Eds.), *Modellversuchsprogramm "Lebenslanges Lernen"*. Opladen: Leske + Budrich.
- (in press-f). Verantwortung lernen, Verantwortung lehren, Verantwortung lehren lernen. In Stiftung Brandenburger Tor (Ed.), *Jugend übernimmt Verantwortung*. Berlin: H&P Druck Berlin.
- (in press-g). Zur Genese des rechtsextremen Potentials in Deutschland und mögliche Antworten seitens der Schule. In C. Petry & E. Welz (Eds.), *Demokratie lernen und leben—Eine Initiative gegen Rechtsextremismus, Rassismus, Antisemitismus, Fremdenfeindlichkeit und Gewalt. Gutachten und Empfehlungen: Vol. I. Probleme—Voraussetzungen—Möglichkeiten*. Weinheim: Beltz.
- (2001). Kognitive Entwicklung, Sozialisation und die Entstehung individueller Differenzen. In S. Hoppe-Graff & A. Rümmele (Eds.), *Entwicklung als Strukturgenese* (pp. 305–333). Hamburg: Dr. Kovac.
- (2000a). Lernwelt und Lebenswelt. Überlegungen zur Schulreform. *Neue Sammlung*, 40, 369–382.
- (2000b). *The responsible practice of science: Remarks about cross-pressures of scientific progress and the ethics of research*. Max Planck Forum 2 (Ethos der Forschung) (pp. 169–180). München: Max-Planck-Gesellschaft.
- (2000c). Verantwortung lernen, Verantwortung lehren, Verantwortung lehren lernen. In Stiftung Brandenburger Tor (Ed.), *Jugend übernimmt Verantwortung* (pp. 68–76). Berlin.
- (1999a). Aus Fehlern wird man klug. Zur Ontologie der Fehlertypen. In W. Althof (Ed.), *Fehlerwelten. Vom Fehlermachen und Lernen aus Fehlern* (pp. 111–127). Opladen: Leske + Budrich.
- (1999b). Bedingungen erfolgreicher Schultransformation. In E. Risse & H.-J. Schmidt (Eds.), *Von der Bildungsplanung zur Schulentwicklung* (pp. 119–132). Neuwied: Luchterhand.
- (1999c). The cognitive context of historical change: Assimilation, accommodation, and the segmentation of competence. *New Directions for Child and Adolescent Development*, 83, 5–17.
- (1999d). Notizen zur Funktion von Gleichheit und Gerechtigkeit im Bildungssystem. In Heinrich-Böll-Stiftung (Ed.), *Bildung: Brücken in die Zukunft* (pp. 197–200). Berlin: Heinrich-Böll-Stiftung.
- (1999e). Soziale Selektion, Sozialisation und individuelle Entwicklung. 10 Thesen zur sozialkonstruktivistischen Rekonstruktion der Sozialisationsforschung. In M. Grundmann (Ed.), *Konstruktivistische Sozialisationsforschung* (pp. 35–79). Frankfurt a.M.: Suhrkamp.
- (1999f). Das Stiftungsprogramm "Jugend übernimmt Verantwortung." In Stiftung Brandenburger Tor (Ed.), *Jugend übernimmt Verantwortung* (pp. 44–55). Berlin.
- (1999g). Der Wettbewerb "Jugend übernimmt Verantwortung." Bericht über Ergebnisse des Wettbewerbs. In Stiftung Brandenburger Tor (Ed.), *Jugend übernimmt Verantwortung* (pp. 6–9). Berlin.
- (1998a). Selbstwirksamkeit im Kontext der Schulreform. *Pädagogische Führung*, 9, 56–59.
- (1998b). Selbstwirksamkeit in der Schulreform. *Unterrichtswissenschaft*, 26, 100–106.
- Edelstein, W., Grundmann, M., & Mies, A. (1999). The development of internal vs. external control beliefs in developmentally relevant contexts of children's and adolescents' life-worlds. In W. J. Perrig & A. Grob (Eds.), *Control of human behaviour, mental processes and consciousness* (pp. 377–390). Mahwah, NJ: Erlbaum.
- Edelstein, W., & Nunner-Winkler, G. (Eds.). (2000). *Moral im sozialen Kontext*. Frankfurt a.M.: Suhrkamp (506 p.).
- 
- Edelstein, W., Oser, F., & Schuster, P. (Eds.). (in press). *Moralische Erziehung in der Schule. Beiträge zur Entwicklungspsychologie und pädagogischen Praxis*. Weinheim: Beltz.
- Edelstein, W., & Schröder, E. (2001). The impact of social structure on development: An analysis of individual differences in cognition. In A. Tryphon & J. Vonèche (Eds.), *Working with Piaget: Essays in honour of Bärbel Inhelder* (pp. 85–101). Hove, UK: Psychology Press Ltd.
- (2000). Full house or Pandora's box? The treatment of variability in post-Piagetian research. *Child Development*, 71, 840–842.
- Fischer, K., & Thußbas, C. (2000a). Die Wirkung humoristisch-episodischer Elemente in der Fernsehwerbung. Eine experimentelle Studie (Abstract). In E. Schröder, A. Mecklinger, & A. Widmann (Eds.), *Beiträge zur 41. Tagung experimentell arbeitender Psychologen* (p. 382). Lengerich: Pabst.
- (2000b). Die Wirkung humoristisch-episodischer Elemente in der Fernsehwerbung. Eine experimentelle Studie. *Medienpsychologie*, 1, 51–68.
- Gonzalez, E. J., Smith, T. A., Sibberson, H., Schwippert, K., et al. (1998). *User guide for the TIMSS International database. Final year of secondary school*. Chestnut Hill, MA: Boston College.
- Gruehn, S. (2000). *Unterricht und schulisches Lernen: Schüler als Quellen der Unterrichtsbe-*

schreibung. Münster: Waxmann (252 p.).

**Gruehn, S., & Schnabel, K.** (in press). Schulleistungen im moralisch-evaluativen Lernbereich: Das Beispiel Lebensgestaltung-Ethik-Religionskunde (LER) in Brandenburg. In F. E. Weinert (Ed.), *Leistungsmessung in Schulen*. Weinheim: Beltz.

Grundmann, M., Binder, T., **Edelstein, W.**, & Krettenauer, T. (1998a). Soziale Krisenerfahrung und die Wahrnehmung sozialer Anomie bei Ost- und Westberliner Jugendlichen: Ergebnisse einer Kohorten- und Längsschnittanalyse. In M. Grundmann et al. (Eds.), *Sozialisation und Entwicklung in den neuen Bundesländern* (pp. 171–198). Weinheim: Juventa.  
 – (1998b). Soziale Krisenerfahrung und die Wahrnehmung sozialer Anomie bei Ost- und Westberliner Jugendlichen: Ergebnisse einer Kohorten- und Längsschnittanalyse. *Zeitschrift für Soziologie der Erziehung und Sozialisation*, 71–187 (2. Beiheft).

Haag, L., & **Stern, E.** (2000a). Lateinunterricht auf dem Prüfstand. *Altsprachlicher Unterricht*, 4–5, 86–89.  
 – (2000b). Non scholae sed vitae discimus? Auf der Suche nach globalen und spezifischen Transfereffekten des Lateinunterrichts. *Zeitschrift für Pädagogische Psychologie*, 14, 146–157.

**Händle, C.** (in press-a). Anspruchsvolle Schulprojekte zur politischen Bildung. *Neue Sammlung*.  
 – (in press-b). Formelle und informelle Qualifizierung für den Lehrberuf. Die doppelte Sozialisation von Lehrpersonen. In U. Kolbe, B. Koch-Priebe, & J. Wildt (Eds.), *Didaktik der Bildung von Lehrerinnen und Lehrern*. Opladen: Leske + Budrich.  
 – (in press-c). Lehrerinnen im Transformationsprozess. In W. Keim & C. Uhlig (Eds.), *Kritik der Transformation*. Frankfurt a.M.: Lang (Jahrbuch der Pädagogik, Vol. 10).  
 – (in press-d). Mehr Schulqualität durch neue Formen der Steuerung? In D. Hoffmann (Ed.), *Ökonomisierung der Bildung*. Weinheim: Deutscher Studien Verlag.

– (in press-e). Schulpartnerschaften als zusätzliche Aufgaben von Schulen. *Die lernende Schule*.

– (in press-f). Stabilisierung oder Veränderung des traditionellen Geschlechterverhältnisses im Bildungssystem der BRD. In B. Geißel & B. Seemann (Eds.), *Neue Bildungspolitik—zwischen Risiko und Chance für Frauen*. Opladen: Leske + Budrich.

– (in press-g). Weiterbildung der DSE für Erziehungswissenschaftlerinnen aus Ostafrika. Ein integrierter Ansatz zur Vermittlung qualitativer Methoden der Bildungsforschung. *Zeitschrift für internationale Bildungsforschung und Entwicklungspädagogik (ZEP)*.

– (2000a). Lehrerinnen als Expertinnen für Schulentwicklung. In C. Grohn-Menard & C. Gronenberg (Eds.), *Raum für Veränderung* (pp. 153–159). Bielefeld: Kleine Verlag (Wissenschaftliche Reihe, Vol. 128).

– (2000b). Professionelle und zusätzliche Qualifizierung von Lehrpersonen. In M. Schmerr (Ed.), *Erfahrungen nutzen—für Schulen von morgen* (pp. 106–115). Pfungstadt: Spitzer.

– (2000c). Restauration und Reform im Bildungssystem der neuen Bundesländer nach der Wende. In K. Neumann & R. Uhle (Eds.), *Pädagogik zwischen Reform und Restauration* (pp. 161–174). Weinheim: Deutscher Studien Verlag.

– (2000d). Voneinander lernen? Grundschullehrerinnen in den Neubundesländern. *Grundschule*, 33, 16–18.

– (2000e). Zur Diskussion politischer Bildung in der BRD am Ende des 20. Jahrhunderts. In M. Schmerr (Ed.), *Erfahrungen nutzen—für Schulen von morgen* (pp. 82–91). Pfungstadt: Spitzer.

– (1999a). Civic Education. Politische Bildung—Bildungsbiographien. In D. Hoffmann (Ed.), *Rekonstruktion und Restitution des Bildungsbegriffs* (pp. 267–285). Weinheim: Deutscher Studien Verlag.

– (1999b). "Do respect everyone's body and feelings." Eine Schulkultur sozialer Integration. In I. Kunze (Ed.), *Schulen in drei Ländern. Portraits aus didaktischer Perspektive* (pp. 95–120). Weinheim: Deutscher Studien Verlag.

– (1999c). Politische Bildung in ausgewählten Projektdokumentationen. Eine Untersuchung der

Einsendungen zum Förderprogramm Demokratisch Handeln 1995. In C. Händle, D. Oesterreich, & L. Trommer, *Aufgaben politischer Bildung in der Sekundarstufe I* (pp. 209–248). Opladen: Leske + Budrich.

– (1999d). Politische Bildung in der Schule. In C. Händle, D. Oesterreich, & L. Trommer, *Aufgaben politischer Bildung in der Sekundarstufe I* (pp. 13–67). Opladen: Leske + Budrich.

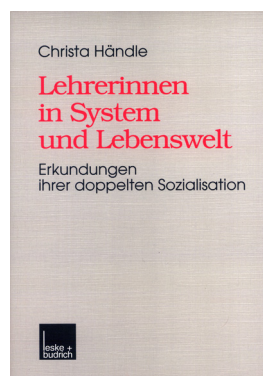
– (1999e). Restoring traditional gender relations in the process of German unification. In B. Brock-Utne et al. (Eds.), *Globalisation on whose terms?* (pp. 125–137). Oslo.

– (1998a). Globale, regionale und lokale Orientierung in Schulprojekten zur politischen Bildung. In F. E. Anhelm & W. Wortmann (Eds.), *Globalisierung am Horizont politischen Lernens* (136–146). Loccum: Loccumer Protokolle 53/97.

– (1998b). Der interdisziplinäre Ansatz in der Bildungsforschung. In D. Hoffmann & K. Neumann (Eds.), *Die gegenwärtige Struktur in der Erziehungswissenschaft* (pp. 55–64). Weinheim: Deutscher Studien Verlag.

– (1998c). Kritik der Dominanzbeziehung zwischen Ost und West. In M. von Lutzau (Ed.), *Frauen Kreativität Macht Schule* (pp. 99–106). Weinheim: Deutscher Studien Verlag.

– (1998d). *Lehrerinnen in System und Lebenswelt. Erkundungen ihrer doppelten Sozialisation*. Opladen: Leske + Budrich (336 p.).

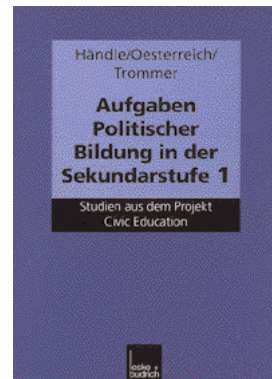


– (1998e). Ein Wechselbalg aus Velten. Die Deutsche Lehrerzeitung mit neuem Gesicht? *Erziehung und Wissenschaft*, 50, p. 36.

**Händle, C., Nitsch, W., & Uhlig, C.** (1998). *LehrerInnen und Er-*

*ziehungswissenschaftlerInnen im Transformationsprozess*. Weinheim: Deutscher Studien Verlag.

**Händle, C., Oesterreich, D., & Trommer, L.** (1999a). *Aufgaben politischer Bildung in der Sekundarstufe I*. Opladen: Leske + Budrich (281 p.).



– (1999b). Concepts of civic education in Germany based on a survey of expert opinion. In J. Torney-Purta, J. Schwille, & J.-A. Amadeo (Eds.), *Civic education across countries: Twenty-four case studies from the IEA civic education project* (pp. 257–284). Amsterdam: International Association for the Evaluation of Educational Achievement and Ebron Press.

– (1998). Eine Studie zur politischen Bildung in der Sekundarstufe I im Rahmen der IEA. *DVPB aktuell*, 2, 29–31.

**Hardy, I.** (in press). Repräsentationsaktivitäten zur Förderung proportionalen und graphisch visuellen Verständnisses im Grundschulalter. In H. Petillon (Ed.), *Handbuch Grundschulforschung: Vol. 5. Individuelles und soziales Lernen—Kindperspektive und pädagogische Konzepte*. Leverkusen: Leske + Budrich.

– (2000). Die Beziehung zwischen Konversation und Kontext im Fremdsprachenunterricht. In D. Leutner & R. Brünken (Eds.), *Neue Medien in Unterricht, Aus- und Weiterbildung* (pp. 75–84). Münster: Waxmann.

– (1999). Wie Kinder lernen: Von der Bedeutung soziokultureller Lernerfahrungen für die Denkentwicklung. *Grundschulmagazin*, 72, 4–7.

**Hart, D., Keller, M., Edelstein, W., & Hofmann, V.** (1998).



- Childhood personality influences on social-cognitive development: A longitudinal study. *Journal of Personality and Social Psychology*, 74, 1278–1289.
- Hoffmann, L., Krapp, A., Renninger, K. A., & Baumert, J. (Eds.). (1998). *Interest and learning: Proceedings of the Seon Conference on Interest and Gender*. Kiel: Institut für die Pädagogik der Naturwissenschaften.
- Hosenfeld, I., & Höft, S. (1999). Robustheit statistischer Testverfahren. In B. Strauß, H. Haag, & M. Kolb (Eds.), *Datenanalyse in der Sportwissenschaft* (pp. 359–375). Schorndorf: Hofmann.
- Hosenfeld, I., Köller, O., & Baumert, J. (1999). Why sex differences in mathematics achievement disappear in German secondary schools: A reanalysis of the German TIMSS-data. *Studies in Educational Evaluation*, 25, 143–161.
- Keller, M., & Edelstein, W. (1999). Le développement du raisonnement sociomoral dans un contexte interculturel. In J.-L. Beauvois, N. Dubois, & W. Doise (Eds.), *La construction sociale de la personne* (pp. 43–46). Grenoble: Presses Universitaires de Grenoble.
- Keller, M., Edelstein, W., Schmid, C., Fang, F., & Fang, G. (1998). Reasoning about responsibilities and obligations in close relationships: A comparison across two cultures. *Developmental Psychology*, 34, 731–741.
- Klieme, E. (2000). Fachleistungen im voruniversitären Mathematik- und Physikunterricht: Theoretische Grundlagen, Kompetenzstufen und Unterrichtsschwerpunkte. In J. Baumert, W. Bos, & R. Lehmann (Eds.), *TIMSS/III. Dritte Internationale Mathematik- und Naturwissenschaftsstudie—Mathematische und naturwissenschaftliche Bildung am Ende der Schullaufbahn: Vol. 2. Mathematische und physikalische Kompetenzen am Ende der gymnasialen Oberstufe* (pp. 57–72). Opladen: Leske + Budrich.
- (1999). Evaluation report. In E. Klieme, E. Lucius, & E. Zabel, *Report on the 9th International Biology Olympiad* (pp. 29–77). Kiel: Institut für die Pädagogik der Naturwissenschaften.
- Klieme, E., Artelt, C., & Stanat, P. (in press). Fächerübergreifende Kompetenzen: Konzepte und Indikatoren überfachlicher Bildung. In F. E. Weinert (Ed.), *Leistungsmessungen in Schulen*. Weinheim: Beltz.
- Klieme, E., Baumert, J., Köller, O., & Bos, W. (2000). Mathematische und naturwissenschaftliche Grundbildung: Konzeptionelle Grundlagen und die Erfassung und Skalierung von Kompetenzen. In J. Baumert, W. Bos, & R. Lehmann (Eds.), *TIMSS/III. Dritte Internationale Mathematik- und Naturwissenschaftsstudie—Mathematische und naturwissenschaftliche Bildung am Ende der Schullaufbahn: Vol. 1. Mathematische und naturwissenschaftliche Grundbildung am Ende der Pflichtschulzeit* (pp. 85–133). Opladen: Leske + Budrich.
- Klieme, E., Baumert, J., & Schwippert, K. (2000). Schulbezogene Evaluation und Schul Leistungsvergleiche. Eine Studie im Anschluss an TIMSS. In H. G. Rolff, W. Bos, K. Klemm, H. Pfeiffer, & R. Schulz-Zander (Eds.), *Jahrbuch der Schulentwicklung* (Vol. 11, pp. 387–438). München: Juventa.
- Klieme, E., & Bos, W. (2000). Mathematikleistungen und mathematischer Unterricht in Deutschland und Japan. Triangulation qualitativer und quantitativer Forschungsansätze im Rahmen der TIMS-Studie. *Zeitschrift für Erziehungswissenschaft*, 3, 359–379.
- Klieme, E., Ebach, J., Funke, J., & Reeff, J.-P. (in press). *Analytical problem solving in real world contexts. Assessment framework for the International Adult Literacy and Life Skills Survey*. Ottawa: Statistics Canada, and Washington, DC: National Center of Education Statistics.
- Klieme, E., Funke, J., Leutner, D., Reimann, P., & Wirth, J. (in press). Problemlösen als fächerübergreifende Kompetenz. Konzeption und erste Resultate aus einer Schulleistungsstudie. *Zeitschrift für Pädagogik*.
- Klieme, E., Knoll, S., & Schümer, G. (1999). *Mathematikunterricht der Sekundarstufe I in Deutschland, Japan und den USA. CD-Rom-Dokumentation der TIMSS-Videostudie*. Berlin: Max-Planck-Institut für Bildungsforschung und Stuttgart: Klett.
- Klieme, E., Köller, O., & Stanat, P. (in press). TIMSS und PISA: Von der Untersuchung fachlichen Lernens zur Analyse allgemeiner Kompetenzentwicklung. *Journal für Schulentwicklung*.
- Klieme, E., & Nauels, H. (1999). Die Qualität medizinischer Prüfungen aus der Sicht der Psychodiagnostik. In U. Fuchs (Ed.), *Qualität der Lehre* (pp. 276–281). Münster: Lit-Verlag.
- Klieme, E., & Thußbas, C. (in press). Kontextbedingungen und Verständigungsprozesse im Geometrieunterricht. Eine Fallstudie. In S. von Aufschnaiter & M. Welzel (Eds.), *Nutzung von Videodaten zur Untersuchung von Lehr-Lernprozessen*. Münster: Waxmann.
- Knoll, S. (1998). Anforderungsgestaltung im Mathematikunterricht. *Mathematik lehren*, 90, 47–51.
- Knoll, S., & Stigler, J. W. (1999). Management and analysis of large-scale video surveys using the software vPrism TM. *International Journal of Educational Research*, 31, 725–734.
- Koerber, S. (2000). *Der Einfluss externer Repräsentationsformen auf proportionales Denken im Grundschulalter*. Doctoral dissertation, Technische Universität Berlin.
- Köhler, H. (in press-a). Ausgewählte Probleme der Realisierung der achtjährigen Grundschule in der SBZ/DDR. In P. Drewek & A. Huschner (Eds.), *Historische Eigendynamik und politische Transformation der Schule im 20. Jahrhundert. Regionale Schulentwicklung in Berlin und Brandenburg 1890–1990*. Weinheim: Bibliothek für Bildungsforschung, Studien Verlag.
- (in press-b). Zensur, Leistung und Schulerfolg in den Schulen der DDR. *Zeitschrift für Pädagogik*.
- (1999). *Was die Schulstatistik der SBZ/DDR erfragte. Analyse und Dokumentation des Erhebungsprogramms 1945–1989*. Berlin: Max-Planck-Institut für Bildungsforschung (Studien und Berichte, Vol. 67).
- Köhler, H., & Baumert, J. (1998). Bildung in Schleswig-Holstein. In J. Petersen & G.-B. Reinert (Eds.), *Bildung in Deutschland* (Vol. 3, pp. 336–381). Donauwörth: Auer.
- Köhler, H., & Schulze, E. (in press). *Bildungsstatistische Ergebnisse der Volkszählungen in der DDR 1950 bis 1981. Dokumentation und ausgewählte Analysen*. Berlin: Max-Planck-Institut für Bildungsforschung.
- Köller, O. (in press-a). High school dropout. In N. J. Smelser & P. B. Baltes (Eds.), *International encyclopedia of the social and behavioral sciences*. Oxford, UK: Elsevier Science.
- (in press-b). Mathematical world views and achievement in advanced mathematics: Findings from the TIMSS population III. *Studies in Educational Evaluation*.
- (2000a). Goal orientations: Their impact on academic learning and their development during early adolescence. In J. Heckhausen (Ed.), *Motivational psychology of human development: Developing motivation and motivating development* (pp. 129–142). Oxford, UK: Elsevier.
- (2000b). Soziale Vergleichsprozesse im Kursystem der gymnasialen Oberstufe. In J. Baumert, W. Bos, & R. Lehmann (Eds.), *TIMSS/III. Dritte Internationale Mathematik- und Naturwissenschaftsstudie—Mathematische und naturwissenschaftliche Bildung am Ende der Schullaufbahn: Vol. 2. Mathematische und physikalische Kompetenzen am Ende der gymnasialen Oberstufe* (pp. 215–228). Opladen: Leske + Budrich.
- (1998a). Different aspects of learning motivation: The impact of interest and goal orientation on scholastic learning. In L. Hoffmann, A. Krapp, K. A. Renninger, & J. Baumert (Eds.), *Interest and learning: Proceedings of the Seon Conference on Interest and Gender* (pp. 317–326). Kiel: Institut für die Pädagogik der Naturwissenschaften.
- (1998b). *Zielorientierungen und schulisches Lernen*. Münster: Waxmann.



- Köller, O., & Baumert, J.** (in press). Leistungsgruppierungen in der Sekundarstufe I und ihre Konsequenzen für die Mathematikleistung und das mathematische Selbstkonzept der Begabung. *Zeitschrift für Pädagogische Psychologie*.
- (1998). Ein deutsches Instrument zur Erfassung von Zielorientierungen bei Schülerinnen und Schülern. *Diagnostica*, 44, 173–181.
- Köller, O., Baumert, J., Clausen, M., & Hosenfeld, I.** (1999). Predicting mathematics achievement of eighth grade students in Germany: An application of parts of the model of educational productivity to the TIMSS data. *Educational Research and Evaluation*, 5, 180–194.
- Köller, O., Baumert, J., & Neubrand, J.** (2000). Epistemologische Überzeugungen und Fachverständnis im Mathematik- und Physikunterricht. In J. Baumert, W. Bos, & R. Lehmann (Eds.), *TIMSS/III. Dritte Internationale Mathematik- und Naturwissenschaftsstudie—Mathematische und naturwissenschaftliche Bildung am Ende der Schullaufbahn: Vol. 2. Mathematische und physikalische Kompetenzen am Ende der gymnasialen Oberstufe* (pp. 229–269). Opladen: Leske + Budrich.
- Köller, O., Baumert, J., & Rost, J.** (1998). Zielorientierungen: Ihr typologischer Charakter und ihre Entwicklung im Jugendalter. *Zeitschrift für Entwicklungspsychologie und Pädagogische Psychologie*, 30, 128–138.
- Köller, O., Baumert, J., & Schnabel, K.** (2000). Zum Zusammenspiel von schulischem Interesse und Lernen im Fach Mathematik. Längsschnittanaly-

sen in den Sekundarstufen I und II. In U. Schiefele & K. Wild (Eds.), *Interesse und Lernmotivation—Untersuchungen zu Entwicklung, Förderung und Wirkung* (pp. 163–183). Münster: Waxmann.

– (1999). Wege zur Hochschulreife: Offenheit des Systems und Sicherung vergleichbarer Standards. Analysen am Beispiel der Mathematikleistungen von Oberstufenschülern an integrierten Gesamtschulen und Gymnasien in Nordrhein-Westfalen. *Zeitschrift für Erziehungswissenschaft*, 2, 370–405.

- Köller, O., & Bos, W.** (1998). TIMSS–Germany: Design, instruments, and research questions. *Newsletter of the International Society for the Study of Behavioral Development*, 33, 6–7.
- Köller, O., Daniels, Z., Schnabel, K., & Baumert, J.** (2000). Kurswahlen von Mädchen und Jungen im Fach Mathematik: Zur Rolle des fachspezifischen Selbstkonzepts und Interesses. *Zeitschrift für Pädagogische Psychologie*, 14, 26–37.
- Köller, O., & Gehrke, J.** (1999). Multiple Regressionsanalyse. In B. Strauß, H. Haag, & M. Kolb (Eds.), *Datenanalyse in der Sportwissenschaft* (pp. 377–398). Schorndorf: Hofmann.
- Köller, O., & Hosenfeld, I.** (1999). Kausalitätsüberzeugungen, Selbstwirksamkeitsüberzeugungen und Schulleistungen. In B. Hannover, U. Kittler, & H. Metz-Göckel (Eds.), *Sozialkognitive Aspekte der Pädagogischen Psychologie—Dokumentation des 3. Dortmunder Symposiums für Pädagogische Psychologie 1998* (Vol. 1, pp. 140–151). Essen: Die blaue Eule.

**Köller, O., Klemmert, H., Möller, H., & Baumert, J.** (1999). Leistungsbeurteilungen und Fähigkeitsselbstkonzepte. Eine längsschnittliche Überprüfung des Modells des Internal/External Frame of Reference. *Zeitschrift für Pädagogische Psychologie*, 13, 128–134.

**Köller, O., & Klieme, E.** (2000). Geschlechtsdifferenzen in den mathematisch-naturwissenschaftlichen Leistungen. In J. Baumert, W. Bos, & R. Lehmann (Eds.), *TIMSS/III. Dritte Internationale Mathematik- und Natur-*

*wissenschaftsstudie—Mathematische und naturwissenschaftliche Bildung am Ende der Schullaufbahn: Vol. 2. Mathematische und physikalische Kompetenzen am Ende der gymnasialen Oberstufe* (pp. 373–404). Opladen: Leske + Budrich.

**Köller, O., Klieme, E., & Stern, E.** (1999). *Der Forschungsbezug Erziehungswissenschaft und Bildungssysteme am Max-Planck-Institut für Bildungsforschung*. Newsletter der Fachgruppe Pädagogische Psychologie 1.

**Köller, O., & Möller, J.** (in press). Selbstbezogene Fähigkeitskognitionen im Kontext Schule: Die Rolle unterschiedlicher Referenzrahmen. In R. K. Silbereisen (Ed.), *Bericht über den 42. Kongreß der Deutschen Gesellschaft für Psychologie in Jena 2000*.

– (1998). Kontrafaktisches Denken. In D. H. Rost (Ed.), *Handwörterbuch Pädagogische Psychologie* (pp. 259–262). Weinheim: Beltz/Psychologie Verlags Union.

**Köller, O., & Schiefele, U.** (1998). Zielorientierungen. In D. H. Rost (Ed.), *Handwörterbuch Pädagogische Psychologie* (pp. 585–588). Weinheim: Beltz/Psychologie Verlags Union.

**Köller, O., Schnabel, K., & Baumert, J.** (in press). Does interest matter? The relationship between academic interest and achievement in mathematics. *Journal for Research in Mathematics Education*.

– (2000). Der Einfluß der Leistungsstärke von Schulen auf das fachspezifische Selbstkonzept der Begabung und das Interesse. *Zeitschrift für Entwicklungspsychologie und Pädagogische Psychologie*, 32, 70–80.

**Köller, O., & Schümer, G.** (1998). Why did Japanese students do so well in TIMSS? Results from the TIMSS Videotape Study and information about the educational system in Japan. *Newsletter of the International Society for the Study of Behavioral Development*, 33, 7–8.

**Koerber, S.** (in press). Helfen visuelle Repräsentationen beim Denken? In H. G. Roßbach, K. Czerwenka, & K. Nölle (Eds.), *Jahrbuch Grundschulforschung*.

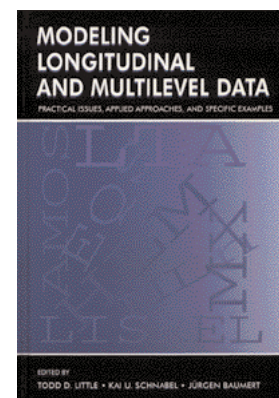
*Forschungen zu Lehr- und Lernkonzepten für die Grundschule*.

**Krettenauer, T., & Edelstein, W.** (1999). From substages to moral types and beyond: An analysis of core criteria for morally autonomous judgements. *International Journal of Behavioral Development*, 23, 899–920.

**Kuptsch, C., Kleinmann, M., & Köller, O.** (1998). The chameleon effect in assessment centers: The influence of interindividual consistency on the construct validity of assessment centers. *Journal of Social Behavior and Personality*, 13, 103–116.

**Lee, V. E., Smerdon, B., Alfeld-Liro, C., & Brown, S.** (2000). Inside large and small high schools: Curriculum and social relations. *Educational Evaluation and Policy Analysis*, 22, 147–171.

**Little, T. D., Schnabel, K., & Baumert, J.** (Eds.). (2000). *Modeling longitudinal and multilevel data. Practical issues, applied approaches, and specific examples*. Mahwah, NJ: Erlbaum (297 p.).



**Marsh, H. W., Köller, O., & Baumert, J.** (in press). Reunification of East and West German school systems: Longitudinal multilevel modeling study of the big-fish-little-pond effect on academic self-concept. *American Educational Research Journal*.

**Mauch, M., & Thußbas, C.** (in press). Geschlechtsrollenschema und Computereinstellung: Ist das feminine Geschlechtsrollenschema Ursache der Computerdistanz von Frauen? *Zeitschrift für Frauenforschung*, 3.

Meiser, T., Stern, E., & Langeheine, R. (1999). Latent change in discrete data: Unidimensional, multidimensional, and mixture distribution Rasch models for the analysis of repeated observations. *Methods of Psychological Research Online*, 3, 75–93.

Möller, J., & Köller, O. (in press-a). Dimensional comparisons: An experimental approach to the internal/external frame of reference model. *Journal of Educational Psychology*.  
 – (in press-b). Frame of reference effects following the announcement of exam results. *Contemporary Educational Psychology*.  
 – (2000). Spontaneous and reactive attributions following academic achievement. *Social Psychology of Education*, 4, 67–86.  
 – (1999). Spontaneous cognitions on academic test results. *The Journal of Experimental Education*, 67, 150–164.  
 – (1998a). Dimensionale und soziale Vergleiche nach schulischen Leistungen. *Zeitschrift für Entwicklungspsychologie und Pädagogische Psychologie*, 30, 118–127.  
 – (1998b). Leistungs- und geschlechtsbezogene Vergleiche in der Schule. *Empirische Pädagogik*, 12, 119–131.

Nunner-Winkler, G., & Edelstein, W. (2000). Einleitung. In W. Edelstein & G. Nunner-Winkler (Eds.), *Moral im sozialen Kontext* (pp. 7–31). Frankfurt a.M.: Suhrkamp.

Oesterreich, D. (2001). Masenfucht in die Sicherheit? Zum politischen Verhalten autoritärer Persönlichkeiten. Theoretische Überlegungen und Ergebnisse von vier empirischen Untersuchungen. In W. Heitmeyer (Ed.), *Schattenseiten der Globalisierung* (pp. 275–297). Frankfurt a.M.: Suhrkamp.  
 – (2000a). Autoritäre Persönlichkeit und Sozialisation im Elternhaus. Theoretische Überlegungen und empirische Ergebnisse. In S. Rippl, C. Seipel, & A. Kindervater (Eds.), *Autoritarismus. Kontroversen und Ansätze der aktuellen Autoritarismusforschung* (pp. 69–90). Opladen: Leske + Budrich.  
 – (2000b). Ziele und Realität politischer Bildung in der Bundesrepublik Deutschland. Eine

empirische Studie über die Sicht von Experten und Expertinnen. In H. H. Krüger & H. Wenzel (Eds.), *Schule zwischen Effektivität und sozialer Verantwortung* (pp. 79–90). Opladen: Leske + Budrich.  
 – (1999). Flucht in die Sicherheit: Ein neuer Ansatz und ein neues Maß zur autoritären Persönlichkeit. *Zeitschrift für Politische Psychologie*, 7, 289–302.  
 – (1998a). Authoritarianism and right-wing extremism among German youth. Evidence from three empirical studies. In M. Watts (Ed.), *Cross-cultural perspectives on youth, radicalism and violence* (pp. 39–54). Greenwich, CT: JAI Press.  
 – (1998b). Lernziel: Die deutsche Nation. Expertenbefragung zu den Zielen politischer Bildung in der Sekundarstufe I. In F. E. Anhelm & W. Wortmann (Eds.), *Globalisierung am Horizont politischen Lernens* (pp. 147–163). Loccum: Loccumer Protokolle 53/97.  
 – (1998c). Ein neues Maß zur Messung autoritärer Charaktermerkmale. *Zeitschrift für Sozialpsychologie*, 1, 56–64.

Oesterreich, D., Händle, C., & Trommer, L. (in press). Wie läßt sich politische Bildung verbessern? Empfehlungen aus der Sicht von Experten und Expertinnen. *Die Deutsche Schule*.  
 – (1999). Eine Befragung von Experten und Expertinnen zur politischen Bildung in der Sekundarstufe I. In C. Händle, D. Oesterreich, & L. Trommer, *Aufgaben politischer Bildung in der Sekundarstufe I* (pp. 131–208). Opladen: Leske + Budrich.

Patrick, H., Ryan, A. M., Alfeld-Liro, C., Fredricks, J., Hruza, L., & Eccles, J. S. (1999). Adolescents' commitment to developing talent: The role of peers in continuing motivation for sports and the arts. *Journal of Youth and Adolescence*, 28, 741–763.

Rode, C., Cosmides, L., Hell, W., & Tooby, J. (1999). When and why do people avoid unknown probabilities in decisions under uncertainty? Testing some predictions from optimal foraging theory. *Cognition*, 72, 269–304.

Rode, C., & Wang, X. T. (2000). Risk-sensitive decision making examined within an evolutionary framework. *American Be-*

*havioral Scientist*, 43, 926–939.

Rundshagen, I., Schnabel, K., & Schulte Am Esch, J. (2000). Midlatency median nerve evoked responses during recovery from propofol/sufentanil total intravenous anaesthesia. *Acta Anaesthesiologica Scandinavica*, 44, 313–320.

Rundshagen, I., Standl, T., & Schnabel, K. (1999). Patients' evoked responses during recovery of postoperative pain in orthopedic patients. *British Journal of Anaesthesia*, 82, 374–378.

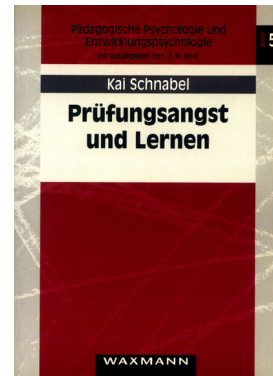
Savelsbergh, E. R., de Jong, T., & Ferguson-Hessler, M. G. M. (2000). Physics learning with a computer algebra system: Towards a learning environment to promote enhanced problem representations. *Journal of Computer-Assisted Learning*, 16, 229–242.  
 – (1998). Competence related differences in problem representations. In M. van Someren, P. Reimann, T. de Jong, & H. Boshuizen (Eds.), *The role of multiple representations in learning and problem solving* (pp. 128–141). Amsterdam: Elsevier.

Schecker, H., & Klieme, E. (2000). Erfassung physikalischer Kompetenz durch Concept-Mapping-Verfahren. In H. Fischer & J. Peuckert (Eds.), *Concept Mapping in fachdidaktischen Forschungsprojekten der Physik und Chemie* (pp. 23–56). Berlin: Logos Verlag.

Schiefele, U., & Köller, O. (1998). Intrinsische und extrinsische Motivation. In D. H. Rost (Ed.), *Handwörterbuch Pädagogische Psychologie* (pp. 193–197). Weinheim: Beltz/Psychologie Verlags Union.

Schnabel, K. (in press-a). Psychologie der Lernumwelt. In B. Weidenmann, A. Krapp, M. Hofer, G. L. Huber, & H. Mandl (Eds.), *Pädagogische Psychologie* (4th ed.). Weinheim: Beltz/Psychologie Verlags Union.  
 – (in press-b). Tagträume für die Schule von Morgen. In B. Nacke (Ed.), *Visionen für Gesellschaft und Christentum. Wohin sich Gesellschaft entwickeln kann*. Würzburg: Echter.  
 – (1999). Wissenschaft ist Abstraktion, aber Abstraktes ist zu

nix zu gebrauchen. *Unterrichtswissenschaft*, 27, 333–336.  
 – (1998a). *Prüfungsangst und Lernen. Empirische Analysen zum Einfluß fachspezifischer Leistungsängstlichkeit auf schulischen Lernfortschritt*. Münster: Waxmann (201 p.).



– (1998b). Schuleffekte. In D. H. Rost (Ed.), *Handwörterbuch Pädagogische Psychologie* (pp. 431–435). Weinheim: Beltz/Psychologie Verlags Union.  
 – (1998c). TIMSS—Mathematisch-naturwissenschaftlicher Unterricht im internationalen Vergleich—Wie können Schulen und Lehrer reagieren? In Verband Bildung und Erziehung e.V. (Ed.), *Wie wird Deutschlands Bildung fit für die Zukunft?* (pp. 24–33). Würzburg: Verband Bildung und Erziehung e.V.

Schnabel, K., Baumert, J., & Bos, W. (2000). Mathematisch-naturwissenschaftliche Grundbildung am Ende der Sekundarstufe II—Deutschland im internationalen Vergleich. Analysen unter Nutzung der Dritten Internationalen Mathematik- und Naturwissenschaftsstudie (TIMSS III). In *Jahrbuch der Max-Planck-Gesellschaft* (pp. 769–779). München: Max-Planck-Gesellschaft.

Schnabel, K., & Gruehn, S. (2000). Studienfachwünsche und Berufsorientierungen in der gymnasialen Oberstufe. In J. Baumert, W. Bos, & R. Lehmann (Eds.), *TIMSS/III. Dritte Internationale Mathematik- und Naturwissenschaftsstudie—Mathematische und naturwissenschaftliche Bildung am Ende der Schullaufbahn: Vol. 2. Mathematische und physikalische Kompetenzen am Ende der gymnasialen Oberstufe* (pp. 405–444). Opladen: Leske + Budrich.

- Schnabel, K., Köller, O., & Baumert, J.** (in press). Stim- mungsindikatoren und Leis- tungsängstlichkeit als Prädikto- ren für schulische Leistungsent- wicklung: Eine längsschnittliche Vergleichsanalyse. In C. Fink- beiner & G. W. Schnaitmann (Eds.), *Lehren und Lernen im Kontext empirischer Forschung und Fachdidaktik*. Donauwörth: Auer.
- Schnabel, K., & Leschinsky, A.** (in press). La transition de l'école à la formation profes- sionnelle initiale en Allemagne. In M. Guigue (Ed.), *Problème d'orientation des jeunes*.
- Schnabel, K., Little, T. D., & Baumert, J.** (2000). Modeling longitudinal and multilevel data. In T. D. Little, K. Schnabel, & J. Baumert (Eds.), *Modeling longi- tudinal and multilevel data. Practical issues, applied ap- proaches, and specific examples* (pp. 9–13). Mahwah, NJ: Erl- baum.
- Schnabel, K., & Schwippert, K.** (2000). Einflüsse sozialer und ethnischer Herkunft beim Über- gang in die Sekundarstufe II und den Beruf: 1. Schichtenspezifi- sche Einflüsse am Übergang auf die Sekundarstufe II. In J. Baumert, W. Bos, & R. Lehmann (Eds.), *TIMSS/III. Dritte Interna- tionale Mathematik- und Natur- wissenschaftsstudie—Ma- thematische und naturwissen- schaftliche Bildung am Ende der Schullaufbahn: Vol. 1. Mathema- tische und naturwissen- schaftliche Grundbildung am Ende der Pflichtschulzeit* (pp. 261–281). Opladen: Leske + Budrich.
- Schneider, W., & **Stern, E.** (2000). Die Entwicklung von Kompetenzunterschieden. *Grundschule*, 32, 22–24.
- Schröder, E., Bödeker, K., & **Edelstein, W.** (2000a). *The de- velopment of formal thought: A manual including measurement procedures and descriptive analyses*. Berlin: Max Planck In- stitute for Human Development (Materialien aus der Bildungs- forschung, Vol. 68).
- (2000b). *The development of syllogistic reasoning: A manual including measurement proce- dures and descriptive analyses*. Berlin: Max Planck Institute for Human Development (Materia- lien aus der Bildungsforschung, Vol. 69).
- (2000c). *Proportional, combi- natorial, and correlational rea- soning: A manual including measurement procedures and descriptive analyses*. Berlin: Max Planck Institute for Human De- velopment (Materialien aus der Bildungsforschung, Vol. 70).
- Schröder, E., & **Edelstein, W.** (2001). The impact of develop- mental change and social con- straints on cognition: The exam- ple of syllogistic reasoning. In A. Tryphon & J. Vonèche (Eds.), *Working with Piaget: Essays in honour of Bärbel Inhelder* (pp. 103–121). Hove, UK: Psychology Press Ltd.
- Schümer, G.** (1999a). *Basic data on the educational system of Berlin*. Berlin: Max Planck Insti- tute for Human Development (Materialien aus der Bildungs- forschung, Vol. 64).
- (1999b). L'insegnamento della matematica in Giappone, Stati Uniti e Germania: osservazioni sulla difficoltà della valutazione del sistema scolastico. *CADMO*, 7, 19–38.
- (1999c). Lehrer in Japan: Ar- beitsbedingungen und Arbeits- ethos. *Pädagogik*, 51, 30–35.
- (1999d). Mathematics educa- tion in Japan. *Journal of Cur- riculum Studies*, 31, 399–427.
- (1999e). Mathematikunter- richt in Japan: Ein Überblick über den Unterricht in öffent- lichen Grund- und Mittelschu- len und privaten Ergänzung- schulen. In V. Schubert (Ed.), *Lernkultur: Das Beispiel Japan* (pp. 45–76). Weinheim: Deut- scher Studien Verlag.
- (1999f). Projektunterricht in der Regelschule: Anmerkungen zur pädagogischen Freiheit des Lehrers. In U. Steffens & T. Bar- gel (Eds.), *Lehren und Lernen im offenen Unterricht* (pp. 41–56). Wiesbaden: Landesinstitut für Pädagogik.
- (1998). Vzdělávání v oblasti matematiky v Japonsku, Spo- jených státech a v Nemecku. Prohlubování obtížnosti a hod- nocení vzdělávací účinnosti. In S. Navrátil & J. van Buer (Eds.), *Rozvoj autonomie škol. Podmín- sky, prostředky, evaluate* (pp. 111–123). Usti nad Labem: Uni- verzita J. E. Purkyne.
- Schwippert, K., & Schnabel, K.** (2000). Einflüsse sozialer und ethnischer Herkunft beim Über- gang in die Sekundarstufe II und den Beruf: 2. Mathematisch- naturwissenschaftliche Grund- bildung ausländischer Schulaus- bildungsabsolventen. In J. Baumert, W. Bos, & R. Lehmann (Eds.), *TIMSS/III. Dritte Interna- tionale Mathematik- und Natur- wissenschaftsstudie—Ma- thematische und naturwissen- schaftliche Bildung am Ende der Schullaufbahn: Vol. 1. Mathema- tische und naturwissen- schaftliche Grundbildung am Ende der Pflichtschulzeit* (pp. 282–300). Opladen: Leske + Budrich.
- Siegler, R. S., & **Stern, E.** (1998). Conscious and unconscious strategy discoveries: A microge- netic analysis. *Journal of Experi- mental Psychology: General*, 127, 377–397.
- Stanat, P., & Artelt, C.** (in press). Der Beitrag interna- tionaler Schulleistungsvergleiche zur Qualitätssicherung: Das Bei- spiel PISA. In H. Döbert & C. Ernst (Eds.), *Schule und Qualität. Basiswissen Pädagogik: Aktuelle Schulkonzepte* (Vol. 6). Hohen- gehen: Schneider Verlag.
- Stern, E.** (in press-a). Intelli- gence, prior knowledge, and learning. In N. J. Smelser & P. B. Baltes (Eds.), *International ency- clopedia of the social and be- havioral sciences* (Vol. 3.5). Ox- ford, UK: Elsevier Science.
- (in press-b). Intelligenz, Wis- sen, Transfer und der Umgang mit Zeichensystemen. In E. Stern & J. Guthke (Eds.), *Perspektiven der Intelligenzforschung*. Lengerich: Pabst.
- (in press-c). Schulisches Ler- nen: Was wird transferiert? In K. Reschke & E. Witruk (Eds.), *Das Lernen lernen*. Regensburg: Roderer Verlag.
- (in press-d). Wie abstrakt lernt das Grundschulkind? Neuere Ergebnisse der entwick- lungspsychologischen For- schung. In H. Petillon (Ed.), *Handbuch Grundschulforschung: Vol. 5. Individuelles und soziales Lernen—Kindperspektive und pädagogische Konzepte. Lever- kusen: Leske + Budrich*.
- (2000). Fördermöglichkeiten des Lerntransfers im wirt- schaftsbetrieblichen Unterricht. *Wirtschaft und Erziehung*, 10, 359–362.
- (1999). Development of math- ematical competencies. In F. E. Weinert & W. Schneider (Eds.), *Individual development from 3 to 12* (pp. 154–170). Cambridge, UK: Cambridge University Press.
- (1998a). Early training: Who, what, when, why, and how? In M. Beishuizen, K. P. E. Grave- meijer, & E. C. D. M. van Lies- hout (Eds.), *The role of contexts and models in the development of mathematical strategies and procedures* (pp. 239–253). Utrecht: CD-B Press.
- (1998b). *Die Entwicklung des mathematischen Verständnisses im Kindesalter*. Lengerich: Pabst (247 p.).
- (1998c). Die Entwicklung schulbezogener Kompetenzen: Mathematik. In F. E. Weinert (Ed.), *Entwicklung im Kindes- alter—Bericht über eine Längs- schnittstudie* (pp. 95–113). Weinheim: Beltz.
- (1998d). Schneisen im Dschungel wissenschaftlicher Fragestellungen. In H. Bruegel- mann, M. Fölling-Albers, & S. Richter (Eds.), *Jahrbuch Grundschule. Fragen der Praxis— Befunde der Forschung* (pp. 123–127). Seelze: Friedrich Verlag.
- (1998e). Schulisches Lernen: Was wird transferiert? In K. Reschke & E. Witruk (Eds.), *Das Lernen lernen* (pp. 55–67). Re- gensburg: Roderer Verlag.
- Stern, E., Aprea, C., & Ebner, H.** (in press). Improving cross-con- tent transfer in text processing by means of active graphical representation. *Learning and In- struction*.
- Stern, E., & Haag, L.** (2000). Non vitae sed scholae discimus: Das Schulfach Latein auf dem Prüfstand. *Forschung und Lehre*, 11, 91–93.
- Stern, E., & Hardy, I.** (in press). Leistungsmessung in Mathema- tik. In F. E. Weinert (Ed.), *Hand- buch der Kultusministerkonfe- renz: Leistungsmessung in Schulen*. Weinheim: Beltz.
- Stern, E., Hardy, I., & Koerber, S.** (in press). Die Nutzung graphisch-visueller Repräsen- tationsformen im Sachunterricht. In K. Spreckelsen, A. Hartinger, & K. Möller (Eds.), *Ansätze und Methoden empirischer For- schung zum Sachunterricht*. Bad Heilbrunn: Klinkhardt.
- Stern, E., & Koerber, S.** (2000). Mentale Modelle von Zeit und Zukunft. In B. Strauß, J. Möller,

- Et S. Jürgensen, *Psychologie und Zukunft* (pp. 15–29). Göttingen: Hogrefe.
- Stern, E.**, & Staub, F. (2000). Mathematik lernen und verstehen: Anforderungen an die Gestaltung des Mathematikunterrichts. In E. Inckermann, J. Kahler, & A. Speck-Hamdan (Eds.), *Sich Lernen leisten. Grundschule vor den Herausforderungen der Wissenschaft* (pp. 90–100). Neuwied: Luchterhand.
- Stigler, J. W. et al., & **Knoll, S.** (1999). *The TIMSS videotape classroom study. Methods and findings from an exploratory research project on eighth-grade mathematics instruction in Germany, Japan, and the United States*. Washington, DC: Government Printing Office.
- Thußbas, C.** (2000). Inhalt, Vorwissen und analoger Transfer. Der Einfluss der Typizität von Cover Stories auf analoges Problemlösen in der Mathematik (Abstract). In D. Vorberg, A. Fuchs, T. Futterer, A. Heinecke, U. Mattler, & U. Heinrich (Eds.), *Tagungsband zur 42. Tagung experimentell arbeitender Psychologen* (p. 84). Lengerich: Pabst.
- Trautwein, U., Köller, O., & Baumert, J.** (in press). Lieber oft als viel: Hausaufgaben und die Entwicklung von Leistung und Interesse im Mathematik-Unterricht der 7. Jahrgangsstufe. *Zeitschrift für Pädagogik*.
- Trautwein, U., Köller, O., Schmitz, B., & Baumert, J.** (in press). Do homework assignments enhance achievement? A multilevel analysis in 7th grade mathematics. *Contemporary Educational Psychology*.
- Trommer, L.** (2000). Lehrpläne zur Politischen Bildung in der Sekundarstufe I. *Gegenwartskunde*, 49, 79–86.
- (1999). Eine Analyse der Lehrpläne zur Sozialkunde in der Sekundarstufe I. In C. Händle, D. Oesterreich, & L. Trommer, *Aufgaben politischer Bildung in der Sekundarstufe I* (pp. 69–129). Opladen: Leske + Budrich.
- Trost, G., **Klieme, E.**, & Nauels, H.-U. (1998). The relationship between different criteria for admission to medical school and student success. *Assessment in Education*, 5, 247–254.
- Vetter, P. H., & **Köller, O.** (1998). First versus rehospitalized patients with an affective disorder or schizophrenia: Differences in long-term course and outcome. *Psychopathology*, 31, 260–264.
- Vetter, P. H., Krauss, S., Steiner, O., Kropp, P., Möller, W. D., Moises, H. W., & **Köller, O.** (1999). Vascular dementia versus dementia of Alzheimer's type: Do they have differential effects on caregivers' burden? *Journals of Gerontology: Psychological Sciences and Social Sciences*, 54, 93–98.
- Vetter, P. H., Krauss, S., Steiner, O., Moises, H. W., Kropp, P., Möller, W. D., & **Köller, O.** (in press). Vascular dementia: Do patients and family caregivers make adequate use of available supports? *Aging & Mental Health*.
- Vetter, P. H., Pritzbuher, J. von, Jungmann, K., Kropp, P., & **Köller, O.** (in press). The validity of the ICD-10 classification of recurrent affective disorders: Do endogenous and psychogenic depressions form a homogeneous diagnostic group? *Psychopathology*.
- Vetter, P. H., Pritzbuher, J. von, Jungmann, K., Moises, H. W., Kropp, P., & **Köller, O.** (2000). Motivation to seek psychotherapy in patients with recurrent depressive disorder. *Psychotherapy Research*, 10, 159–168.
- Vetter, P. H., Steiner, O., Krauss, S., Moises, H., Kropp, P., Möller, W., D., & **Köller, O.** (1998). Factors affecting the utilization of homecare supports by caregiving relatives of Alzheimer's patients. *Dementia and Geriatric Cognitive Disorders*, 9, 111–116.
- Watermann, R.** (2000). *Berufliche Wertorientierungen im Wandel. Eine Kohortenanalyse zur Dynamik arbeitsbezogener Einstellungen anhand von ALLBUS-Umfragedaten*. Münster: Institut für sozialwissenschaftliche Forschung e.V. (225 p.).
- Watermann, R., & Baumert, J.** (2000). Mathematische und naturwissenschaftliche Grundbildung beim Übergang von der Schule in den Beruf. In J. Baumert, W. Bos, & R. Lehmann (Eds.), *TIMSS/III. Dritte Interna-*
- tionale Mathematik- und Naturwissenschaftsstudie—Mathematische und naturwissenschaftliche Bildung am Ende der Schullaufbahn: Vol. 1. Mathematische und naturwissenschaftliche Grundbildung am Ende der Pflichtschulzeit* (pp. 199–259). Opladen: Leske + Budrich.
- Watermann, R., Erlemeier, N., & Weber, G.** (2000). Alterskonzepte bei Professionellen in der Altenpflege. In J. Reinecke & C. Tarnai (Eds.), *Angewandte Klassifikationsanalyse* (pp. 252–267). Münster: Waxmann.

