

Center for Educational Research

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Introductory Overview

The specific concern of the Center for Educational Research is the study of 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 multi-level 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 longitudinal studies,

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 four 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, value commitment, and successful transitions to university education, vocational training, and the labor market. Two longitudinal studies form the basis for this research program. The ongoing, multi-wave, multiple-cohort study **Learning Processes, Educational Careers, and Psychosocial Development in Adolescence and Young Adulthood (BIJU)** was initiated in 1991 with a sample of more than 5,000 13-year-olds. Data from six measurement points are now available for the main cohort. The longitudinal **Transformation of the Upper Secondary School System and Academic Careers (TOSCA)** study started in 2002; a second measurement took place in 2004. The homework project, which uses data from multiple sources (e.g., BIJU, PISA), establishes a link between Research Areas I and II.

Research Area II comprises projects representing the first steps toward the establishment of a national 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 major project in this research area is the OECD's **Programme for International Student Assessment (PISA)**. In addition to international coopera-

tion, the project has intensified collaboration between researchers at different universities and institutes within Germany. At our Institute, our involvement in the PISA study has prompted the development of a closely associated research program that underpins the methodology of the PISA study and supplements its findings. This program includes studies designed to investigate the role of test motivation and coaching, the validity of the translations used in international comparisons, and theoretical dimensions of reading literacy. Furthermore, the Center has played a leading role in developing and evaluating measures for the assessment of self-regulated learning. These measures have now become an integral component of the international PISA project. The large-scale assessments have also been used to demonstrate how the evaluation of comprehensive school reform measures can be combined with national reference data. The research questions being addressed within **Research Area III** draw on a key finding of PISA 2000. In Germany, at least 25% of the upcoming generation represent a potential at-risk group as far as reading literacy is concerned. Most of the projects in this Research Area have been designed to investigate, from the theoretical and empirical perspectives, the functional mechanisms underlying intervention programs aiming to foster metamemory and learning strategies in the domain of reading comprehension. The studies are experimental or quasi-experimental in design. They include an investigation of an experimental training program based on the recip-

rocal learning approach, a study of a training program targeting metamemory and reading strategies within the family context, and an examination of the role of phonological awareness in the language development of bilingual children. Finally, the **Jacobs Summer Camp Project** investigates the role of implicit and explicit language learning, with a particular focus on proficiency in school-related academic language.

Research Area IV 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 longitudinal studies in school environments with a strong emphasis on teacher expertise (**COACTIV**). 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.

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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 areas of individual functioning. While parents play a dominant role in their children's development during infancy, childhood, and early adolescence, for example, their influence decreases during adolescence and often ceases entirely in adulthood. The social institution of the school also plays a major role during childhood and adolescence, particularly in the domain of academic learning and, more generally, cognitive development. Furthermore, schools have an impact on the formation or development of motivation, emotions, attitudes, and other personal characteristics.

Given its theoretical focus on institutional influences on human development, the research conducted at the Center for Educational Research entails longitudinal, multilevel stud-

ies that collect data at school, class, and individual levels, cover more than one knowledge domain, and allow both intraindividual change across domains and interindividual

The BIJU Study—Aims and Data Collection

BIJU has four guiding components:

- (1) providing institutional and individual baseline data on the integration of the East and West German educational systems; since 1991;
- (2) analyzing domain-specific learning as a function of personal resources and institutional opportunity structures;
- (3) analyzing long-term trajectories of psychosocial development in adolescence and young adulthood;
- (4) analyzing ways of coping with the transition from school to vocational training or university.

Data collection began with a survey of the main cohort (longitudinal cohort 1) in the 1991/92 school year (see Figure 1). Data was gathered from 7th graders at three measurement points. The first point of measurement coincided with the transformation of the unitary school system of the former East Germany to the tracked system adopted from West Germany. 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 fifth wave took place in Spring 1997, when participants were either in vocational education or in the academic track of upper secondary level. The sixth wave of data collection was conducted in 2001, and focused on how students had mastered the transition from school to university or from vocational education to the labor market.

The sample of school classes comprises some 8,000 students from 212 secondary schools of all types in the states of Berlin, Mecklenburg-West Pomerania, North Rhine-Westphalia, and Saxony-Anhalt. In Spring 1993, the sample was supplemented by a second longitudinal cohort of 1,330 students in the final grade of lower secondary schooling. In order to provide a baseline for an East-West comparison at the end of lower secondary education, a separate cross-sectional study of approximately 1,600 10th graders was also carried out. This study concentrated on issues of political socialization, and the transition to vocational training and working life.

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differences in patterns of intraindividual change to be investigated. The two flagship studies in Research Area I, *Learning Processes, Educational Careers, and Psychosocial Development in Adolescence and Young Adulthood* (BIJU), and *Transformation of the Secondary School System and Academic Careers* (TOSCA) were designed to investigate the effects of learning contexts in high-school and college environments on human development, bearing in mind the requirements of multilevel longitudinal designs. Recently, the TOSCA and BIJU studies have been supplemented by a set of studies allowing in-depth analyses of the effects of homework assignments and homework completion on academic achievement. In the following, some current research from BIJU, TOSCA, and the homework project is presented in more detail.

Opportunity Structures and the Development of Self-Concept and Interest in Upper Secondary Schools

In recent years, ample evidence has been accumulated to confirm that motivational components, such as self-concept and interest, are powerful predictors of students' achievement and achievement-related behavior. Moreover, several studies have shown how factors at the person level and features of the learning environment impact on a student's motivation to learn. The longitudinal BIJU study (see Figure 1 for an overview of the research design) provides an excellent opportunity to examine the dynamic interplay between self-concept, interest, and achievement (e.g., Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005). The wealth of information that has been compiled on educational opportunity structures within the BIJU study also permits in-depth analyses of how composition and context factors in-

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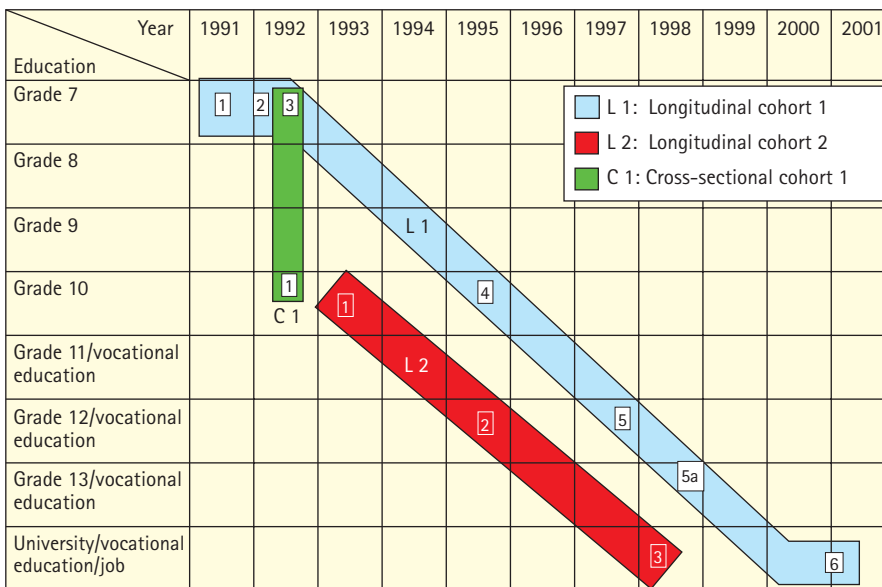


Figure 1. Research design of the BIJU project.

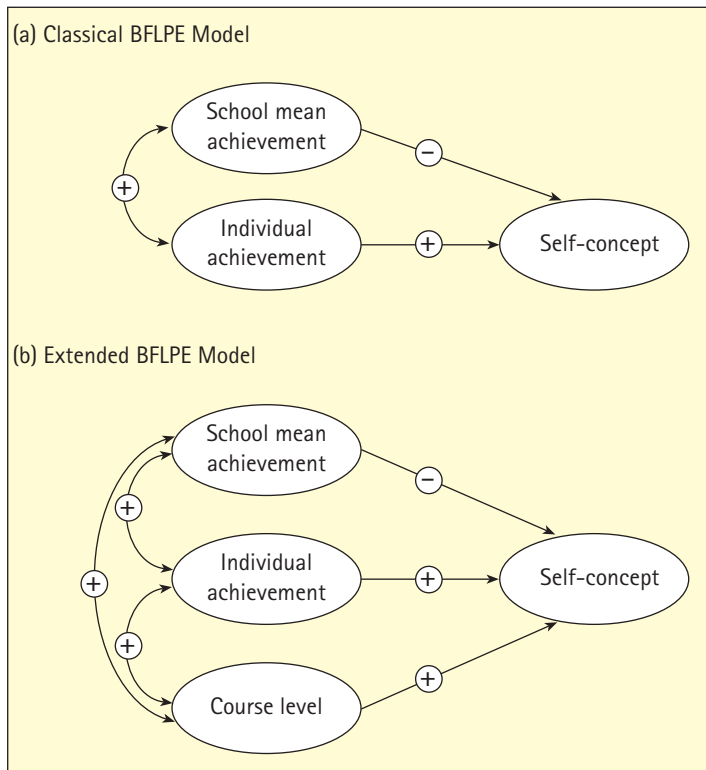


Figure 2. The Big-Fish-Little-Pond Effect (BFLPE).

fluence human development (e.g., Baumert, Trautwein, & Artelt, 2003; Nagy, Trautwein, Köller, Baumert, & Garrett, in press; also see Lüdtke, Köller, Marsh, & Trautwein, in press). For example, a series of analyses has been conducted with the BIJU data to investigate the influence of the mean performance level of a class on the self-concept of the individual members of that class (e.g., Köller, 2004a; Marsh, Köller, & Baumert, 2001; Marsh & Köller, 2004). These and many other studies illustrate that a person's self-concept of ability is heavily influenced by the achievement of others in his or her immediate environment, and less so by his or her objective standing. This phenomenon is now commonly held to result from a "frame of reference

effect." Individuals tend to construct their frames of reference from the people close to them. Very often, the frame of reference is simply the physical environment: classmates, members of the same athletic club, people who work in the same institution.

In education, frame of reference effects result in students developing comparably low self-concepts in high-achieving groups and comparably high self-concepts in low-achieving groups. Herbert Marsh has coined the term "Big-Fish-Little-Pond Effect" (BFLPE) to describe the finding that students in high-achieving groups develop lower self-concepts than equally proficient students in low-achieving environments. The classical BFLPE model is illustrated in Figure 2(a). According to the BFLPE, students' self-concepts are strongly influenced by the act of comparing or *contrasting* their own performance with that of their classmates. For this reason, researchers have also used the term *contrast effect* to describe the negative path coefficient from school-average achievement to students' self-concepts.

In recent years, however, educational researchers have begun to ask whether the contrast effect really does tell the whole story. Does membership of a high-status group not have any positive effects at all? Is there no "basking in reflected glory" or "assimilation" effect of being placed in a high-achieving group? In other words, might self-concept in fact be enhanced by membership of groups that are positively valued by the individual? This kind of assimilation effect might counterbalance the

negative effects experienced by students in academically selective classes who use their classmates as a basis of comparison. Thus, a (negative) contrast or social comparison effect (e.g., "A lot of students are better than I am, so I can't be as good as I thought") might compete with a (positive) assimilation effect (e.g., "I must be smart because I am in a selective course")—this phenomenon is illustrated in Figure 2(b). To date, very little empirical support has been found for assimilation effects, though studies of the phenomenon have been rather sparse. We investigated possible assimilation effects in the last two years of Gymnasium schooling (Trautwein, Köller, Lüdtke, & Baumert, in press) by capitalizing on a specific feature of upper secondary education in Germany: the differentiation between basic and advanced courses. Course selection is an integral part of the last two years (grades 12 and 13) of the Gymnasium, the most academically competitive college-bound track in Germany, with students selecting two (and only two)

advanced courses in addition to their core classes. Thus, in contrast to the US, for example, even students who perform well across the board are forced to specialize. Although certain restrictions apply, students can choose from a wide range of subjects. Importantly, poor prior achievement does not preclude enrollment in a specific subject although, in practice, high achievement is a major predictor of course selection. Advanced courses differ from basic courses in several ways. They involve five lesson hours per week, compared to two lesson hours for basic courses; they cover more material and do so on a more challenging level. Once enrolled in an advanced course, students find themselves in a new "pond" of students "specializing" in that subject. This leads to a higher overall level of achievement in advanced courses than in basic courses. Given the contrast effect typically found in high-achieving settings, one might expect a student's self-concept in a subject to decline when he or she embarks on

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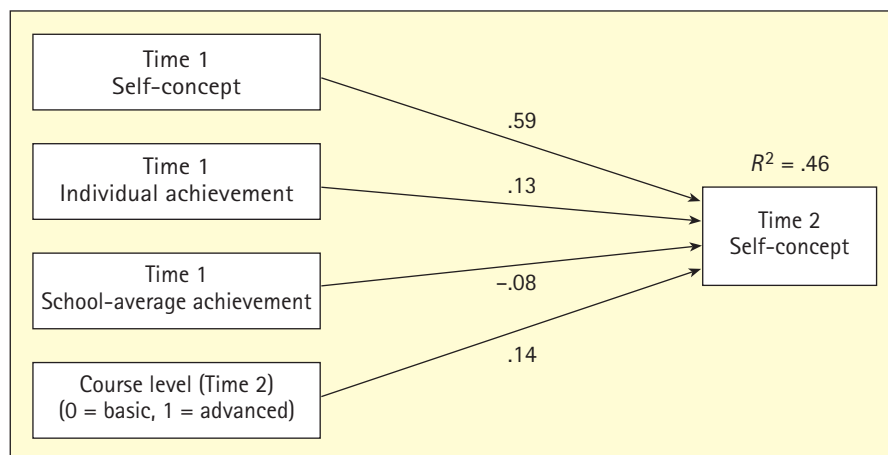


Figure 3. Regressing grade12 self-concept on four predictors: Results of multilevel modeling.

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an advanced course in that subject. At the same time, however, given the high general level of achievement in advanced courses, attending a course of this type might have positive effects on the student's self-concept in that subject. Moreover, course selection is a part of identity formation. Seen from the perspective of well-being and psychological growth, it makes sense to "self-enhance" in areas that play an important role in one's life.

We used data from the fourth and fifth waves of the BIJU study to examine the effects of advanced math course selection on math self-concept. The key results of a set of multilevel regression analyses are shown in Figure 3. A student's math self-concept in grade 12 was strongly predicted by his or her math self-concept two years earlier. Grade 10 math achievement also impacted positively on grade 12 math self-concept. Most importantly, we found a *negative* effect of school-average math achievement on math self-concept (the typical BFLPE) as well as a *positive* effect of course level on math self-concept, indicating that assimilation effects are also in operation.

This pattern of results illustrates the powerful effects of educational opportunity structures on the development of student motivation. For the development of student motivation to be fully understood, in-depth analyses of the student environment—including institutional structures and educational practices—are essential.

Opportunity Structures and the Transition From School to Work or University

Like the BIJU study, the TOSCA project addresses both educational and psychological research questions. From the educational perspective, TOSCA examines the opportunity structures open to students from different backgrounds, the educational standards attained in German upper secondary schools, and the comparability of the school-leaving qualifications awarded across Germany. It also attempts, on the basis of multiple measures and assessments, to predict the academic choices that students from different backgrounds are likely to make. From the psychological perspective, a strong focus of the TOSCA study is on self-selection versus socialization processes during the transition from school to work or university. Among other constructs, we examine personal goals, academic and nonacademic self-concepts, vocational interests, and personality.

Social Background

The extent to which differences in students' backgrounds impact on their academic outcomes varies from one school system to the next. The findings of the PISA study, for example, show that there is a link between social background and performance in all participating countries, but that nowhere is this relationship as strong as it is in Germany. One reason for this is the strict ability grouping of the German three-tier secondary school system, and the fact that students' chances of attending the most attractive school type (Gymnasium) hinge on

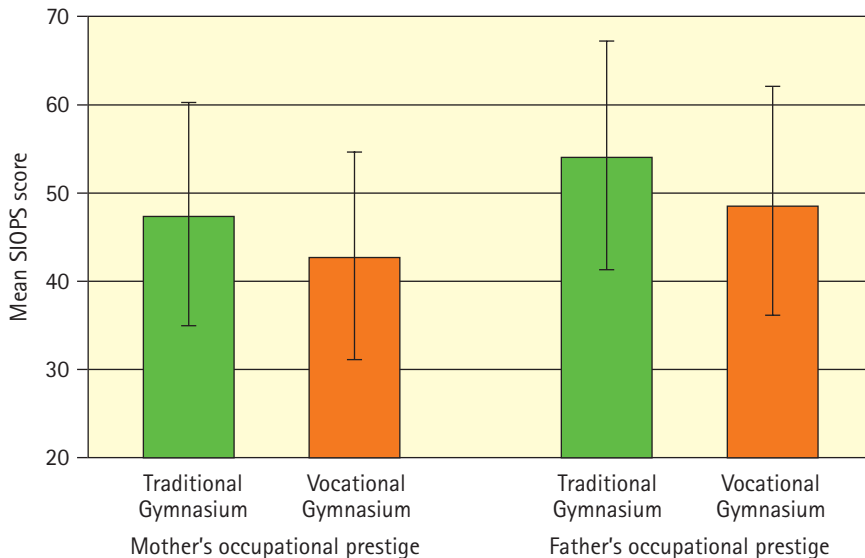


Figure 4. Parents' occupational prestige by type of Gymnasium school (means and standard deviations).

their social background. In recent decades, efforts have been made to weaken the link between student backgrounds and academic outcomes in Germany by establishing comprehensive schools and vocational Gymnasium schools (Chang, 2005; Köller, Baumert, Cortina, Trautwein, & Watermann, 2004; Köller, Watermann, Trautwein, & Lüdtke, 2004a). One of the stated goals of vocational Gymnasium schools was to open up alternative routes to higher education for talented students from less privileged backgrounds who had not transferred to a traditional Gymnasium immediately after primary school. How successful have vocational Gymnasium schools been in these attempts? In TOSCA, parents' occupations were coded on the Standard International Occupational Prestige Scale (SIOPS), thus providing an insight into students' social backgrounds. As shown in Figure 4, significant differences were found between the parents of students

enrolled in vocational and traditional Gymnasium schools (Maaz, Nagy, Trautwein, Watermann, & Köller (2004). Whereas the mean occupational prestige score for the fathers of students at traditional Gymnasium schools was $M = 54.31$ ($SD = 12.95$), the mean score for fathers of students at vocational Gymnasium schools was $M = 48.85$ (see Figure 4). A similar pattern emerged for the mothers.

Marked differences were also observed in the parents' educational qualifications. Overall, the parents had a high level of education, but significant differences were again discerned according to the type of Gymnasium school attended by their children. 44% of students at traditional Gymnasium schools reported that at least one of their parents was a university graduate. The corresponding figure for students at vocational Gymnasium schools was only half the size, at 24%. These results confirm that vocational Gymnasium schools do, to a certain

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Data Collection in TOSCA

At Time 1, the TOSCA project encompassed a representative sample of 4,730 students in their last year of upper secondary education (aged about 17-19 years) sampled between March and May 2002. All students were attending either traditional Gymnasium schools or one of the five forms of vocational Gymnasium school that have been established in the state of Baden-Wuerttemberg. More than 60% of these students consented to be recontacted for follow-up studies. The second wave of data collection took place from February to May 2004. A total of 2,316 students participated in this follow-up; most of them had since gone on to higher education.

Measures used in TOSCA focus on academic achievement variables (e.g., TIMSS tests, TOEFL scores) and cognitive abilities (indicators of IQ). Additional instruments include student self-reports on motivation and personal goals, academic and nonacademic self-concept, interests, and family background. Finally, the students' school and family context was further investigated using teacher, head teacher, and parent questionnaires.

extent, attract students who are not the "typical" clientele of the traditional Gymnasium in terms of their parents' educational levels or occupational prestige. Vocational Gymnasium schools are thus contributing to increased heterogeneity of student backgrounds in the group of school leavers qualifying for higher education.

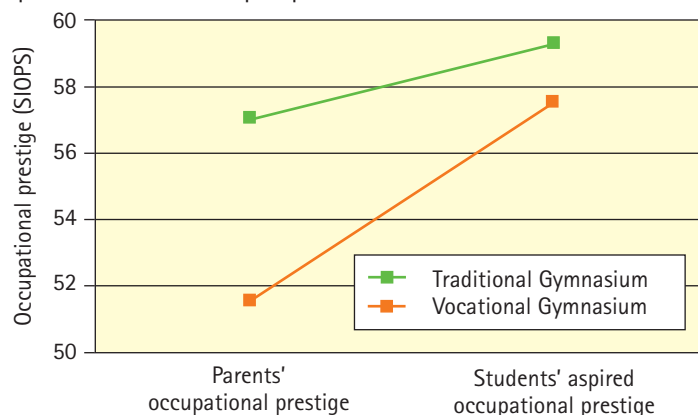
Given that the vocational Gymnasium is indeed offering students from less privileged homes access to university entrance qualifications, it is interesting to explore how students exploit these new opportunities. In other words, how do students' social backgrounds and the type of Gymnasium attended relate to the prestige of their long-term career goals? This question is approached from two perspectives:

(1) We explore whether any differences in the prestige of respondents' long-term career aspirations can be discerned as a function of the type of Gymnasium attended. (2) Respondents' long-term career goals are compared with their parents' occupational prestige to obtain a measure of *aspired social mobility* (difference between the two prestige scores). The aspired social mobility of the school leavers is then set in relation to the type of Gymnasium attended.

First, inspection of the mean prestige scores of the students' career goals shows that students at traditional Gymnasium schools (see Figure 5) aspire to jobs with higher mean occupational prestige than do their peers at vocational Gymnasium schools. If students at vocational

Gymnasium schools prove to come from lower socioeconomic status groups than their peers at traditional Gymnasium schools, this weak effect of the type of

Figure 5. Aspired social mobility by type of Gymnasium attended.



Gymnasium might indicate that differences in social background that already exist at entry to upper secondary schooling are perpetuated in students' career aspirations. For any conclusions about the reproduction of social inequality or differences in social mobility to be drawn, parents' occupations must also be taken into account. We define students' *aspired social mobility* to be the difference between the prestige scores of their long-term career aspirations and the prestige scores of their parents' occupations. We are particularly interested in any differences in aspired social mobility that can be discerned as a function of the type of Gymnasium attended. The mean occupational prestige of the careers aspired to by students at traditional Gymnasium schools is $M = 2.31$ points ($p < .001$) higher than the prestige of their parents' careers (more specifically, of their mother's or father's career, depending on which scores higher on the prestige scale). On average, the aspired social mobility scores of students at vocational Gymnasium schools exceed those of their peers at traditional Gymnasium schools by $b = 3.45$ ($p < .001$). Hence, students at vocational Gymnasium schools aspire to jobs scoring an average of 5.76 points higher on the prestige scale than their parents' jobs. This finding in itself could be interpreted as an indication of upward social mobility. It is also interesting to examine parents' occupational prestige scores as a function of the type of Gymnasium that their children attend. Parents of students in vocational Gymnasium schools score $b = -5.02$ points ($p < .001$) lower on this scale than par-

ents of students in traditional Gymnasium schools. The difference in the prestige scores of the careers aspired to by the students is much smaller, at just $b = -1.57$ points ($p < .001$), consistent with the differences observed in aspired social mobility (see Figure 5). Given that marked differences in social background characteristics were ascertained at the beginning of upper secondary schooling, these results indicate that vocational Gymnasium schools serve to reduce inequality. Figure 5 shows the social background, occupational prestige of the long-term career goal, and aspired social mobility of the two student groups. Further analyses will investigate the role of different occupational fields and university courses for the occupational prestige attained by the TOSCA respondents over time.

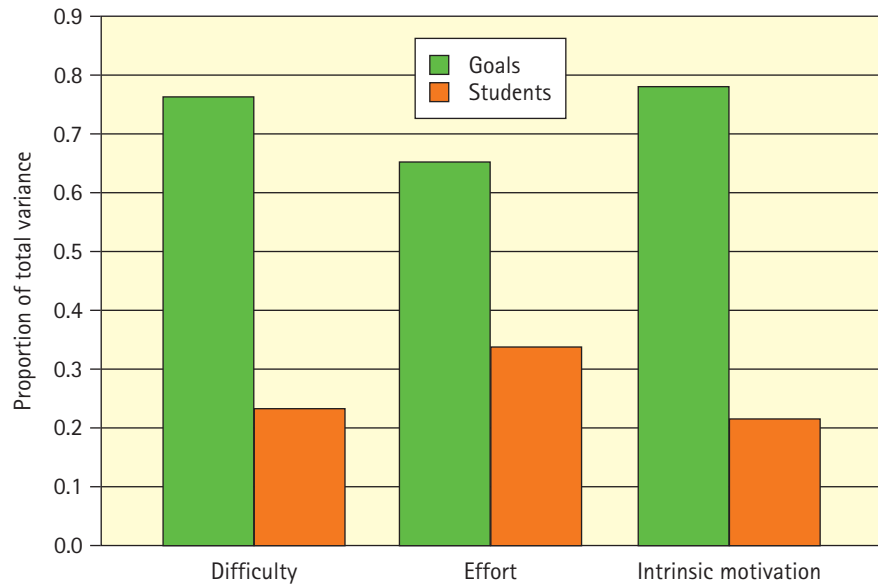
Personal Goals of Students at Gymnasium Schools

One of the central psychological components of the TOSCA study involves the in-depth investigation of students' personal goals. Two methods were applied. First, students were asked to rate their agreement with a list of goals ("To be rich and famous. How important is this goal to you?") presented in a questionnaire (Klusmann, Trautwein, & Lüdtke, 2005). Second, students were asked to name six goals they planned to pursue in the coming months and years (Lüdtke, in press). In the next step, they were asked to rate these goals on various dimensions; for example, how difficult it would be to achieve each goal, and why they wished to pursue it (e.g., self- vs. other-determined goals).

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Figure 6. Personal goal ratings: Variance at the goal and the student level.



Here, it is interesting to explore whether an individual rates all of his or her goals in the same kind of way. Do individuals rate all their goals to be similarly difficult, for example, or do they simultaneously pursue goals of varying difficulty levels? Do people pursue some goals for other-determined reasons (e.g., because their parents and friends expect it of them) and others for self-determined reasons? When addressing this question, it is important to remember that personal goals have a multilevel structure analogous to that familiar from school research: Goals are nested within individuals in the same way as students are nested within schools. In a multilevel analysis (HLM), we thus split the variance in goal ratings into two components: variance *between* individuals (i.e., at the student level) and variance *within* individuals (i.e., at the goal level). It emerged that most (between 65% and 78%) of the variance was within individuals. The results of the variance components

analysis for three selected goal attributes are documented in Figure 6. What are the implications of these findings for research on personal goals? In terms of *content*, it can be argued that there are significant differences in respondents' ratings at the goal level. These differences are neglected when data are aggregated at the person level, as is very often the case in research on personal goals. It is thus important to explore whether, and to what extent, these differences at the goal level constitute theoretically relevant variance that is related to key outcome measures. From a *psychometric* perspective, though, it is important to note that, even with large differences in goal ratings, satisfactory reliabilities for aggregated person scores can be attained by means of the *aggregation principle* provided that data are aggregated over a sufficiently large number of goals. The conclusion to be drawn is that future research involving personal goal ratings should provide a breakdown of variance.

Learning Opportunities Provided by Homework

Our work on the effects of homework assignments and homework completion originated from analyses conducted within the BIJU study (e.g., Trautwein, Köller, Schmitz, & Baumert, 2002; Trautwein & Köller, 2002), and has become an additional field of interest within Research Area I that forges a strong link to Research Area II. The homework project draws on data sets from different sources, such as PISA 2000, PISA 2003, and a study conducted in collaboration with the University of Fribourg, Switzerland.

From a conceptual and methodological point of view, homework research calls for a multilevel perspective (Trautwein & Köller, 2003b) in which the effects of homework assignments (teacher variables) and of homework completion (student variables) are separated. Trautwein and Köller (2003e) have proposed a multilevel homework model as a general framework for homework research. According to this model, students' homework behavior impacts on their achievement, whereby effort and the use of learning strategies are predicted to be more important than the time spent on homework. Moreover, in line with the predictions of expectancy-value theory, as described in the work of Jacquelynne Eccles, homework behavior is believed to be heavily influenced by motivational predictors (e.g., belief in being able to solve homework problems, perceived utility of homework problems). The effects of cognitive abilities and personality as well as the impact of the family context and parental behavior are seen

as (partially) mediated by motivational predictors. Likewise, effects of the instructional environment (e.g., homework quality and control) are expected to be partially mediated by homework motivation.

Among the questions addressed by the homework project, several are of great practical interest to teachers, students, and their parents (e.g., Trautwein & Köller, 2003e; Trautwein & Kropf, 2004). For instance, do homework assignments improve student achievement? Our studies (e.g., Trautwein, Köller, Schmitz, & Baumert, 2002) indicate that frequent homework assignments in 7th-grade mathematics are positively associated with achievement gains on the class level, but that long time-consuming assignments do not show positive effects. Focusing on individual students within the same classroom, those who put a lot of effort into their mathematics homework (but do not necessarily report long study times) fare better than those who invest less effort. In contrast to common beliefs, homework control by teachers and parents is only loosely connected to the effort invested in homework.

A second question of great practical relevance is whether—as some teachers claim—students' homework behavior is largely dependent on stable personality characteristics of the students and less so on the characteristics of a specific academic subject or the quality of homework. Our results only partially support this view. On the one hand, there is indeed a substantial significant correlation between students' homework behavior across domains. On the other hand, the strength of this cor-

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die tageszeitung

Annoying Parents

Anyone who has ever been to school knows that homework is a pain. But now there is scientific evidence to confirm that homework is particularly annoying **when Mom (or even Dad) sits down uninvited at the table**, offering help and motivation. Educational scientist Ulrich Trautwein has investigated the **educational value of homework** and identified the main motivational problems facing young people. These include the interference of overly concerned parents—and the time that homework takes. **The longer kids spend at home puzzling over math problems, the less fun they have**—and the less they learn. But **teachers also make mistakes** when setting homework. Instead of giving students **individualized assignments**, they expect their charges to continue **drilling what has been learned in the lesson, mechanically applying set routines**. So is homework pointless? No, says

Trautwein, researcher at the Max Planck Institute, with homework it's a case of "no pain, no gain." It's just important to realize that, in this case, pain does not mean the amount of time spent on homework, but "the effort made to do it properly."

relation leaves room for factors other than stable personality characteristics as well. Data from more than 80 classrooms with French as a second language (joint project with the University of Fribourg) revealed teacher effects on both homework motivation and homework effort.

Students' perceptions of homework quality have a significant impact on their homework motivation (expectancy and value) which is, in turn, associated with a higher percentage of homework tasks completed (e.g., Trautwein & Köller, 2003e).

NERVIGE ELTERN

Dass Hausaufgaben ätzend sind, weiß jeder Schüler. Nun ist aber wissenschaftlich nachgewiesen, wann die Heimarbeit besonders nervt – wenn Mama (oder gar Papa) sich ungefragt mit an den Tisch setzt, um zu helfen und zu motivieren. Der Bildungsforscher Ulrich Trautwein hat den **pädagogischen Wert von Hausaufgaben** untersucht und dabei die wichtigsten motivationalen Probleme für Jugendliche identifiziert: Die **fürsorgliche Belagerung durch die Eltern** gehört dazu. Und der Zeitaufwand für Hausaufgaben. **Je länger die Kids zu Hause an Mathe knobeln, desto weniger Spaß haben sie – und desto geringer sind die Lerneffekte. Aber auch die Lehrer machen Fehler...**

Research Area II

Establishing a Monitoring System for Educational Performance: Foundational Studies

Germany is one of the few industrial states which has only recently begun to establish a national system of quality control to monitor the outcomes of educational processes. The Center for Educational Research's involvement in large-scale assessments and studies on associated methodological and content-related topics is an integral part of this process of establishing a monitoring system for educational performance in Germany. The country's participation in TIMSS and PISA has provided reliable data on the performance of selected cohorts of students in curricular and cross-curricular domains (Stanat & Lüdtke, in press). After conducting the first cycle of the PISA study in 2000, the Center handed over responsibility for future large-scale assessments, particularly the second wave of PISA (PISA 2003), to the Leibniz Institute for Science Education at the University of Kiel.

The Programme for International Student Assessment (PISA)

In 1997, the OECD launched a program to monitor the outcomes of education systems in terms of student achievement, and to provide internationally comparable indicators of performance in key domains on a regular basis. All 16 of the German states are participating in PISA. The Center for Educational Research headed the consortium responsible for the management of PISA 2000 in Germany. The Center is also involved in the 2003 assessment, using it mainly as a vehicle for research.

PISA is designed to provide information on the outcomes of school systems in the participating countries. The project assesses the 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 three-year cycles, the study presents a tool for monitoring changes in the performance of coun-

tries' education systems and for gauging the effects of measures taken to improve learning outcomes. PISA allows for in-depth analyses of the outcomes of educational systems within and across the participating countries. The project is designed to yield three types of indicators:

- Profiles of the knowledge and skills acquired by students approaching the end of compulsory education in curricular and cross-curricular domains. These profiles pinpoint the strengths and weaknesses of educational systems and locate areas requiring action.
- Contextual indicators relating performance to student and school characteristics. Information on these relationships can shed light on the effectiveness of educational systems and draw attention to possible points of intervention.
- Trend indicators showing how results change over time.

Data collection for the first cycle of PISA took place in the year 2000, and a total of nine reports were sub-

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Klaus-Jürgen Tillmann (University of Bielefeld),
Manfred Weiß (German Institute for International Educational Research)

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Prenzel, M., Baumert, J., Blum, W., Lehmann, R., Leutner, D., Neubrand, M., Pekrun, R., Rolff, H.-G., Rost, J., & Schiefele, U. (Eds.). (2004). *PISA 2003. Der Bildungsstand der Jugendlichen in Deutschland—Ergebnisse des zweiten internationalen Vergleichs*. Münster: Waxmann.



sequently published by the PISA 2000 consortium as well as members of the Center. The second cycle of PISA was conducted in 2003, with the first report being published in 2004 (Prenzel et al, 2004). Based on theoretical approaches from psychology, sociology, and education, the Center for Educational Research has systematically extended the international design of the project, allowing us to explore basic research questions from multi-

ple perspectives with representative samples of students (see Table 1). In addition to the three curricular domains of reading literacy, mathematical literacy, and science literacy, the research design covers cross-curricular competencies. The Center played a leading role in establishing (Baumert et al., 1998; Artelt et al., 2000) and evaluating (Artelt, Baumert, Julius-McElvany, & Peschar, 2003) a framework for a self-report measure to assess cross-

Table 1
Some national supplements to the international PISA design for analyses of knowledge structures and their determinants

| Reading | Mathematics | Science | Cross-curricular competencies | Student background |
|--|---|--|--|--|
| <ul style="list-style-type: none"> Assessment of learning from texts as a component of reading literacy distinct from working with texts Assessment of proximal antecedents of text comprehension to identify possible points for intervention | <ul style="list-style-type: none"> Fine-grained differentiation and description of competency classes Addition of a broader range of items assessing aspects of mathematical literacy not covered by the international test Ratings of items based on a theory of cognitive demands Identification of effects of curricular and didactical traditions on knowledge structures | <ul style="list-style-type: none"> More comprehensive assessment of understanding of scientific concepts to test the distinction between concept and process components of scientific literacy Identification and description of competency levels Differentiation of five cognitive competencies defined in terms of processes in working out science problems | <ul style="list-style-type: none"> Assessment of general problem-solving skills and validation of the construct Assessment of aspects of social competence Exploration of the role schools play in the development of cross-curricular competencies | <ul style="list-style-type: none"> Assessment of mental ability as a control variable for estimating effects of individual-level and school-level factors Assessment of additional indicators for students' social background More differentiated assessment of families' migration history Assessment of peer-group characteristics |

curricular competencies, particularly affective constructs related to self-regulated learning. The implementation of the scales developed (Baumert et al., 1998) was optional for the countries participating in PISA 2000, but has become a permanent component of future PISA cycles and of other large-scale assessments.

Reading Literacy

Each cycle of the international PISA program focuses on one of the three assessment domains. In the first cycle, this major domain was 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 US National Assessment of Educational Progress (NAEP) and the OECD's International Adult Literacy Study (IALS). For the purposes of reporting, three scales were constructed, summarizing students' performance in retrieving information, in interpreting texts, and in reflecting and evaluating. The PISA reading assessment covers a broad range of text types. In addition to continuous texts, which are typically organized in sentences and paragraphs (narratives, etc.), it also includes noncontinuous texts, such as graphs, tables, and forms, that present information in a variety of different ways. Thus, PISA adopts a relatively broad notion of what constitutes a text. In-depth analyses of both the international reading literacy tests and the German extension assessments (of learning from texts and additional proximal antecedents, see Table 1) are presented in a thematic

report on the structure, development, and teaching of reading literacy, edited by Schiefele, Artelt, Schneider, and Stanat (2004).

Mathematical Literacy

Mathematical literacy was a minor domain in the first survey cycle, but became the major domain of the 2003 assessment. The international PISA framework for the assessment of mathematical literacy is strongly influenced by the "realistic mathematics" approach introduced by Hans Freudenthal. The 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 research on instruction. Detailed analyses of the international test conception as well as the German extension assessments (see Table 1) have been published in a thematic report examining mathematical literacy among students in Germany (Neubrand, 2004).

Scientific Literacy

Scientific literacy was also a minor component of the first PISA cycle. It

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Baumert, J., Stanat, P., & Watermann, R. (Eds.) (in prep.). *Herkunftsbedingte Disparitäten im Bildungswesen: Differenzielle Bildungsprozesse und Probleme der Verteilungsgerechtigkeit*. Wiesbaden: VS Verlag für Sozialwissenschaften.

will be the major domain of the third cycle, which will take place in 2006. In line with the Anglo-American notion of scientific literacy, as described in documents, such as the Benchmarks for Science Literacy published by the American Association for the Advancement of Science, the international PISA framework emphasizes process skills. It 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 the understanding of scientific concepts. Although some scientific knowledge is needed for all five processes, only the fifth primarily focuses on this particular aspect of scientific literacy. In other words, the understanding of scientific concepts is not intended to be the main challenge posed by the items designed to assess the first four of the processes covered in the international PISA test.

The scientific framework was supplemented by items (see Table 1) that allowed for further differentiation of cognitive competencies, also in terms of the curricular domains of chemistry, biology, and physics. An overview of the international and national test conceptions and the main results is provided in a thematic report on science education in Germany, published by Rost, Prenzel, Carstensen, Senkbeil, and Groß (2004).

Besides the relatively low performance of German students in the 2000 PISA assessment, other aspects of the results sparked widespread debate. While there is a link between social background and achievement in all PISA countries, nowhere is this relationship as strong as it is in Germany. PISA covers a broad range of student background indicators. A thematic report provides in-depth analyses of the role of student background, in terms of both socioeconomic status and migration background.

In response to the PISA results, the Center has established a new Research Area (see Research Area III) to analyze effective ways of improving reading and language comprehension, focusing particularly on the needs of students from migration backgrounds and families with low socioeconomic status.

In the following, we outline key findings on the topics of school-effectiveness, reading literacy, and cross-curricular competencies, and present three analyses of methodological research questions in the area of large-scale assessment.

School-Effectiveness Research in the Context of Large-Scale Assessments

Using the instruments developed within large-scale assessment projects, our Center has carried out several studies to evaluate innovative school programs. These studies demonstrate how system monitoring and research on whole-school reform—two traditions that, for a long time, were considered to be largely incompatible—can be linked. Building on an investigation of five com-

prehensive schools in the Land of Hesse using instruments from TIMSS and BIJU (Köller & Trautwein, 2003c), we performed an extensive evaluation of the *Laborschule Bielefeld*. The *Laborschule* is one of the most interesting and controversial schools in Germany, having implemented substantial structural changes. It is a comprehensive school that aims at attracting a heterogeneous student body, adopts an experience-oriented approach to teaching and learning, and gives learning reports instead of grades as performance feedback. Due to its strong emphasis on developing the skills and orientations necessary to function as an autonomous citizen, moreover, the school tries to provide an environment that functions like a small society and gives students the opportunity to experience being part of a democratic system. We explored the extent to which this kind of set-up can succeed in meeting the school's stated goals in the domains of personality development and civic education as well as learning goals in the curricular domains of reading, mathematics, and science. The findings indicate that the school is indeed very effective in developing students' competencies, interests, and attitudes in political and social domains. In terms of curricular achievement, however, the picture is mixed. In reading and science, the students at the *Laborschule* reached levels of proficiency that one would expect them to reach on the basis of their background (value-added analyses). In mathematics, however, they clearly lagged behind comparable peers in other schools. This pattern of findings suggests that the

structural changes implemented by the *Laborschule*, some of which are quite similar to Scandinavian school systems, cannot necessarily be expected to result in improved performance. Instead, the crucial factor seems to be quality of instruction, which is apparently higher in some domains of the *Laborschule* than in others.

Reading: Comparison of Performance on Narrative and Nonnarrative Texts

In Germany, the PISA results also prompted a discussion on the adequacy of the reading literacy assessments implemented in the study. It was speculated that the relatively high proportion of noncontinuous texts and the low proportion of continuous narratives might have resulted in German students' performance being underestimated, given that German curricula/standards traditionally pay relatively little attention to noncontinuous texts and—especially in higher grades—concentrate on literature rather than on other text genres.

As a first step, we tested whether these two dimensions could be distinguished. Previous research has shown that there are good reasons for distinguishing narratives from other text genres, particularly those that include graphs and pictures, when it comes to reading and text comprehension (Schnotz & Dudtke, 2004). Dimensionality analysis of the reading items confirms that reading literacy can be differentiated along these dimensions. Of the 129 reading items that were administered in PISA 2000, 17 items referred to 4 narrative texts, 70 items to other

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Key Reference

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types of continuous texts, and the remaining 42 items to noncontinuous texts, like maps, graphs, etc. The task demands of the different text genres proved to differ. As expected, the lowest correlations among the three factors were found between narratives and noncontinuous texts (Artelt & Schlagmüller, 2004). Comparison of mean student performance on the three separate reading literacy factors (narratives, other continuous texts, and noncon-

tinuous texts) shows that, overall, German students did not do better on narrative texts, but in fact performed relatively worse on these tests than on the other text types. Table 2 lists means and standard errors for the three reading factors broken down by countries. Note that, due to the study design, the country means of countries with special education schools are overestimated. Because the test booklets for special education students did not cover all

Table 2
Mean student performance on the three reading factors (narrative texts, continuous texts, noncontinuous texts) by country

| Narrative texts | | | Continuous texts | | | Noncontinuous texts | | |
|------------------------------|------------|------------|------------------------------|------------|------------|------------------------------|------------|------------|
| Country | Mean | SE | Country | Mean | SE | Country | Mean | SE |
| Finland | 540 | 2.6 | Finland | 558 | 3.2 | Finland | 558 | 2.6 |
| Canada | 529 | 1.9 | Canada | 537 | 1.9 | New Zealand | 545 | 3.0 |
| Korea | 526 | 3.1 | Korea | 534 | 2.7 | Australia | 545 | 3.6 |
| Ireland | 521 | 3.8 | Australia | 533 | 3.9 | Canada | 540 | 1.9 |
| New Zealand | 520 | 3.2 | Japan | 531 | 5.6 | Ireland | 537 | 3.9 |
| Norway | 518 | 3.7 | New Zealand | 531 | 3.5 | United Kingdom | 537 | 2.5 |
| United Kingdom | 516 | 3.0 | Ireland | 528 | 3.9 | Sweden | 529 | 2.9 |
| Australia | 513 | 4.0 | Sweden | 524 | 2.5 | Korea | 525 | 2.9 |
| Sweden | 511 | 2.7 | United Kingdom | 519 | 3.0 | Belgium ¹ | 525 | 3.5 |
| Iceland | 509 | 2.5 | Belgium ¹ | 517 | 3.6 | Japan | 522 | 5.7 |
| Austria | 509 | 3.2 | Iceland | 515 | 2.0 | Norway | 520 | 3.5 |
| Japan | 505 | 4.3 | Austria | 513 | 3.2 | France | 518 | 3.1 |
| Hungary ¹ | 505 | 4.2 | Norway | 507 | 3.5 | Iceland | 515 | 2.5 |
| Czech. Republic ¹ | 502 | 2.6 | United States | 507 | 7.1 | Denmark | 512 | 3.0 |
| OECD Mean | 499 | 0.8 | OECD Mean | 506 | 0.7 | United States | 510 | 6.8 |
| Belgium ¹ | 497 | 3.6 | France | 502 | 3.4 | OECD Mean | 508 | 0.8 |
| United States | 497 | 7.6 | Switzerland | 502 | 4.8 | Czech. Republic ¹ | 507 | 2.9 |
| Portugal | 496 | 4.9 | Denmark | 501 | 3.2 | Austria | 505 | 2.8 |
| Russ. Federation | 492 | 4.2 | Germany¹ | 499 | 3.0 | Germany¹ | 500 | 2.7 |
| Spain | 488 | 3.4 | Italy | 495 | 3.3 | Spain | 498 | 3.4 |
| Germany¹ | 485 | 3.6 | Czech. Republic ¹ | 495 | 3.0 | Switzerland | 497 | 4.7 |
| Greece | 485 | 5.0 | Spain | 494 | 2.8 | Hungary ¹ | 490 | 4.7 |
| Denmark | 483 | 3.0 | Hungary ¹ | 487 | 4.4 | Italy | 486 | 3.5 |
| France | 483 | 3.4 | Greece | 482 | 6.3 | Portugal | 466 | 5.1 |
| Italy | 477 | 3.2 | Portugal | 472 | 4.8 | Russ. Federation | 458 | 4.7 |
| Switzerland | 475 | 4.4 | Latvia | 463 | 5.6 | Greece | 458 | 5.4 |
| Latvia | 472 | 5.5 | Russ. Federation | 461 | 4.6 | Latvia | 456 | 5.4 |
| Luxembourg | 445 | 3.0 | Luxembourg | 443 | 2.3 | Luxembourg | 447 | 2.3 |
| Mexico | 435 | 3.5 | Mexico | 427 | 3.8 | Mexico | 406 | 4.3 |
| Brazil | 416 | 3.5 | Brazil | 396 | 3.5 | Brazil | 369 | 4.0 |

¹ Without students from special education schools.

Countries marked in grey: Not statistically different from the OECD mean. SE = Standard error.

three factors, these students had to be excluded from this analysis, resulting in reduction of 4% of the age cohort in Germany (and an overestimation of the combined reading literacy scale of about 10 points). Some countries, including the Russian Federation, Brazil, Portugal, and Hungary, score higher on the narratives factor than on the combined reading literacy scale. Germany is among the 17 countries that score lower on the narratives factor than on the combined reading literacy scale (Artelt & Schlagmüller, 2004). What are the implications of these findings? For one thing, it is clear that the low coverage of narrative texts in the PISA test does not mean that the overall performance of 15-year-olds in Germany is underestimated. Given that narratives and literature are a major focus of German language arts classes, the findings also indicate that the approach taken in German schools does not seem to help students to interpret narratives and literature.

Assessment of Cross-Curricular Competencies

Our Center has contributed substantially to the development of large-scale assessments by drawing up a framework for the assessment of cross-curricular competencies and developing a brief self-report measure of affective constructs, covering processes relevant to lifelong and self-regulated learning.

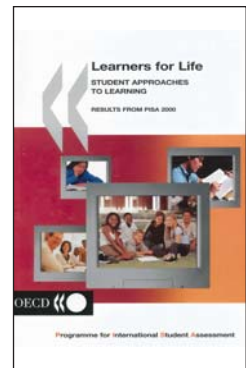
What is the Rationale for Assessment Cross-Curricular Competencies Within Large-Scale Assessments?
PISA is the first international assessment study that goes beyond the

measurement of knowledge and skills in curricular domains and attempts to capture so-called cross-curricular competencies that can be applied in a broad range of situations. This approach follows the general idea that the goals of formal education are not restricted to maximizing curriculum-based knowledge. The approach taken to measure affective constructs related to self-regulated learning is based on Boekaerts' (1997) model of self-regulated learning, which assigns equal status to the cognitive and motivational components of learning. Boekaerts defines self-regulated learning as a complex interactive process involving motivational as well as cognitive self-regulation. Ideally, at the end of their school career, students should have acquired not only competencies in school subjects but also the ability to evaluate whether their approaches to learning are effective, and to gauge their own levels of interest, motivation, and proficiency. Motivation is vitally important for young people leaving school. Similarly, the capacity to evaluate one's own effectiveness and learning strategies is relevant for working life as well as for leisure activities. A positive self-concept, finally, helps individuals to overcome barriers in such activities.

By analyzing students' approaches to learning, namely their motivation, their use of learning strategies, and their academic self-concepts, PISA focuses on central prerequisites for effective self-regulation and lifelong learning. Given that almost no affective scales have been used in former large-scale assessments, the evalua-

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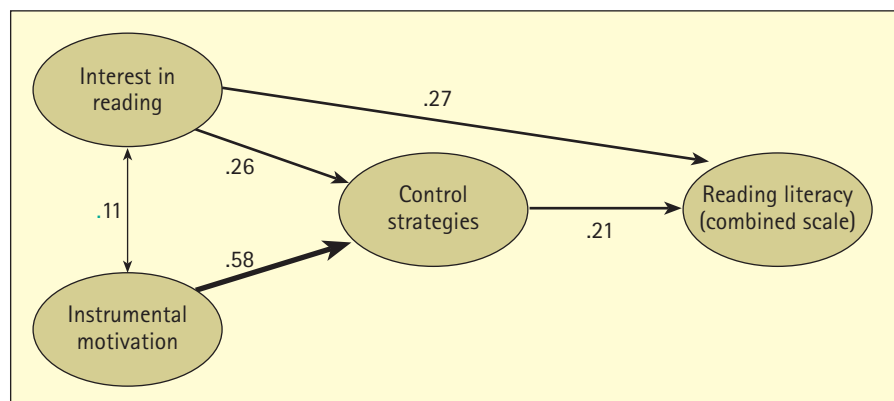


tion of scale equivalence across nations had to be analyzed systematically. As could be shown with multi-group structural equation models as well as comparisons of model fits within each country, the factor structure of the scale does hold (Artelt et al, 2003; Marsh et al., submitted).

The data obtained from the 26 countries that participated in the assessment of affective constructs offer a variety of opportunities to address basic research questions. For example, we investigated the invariance of structural (functional) relations between intrinsic and extrinsic motivation, and students' use of learning strategies as well as their performance on the reading literacy tests across countries. Although intrinsic and extrinsic motivation are often seen as antagonists, both might be important in the regulation of actual learning behavior. Indeed, both are part of the task value component of Eccles' expectancy-value model of achievement-related behavior (Wigfield & Eccles, 2000). In most countries, extrinsic and intrinsic motivation to learn proved to vary independently of each other, and it is

only in a few countries that students who express an interest in reading also seem to be motivated to study because they think it will improve their career prospects. It seems that, in general, the two types of motivation are by no means antagonistic. It was assumed that motivation determines the decision to become engaged in a task and that strategies are the tools used to actually accomplish a task. Indeed, in all countries, students' motivation to learn—especially their instrumental motivation—has a profound impact on their use of control strategies. In addition, this mediation model lends strong support to the hypothesis that students will only control their learning if they are well motivated. Since control of the learning process (like motivation to learn) is, to some extent, an outcome in its own right, helping students to become lifelong learners, this finding is important. It suggests that in all countries, adopting an effective learning strategy depends not just on having cognitive tools (knowing how to learn) but also on having certain attitudes and dispositions (wanting to learn). Figure 1 summarizes these results,

Figure 1. Illustration of the functional relationships (SEM, county average) between motivation, control strategies, and reading literacy.



presenting average path coefficients across countries.

What are the effects of interest in reading and instrumental motivation on reading performance? Interest in reading has a particularly strong link with performance, which is largely independent of the fact that good readers are more likely to adopt certain strategies. On the other hand, students motivated by external factors like getting a good job perform better only where they have other strengths, such as controlling their learning. Students who take a self-evaluative perspective to learning, that is, make frequent use of control strategies, tend to far outperform their peers. The effect of instrumental motivation on performance in the reading literacy assessment can thus primarily be considered a mediated effect (Artelt, in press).

Thus, even where it proves hard to engender a strong love of learning for its own sake among students who have not had this message reinforced in their home and social environment, the evidence shows that students driven by factors, such as job prospects, are more likely to set and monitor learning goals and therefore give themselves a better chance of performing well.

Although there are differences between the 26 participating countries, the picture to emerge from the findings is relatively consistent across the countries. Within the individual educational systems, students who have acquired the prerequisites for self-regulated learning in terms of motivation and learning strategies are at a relative advantage in developing academic competencies. Both intrinsic and extrinsic forms of moti-

vation play an important role in the learning process, although possibly via different mechanisms.

Validity of Large-Scale Assessments

A second focus of research at the Center for Educational Research is concerned with the methodological aspects of large-scale assessment. Research findings related to the following three questions are presented below:

- (1) How do different incentives affect test motivation, effort, and performance on the PISA assessment?
- (2) Is students' performance on a low-stakes test sensitive to coaching?
- (3) Are PISA test scores comparable across countries?

(1) How do Different Incentives Affect Test Motivation, Effort, and Performance on the PISA Assessment?

Large-scale assessments like PISA are often low-stakes tests. In other words, performance on the test has no direct consequences for the students themselves. Given also that neither high-stakes nor low-stakes assessments are very common among German students, we were interested in whether different incentives would affect students' motivation or test performance. We conducted an experiment to test the effects of different types of test motivation on student performance, investigating the impact of (1) social incentives associated with participation in an international study, (2) informational feedback on performance, (3) grades, and (4) performance-contingent financial rewards.

Key References

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The findings suggest that all of these conditions make various components of test motivation equally salient. Accordingly, no differences were found with respect to either intended and invested effort or test performance (Baumert & Demmrich, 2001).

(2) Is Students' Performance on a Low-Stakes Test Sensitive to Coaching?

Coaching is known to improve student performance on tests with high personal relevance (high-stakes tests). To our knowledge, however, there is no research on whether coaching prescribed by outside agents (low-stakes situations) produces similar effects to coaching programs that students elect to join in order to boost their test scores and hence enhance their future prospects (high-stakes situations). We thus explored whether student performance on the reading and mathematics tests of the PISA assessment can be fostered by coaching (and administering a pretest). More specifically, we explored the

potential effects of authentic coaching by a class teacher, and thus investigated the effects of coaching activities that might actually have been implemented by the teachers of students participating in PISA 2003. Coaching and pretest effects were studied for each content domain separately in a pre-/posttest quasi-experimental design. To examine the differential effects of academic tracks, samples were drawn from German Hauptschule and Gymnasium schools (a total of 1,323 students from 66 classes). Teachers prepared their students for the PISA assessment during regular lessons in the week between the pre- and posttest based on the insights they had gleaned from the published frameworks, the released test items, and the mathematics and reading literacy chapters of the German PISA 2000 report. Results show that only the combined effects of pretesting and coaching have substantial positive effects on student performance. The incremental effects of coaching and pretesting in high-stakes tests are slightly

Table 3
Means and standard deviations at pre- and posttest and effect size of differences broken down by subject, school type, and treatment condition

| | | | Pretest | Posttest | |
|---------------------|-------------|----------------------|------------------------|------------------------|----------|
| Treatment condition | | | <i>M</i> (<i>SD</i>) | <i>M</i> (<i>SD</i>) | <i>d</i> |
| Reading | Hauptschule | Coaching and pretest | 426 (81) | 422 (93) | -.04 |
| | | Pretest | 431 (75) | 417 (84) | -.17 |
| | Gymnasium | Coaching and pretest | 565 (59) | 577 (89) | .18* |
| | | Pretest | 566 (67) | 557 (91) | -.13 |
| Mathematics | Hauptschule | Coaching and pretest | 429 (59) | 438 (69) | .16* |
| | | Pretest | 445 (54) | 457 (69) | .20 |
| | Gymnasium | Coaching and pretest | 539 (63) | 563 (68) | .36* |
| | | Pretest | 562 (64) | 568 (62) | .11 |

higher, but comparable to the effects found in the present study (aggregated across academic tracks). Thus, the personal relevance of the test results seems to play a minor role (see also Baumert & Demmrich, 2001). Coaching in a classroom setting (e.g., for PISA) can be almost as effective as professional coaching programs (e.g., for the SAT). In line with the research literature on high-stakes tests, the effects observed are higher in mathematics than in the reading domain (Brunner, Artelt, Krauss, & Baumert, submitted).

(3) Are PISA Test Scores Comparable Across Countries? Language Background of Items as a Systematic Source of Variance

The possibility that students are at an advantage when working on reading literacy items from their own cultural and linguistic background in an international large-scale assessment can be seen as a threat to the fairness of a test. Effects of this kind have been reported quite frequently in the assessment literature (Allalouf, 2003; Gierl & Khaliq, 2001). The relative difficulty of items often shifts when they are administered in different countries, due to either translation issues or differential opportunities to learn. The international PISA reading literacy assessment consists of test material (texts) from eight different source languages.

An IRT-based analysis of differential item functioning (DIF) was performed for the PISA reading literacy items to investigate whether students of equal ability, but from different language groups, have a sys-

tematic advantage when processing items originating from their own cultural and linguistic background. Effects of this kind were discerned, especially items originating from France ($d = .21$) and Greece but also for German items. Translated to the PISA scale ($M = 500, SD = 100$)—and assuming that these effects generalize—the effect size of .21 indicates that French students would score 21 points higher if the test consisted of items originating from French-speaking countries only. Given that only a few items from non-English-speaking countries were contained in the PISA assessment, this phenomenon does not significantly affect the mean performance of these countries, as a reanalysis of student performance on a test without the biased items shows.

But does this mean that students from English-speaking countries are at an advantage? Since the majority of items stem from English-speaking countries, these effects were modeled by rescaling rather than DIF

Key Reference

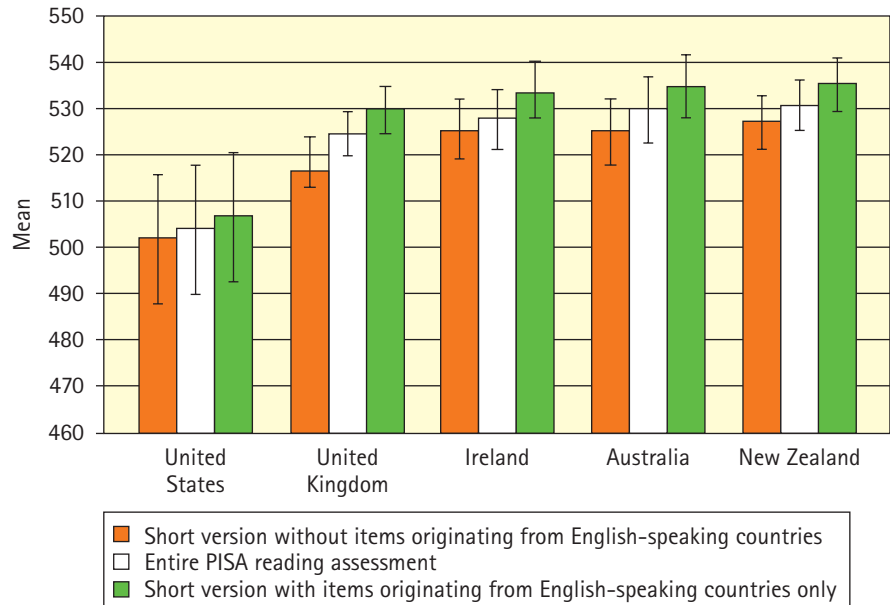
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Table 4
Absolute numbers and relative proportions of items from the PISA reading literacy assessment by source language

| Source language | Absolute number | Relative proportion (in %) |
|------------------------|-----------------|----------------------------|
| English | 66 | 51 |
| Finnish | 11 | 8 |
| French | 18 | 14 |
| German | 5 | 4 |
| Greek | 3 | 2 |
| Spanish | 4 | 3 |
| Swedish | 6 | 5 |
| Danish | 1 | 1 |
| IEA items ¹ | 16 | 12 |
| Total | 129 | 100 |

¹ These items were taken from the *International Adult Literacy Study* initiated by the *International Association for the Evaluation of Educational Achievement* (IEA).

Figure 2. Country means for five English speaking countries in the overall reading test and two short versions, consisting either only of items originated from English speaking countries or all items but those from English speaking countries.



Error indicator: Standard error ($\pm 2SE$).

analysis. We rescaled the achievement scores of students from English-speaking countries for the set of items originating from English-speaking countries only as well as for the set of all other items. The relative advantages discerned for students in the English-speaking countries are far less pronounced (see Figure 2) than would be expected based on the results for the items originating from French-speaking countries.

The fact that most items stem from the Anglo-American background does not mean that students in the five English-speaking countries perform significantly better than their peers elsewhere. Rescaling achievement scores for the set of items originating from English-speaking countries only does not lead to significant differences relative to results on the entire assessment, and it

is only in the United Kingdom that scores on the set of items from English-speaking countries are significantly higher than those on the set of items from non-English-speaking countries.

Overall, results confirm that the source language of the items implemented in international student surveys can be regarded as a systematic source of variance. The cultural bias that may result can be addressed—as was done in PISA 2000—by administering a balanced multi-cultural mix of test items (Artelt & Baumert, 2004).

Research Area III Promoting Language Skills and Reading Literacy: Intervention Studies

Partly in response to results from the *Programme for International Student Assessment (PISA)* that is part of Research Area II within the Center for Educational Research, we launched a series of intervention studies on approaches to promoting students' language skills and reading literacy. National and international analyses of the PISA data revealed that students in Germany perform below the OECD average in reading literacy and that this relative disadvantage is particularly pronounced among students at the lower end of the achievement distribution (Schiefele, Artelt, Schneider, & Stanat, 2004). Almost 25% of the 15-year-olds in Germany failed to reach proficiency level II as defined in PISA and are therefore likely to encounter problems in making the transition from school to work. In addition, the relationship between reading literacy and family background was found to be quite strong within the German school system. Poor readers are highly over-represented among students from families with lower socioeconomic status and among students from immigrant families (Baumert, Stanat, & Watermann, in press; Schümer, Tillmann, & Weiß, 2004). Similarly, there are pronounced differences between students from families with higher and lower socioeconomic status in terms of other important learner characteristics, such as interest in reading, self-efficacy beliefs, and the frequency with which students use learning strategies (Artelt, Baumert, McElvany, & Peschar, 2003). This pattern of results indicates that, overall, Germany seems to be less successful than other countries in helping students with different backgrounds reach acceptable levels of achievement in central domains.

As a consequence of these findings, a new research program has been initiated at the Center for Educational Research that aims at developing and evaluating measures designed to help students acquire proficiency in German language skills and reading literacy. Building on the theoretical framework of PISA, the program focuses on basic competencies representing prerequisites for learning in most domains. Taking into account that, to a large extent, success within the German school system hinges on the transition from elementary to lower secondary school, the studies are targeted primarily at students who have not yet

made this transition. Thus, Research Area III explores the development of central foundations for school success in the domains of language and reading. This complements the ENTERPRISE project within Research Area IV, which analyzes similar foundations in mathematics and science. The new line of research involves four ongoing projects and one completed study. The investigations aim at developing and evaluating approaches to promoting language and literacy skills within the contexts of schools, families, and summer programs. Two of the studies attempt to specify dimensions of second-language acquisition that present spe-

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Figure 1. Father and daughter participating in the parent-child reading program.

cific hurdles for immigrant students' school success and should thus be targeted by interventions. The other three projects explore the effectiveness of programs designed to promote language and literacy skills for students with, and without, migration backgrounds. Experimental and quasi-experimental designs with multiple outcome measures and longitudinal components are employed in all of the studies. After a short overview of the five projects, two of these investigations will be presented in more detail.

Promoting Language Skills and Reading Literacy: Overview of the Projects

The *Reciprocal Teaching and Learning Project* aims at identifying the mechanisms underlying a training program developed by Palincsar and Brown (1984) to improve students' use of strategies in reading and text comprehension. The *Reciprocal Teaching and Learning Program* has been shown to have large effects in a number of studies, yet the processes responsible for these influences have not been specified. In our study, the different components of

the program were systematically varied in the context of an experimental design. The goal was to gauge the separate and combined effects of central elements of the training program, such as teaching students declarative knowledge about strategies, instructing them to monitor comprehension processes, and having them assume different roles in the teaching and learning process. The study explored the impact of these components on the application of reading and comprehension strategies and on reading achievement (Demmrich, 2005). The theoretical background and results of this investigation will be described more fully below.

The *Family and the Acquisition of Reading Literacy Project* was inspired by findings from PISA and other large-scale assessment studies revealing that the relationship between reading achievement and family background is particularly pronounced in Germany. It examines the development and promotion of reading literacy in the context of the family. The study has two main goals. First, based on longitudinal assessments in 33 elementary school classes during the 4th grade and directly after the summer break, it examines the extent to which the development of student achievement is determined by specific characteristics of the family, such as cultural capital. Second, within a quasi-experimental design, the study explores whether a newly developed parent-child reading program (McElvany, Artelt, & Holler, 2004) succeeds in improving the application of learning strategies and reading literacy. The reading program is



based on work by Vygotsky and on models of metamemory development. Outcome measures were assessed with reading tests, participant surveys, and comprehensive video documentations of the parent-child reading sessions. With this evaluation design, it is possible to determine the effects of the intervention in terms of multiple criteria (McElvany, in prep.).

The next three projects focus on central dimensions in the acquisition of German as a second language among elementary school students with migration backgrounds. A doctoral dissertation carried out within the context of the LIFE Research School, and supervised in collaboration with Hans Merkens from the Free University of Berlin, examines whether the same component processes are involved in beginning reading skills for native and nonnative speakers of German in the 2nd and 3rd grades (Limbird, in prep.).

The study, entitled *Phonological Processing, Verbal Abilities, and Literacy Development Among Bilingual Turkish Children in Germany*, focuses on the role of phonological awareness, which has been shown to be one of the strongest predictors of literacy acquisition (see, e.g., Chiappe, Siegel, Gottardo, & Stanovich, 1994). Over 200 2nd-grade children were investigated over two years with regard to their phonological awareness, vocabulary, short-term verbal memory, and performance on various tasks assessing reading skills. Children who reported speaking Turkish at home made up the largest immigrant group, and were thus tested in both Turkish and German to determine the extent to which they could

be considered bilingual. Based on literature relating language background to phonological processing skills, it was expected that bilingual children would perform better on such tasks than their monolingual peers. Initial analyses indicate that Turkish bilingual children do, in fact, show a somewhat enhanced capacity to perceive some types of phonological stimuli, while monolingual children have far stronger skills in tasks measuring vocabulary. In addition, it was found that a well-established model of literacy acquisition (Näslund & Schneider, 1991) fits both groups. As expected, phonological awareness proved to be a significantly more important predictor of reading for the monolingual children than for the bilingual children. At the same time, however, the proportion of variance in reading achievement explained by the model was considerably lower for the bilingual children than for the monolingual German speakers. This indicates that existing models of reading, which have mostly been developed with monolingual children in mind, do not sufficiently capture literacy development in multilingual situations, and may have to be extended by factors specifically relevant to second-language learners, such as more refined measures of syntactic development.

Another doctoral dissertation carried out within the LIFE Research School program (Müller, in prep.) explores the distinction between proficiency in general everyday language and in school-related academic language among second-language learners. Several authors have argued that this distinction is important for un-

In collaboration
with Hans Merkens
(Free University of
Berlin)

In collaboration with Jacobs Foundation, Zurich, Senator for Education and Science of the Free Hanseatic City of Bremen, Heidi Rösch (Technical University of Berlin)

derstanding and promoting immigrant students' school success (Cummins, 2002; Gogolin, 2004). They suggest that it is particularly difficult for second-language learners to attain proficiency in the language used in academic contexts at school, even when these students are able to communicate fluently in everyday situations. However, this assumption has not yet been tested empirically. Similarly, neither the theoretical arguments nor the empirical evidence that have been put forward to support the validity of the distinction between the two dimensions of language proficiency are satisfactory. The *Everyday Communication Skills and School-Related Language Proficiency of Second-Language Learners Project* aims at verifying the assumption that these aspects can, in fact, be differentiated, and that the performance gap between native and nonnative speakers of German is more pronounced for school-related language than for everyday language. In addition, an attempt is made to identify the core characteristics underlying this pattern. The study starts from the assumption that the two dimensions of language proficiency differ in terms of various attributes, such as the complexity of vocabulary and syntax or the degree of contextualization. These characteristics will be varied systematically in a series of videotaped dialogues in order to disentangle their effects on students' listening comprehension. The stimuli will include various school-related and everyday contexts. Contrary to Cummins' supposition that a lack of contextualization constitutes the main hurdle for second-language

learners in mastering the academic dimension of language, we expect to find that the effects of this factor will disappear when complexity of vocabulary and grammar are controlled.

The distinction between language proficiency in everyday and school-related contexts among second-language learners is also considered in the *Jacobs Summer Camp Project*, which is funded by the Jacobs Foundation and conducted in close cooperation with the Senator for Education and Science of the Free Hanseatic City of Bremen. Using the literature on summer setback and summer learning as a starting point, the study examines the learning trajectories of students with different family backgrounds over the summer vacation. It explores the extent to which immigrant students speaking German as a second language experience particularly pronounced learning losses during the break, and whether such losses can be compensated by a targeted summer camp program. Most importantly, the study aims at evaluating the effectiveness of implicit and explicit approaches to helping students with immigration backgrounds improve their German language skills. The Jacobs Summer Camp Project will be described in more detail below.

Reciprocal Teaching and Learning

As a consequence of the PISA study, which showed knowledge and effective use of reading strategies to be important predictors of reading literacy, Anke Demmrich (2005) evaluated the Reciprocal Teaching Program by Palincsar and Brown (1984) in her doctoral thesis. This program

aims at teaching students a number of specific reading comprehension strategies. The reciprocal teaching method has been used with students of different ages (from elementary school children to adolescents and even college students), students showing good and moderate levels of reading ability, but also students with comprehension problems or learning disabilities. The program has almost always been shown to improve reading comprehension, with large learning gains being observed. Reciprocal teaching is a particularly interesting approach because it tends to have considerable positive effects on reading comprehension. In a meta-analysis by Rosenshine and Meister (1994), for example, an average effect size of .88 was found. At the same time, however, little research has been conducted on the mechanisms causing these improvements in reading comprehension, or on the features of the program that are necessary for the learning gains to occur. Therefore, an experimental study was designed to address this research gap. It was assumed that reciprocal teaching helps students to acquire metacognitive knowledge and metacognitive skills, leading to a more efficient, goal-oriented and—by way of practice—partly automatic use of strategies. By being taught when, why, and how to use strategies (conditional strategy knowledge) and by practicing these strategies repeatedly, students acquire declarative knowledge about the strategies (specific strategy knowledge) and about the conditions of their use. During training, they also have ample opportunity to experience the utility of the different

strategies through repeated practice and frequent feedback from their peers and teacher. Thus, the reciprocal teaching procedure is in line with the model of mature metamemory proposed by Borowski, Milstead, and Hale (1988), and with the way these authors assume that metacognitive knowledge is acquired.

To determine which features of the strategy training program cause its pronounced effects, an experimental study was set up in which the tasks and responsibilities assumed by the participating children were varied systematically. As described by Palinscar and Brown (1984), children in the program were assigned to small cooperative learning groups, where they adopted varying roles. In the role of the teacher, they modeled and organized the learning process. In the role of the student, they applied the strategies.

During each session, students worked both as teachers and as students. The teacher role can be subdivided into monitoring activities and organizational tasks. Monitoring activities involve giving feedback on the content and application of the other students' strategy use, helping and guiding during the correction of answers, and "modeling" answers if necessary. Organizational tasks include assigning other students to apply a strategy, deciding when to move on to the next text passage, and managing the classroom setting. The study was based on the assumption that the content-related monitoring tasks of the teacher role are responsible for the large improvements observed in reading comprehension. To test this idea, two exper-

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Table 1
Assignment of tasks to children and trainer in the three experimental conditions

| Tasks | Experimental condition | | |
|--|------------------------|---------------|---------------|
| | Reciprocal teaching | Monitor | Student |
| – apply strategy to text | Student–Child | Student–Child | Student–Child |
| <i>Monitor Function</i> – select strategy to be applied – give feedback on content and application of the strategy – help and guide during correction of answer – “model” answer, if necessary | Teacher–Child | Monitor–Child | Trainer |
| <i>Organizational Function</i> – assign someone to apply a strategy – decide when to move on to the next text passage – classroom management: maintain discipline | Teacher–Child | Trainer | Trainer |
| – explain and model strategies – teach conditional knowledge about strategies – correct children when they make mistakes (with respect to content or to the application of the strategies) | Trainer | Trainer | Trainer |

experimental conditions (“reciprocal” and “monitor” conditions) were designed, varying the monitoring and organizational tasks associated with the teacher role. A third condition involved no reciprocal teaching and learning. Children in this group (“student” condition) only practiced the application of strategies, although they did so extensively. Table 1 summarizes the tasks and the assignment of the tasks to the three experimental conditions. Small, mixed-gender and mixed-ability groups of four to six children took part in a strategy training program after regular school lessons four times a week over a period of four weeks. Participation in the program was voluntary. During the first three sessions, the reading strategies *summarizing, questioning, clarifying,*

and predicting were introduced to the children in all experimental conditions. These strategies were then practiced in 12 consecutive sessions, with tasks being distributed differently depending on the experimental condition. Each group had a trainer and worked on fairly long expository texts, using all of the strategies that could be meaningfully applied to each paragraph before reading further. A total of 55 children in 12 groups participated in the strategy training program. Furthermore, all 5th graders in the participating schools completed pre- and posttests before and after training, such that the performance of the 55 participants could be compared to that of 86 control children who spent the training time on their regular after-

Table 2
Children's declarative knowledge about summarizing and clarifying in the experimental and control conditions

| Strategy | Experimental condition | | | | | | Control group | |
|--|------------------------|-------------|----------|-------------|----------|-------------|---------------|-------------|
| | Reciprocal | | Monitor | | Student | | Control | |
| | <i>M</i> | <i>(SD)</i> | <i>M</i> | <i>(SD)</i> | <i>M</i> | <i>(SD)</i> | <i>M</i> | <i>(SD)</i> |
| <i>Summarizing</i> | | | | | | | | |
| Contains most important content | .94 | (.24) | .95 | (.22) | .67 | (.48) | .51 | (.50) |
| Is shorter than the text | .88 | (.33) | .70 | (.47) | .78 | (.43) | .36 | (.48) |
| Is formulated in own words | .35 | (.49) | .50 | (.51) | .22 | (.43) | .13 | (.34) |
| Total <i>N</i> of characteristics identified | 2.18 | (.39) | 2.15 | (.87) | 1.67 | (.84) | 1.00 | (.89) |
| <i>Clarifying</i> | | | | | | | | |
| External: ask other people to help | 1.12 | (1.36) | 1.00 | (.97) | 1.22 | (.94) | .89 | (.66) |
| External: use other resources (dictionaries, etc.) | .71 | (.59) | 1.00 | (1.17) | .94 | (.64) | 1.13 | (.86) |
| Text-related strategies | 1.59 | (.94) | 1.60 | (1.05) | .94 | (.87) | .87 | (.94) |

noon activities. The dependent variables included various measures of metacognitive knowledge: knowledge about two specific reading strategies that were taught in the training program (summarizing and clarifying), relational and conditional strategy knowledge, and planning knowledge.

Table 2 shows selected results from the study. When comparing the three experimental conditions, the following picture emerges: Children in the *reciprocal* and *monitor* groups acquired more knowledge about the reading strategies *summarizing* and *clarifying* than did children in the *student* condition: They identified more features of a good summary and thought of more text-related strategies to clarify the meaning of unknown words or sentences. Large effect sizes of about .70 were observed for these measures. When comparing the two treatment groups that were expected to have positive effects (*reciprocal* and *monitor*) with the performance of the control

group, effect sizes range from .70 to almost 1.30.

As expected, the results for children's knowledge and performance measures in the *reciprocal* and *monitor* conditions did not differ significantly. Children in both of these groups outperformed their peers in the *student* condition, even though the number of learning opportunities for every child in the *student* condition was higher, given that this group had no other task than to practice strategies, and therefore worked through more text paragraphs than the children in the other groups. Additionally, children who received their strategy training in the *student* condition performed only marginally better at posttest than the control children.

Although significant results were only obtained for measures closely related to strategy training—strategy knowledge and strategy application—and not for more general components of metacognitive knowledge, the comparison between the

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experimental conditions provides strong support for the assumption that metacognitive knowledge and skills are acquired when the reciprocal teaching method is used to teach reading strategies. Both conditions (*reciprocal* and *monitor*) that required children to give each other feedback on performance produced similar results. Not only did students in these conditions acquire more knowledge about the reading strategies *summarizing* and *clarifying*, they also applied the *summarizing* strategy better than the *control* children and the children in the *student* condition. These findings are consistent with the componential theory of metamemory advanced by Borkowski, Milstead, and Hale (1988). The authors propose that specific strategy knowledge, which is at the center of their model, represents a prerequisite for higher order components that, in turn, aid further acquisition of strategy knowledge. In these respects, the cooperative setting of the reciprocal teaching method seems to promote internalization of interindividual social processes. The dialogues that occur in the group apparently help the students to develop metamemory acquisition procedures and strategy knowledge. By adopting the role of the teacher (monitoring), the children have the opportunity to monitor, evaluate, and regulate other children's cognition. Few differences in results were detected between the *reciprocal* and the *monitor* conditions; both experimental settings produced virtually the same effects, thus supporting the assumption that it is not the adoption of the teacher role, but the task of monitoring,

evaluating, and regulating other students' strategy execution that makes the reciprocal teaching method so effective.

The Jacobs Summer Camp Project

Over the last four decades, Germany has developed into an immigration country, and the number of students learning German as a second language has grown. Various studies have shown that these students are highly disadvantaged in terms of their educational participation. Results from the first cycle of PISA, for example, show that the relative chance of attending the academic track rather than the lowest track of the three-tier secondary system is 4.4 times higher for students whose parents were both born in Germany than for children of foreign-born parents (cf. Table 3, Model I). Even when SES is controlled, the odds of attending the academic-track *Gymnasium* are almost 3 times higher for students of native parents than for students of immigrant parents (cf. Table 3, Model II). Thus, the social disadvantage that tends to be associated with an immigration background does not fully account for the disparity between immigrant and native students. One factor that does seem to explain this difference, however, is students' reading literacy in the language of instruction, that is, German. Given similar results on the PISA reading test, the relative chances of attending the highest or middle track are no longer lower for students with immigration backgrounds than for students from native families (cf. Table 3, Model III). These findings indicate that a lack of German language skills is the pri-

Table 3
Relative chances of attending different secondary school types as a function of family migration background (odds ratios)¹

| Migration background | Secondary school type (reference category: vocational track <i>Hauptschule</i>) | | | | | | | | | | | |
|--------------------------------|--|------|-----|----|------------------------------------|------|-----|----|----------------------|------|-----|----|
| | Intermediate track <i>Realschule</i> | | | | Academic track <i>Gymnasium</i> | | | | Comprehensive school | | | |
| | Model ² | | | | Model ² | | | | Model ² | | | |
| | I | II | III | IV | I | II | III | IV | I | II | III | IV |
| Both parents born in Germany | 2.64 | 2.19 | ns | ns | 4.42 | 2.69 | ns | ns | 1.92 | 1.71 | ns | ns |
| One parent born in Germany | 1.46 | ns | ns | ns | 3.46 | 2.10 | ns | ns | 1.86 | 1.76 | ns | ns |
| Neither parent born in Germany | Reference category (odds = 1) | | | | | | | | | | | |

¹ Only statistically significant findings reported.

² Model I: without controlling for covariates; Model II: controlling for SES; Model III: controlling for reading literacy; Model IV: controlling for SES and reading literacy.

mary obstacle for immigrant children at the transition from elementary to secondary school (see also Bos, Voss, Lankes, Schwippert, Thiel, & Valtin, 2004; Lehmann, Peek, & Gänsfuß, 1997).

Given the importance of language skills for school success, it is particularly alarming that Germany seems to be considerably less successful than most other countries at providing immigrant students with the necessary support in acquiring the language of instruction. Results from PISA indicate that the disadvantage in reading literacy among 15-year-olds whose home language differs from the language used in the PISA assessment is larger in Germany than in almost any other participating country (Baumert & Schümer, 2001; see also Schwippert, Bos, & Lankes, 2003). At the same time, little is known about the effectiveness of approaches to supporting the acquisition of German as a second language among immigrant students.

With this situation as the general starting point, the goal of the Jacobs Summer Camp Project is to explore the learning development of children with immigration backgrounds, and to provide evidence on the effectiveness of different approaches to helping these students attain proficiency in the language of instruction. The study builds on research related to summer setback and summer learning, most of which has been carried out in the United States. Within this

Figure 2. Theatre performance prepared in the implicit language support condition of the Jacobs Summer Camp.



Figure 3. Students in the explicit language support condition of the Jacobs Summer Camp.



line of research, a number of studies have found that patterns of learning development over the summer break differ for children from families with lower and higher socioeconomic status (for a meta-analytic summary, see Cooper et al., 1996). According to these findings, students from families with disadvantaged backgrounds show learning losses over the summer break in both reading and mathematics. For students from middle-class backgrounds, on the other hand, summer setback effects were identified in mathematics, but not in reading. In fact, the results suggest that the reading skills of this group tend to increase during the summer break, causing the gap between students from families with lower and higher socioeconomic status to widen. It has been estimated that the disparities resulting from these differential trajectories for reading achievement over the summer months are equivalent to a

learning gain of about three months (Cooper et al., 1996).

At the same time, the literature on summer learning suggests that the larger achievement losses among students from families with lower socioeconomic status can, to some extent, be compensated by summer learning programs. A meta-analysis of studies evaluating the effectiveness of summer schools concluded that both student groups profit from attending summer learning programs (Cooper et al., 2000). Therefore, summer schools that are specifically geared toward disadvantaged students should help to prevent the achievement differences from widening during the summer months.

Drawing on this body of research on summer setback and summer learning from the United States, the Jacobs Summer Camp Project was designed to pursue four main objectives:

(1) The first goal of the project is to determine whether, and to what extent, differential achievement losses are observed over the German summer break which, at roughly six weeks, is much shorter than in the United States. The main focus of the project is on children from immigrant families. Thus far, research on summer setback and summer learning has mainly examined the learning trajectories of students from different socioeconomic and ethnic backgrounds. Less attention has been paid to the potentially moderating role of the students' home language. Based on the finding that summer setback effects tend to be more pronounced for domains requiring factual and procedural knowledge (e.g., computation and spelling) than for more conceptually based domains (e.g., problem solving and reading), it might be suspected that second-language skills are particularly vulnerable to summer learning losses (Cooper et al., 1996). This contention has not yet been tested empirically, however.

(2) The second objective of the Jacobs Summer Camp Project is to develop, implement, and evaluate a program to promote German language skills during the school vacation. Two approaches are differentiated. The first aims to determine whether it is sufficient to engage students in language-intensive activities in order to counter the learning loss associated with the school vacation. Such activities are expected to trigger implicit learning processes that have positive effects on language development ("implicit language support component"). This component is operationalized in a

theater activities program devised by experienced theater teachers. The second approach to promoting German language skills consists in systematic instruction in German as a second language, designed to foster explicit language learning ("explicit language support component"). This component takes a systematic approach to language learning, the aim of which is to promote the conscious perception and use of linguistic structures (Rösch, 2003). Most students of non-German origin were born in Germany and have spent their entire school career in this country. Many of them appear to have a fairly good command of the German language. However, even children who speak German fairly fluently in conversational situations may not have acquired the "cognitive academic language proficiency" (Cummins, 2002) held to be a prerequisite for academic success. Key aspects in this regard include vocabulary and grammar. The implicit grammar that has been developed by minority language children often deviates markedly from the norm. The aim of instruction in German as a second language is to help students develop correct and explicit grammar knowledge.

(3) A third general goal of the Jacobs Summer Camp Project is to explore the distinction between proficiency in general everyday language and school-related academic language, which is considered to be critical for understanding and promoting immigrant students' learning development (e.g., Cummins, 2002; Gogolin, 2004).

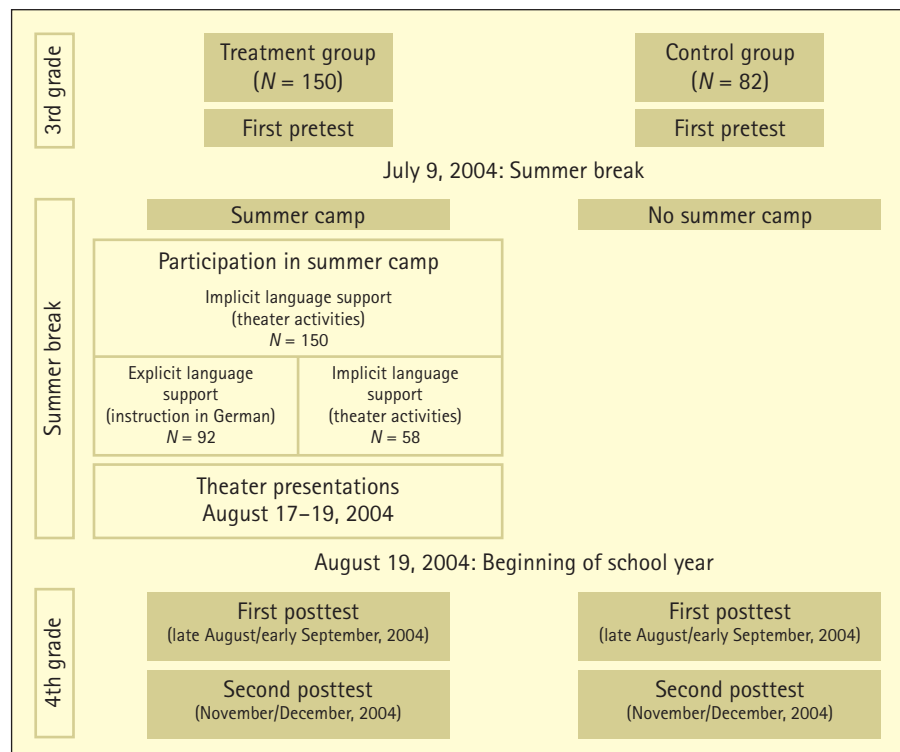
(4) The fourth and final aim of the study is more practical in nature,

that is, to find out whether it is feasible to implement a summer camp of this kind in Germany. One of the main questions was whether parents, some of whom have little or no command of German, are prepared to let their children attend a summer camp. This was particularly unclear for girls from Muslim families. It was also uncertain whether children would be willing to participate in a program where they were expected to attend lessons over the summer vacation. Even the children's readiness to engage in theater activities could not be taken for granted. Inasmuch as it is highly unusual for teachers in Germany to work during school vacations, moreover, we could not be sure that it would be possible to recruit qualified teaching staff for the camp. Because the Jacobs

Summer Camp is the first program of its kind to be run in Germany, analyses of these practical experiences also form an important part of the program evaluation.

Figure 4 shows the research design of the Jacobs Summer Camp Project, comprising an experimental approach with pre- and posttests. Because performance at the elementary level is decisive for educational success in the German school system, where students are tracked at a relatively early age, it was decided to aim the program at primary school students. In Germany, it is generally considered reasonable for children to spend longer periods away from home from the 3rd grade onward. The camp was thus directed at students who had just completed the 3rd grade. The project was carried

Figure 4. Research design of the Jacobs Summer Camp Project.



out in the city state of Bremen where the proportion of immigrant students in schools is relatively high. All students in more than 30 schools were invited to sign up for the summer program. Thus, in addition to immigrant students, the sample also includes children from socially disadvantaged German families.

To ensure that effects of a moderate size could be detected, an attempt was made to recruit at least 250 applicants for the program. With a total of 251 students signing up, this goal was reached. For logistic reasons, however, students from nine schools had to be excluded from participation, leaving an applicant pool of $N = 232$. Of these, 150 children were assigned at random to a treatment group and 82 to a control group. This ensured that the children in the different conditions would be comparable in terms of their willingness to attend a remedial program over the summer break. Moreover, all students in the classes of the *experimental* and *control* children who had not applied to attend the summer camp were included in the assessments as an additional comparison group. This opens up further opportunities for the evaluation of summer learning loss and the efficacy of the Jacobs Summer Camp Project in combating this loss. Most importantly, it allows for the differentiation of students' learning development as a function of their summer break activities, such as travel to their families' countries of origin. The children in the treatment group were distributed across two conditions. All of the children selected for the camp participated in the theater and recreational components. In two

of the three camps, the children also attended lessons in German as a second language. This design makes it possible to examine the extent to which learning gains are achieved by implicit language support, and which additional effects are associated with explicit language support. The summer camp program comprised four phases: During the first two weeks, students commuted between the camp and their homes by bus. During the third week, they stayed in the camp overnight. The fourth week was devoted to recreational activities, such as a visit to the science museum and a day with the boy and girl scouts. During the fifth week, finally, the theatre performances that the students had developed at the camp were rehearsed and presented on stage in Bremen. Students' performance levels as well as indicators for their psychosocial development were assessed using a variety of tests and questionnaires at three points in time: (1) shortly before the summer vacation, (2) directly after the summer vacation, and (3) about three months after the end of the camp. The written assessments were administered to all children in the treatment and control groups as well as to all students enrolled in the classes of children who had applied to attend the Jacobs Summer Camp. In addition to written tests, oral language samples were collected from students in the treatment and control groups as part of the pretest and the first posttest assessment. More specifically, students who had applied to participate in the summer camp were video-recorded as they described picture stories and retold texts on everyday

and school-related topics that test administrators had read to them. Differential as well as overlapping effects are expected for the implicit and explicit language support conditions. For example, the implicit component entails motivational and affective goals, such as an increase in students' motivation to speak correctly and a reduction in anxiety associated with public speaking. The explicit component, on the other hand, should result in improvements with regard to structural aspects of language, such as use of pronouns and prepositions, declination, and conjugation. Both treatments are expected to have positive effects on vocabulary related to the overall theme of the camp ("travel") as well as on the appropriateness of spoken language.

Regarding the question of whether it is feasible to carry out a summer program geared toward immigrant students, we can conclude that the Jacobs Summer Camp was a success. We were able to reach the target of at least 250 applicants, which many school officials, principals, and teachers had predicted to be an unrealistic goal. Among the 149 students who came on the first days of the camp, 13 fell ill or were unable to attend every day for family-related reasons, such that they missed more than a week of the program. All of the remaining children came back practically every day. This also applied to most of the girls from Muslim families. Only two of these girls were not allowed to stay overnight during the third week of the program, and had to be bussed to camp every day.

All of the ten theatre groups in the Jacobs Summer Camp succeeded in developing performances and in presenting these on stage in Bremen at the end of the program. The children's parents, teachers, and principals as well as the general public were invited to attend the performances, and their responses were very positive. Within a period of just three weeks, the children and their theatre teachers had succeeded in putting together outstanding productions. This highly successful finale to the summer camp quite obviously boosted the children's self-confidence and underscored the integrating role of programs involving immigrants and nonimmigrants, parents and schools, school-type instruction, and the arts.

Both posttests for the Jacobs Summer Camp Project have been completed and the data are currently being analyzed. First results indicate that the treatment did have significant effects on students' language development. For the most part, however, these effects seem to be limited to the explicit instruction component.

Research Area IV

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 expert'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 and mathematics 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. Overcoming certain misconceptions that are deeply rooted in everyday experience is the most difficult task of science education. 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 attends 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 occur 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. 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 uncon-

scious 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?

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 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.

Insightful Learning Through Cognitive Activation in Powerful Learning Environments

There is now wide agreement among researchers in the field of learning and instruction as to the framework of insightful learning, summarized as follows by Baumert et al. (2004):

- Insightful learning is an active individual process of construction by which knowledge structures are modified, enhanced, integrated into networks, organized by hierarchies, or newly generated. Insightful learning crucially relies on the active mental processing that is implied in any active analysis of the social or natural environment or in the use of symbol systems.
- Insightful learning means making sense of things by mastering new contexts that organize and structure knowledge. For this, the object has to have a minimum intellectual and/or practical appeal for the learner.
- Insightful learning depends on individual cognitive conditions, but mainly on prior domain-specific knowledge. The quality and ease of further learning is crucially determined by the extent and organization of the available knowledge base.
- Insightful learning, while being highly systematic, is always situated and bound up with a specific context. Knowledge acquisition will typically occur in a social context, and knowledge will carry the marks of the specific context in which it was acquired. The fact that knowledge is situated often results in its being constrained in its range of application. In order to enhance this range, a variation of

the contexts in which knowledge is acquired and applied must be provided.

- Insightful learning is regulated by motivation and by metacognitive processes (e.g., planning, control, evaluation).
- Insightful learning is supported by certain cognitive mechanisms. These include the building of knowledge units with high informational content that can be remembered and retrieved as a whole (chunks), the emergence of which will be fostered by the use of multiple forms of knowledge representation. They also include the automation of action sequences and reasoning operations.

This framework of insightful learning can be applied to all kinds of subjects taught in school if it is linked up with an investigation of domain-specific knowledge structures. Research on learning and instruction can contribute to the improvement of classroom instruction by furthering an understanding of the psychological processes of insightful learning in a specific content domain. The goal of this kind of research must be to support teachers in getting a feeling for learners' prior knowledge.

This includes an understanding of the sources of students' errors and mistakes as well as an identification of such knowledge elements as learners can build on when presented with explanations or problems in the course of classroom instruction. A better understanding of learners' prior knowledge helps teachers to decide how instruction should be shaped in order to allow students to gain a deep understand-

ing of domain-specific concepts and to develop adequate, nonschematic epistemological beliefs.

In Research Area IV, we examine the conditions that are necessary to initiate insightful learning processes in the fields of mathematics and science education. The studies are conducted in the laboratory (ENTERPRISE), within a multimethod longitudinal approach (COACTIV), or as video-based studies in actual school environments (TIMSS-Video). Most of the investigations address research questions that have emerged directly from Research Areas I and II. For instance, one study (dissertation

project Mareike Kunter) combined data from the TIMSS achievement tests and questionnaires with information from video observations of teaching (TIMSS-Video). Investigating the impact of several instructional features on students' learning and motivational development over the course of one school year, the study revealed that cognitively activating instruction had positive effects on students' achievement gains.

The following section describes two of the major projects (COACTIV and ENTERPRISE) in more detail.

The Center for Educational Research 2004



Left to right: Rainer Watermann, Martin Brunner, Oliver Lüdtke, Andrea Müller, Kai Maaz, Ulrich Trautwein, Michael Schneider, Petra Stanat, Elsbeth Stern, Ilonca Hardy, Jürgen Baumert, Mareike Kunter, Cordula Artelt, Gundel Schümer, Stefan Krauss, Nele McElvany, Yi-Miau Tsai, Gabriel Nagy, Uta Klusmann, Hella Beister, Nicole Husemann (not pictured: Helmut Köhler, Detlef Oesterreich, Thomas Rochow).

COACTIV: Cognitive Activation in the Classroom: The Orchestration of Learning Opportunities for the Enhancement of Insightful Learning in Mathematics

Teaching for Understanding: Linking PISA to Research on Learning and Instruction

The aim of the COACTIV study is to investigate teachers' professional knowledge and the way this knowledge relates to domain-specific instructional processes. By assessing the professional knowledge of mathematics teachers, and then linking this knowledge to features of their classroom instruction and to the development of their students' mathematical literacy, the study provides unique insights into the prerequisites for students' mathematical learning.

The COACTIV study is embedded in the PISA 2003 assessment. With mathematics literacy forming the main component of PISA 2003, a differentiated investigation of the structure of the mathematical competencies acquired by the end of lower secondary level is possible. Moreover, the PISA 2003 study was extended to a longitudinal design, spanning the period of one academic year, with a sampling plan allowing for teachers to be assigned to the classes they teach, and for class and school effects to be separated systematically.

Insightful Learning and Cognitive Activation in Mathematics Classrooms—The Framework of the COACTIV Study

The COACTIV study, which is funded by the German Research Foundation (DFG), is based on preliminary work carried out in the context of *BIJU*, *TIMSS*, and *TIMSS Video*. In the following, we will outline the study's theoretical background and methodological approach and present selected findings on the learning environments provided by different school types.

The study investigates the three cornerstones of competence acquisition—that is, teachers, lessons, and students—in a combined approach. The theoretical framework that underlies this approach draws on aspects of teacher expertise, the process-mediation-product model, and the (social-)constructivist approach.

The main question guiding our analyses is as follows: How can teachers facilitate insightful student learning during lessons? The core ideas are outlined in Figure 1 and will be explained below.

We consider insightful learning to be a mental process characterized by the active and independent construction of domain-specific knowledge. The product of the learning process is a thorough understanding of domain-specific concepts comprising declarative knowledge, skills, and procedures. The process of insightful learning is supported by motivational variables, such as interest, and self-related cognitions, such as control beliefs.

Insightful learning processes take place in powerful learning environments (De Corte et al., 1996). Within the COACTIV theoretical framework, two aspects of the learning environment are considered to be particularly important for initiating and sustaining insightful learning processes: the degree of cognitive activation and the teacher's support of personal autonomy and competence.

Learning opportunities that stimulate insightful learning processes entail what we term *cognitively activating elements*. In the classroom context, cognitively activating elements can be found in the tasks that

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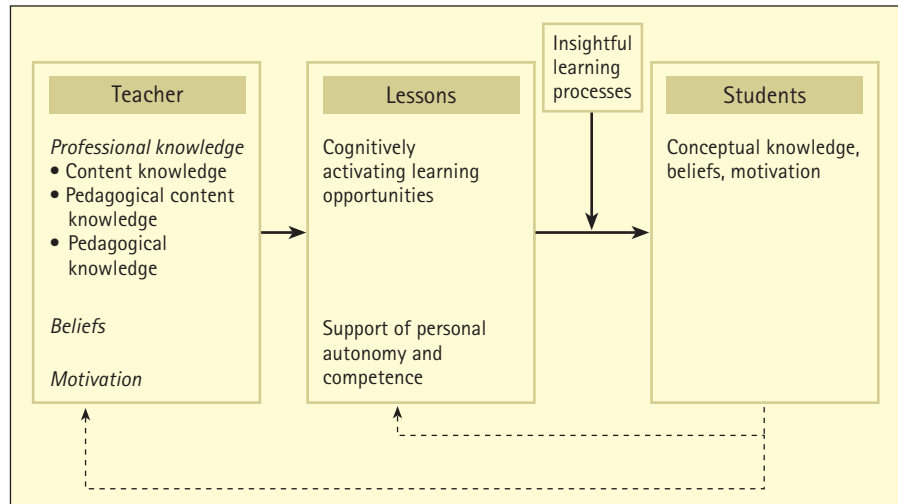
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Figure 1. Teachers' competencies, mathematics lessons, and students' learning: The three cornerstones of the COACTIV study.



students work on, or in the discourse between teachers and students. Cognitively activating tasks might, for example, draw on students' prior knowledge by challenging their existing beliefs. Cognitive activation can take place during class discussion when the teacher does not simply declare students' answers to be "right" or "wrong," but encourages them to evaluate the validity of their answers and solutions for themselves. The particular challenge of creating cognitively activating learning opportunities is therefore to teach at a level that ideally animates *all* learners to actively engage with the learning content, by challenging, but not overwhelming them. This is a demanding task for teachers in classroom situations—it is no easy matter to create optimal learning conditions for groups of students who may differ greatly in terms of motivation or prior knowledge. The adaptive orchestration of tasks is a key to meeting this challenge. Teachers have to select tasks that meet different individual student

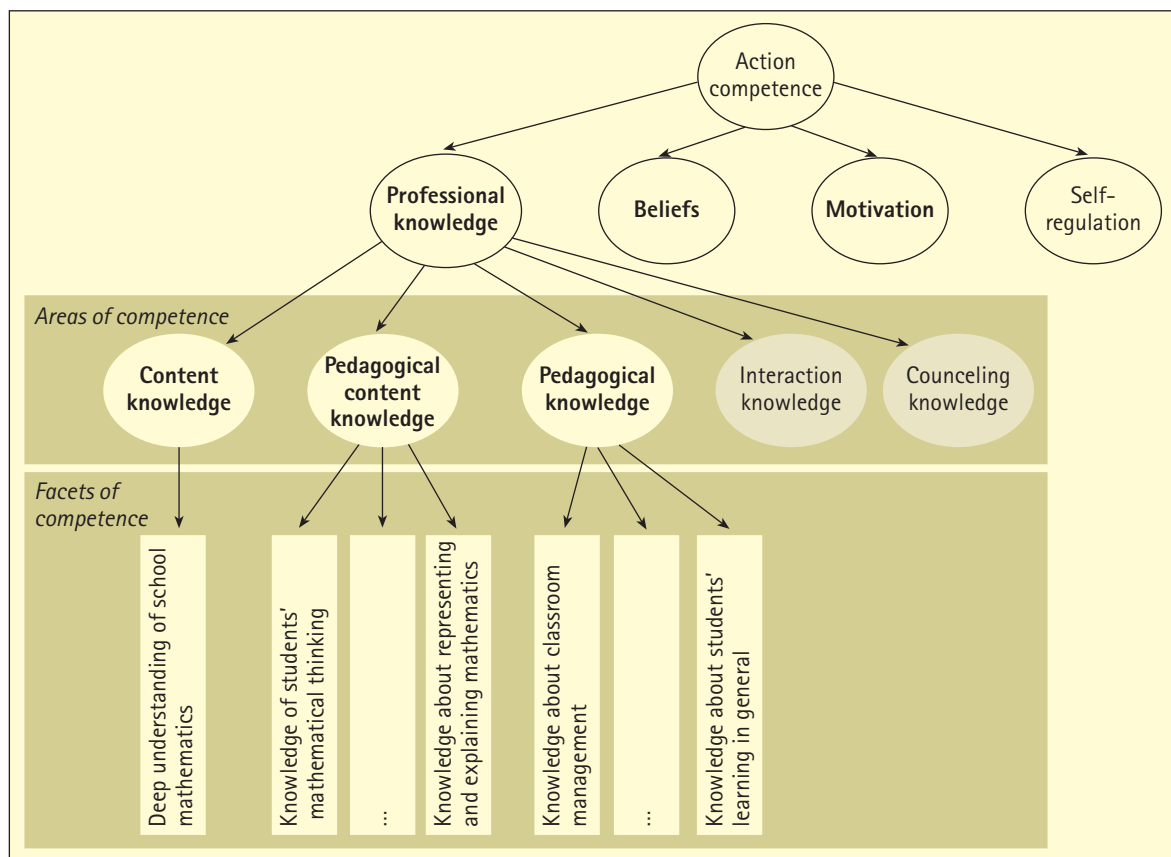
needs, that is, tasks that vary in terms of their difficulty and cognitive demands as well as—in order to help learners gain transferable knowledge—in structural and contextual terms. These tasks must be presented in an order that allows students to gradually expand their knowledge, and practice existing skills.

It takes more than demanding assignments to inspire students to engage in insightful learning processes, however. Studies based on the theory of self-determination developed by Deci and Ryan (2000) show that students engage in insightful learning processes, and develop intrinsic motivation, such as domain-specific interest, when they feel challenged as well as personally supported in their learning environments. Consequently, teachers need to implement tasks in a way that respects students' cognitive autonomy. At the same time, they need to be acutely aware of students' difficulties—be they comprehension problems or social and personal matters—

and to respond in a reassuring way. In other words, teachers need to give their students the feeling of being personally valued and supported. The teacher's *support of personal autonomy and competence* can thus be considered a second crucial aspect of powerful learning environments. Putting these two instructional aspects—cognitive activation and support of students' personal autonomy and competence—into practice requires a broad and profound base of knowledge on the teacher's part: first, a deep understanding of the contents to be taught; second, awareness of how best to present these contents to students; and third, knowledge about teaching and learning processes in general. Based

on the work of Lee Shulman (1987; also see Bromme, 1992), the terms of *content knowledge*, *pedagogical content knowledge*, and *pedagogical knowledge* have been established to describe these facets of professional knowledge. In addition to these types of knowledge, teachers' attitudes and beliefs about their subject and about teaching in general influence the way they teach. Whether teachers like and value the subject they teach and, even more importantly, whether they feel responsible for their students and aim at supporting their personal growth, may determine whether their teaching serves to create powerful learning environments.

Figure 2. Action competence of mathematics teachers (for an account of the concept of competence, see Weinert, 1999, 2001).



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Krauss, S., Kunter, M., Brunner, M., Baumert, J., Blum, W., Neubrand, M., Jordan, A., & Löwen, K. (2004). COACTIV: Professionswissen von Lehrkräften, kognitiv aktivierender Mathematikunterricht und die Entwicklung von mathematischer Kompetenz. In J. Dool & M. Prenzel (Eds.), *Bildungsqualität von Schule: Lehrerprofessionalisierung, Unterrichtsentwicklung und Schülerforderung als Strategien der Qualitätsverbesserung* (pp. 31–53). Münster: Waxmann.

In the COACTIV study, we apply this general theoretical framework to the context of secondary school mathematics teaching. Our focus lies on investigating mathematics teachers' expertise, on the one hand, and on reconstructing mathematics lessons, on the other.

Figure 2 describes teachers' knowledge and beliefs (left-hand box in Figure 1) in more detail and provides an overview of our theoretical approach to teachers' competence. In COACTIV, scales were constructed to assess teachers' action competencies in all areas, with the exception of those shaded in Figure 2 (Krauss et al., 2004).

Theoretically, mathematics lessons (middle box in Figure 1) are the crucial opportunities for insightful learning to occur. The underprovision of cognitively activating learning opportunities seems to be a particular weakness of mathematics teaching in German secondary schools, however. Results of international studies such as TIMSS Video show that German mathematics lessons typi-

cally focus on drilling routines rather than on developing conceptual knowledge. Teachers tend to guide students through new topics step-by-step, presenting the new ideas themselves, and rarely making reference to students' conceptions. In the next phase of instruction, students work on similar problems, and practice the skills that have been demonstrated in individual seatwork. The tasks set are usually very routine-oriented; their solutions require the application of procedures rather than conceptual understanding. This lesson format is so widespread in Germany that one might call it the "monoculture of mathematics teaching." One of the main questions addressed by the COACTIV study is whether teachers choose this "task monoculture" deliberately, based on traditional beliefs about learning, or because they lack the necessary professional knowledge.

The empirical investigation of teachers' professional knowledge and the reconstruction of mathematics lessons present great methodological

Methodological Approach of the COACTIV Study

COACTIV is embedded in the longitudinal component of the PISA 2003 study. Both the students sampled for PISA and their mathematics teachers were assessed twice—once at the end of the 9th grade, and once at the end of the 10th grade. We are thus able to combine student achievement and questionnaire data with their teachers' data, and to observe changes over the course of a school year. The teacher sample consists of 352 teachers and their math classes in the first wave and 223 teachers and their classes in the second wave (the reduction in sample size is due to students from vocational schools no longer being included in the assessment at the second wave). A total of 180 teachers participated in both waves of the assessment, and taught the PISA classes over the whole school year. Standardized questionnaires provide the first set of data. Both teachers and students were asked to report on and evaluate various aspects of their mathematics lessons. Most of these questions are based on scales that are already well established in the field of instructional research. To assess teachers' professional knowledge, we developed an array of new instruments, some of which are computer-based. In particular, we focused on developing new instruments to assess teachers' content and pedagogical content knowledge.

The second set of data is derived from the teaching material collated from the teachers, who were asked to submit the tasks they actually employed in their PISA classes (homework assignments, exams, and tasks used in introductory lessons). These tasks were coded by trained raters, using a newly developed classification scheme to tap various didactic aspects (e.g., task format, type of cognitive process needed to solve the task).

challenges. With its combined approach and use of various innovative methods, the COACTIV study offers a unique opportunity to gain insights into the prerequisites for students' mathematical learning. The study's methodological approach is summarized above.

Teaching and Teachers in Different School Types—Differential Patterns of Mathematics Instruction

COACTIV focuses on the empirical investigation of how students' mathematical knowledge is enhanced by cognitive activation and personal support during lessons, and on the role that teachers' professional knowledge plays in creating such learning contexts. In the following, we will concentrate on mathematics lessons and present selected findings on patterns of math instruction that are specific to certain school types in Germany.

The German secondary school system is characterized by the early tracking of students to different school types (vocational, intermediate, academic track; comprehensive schools) based on their ability. Studies, such as TIMSS, PISA, and BIJU, have repeatedly reported significant differences in the school achievement of students in different tracks. Moreover, it has been demonstrated that these differences are not only a corollary of early selection but that they continue to grow over the school career, with students from academic track schools showing relatively larger learning gains than other students (a phenomenon known as the St. Matthew effect). These different learning rates are associated with remarkable differences in the teach-

ing cultures of the various school types. Studies based on lesson observations (e.g., TIMSS Video) and on students' reports on their lessons (e.g., Gruehn, 2000) have identified differential patterns of teaching across school types. These differences are particularly pronounced when the academic track is compared with the other tracks. For instance, a reanalysis of the TIMSS Video data revealed notable differences in the way teachers create learning situations in early secondary school mathematics lessons (Kunter, 2004). Cognitively activating tasks that require the active construction of knowledge were only employed in academic track lessons, if at all. Elements of cognitive activation were rarely discerned in mathematics lessons in other school types, where there was a very strong focus on practicing skills and routines.

The data provided by the COACTIV study enable us to investigate these differences in teaching patterns from several perspectives. Drawing on preliminary work (Clausen, 2000), we assume differential validities for different data sources. A first indication of differences in the organization of learning opportunities is provided by the teachers' own reports of their lesson goals, preferred assignments and tasks, and general approaches to mathematical learning. These reports provide us with insights into the principles that guide teachers' lesson planning. Whether these principles are actually put into practice in the classroom can be evaluated by reference to the tasks teachers set. Finally, we consult students' reports on their lessons to

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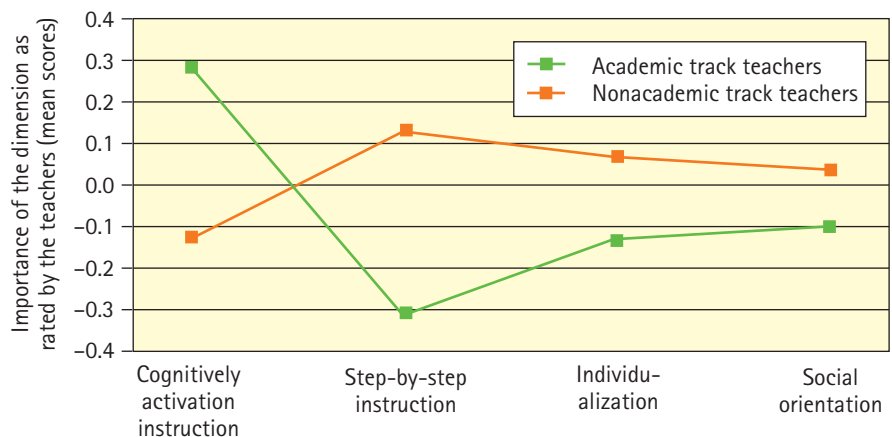
find out how students experience the learning environment, and to what extent they feel challenged and supported. In the following, we will present selected results that illustrate patterns of instruction specific to different school types in all of these areas. The results are based on (1) the teacher questionnaire on teaching goals and preferred lesson structures, (2) our categorization of the tasks assigned by the teachers, and (3) the student questionnaire on mathematics lessons. The teacher questionnaire provides us with information about the principles underlying classroom instruction. Assuming that teachers are best positioned to report on the didactic and methodological set-up of their lessons, we asked them about their educational goals, beliefs about mathematical learning, preferred task types, and the principles guiding their lesson planning. We can thus investigate whether teachers agree with our conception of cognitive activation and personal support being the core elements of teaching and, in addition, whether the opinions of

teachers in different school types converge. The assessment covered dimensions such as the following, each of which was measured by several scales.

- Cognitively activating instruction: To what extent do teachers aim at providing their students with cognitive challenges, and attempt to support the active and independent construction of knowledge?
- Step-by-step instruction with close supervision: To what degree do teachers prefer a step-by-step approach in which they proceed gradually, giving detailed instruction, focusing on routine practices, and providing close supervision?
- Individualization: To what degree do teachers consider within-class differences in students' prior knowledge when selecting tasks and evaluating students?
- Social orientation: How important is it for teachers to maintain good social relationships with their students, and to provide them with personal support?

When these dimensions are combined, the profile to emerge reflects

Figure 3. Approaches to teaching in academic track and nonacademic track schools.



All scales have a mean of 0 and a standard deviation of 1, all differences are significant with $p < .05$.

prototypical patterns in teachers' approaches to instruction. These patterns are characteristic of certain school types, as can be seen in Figure 3.

As shown by Figure 3, it is mainly the teachers in the academic track who report applying the principle of cognitive activation in their lessons. Accordingly, these teachers do not endorse step-by-step instruction. Rather, this form of teaching is preferred by teachers in nonacademic track schools, where cognitively activating elements do not feature strongly. In terms of individual student support, however, it is the teachers in nonacademic track schools who stress the importance of individualization and social orientation in the classroom. These aspects seem to have relatively little significance for academic track teachers. These results show that mathematics teachers in German secondary schools do not unanimously support our conception of powerful learning environments presented above—the aspects of cognitive activation and support for personal autonomy and competence are not generally considered to be the two guiding principles. In fact, two different patterns of teaching aims emerge: Whereas academic track teachers endeavor to establish cognitively challenging learning environments, but attach less value to the provision of personal support, the reverse is true of the nonacademic track teachers. Because these data were drawn from teacher self-reports, these profiles reflect differences in teachers' conceptions of teaching, but do not necessarily provide valid insights into actual differences in classroom

learning opportunities. To find out more about the actual classroom situation, we will now examine the tasks assigned by the teachers in their mathematics lessons.

The tasks that teachers employ in their lessons indicate the degree to which they succeed in translating their teaching principles into corresponding learning opportunities in the classroom. Cognitively activating tasks require conceptual knowledge and understanding. In COACTIV, we assessed a subset of the math problems that the teachers set as homework assignments, in exams, or to introduce new topics. On average, 100 problems per teacher were assessed. These problems—which were coded by trained raters—reflect the cognitive demands of the lessons. Several categories of cognitive activation were evaluated.

All tasks were classified as either technical tasks or modeling tasks, based on the cognitive processes that are required to solve them. Technical tasks require only factual knowledge or computational skills. Modeling tasks, on the other hand, require students first to construct a representation of the problem situation by interpreting the information given in the task statement. This situational model then has to be translated into a mathematical model, from which the mathematical solutions needed to solve the problem can be derived. These solution strategies then have to be implemented, interpreted, and validated. The match between the situational model and the mathematical model determines the quality of the task solution. Modeling tasks are further categorized as computational mod-

Table 1
Even tasks on a low difficulty level may imply conceptual understanding:
Examples of tasks with diverse levels of curricular knowledge
and cognitive demands

| | Low level of curricular knowledge | High curricular level of knowledge |
|--------------------------|--|--|
| Technical task | Consider the function $f(x) = 3x - 1$. Find the value of x when $f(x) = 11$. | Let f be the quadratic function $f(x) = 2x^2 + 5x - 3$. Write $f(x)$ in vertex form. |
| Conceptual modeling task | How does the surface area of a square change when the side length is tripled? Show your reasoning. | Thomas' father wants to give him some money towards a motorbike. He makes Thomas two offers: (1) 15€ today, a further 20€ tomorrow, a further 25€ the next day, and so on for a two weeks (i.e., increasing the sum by 5€ every day). (2) 5 cents today, a further 10 cents tomorrow, a further 20 cents the next day, and so on (i.e., doubling the sum every day), again for 14 days. Which offer should Thomas choose? Show your reasoning. |

ing tasks or conceptual modeling tasks. If the situational model is close to the mathematical model required to solve it, and the solution strategies primarily entail calculations and mathematical algorithms (even demanding ones), it is called a computational modeling task. If the mathematical model requires the students to link several concepts or strategies, or to draw inferences going beyond the information given in the task statement, the task is called a conceptual modeling task.

It is important to note that this classification *does not* equate with problem difficulty in terms of the average student success rate on a problem. All three types of problems—technical tasks, computational modeling tasks, and conceptual modeling tasks—can occur at all difficulty levels. Table 1 illustrates this point. Task difficulty was approximated by the level of curricular knowledge required to solve a task (this dimen-

sion indicates the grade level at which the task would be appropriate).

The task classification allows us to examine whether academic track teachers really do employ a relatively large proportion of cognitively activating tasks—particularly conceptual modeling tasks—in the classroom, in accordance with their teaching principles. Figure 4 presents the results for the homework assignments set by teachers during the 9th grade. Irrespective of the school track, these results illustrate that the focus on routine and practice considered typical of German mathematics classrooms is carried over to the tasks set as homework (Figure 4): In all school types, approximately half of the problems students are set are purely technical ones designed to drill routines. Yet the figure also shows differences between the school types, which are most pronounced for the class of conceptual

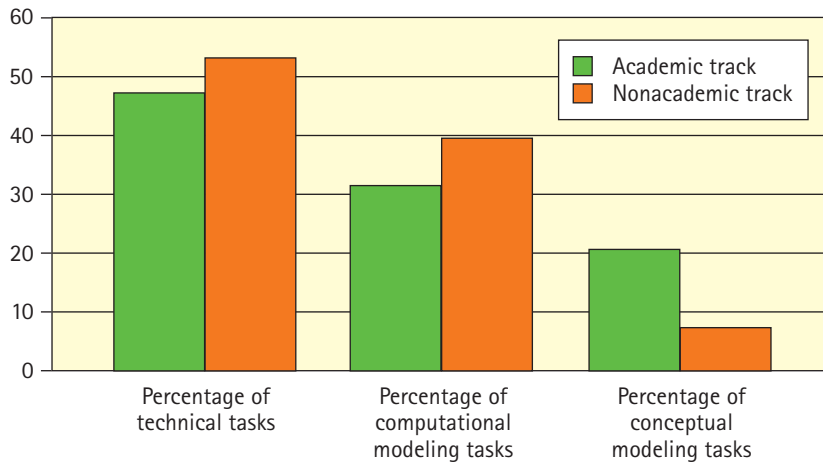


Figure 4. Distribution of the classes of homework problem set by teachers in academic track and nonacademic track.

modeling tasks. Only 7% of the problems set by teachers in nonacademic track schools were cognitively activating conceptual modeling tasks, compared with 21% of the problems set by teachers in the academic track. These differences remain even when controlling for the level of task difficulty.

Our results thus show that it is difficult to describe the state of mathematics teaching in Germany in general terms, as teachers' conceptions of instruction and the learning opportunities created in their classrooms differ remarkably across school tracks. The principle of cognitively activating teaching on which academic track teachers base their approach is indeed mirrored in the tasks that these teachers set for their students. Teachers in other school types seem reluctant to present their students with tasks that require active engagement with the content, and thus provide fewer opportunities for cognitive activation. Can we thus conclude that teaching in the academic track is in line with our conception of a powerful learning environment?

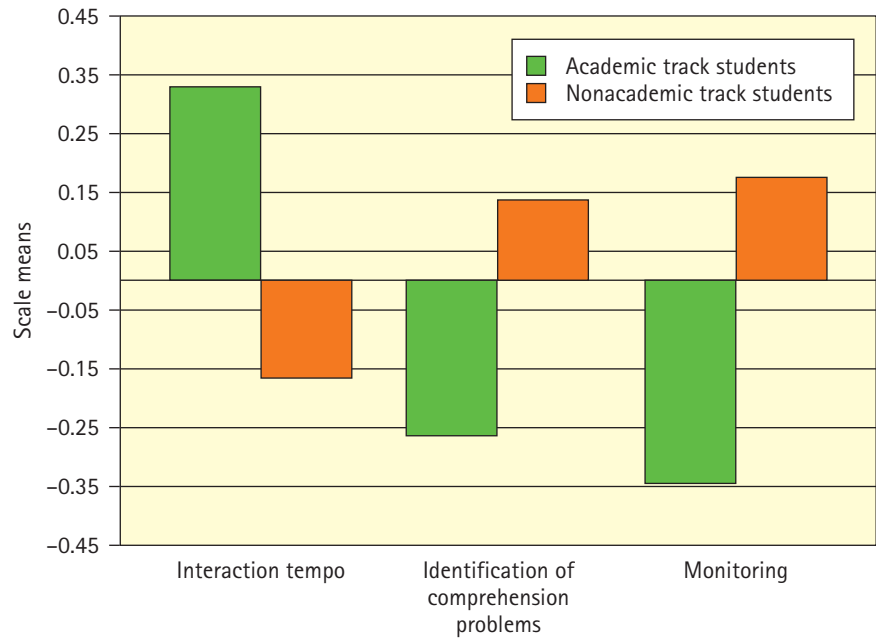
Our data indicate that the situation is not so clear cut. As mentioned above, challenging tasks alone do not suffice to initiate insightful learning processes. In order to foster students' cognitive autonomy and active construction of knowledge, teachers need to provide students with personal support by stimulating individual learning processes and assisting them when difficulties arise. The prerequisites for this kind of individual support are attentiveness to individual student problems, patience with every single student, and a respectful form of interaction that values the learner as an autonomous person—aspects we have subsumed under the support of autonomy and competence. As reflected by the teaching principles that they endorse, teachers in nonacademic track schools attach much greater importance to these aspects. Information as to whether this principle is actually put into practice in the classroom is best gained by reference to the students' reports.

In the following, we will thus present results from the COACTIV student questionnaire on mathematics

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Figure 5. Students' perceptions of support from their mathematics teachers by school type.



All scales have a mean of 0 and a standard deviation of 1, all differences are significant with $p < .05$.

lessons. In a written questionnaire, students evaluated aspects, such as (1) whether the interaction tempo gives them adequate time to think, (2) how well their teachers are able to diagnose the strengths and weaknesses of individual students and to identify comprehension difficulties, and (3) how well their teachers respond to student problems and distractions in lessons ("monitoring"). As shown by Figure 5, students at academic track schools consistently report lower levels of support from their teachers than do students at other school types. These data indicate that teachers at academic track schools seem to rely too heavily on their students' high levels of cognitive potential. They interact with their students in a high tempo that their students consider to be overtaxing and unreasonable, and tend not to actively monitor whether their

students are able to keep up. Teachers at other school types seem to be much more prepared to monitor their students' understanding, and to respond to individual difficulties. What are the implications of these findings as regards the prerequisites for insightful learning in mathematics lessons? First, our results indicate that truly powerful math instruction that supports independent and insightful student learning is a rather rare occurrence in German secondary schools. Second, mathematics lessons take very different forms in the different school types. Whereas, in academic track schools, the focus is on stimulating and fostering processes of comprehension, and teachers succeed in achieving this goal—to a certain extent, at least—through the tasks they select, mathematics teachers in other school types focus on practicing routines,

and give their students little opportunity to engage in the independent construction of knowledge. Nevertheless, students in nonacademic track schools seem to have a more positive attitude to math lessons; their teachers evidently do their best to provide students with personal support, an aspect which seems to be less well developed in academic track mathematics lessons. How might these contrasting patterns of instruction be explained? Our data suggest that teachers are not sufficiently able to gauge the potential of either mathematics problems or their students. With regard to tasks, German mathematics teachers seem to confuse the cognitive demands of tasks with their difficulty, assuming that challenging cognitive processes, such as mathematical modeling, are only possible with tasks requiring a high level of curricular knowledge. Consequently, particularly in the lower tracks, teachers fail to vary the cognitive demands of the problems they set, leading to the emphasis on routine exercises observed in COACTIV. At the same time, teachers seem to be under specific misconceptions as regards the potential of their students. For example, teachers at nonacademic track schools seem to assume that comprehension-oriented learning would overtax their students; thus, they focus on routine procedures. However, the findings of international educational assessments, such as PISA, indicate that this kind of approach might underestimate students' cognitive abilities. Indeed, results suggest that conceptual understanding is not simply a matter of general ability level—numerous

countries managed to foster conceptual mathematical understanding in the lower ability ranges much better than Germany. Teachers at academic track schools, on the other hand, seem to take the cognitive abilities of their students for granted, and to assume that they no longer require individual support, the upshot being that they tend not to individualize their instruction, even when setting cognitively demanding tasks. One possible effect of this lack of individual nurturing and support is also evident from the findings of PISA 2003. Students at academic track schools score lower on measures of math-related motivation (e.g., interest and achievement motivation) than do students at other school types. Although this phenomenon can probably largely be explained by reference group effects, it remains to be investigated whether these lower levels of domain-specific motivation result in students being less willing to engage in the critical and independent construction of mathematical knowledge.

To conclude, the findings from our investigation of mathematics teachers and mathematics lessons in Germany suggest that the necessary prerequisites for insightful learning are not fully in place in either academic or nonacademic track mathematics classrooms. Much could be gained from *integrating* the approaches of both school types. Future research will thus explore how it might be possible to balance cognitively demanding and individually supportive teaching, and to investigate the role that teachers' content and pedagogical content knowledge play in this relationship.

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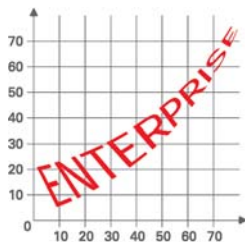
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Understanding comes from having a good representation

Novick & Hmleo



ENTERPRISE: Cognitive Activation in Elementary School Children: The Potential of Diagrammatic Tools

The ENTERPRISE project (Enhancing Knowledge Transfer and Efficient Reasoning by Practicing Representation In Science Education) 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.

It is now widely recognized that higher-order cognitive activities of humans, such as learning, reasoning, and transfer, are based on elaborated knowledge rather than on formal rigor (Haag & Stern, 2003). 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 allow for the construction of meaning in concepts, ideas, or plans. Within the mental-tool framework, understanding can be conceptualized as the ability to use representations in flexible ways. 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 devised as tools for knowledge representation only 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 markedly in-

creased over the past decades. In view of this trend, cognitive science has been strongly committed to the research of diagrammatic literacy. Beyond the function of displaying information, however, diagrams and graphs can also serve as active reasoning and transfer tools (Stern, 2001). The ENTERPRISE project has put a major emphasis on the use of line graphs as powerful reasoning tools for understanding proportional scientific concepts, such as, among many others, speed, density, or the degree of concentration of different mixtures of liquids. Research was focused on elementary school children because the cognitive potential of this age group has long been underestimated (Stern, in press).

Line Graphs as Powerful Reasoning Tools: Effects of Different Contrasts on Understanding the Slope of Line Graphs

Line graphs are broadly disseminated in learning material dealing with topics of formal domains, such as science or economics. They are most appropriate for representing causal as well as incidental relationships between two variables. In Germany, students encounter line graphs as a means for data representation already in early secondary school, while core elements of graphs, such as the slope or the intersection on the y-axis, are part of the mathematics curriculum in 8th grade, when students learn to map linear functions on graphs. However, 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 (Stern, Aprea, & Ebner, 2003). In recent years, the interpretation of the slope of a graph could be shown as being within the reach of 4th graders (Koerber, 2003). It was therefore concluded that starting to use graphs already in elementary school might help students to gain deeper insight into the structure and the potential of these reasoning tools, and facilitate learning when, in accordance with the grade 8 mathematics curriculum, they start to use them for representing linear functions. Before students learn to map formulas on graphs, they should have been familiarized with their core elements, that is, the slope or the intercept. In an experimental training study, Anja Felbrich investigated methods of focusing students' attention on the meaning of the slope of the graph.

Students frequently confound the slope of a graph with its relative height or with the length of the line; they also tend to read graphs as pictures of situations. For example, if shown a distance-time graph, such as in Figure 1, with the visual appearance of a hill and asked to describe what happens, students will infer that a hill has been climbed, not recognizing the abstract nature of the relationship between the variables represented by the graph. Students who are not able to solve this problem lack the knowledge of graphs as mental tools with specific affordances and constraints. In order to appreciate a graph as a tool, one needs to understand its underlying structural principles and, thus, to know what actions and operations it affords, and whether and under

which circumstances certain constraints apply. One feasible method to learn abstract concepts underlying graphical representations is to learn from comparisons. Several studies have shown that *comparing or contrasting two cases* will facilitate insight and abstraction, lead to differentiated knowledge structures, and foster transfer of strategies. Figure 2 highlights how contrasts can shape the meaning. As learners actively construct and reconstruct their knowledge depending on new information offered by the environment, a recently acquired concept will be differentiated and shaped in correspondence with the new information offered by the learning material and, as a consequence, the learner's understanding of the con-

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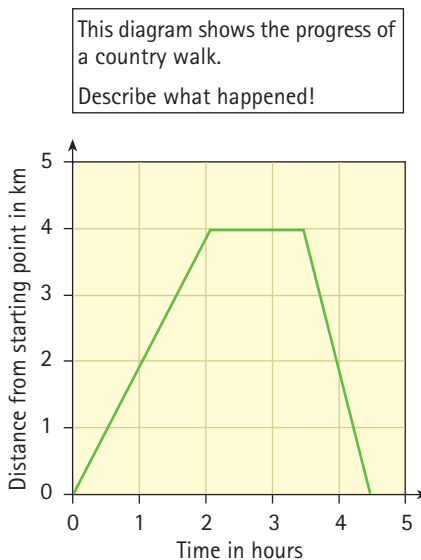


Figure 1. A source of misinterpretation of graphs.

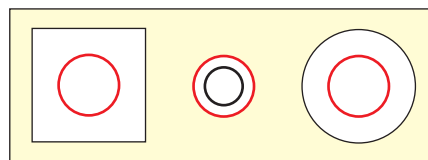


Figure 2. The contrast makes the meaning: What is the red object, a circle, a large circle, or a small circle?

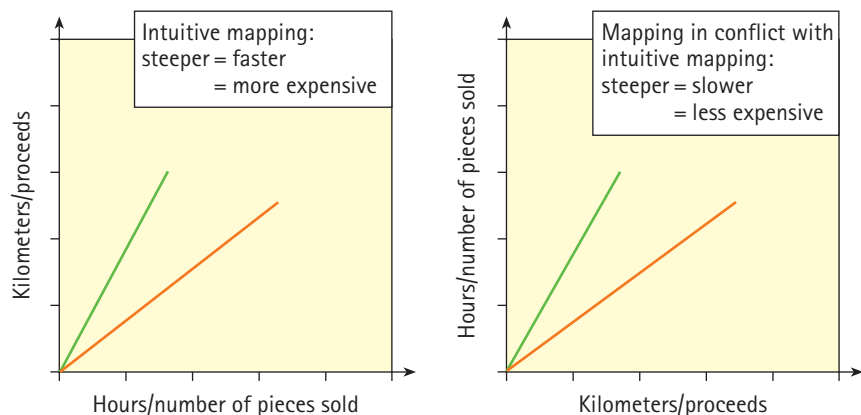
cept will change. Thus, for two learning opportunities to be considered as contrasting cases, an important constraint has to be satisfied: The second case has to highlight a new perspective and/or present new information with respect to the concept to be learned and, therefore, will have the potential of reshaping and furthering the current state of understanding. But what kind of information is perceived by the learner as being new or varying depends on the specific nature of the contrast, so that an efficient contrast has to be finely tuned to the learning goals. In designing learning environments which foster an understanding of graphs as tools it is, therefore, crucial to decide which elements or properties of graphs shall be contrasted. For developing an understanding of the slopes of line graphs as an integration of the information mapped onto the axes, two kinds of contrast were integrated in the learning environment.

Content contrast: A comparison of different meanings of the slope in different content areas highlights the fact that different proportional concepts, for example, speed or unit price, may be inferred from the

slope in a distance–time graph and in a graph showing proceeds and the number of pieces sold, respectively. With such a content-based contrast the learner is likely to perceive that the concepts mapped onto the slope are composites of variables mapped onto the axes, that is velocity as meter per second and unit price as proceeds per piece. However, this type of contrast also involves the risk of inappropriate overgeneralization. Although learners may come to perceive and interpret the slope as a (new) feature of graphs, they may conclude that the steeper line is always associated with a larger amount of the represented variable since both the faster speed and the higher unit price can be inferred from the steeper slope. The contrast in content does not focus on the meaningful integration of the two variables mapped onto the axes.

Structural contrast: A deeper understanding of the concept of slope can be fostered by contrasting two graphs, the content of which is the same while, in the second case, the assignment of variables to the axes is reversed. This switch of labels on the axes results in a reversal of the

Figure 3. This contrast thus highlights the specific ways in which information from the variables mapped onto the axes is integrated in the slope.



meaning of the slope, as shown in Figure 3. In the context of speed, the steeper slope now represents the slower speed since in this case it instantiates seconds per meter and not meter per second as in the first case.

In a study with more than 100 5th graders, Anja Felbrich tested whether students learning with the structural contrast do acquire a more flexible and transferable knowledge of the slope of a graph, compared to students learning with a content contrast. In order to test the cognitive potential of contrasts, an experimental training study was run, with four independent treatment group, and a baseline group who only did the tests but received no training. In the basic part of the two-afternoon training, which was the same for the four treatment groups, students were guided to discover that the relative speed of an object can be inferred from the slope of a distance-time graph. The second part of the training was different for the four treatment groups. For the no-contrast group, it was further practice with the same material. The structural-contrast group learned to integrate the information mapped on both axes. In the content-contrast group, the focus was on the applicability of the slope to different contexts. In the combined-contrast group, the variations of the content-group and the structural group were combined.

Prior to and after the training, two tests were administered where the slope of line graphs had to be interpreted. The Near-Transfer-Test contained items in a speed context, that is, the content area dealt with in the

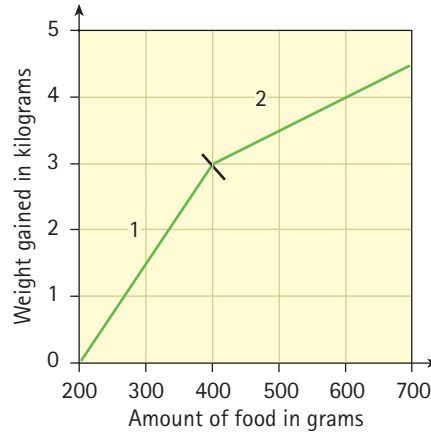
training, while the Far-Transfer-Test used contexts not covered by the training. In order to be able to differentiate between a flexible understanding of the slope (the meaning of the slope being derived from both axes) and a superficial understanding of the slope ("the steeper slope always represents more of something") the Far-Transfer-Test contained both possible ways of assigning variables to axes: "conventional mappings" in line with graphing convention and "unconventional mappings" violating these conventions. Examples of items are presented in Figure 4.

Results revealed that children participating in the four training groups significantly improved their performance on the Near-Transfer-Test as well as on the Far-Transfer-Test tests from pre- to posttest, while participants from the baseline group did not.

The four training groups did not differ regarding either the Near-Transfer-Test or the conventional mapping items of the Far-Transfer-Test. At the same time, however, the no-contrast group performed less well on the unconventional mapping items in the Far-Transfer-Test than the three contrast groups. Thus, it seems that students in the no-contrast group entertain a superficial decision strategy which enables them to perform well on items with a conventional mapping, but fails when the meaning of the slope has to be inferred from the assignment of variables to axes, as is the case for items with unconventional mappings. The same tendency is observable for the content-contrast group.

Figure 4. Sample item with conventional and unconventional mapping of variables to axes.

Use the diagrams to answer the question in the box!

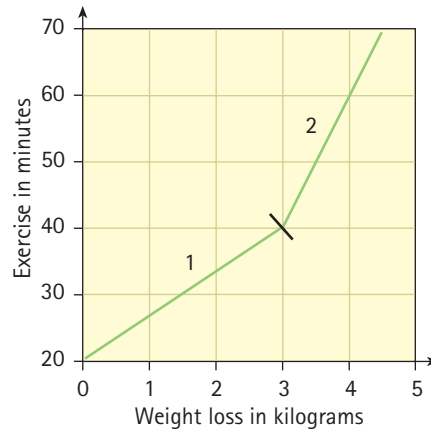


Conventional mapping

How many additional kilograms will the pigs gain in weight if they are given 100 grams *more* of food?
Fill in the spaces!

According to section 1:
_____ kilograms per 100 grams of food.

According to section 2:
_____ kilograms per 100 grams of food.



Unconventional mapping

How many additional kilograms will the person lose in weight if he or she exercises 10 minutes *more* than usual?
Fill in the spaces!

According to section 1:
_____ kilograms per 10 minutes of training.

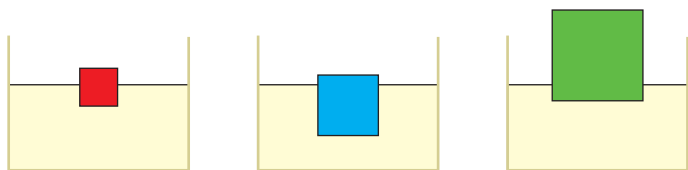
According to section 2:
_____ kilograms per 10 minutes of training.

The advantage of the structural-contrast group was revealed in the transfer test with unconventional mappings. However, combining both kinds of contrasts seems to overtax the ability of students, as no gains on the transfer test could be detected. Altogether, results suggest that 5th graders can acquire insightful knowledge about linear graphs in a learning environment which guides them in discovering structural elements of the graphs by contrasting cases.

How to Improve 3rd-Grade Students' Representational Competencies Within the Curriculum of Floating and Sinking of Objects

In recent years, learning environments for 3rd graders were worked out which support a basic understanding of the scientific concepts underlying the floating and sinking of objects in water, as there are buoyancy force and density. Results from a school study suggested that complex physics topics are already accessible to elementary school children on a permanent conceptual basis, especially if structured instruc-

Here are three cubes in water basins. They are made of different materials.



Which cube is made of the heaviest material? Make an X!

| | | | | | |
|----------|--------------------------|-----------|--------------------------|------------|--------------------------|
| red cube | <input type="checkbox"/> | blue cube | <input type="checkbox"/> | green cube | <input type="checkbox"/> |
|----------|--------------------------|-----------|--------------------------|------------|--------------------------|

Which cube is made of the lightest material? Make an X!

| | | | | | |
|----------|--------------------------|-----------|--------------------------|------------|--------------------------|
| red cube | <input type="checkbox"/> | blue cube | <input type="checkbox"/> | green cube | <input type="checkbox"/> |
|----------|--------------------------|-----------|--------------------------|------------|--------------------------|

Figure 5. An item from the test on floating and sinking which measures an understanding of density.

tion allows for an integration of students' preexisting and new concepts. At the same time, the study revealed certain deficits in the understanding of the concept of density, which were measured with items such as depicted in Figure 5. Many students still focused on weight and neglected volume. In a laboratory study, it was shown that especially a balance beam as a tool for representing two-dimensional concepts, as depicted in Figure 6, helped children to realize the inadequacy of their pre-conceptions as well as to integrate mass and volume to form the proportional concept of density (Möller, Jonen, Hardy, & Stern, 2002). Based on these results, the so-called integrative school study was run with 3rd graders to test the potential of the balance beam in classroom environments when integrated into the curriculum of floating and sinking, such as demonstrated in Figure 7. Similar to the curriculum worked out for the laboratory study, children

were trained in disentangling volume and mass by representing both dimensions with the help of Lego bricks on the two arms of the balance beam. On doing so, children learned that each kind of material can be represented at a fixed place on the arm of the balance beam. This helped children to understand that mass and volume have to be increased by the same factor in order to maintain the equilibrium of the balance beam. In independent groups, the effect of the balance beam was compared to that of self-constructed representations. In classrooms where self-constructed representations were practiced, students were equipped with a broad variety of material, such as paper, pencils, little bricks made of wood, and cardboards of different colours. The tests on understanding floating and sinking presented in the school study and the test for proportional reasoning presented in the laboratory study were used as pre- and

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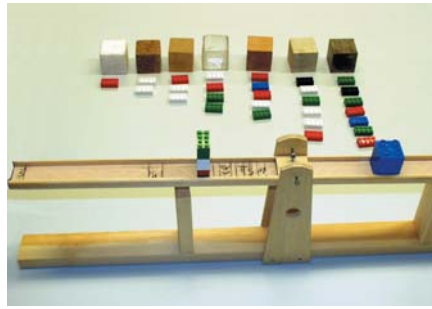


Figure 6. The balance beam represents different kinds of material.

posttest. Results of the altogether 98 students (each treatment was realized in two classrooms) revealed significant increases in both tests for both groups. No superiority of either form of representation was revealed (Hardy, Jone, Möller, & Stern, 2004). However, since the correct use of the balance beam is dependent on students' multiplicative additions on either end of the beam, they might get a deeper insight into the representation of two-dimensional concepts. It was hypothesized that students who had practiced representation with the help of the balance beam should have acquired some knowledge helping them to understand forms of representation which are based on similar princi-

Figure 8. A graph which can already be understood by 3rd graders.

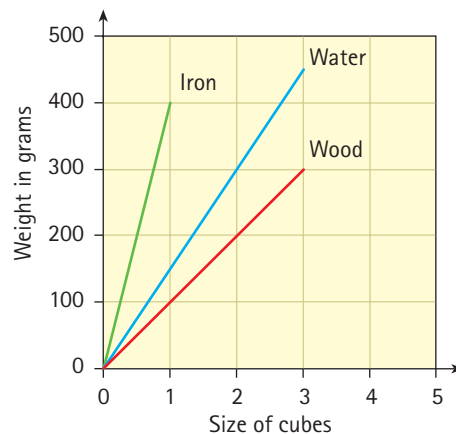


Figure 7. The balance beam in school.

ples, such as the graph of a linear function (Hardy, Schneider, Jone, Stern, & Möller, in press). Whether this was the case was tested in a follow-up study where a representative sample of 56 children from both groups received a short introduction on how to map the mass and the volume (labelled as weight and size of the cubes for the children) of certain materials on the axes of coordinate systems, and to construct a linear graph on this basis. A test on the use of graphs as reasoning tools in the context of density and speed was presented after the training. For instance, children were presented with a graph, such as depicted in Figure 8 and they had to predict whether an unknown material of size 2 and weight 400 will float or sink. Results revealed that students who had worked with the balance beam during the curriculum on floating and sinking outperformed students who had worked with self-constructed representations. This result suggests—in accordance with former findings—that the balance beam is an appropriate tool to support elementary school children's understanding of proportional concepts.

Contributions of the Center for Educational Research to the Preparation of New Research Fields

As a result of the PISA shock, the Germany Federal Ministry of Education and Research commissioned two reports focusing on research and practice which can be expected to improve school achievement.

(1) Fostering text and reading comprehension

How can text and reading comprehension be improved among German students? Cordula Artelt was asked to bring together a team of experts that analyze approaches to fostering text and reading comprehension, leading to recommendations for approaches that might add to the projects already implemented in the federal states. Fourteen experts from different fields made contributions to the report, resulting in a recent overview over factors influencing text and reading comprehension from a developmental, a differential, and an intervention perspective. Against the background of the newly developed output orientation in the German school system, the report also looks at the potentials of systematic collaboration between schools and other institutions or groups to reach high standards in reading. There are different ways of supporting children in their processes of becoming expert readers. Instead of focusing a one-size-fits-all method, the report gives recommendations for the neglected content of interventions, and highlights processes of professional development and collaboration within schools as well as among schools and other institutions and groups to improve and supplement future attempts of improving text and reading comprehension among students in Germany.

(2) In what aspects can the neurosciences contribute to a better understanding of school learning?

In recent years, considerable progress has been made in understanding the neurobiological foundations of learning. Animal research allows researchers to investigate how the brain changes as a result of stimulus-response learning, and many of their findings can be expected to apply to the human brain as well. Yet, simple stimulus-response learning, despite its importance in everyday life, is not what is called for in schooling which, rather, relies on insightful learning based on the use of symbol systems as thinking tools. As yet, little is known about the brain functions typical for human beings. Brain imaging methods only provide a very rough insight in what happens when human beings show cognitive activities, such as reading, doing arithmetic, or solving problems. Despite this vague scientific basis, findings from brain research often give rise to more or less unfounded hopes concerning their direct use for improving school learning. Elsbeth Stern was asked to work out a perspective for research collaboration between scientists specialized on learning and instruction, on the one hand, and neuroscientists, on the other hand. Together with Roland Grabner, an experienced EEG researcher, she invited more than 20 experts to take part in a workshop discussing methods of brain research and their potential contribution to understanding school-related learning, compared to more conventional methods, such as achievement measures or observation of behavior. The conclusion reached was that, while no hints for short-term improvement of learning and instruction can be derived from brain research, collaboration may, in the long run, contribute to a better understanding of brain functions in cultural contexts.

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Public Understanding of Science: Activities of the Center for Educational Research in Disseminating Important Results on Learning and Instruction

After the publication of the PISA report in December 2001, the Research Center got into the spotlight of public attention. Germany was not only shocked by its average ranking in academic achievement but also by two other prominent results: the underrepresentation of German students on the highest achievement level and their overrepresentation on the lowest level. The whole country called for explanations, and the PISA group was flooded by invitations for talks and interviews. Around 80 presentations were given in 2002. It was remarkable that invitations did not only come from schools, centers for teacher education, and politicians but also from institutions that traditionally are not concerned with questions of classroom education, for example, trade unions, employers' associations, and large companies. In the years 2003 and 2004, public interest increased even further. In these two years, more than 100 presentations and more than 30 interviews in newspapers were given by members of the Research Center at the following occasions: Workshops for teacher education; Meetings of school administrators and/or school principals; Meetings of politicians responsible for education; Conferences for applied education; Institutions for adult education; Meetings of business organizations, such as trade unions or employer associations

For many years, German educational traditions were dominated by the humanities rather than by empirical research. At the same time, public discussion about education was driven by contrasting ideological beliefs. Given this background, the opportunity of presenting the basic ideas of an education based on scientific evidence was taken very seriously by the members of the Center. By presenting the audience with a broad variety of methods of data collection and data analysis, it was demonstrated how empirical data can constrain decisions for designing educational systems in case of contradicting beliefs and opinions.

The common message of all presentations was that the highest priority for change is on a content-g geared improvement of learning environments at school. Improving academic achievement means that teachers have a core role: They have to present their students with tasks which foster cognitive activation. No reform of the school system can ever be expected to succeed without tackling learning environments.

A major message of presentations based on results of the TIMS Video Study was that classroom interaction can be investigated in a scientific way, and that we now know that the kind of instruction most German students have experienced is not typical for the instruction in more successful countries, such as Japan. The so-called questions-developing teaching style typical for Germany means that teachers only accept answers to their questions which fit into their own knowledge system. Those who criticize this teaching style call it the "Easter-bunny-pedagogy," which means that teachers hide knowledge and students have to search for it.

Presentations of the longitudinal BIJU and TOSCA projects focused on the effects of differential opportunity structures as provided by the highly differentiated school system in Germany, the effects of the so-called vocational Gymnasium in terms of broadened access to university education, and the role of minimum achievement standards for school evaluation and development.

The main message of the ENTERPRISE project was that early education should aim at laying the foundations for knowledge construction. For science and mathematics this means that children have to be involved in activities that allow them to develop basic concepts which later can be re-structured and extended.

„Bildungsstandards sind revolutionär“

n Instituts für Qualität im Bildungswesen, über Leistungstests, Gesamtschulen und die bevorz
s. L. zum Trotz – nichts tut eine höhere *allgemein* arbeit. Auch Fo
Lernfähigkeit im Kindesalter. Vieles spricht sogar

BT ES BEI TOSCA BESSERE NOTEN FÜR DAS LAND

mnasien
? Studie stellt beruflichen Gymnasien ein gutes Zeugnis
Bildungsforscher: Wichtiger Beitrag zur Modernisierung des Bildungssystems – Chance zum Ausgleich sozialer Unge
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Nach der Pisa-Studie: Unterricht auch in den Sommerferien

Sind Kinder anders lernberei
lidaktik“ glau
Großes „Jacobs-Sommerncamp“ mit 150 Bremer Kindern in Hepstedt, Verden und Syke
Hepstedt (hr). Die Ergebnisse der Pisa-Studie sind im Grunde der Hintergrund für Durchführung eines „Ja
Stadtteilen Oslebshausen, Gröpelingen, Huchting und Horn. Die Camp-Teilnehmer haben im Einzelnen die tür
Zeichens Leiter der Pisa-Studie. Auf die Kinder, die täglich mit dem Bus von zu Hause zum Naturerlebn
stündigen Deutschunterricht. Die Mehrzahl der Kinder wird in Deutsch als Zweitsprache unterrichtet. Einige
Teils ist eine am im Ernst-Waldau
Anwesenheit der B
findende Theater
Das Motto d

Schul-Schockierer mit guten Absichten

Einblick ins Max-Planck-Institut für Bildungsforschung, das die Pisa-Studie verantwortet

Was Hännschen lernt

Die Kognitionspsychologin Elsbeth Stern erforscht, wie Kinder sich Wissen aneignen / VON REINHARD

Arzte trinken Pipi.“ Große Heiterkeit in der Cafeteria des Berliner Max-Planck-Instituts für Bildungsforschung. Ein Vater zitiert seinen dreijährigen Sohn, der wegen einer Blasenentzündung ins Krankenhaus eingeliefert wurde. Anschließend verkündet er: „Mein Sohn ist anders lernbereit, wie uns einige Vertreter der „Neu-
Max-Planck-Institut für psychologische Forschung in München arbeitete sie sieben Jahre lang, bis sie 1994 einen Lehrstuhl für pädagogische Psychologie an der Universität Leipzig übernahm und 1997 nach Berlin wechselte. Auf dem Weg zu ihrem Lernlabor referiert Stern eine der Grundthesen: „Kinder im frühen Alter de-
nicht wirklich sicher verarbeitet. Daher ist für Stern der Umgang mit Schwächen und Fehlern die Nagelprobe für die Intelligenz der Schule. Dürfen sich Schüler so zeigen, wie sie sind, ohne Nachteile zu befürchten? Oder werden sie
Der „interessante“ stammt aus einer Studie des Schweizer Fritz Lehmann. Forscher wollten wissen, was die Kinder von dem Lehrer auf das Land mitbrachten.
sen sich einige
punktprogramm

»Mehr Mut zu Experimenten!«

Ein Gespräch mit dem Erziehungswissenschaftler Jürgen Baumert über Gesamtschulen, Leistung und Gerechtigkeit

DIE ZEIT: Plötzlich ist die Gesamtschule wieder im
ZEIT: Müssen wir uns damit abfinden, dass unser
gleich weniger ausgeprägt ist. Mehr als ganz

Projects of W. Edelstein, Director Emeritus

Rise of a Right-Wing Culture Among German Youth: Prevention Through Quality Education?

Right-wing extremism has been on the rise in Germany during the past decade, especially among young people in the Eastern provinces. Numerous studies have shown that racist, xenophobic, and anti-Semitic attitudes have extended beyond the groups originally most affected by prejudice, and reached toward "the center of civil society" (Heitmeyer, 2002; Bromba & Edelstein, 2001). In the recent provincial elections in the East, the nationalist and xenophobic right obtained a significant proportion of the vote—up to 25% in some voting districts in Saxony, and well above that number among young male voters in some places.

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Both government agencies and civil society have attempted to counter the right-wing attacks: through police action, policy measures, and the funding of organizations dedicated to the service of democracy, citizenship education, and tolerance. What has been lacking, however, is preventive action and planning that reach beyond the problems and incidents of the present.

Effective prevention, however, presupposes a theoretical base which permits a historical, social, and psychological reconstruction of causes for the rise and expansion of right-wing mentalities, attitudes, stereotypes, and dispositions. Based on interdisciplinary approaches which originated in Elder's work on *Children of the Great Depression* across the lifespan (Elder, 1974; Elder & Caspi, 1988) and in our own longitudinal work on *Individual Development and Social Structure* in Iceland (e.g., Edelstein, Keller, & Schroeder, 1990; Edelstein, 1999), we have constructed a model of the multiple and interacting causes and antecedent conditions for adolescent vulnerability leading to the development of dispositions and mindsets that are

typical for right-wing youth in Germany—and in a number of other societies, in particular in Eastern Europe. In various forms, these appear typical of youthful rebels around the world (Larsen, Brown, & Mortimer, 2002; Larsen & Verna, 2002). Important features of the model comprise the interaction between long historical processes (the corrosion of tradition, the rise of individualism, and the expansion of anomie), cohort effects (the downfall of socialism in the East), context effects (socioeconomic deprivation in postunification Eastern Germany), and proximal factors constituted by the psychological implications of socialization (attachment patterns, identity formation, and the experience of schooling in the East). These factors, at the various levels, are empirically well supported (Edelstein, 2005).

Keeping vulnerable groups from attraction to right-wing causes and affiliations in adolescence calls for a substitution of those conditions that trigger the emergence of extremism and violence and that provide compensation for the experience of humiliation and exclusion. The com-

pensation for the right is provided by a sense of community, often enhanced by nazi rock music and feelings of superiority and negative affect toward those perceived as inferior, foreign, or weak. Violence plays a major role in this experience (Frindte & Neumann, 2002; Heitmeier, 2002, 2004).

School provides an important experiential context for the emergence of right-wing groups and associations. Various studies have shown that the number of youths embracing right-wing positions increases as schools fail to provide an experience of community, opportunities for participation, and teacher trust. In such schools, learning is perceived as meaningless, boredom is intense, and hope for the future is limited. In short, these schools are hotbeds of anomie-generating experiences (Sturzbecher, 1997, 2001).

As a response, a program of school development was proposed to the Joint Federal and States' Commission on Educational Planning and Research (BLK), which was designed to provide at least some of the opportunities for citizenship learning and participatory experience strongly felt to be lacking in many German schools (Edelstein & Fauser, 2001). The proposal passed the Commission in 2002 and the program was adopted by 13 out of the 16 States, with the Federal Ministry of Education providing one half of the proposed five-year budget of some 6 million Euro. The program was named "Learning and Living Democracy." It consists of four modules: instruction for democracy (including organizational elements, such as interactive course planning or mutu-

ally agreed portfolios); projects or workshops; school democracy and participatory processes; and democratic experiences in the community such as service learning. Teachers are offered advanced training opportunities involving a dozen areas of concern from self-efficacy to civic learning, from the skill of conducting dilemma discussions to self-evaluation of schools. Further, high-level training is provided to a set of some 150 expert teachers who will be certified as democracy agents serving the transfer of viable products and processes developed in the roughly 170 program schools. Each State entertains between one and four school sets including five or six schools each, with a coordinator organizing each network. The 25 network coordinators provide the organizational backbone of the program, which is served by a central agency located at the Department of Education, Free University of Berlin. The program necessarily transcends the original aim motivating its construction. It reaches beyond the need to respond to the peril of right-wing youth development with an attempt to provide models of democratic citizenship education in high-quality school settings. The focus is on transfer. In sum, the program represents a conception of experiential and situated learning for competence in a participatory institution. Derived from constructivist developmental theory and best practice models of democratic school reform, it marks a step toward quality schools where pupils feel respected as well as motivated for better performance.

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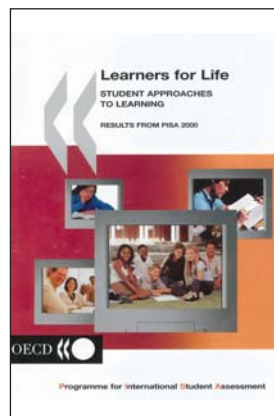
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