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Data in the Domain of School Education - Secondary School: Present situation, New Developments, and Future Requirements

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Data in the Domain of School Education – Secondary School: Present situation, New Developments, and Future Requirements

Petra Stanat, Hans Döbert

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Data in the Domain of School Education – Secondary School: Present situation, New Developments, and Future Requirements

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Abstract

Research on school education is exceptionally active at present. This heightened level of activity is partly due to the realization that, compared to other countries, Germany knows very little about its school system. Before the results from the first cycle of PISA (Programme for International Student Assessment) were published at the end of 2001, for example, even the proportion of immigrant students attending German schools was largely unknown (Baumert and Schümer 2001). Although the situation has changed tremendously over the last 10 years, many questions remain open. One of the major research gaps pertains to how students' competencies and other aspects of educational success develop over time and across different stages of the education system. Similarly, information on factors shaping these developments is lacking. This is particularly the case for process factors within schools, classrooms, and families that affect student learning. Although considerable progress has been made in capturing cognitive competencies and skills, moreover, little is known about how they unfold over time. Also, the role "soft-skills," such as social competencies, play as determinants and outcomes of educational processes is largely unclear. To provide a basis for exploring these and other issues, it is necessary to make existing data sets available to researchers and to generate additional data sets with improved research designs and instrumentation.

1. Currently available data sets

Three types of data sets are currently available in the domain of school education in Germany: official and non-official school statistics (primarily the school statistics and the Mikrozensus), survey data (e.g., SOEP, ALLBUS, the HIS survey of students eligible for university studies), and data from large-scale assessments of student performance (e.g., PISA, TIMSS, IGLU/PIRLS, Länder assessments).[1] From the perspectives of educational monitoring and reporting, the usefulness of these data sets depends, among other things, on the extent to which they include information on (1) students' educational participation (including school-type attendance within the tracked system and grade retention), (2) their learning outcomes in core domains, (3) their family background, and (4) their development over time (preferably based on longitudinal data rather than on retrospective information). In terms of these features, each of the listed data sets has differential strengths and weaknesses.

- The main advantage of the *school statistics* is that they are based on data collected for the entire school population. They include information on educational participation and grade retention. However, the data are cross-sectional and are provided at the aggregate level only. It is consequently neither possible to perform individual-level analyses nor longitudinal analyses with school statistics. In terms of students' background, moreover, the data include only rudimentary information, such as gender and nationality. Indicators of learning outcomes, moreover, are not available as well. An attempt is currently made to reform the data collection process for the school statistics. This reform, which will be described in more detail below, would be in line with the approach taken in many other countries where school statistics are already based on individual-level data and include a student identification number.
- Although the *Mikrozensus* provides data on individuals within households, its usefulness for school-related analyses is quite limited as well. In the past, the Mikrozensus asked respondents only whether or not household members attended a school and, if so, which grade they were in. Information on the attended school type was not collected. This changed in the 2008 survey, which also includes questions on the types of school the household members visit. At the same time, however, questions about attendance of pre-

1 Important additional data sources are research projects focusing on specific aspect of the school system, such as video studies on classroom instruction (e.g., Seidel et al. 2007), studies on transitions from elementary to secondary school (e.g., Ditton 2007), or studies on whole day schooling within the StEG program (Holtappels et al. 2008). It is beyond the scope of this expertise, however, to cover these studies as well.

school institutions, such as Kindergarten, have been eliminated from the survey. Moreover, although the Mikrozensus now collects more detailed information on the families' immigration background, some of the most important questions (e.g., country of birth) will only be asked every four years. Like the school statistics, the Mikrozensus data are cross-sectional and do not include any indicators of learning outcomes. Similar household surveys are also conducted in other countries, such as the Labour Force Survey (LFS) in the UK or the *Arbeitskräfteerhebung* (SAKE) in Switzerland.

- Among the surveys, the *Socio-economic Panel (SOEP)* is the most frequently used data set for individual-level analyses related to schooling. It provides information on school participation and on a large number of background factors over time. Since 2006, the SOEP also collects data on various aspects of cognitive functioning (Wagner et al. 2007). Adolescents are tested with a measure providing data on respondents' verbal, numerical, and figural intelligence, and adults complete short tests of processing speed and word fluency. This addition is useful for many analyses, yet its relevance for questions related to outcomes of schooling is limited. Although schools certainly affect students' intelligence development, their effects on such domain-general cognitive dispositions are considerably smaller than on subject-specific competencies, such as mathematics or foreign languages (Baumert et al. 2007). Again, similar longitudinal household survey are carried out in other countries, such as the Longitudinal Household Study in the UK (UKLHS) or the Labourmarket Monitoring (LAMO) in Austria.
- *Large-scale assessments of student performance* have gained in importance considerably over the past 10 years. Due to such factors as a generally negative attitude towards testing that was shared by many members of relevant stakeholder groups in Germany, as well as the conflict potential associated with comparisons of student performance across the Länder, Germany has, for a long time, refrained from measuring the output of schooling. In the aftermath of the first cycle of the OECD's Programme for International Student Assessment (PISA), whose results were published in 2001 (Baumert et al. 2001; OECD 2001), however, this has changed dramatically. The disappointing results PISA revealed for Germany has spurred a paradigm shift from an almost exclusive input orientation of the school system to a considerably stronger focus on its output – a shift which many other countries, such as the Netherlands, Sweden, or the United States have implemented long ago. The Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic (KMK) decided to participate regularly in the international large-scale assessment studies PISA, TIMSS elementary school, and PIRLS.

In addition, the KMK set up the *Institut zur Qualitätsentwicklung im Bildungswesen* [Institute for Quality Development in the Educational System] (IQB) whose task it is to specify national standards for learning outcomes in various school subjects and to develop test instruments that can be used to evaluate the extent to which the standards are met (Köller 2008). The IQB will administer these tests in representative samples in order to provide information on students' performance level in the 16 Länder.

In addition to these national activities, several Länder have carried out their own assessment studies (e.g., LAU, KESS, MARKUS, ELEMENT, QuaSUM), and all Länder are conducting so-called *Vergleichsarbeiten* ["comparison tests"] on a regular basis in selected grades (typically grades 3 and 8). The main purpose of the *Vergleichsarbeiten* is to provide schools, teachers, parents, and students with feedback about their relative learning results (Hosenfeld, in press). Although the tests are developed centrally, they are administered and scored by the students' teachers, such that the quality of the data is unclear. Moreover, whereas the international, national, and Länder-specific assessment studies typically measure a wide range of background variables, this type of information is either absent from or highly limited in the *Vergleichsarbeiten* data sets.

The international and national student assessment studies present an important data source for analyses on secondary schools. They provide highly reliable information on educational participation as well as learning outcomes. With the exception of a national extension to PISA 2003 (Prenzel et al. 2006) and the nationwide study on language compentencies DESI (Klieme et al. 2008), both of which included a longitudinal addition with two measurement points (PISA: from the end of grade 8 to the end of grade 9; DESI: from the beginning to the end of grade 9), the national assessments typically have cross-sectional designs. Longitudinal studies in selected regions of Germany include BIJU (grades 7-12/transition to work), BIKS (ages 3-8 and 8-12), DESI (beginning and end of grade 9), ELEMENT (grades 4-10), LAU/ULME (grades 5-13, vocational training), SCHOLASTIC (grades 1.4), and TOSCA (grade10-vocational training/university).

In general, the different types of data sets currently available in Germany typically also exist in other countries. In terms of some developments, Germany lags behind, yet the process of catching up with these developments is currently well under way.

2. New developments

2.1. Change of school statistics to individual-level data

In 2003, the KMK decided to change the school statistics to individual-level data and defined a core set of variables to be included in the data set ("Kerndatensatz für schulstatistische Individualdaten der Länder"). The core data set, which the individual Länder may extend as they see fit, encompasses the following variables:

- *Organisational characteristics of the school* (e.g., location, school type, legal status, number of delayed enrolments in first grade)
- *Individual background data of students* (e.g. sex, month and year of birth, nationality, year of immigration to Germany, language spoken in the family, country of birth, grade level, year of enrolment in first grade, school and grade attended the year before, type of grade repetition, focus of special support measures, attendance of all-day schooling and after-school care, place of residence)
- *Individual background data of school leavers and graduates* (similar to data for students remaining in the school as listed above)
- *Individual background data of teachers and data on teacher fluctuation* (e.g. sex, month and year of birth, nationality, type of teacher training, teaching qualification by subjects, gross teaching load, type and hours of reduced or additional teaching load, number of lessons taught at the school, functions within the school's administration, beginning and end of employment at the school)
- Data on classes/courses at the school
- *Organisational data in terms of instructional units* (e.g., grade level, educational track, subject, lessons per week, course type, external participants)

The KMK had aimed at converting the school statistics to individual-level data with the agreed-upon core set of variables by 2007. As the process has not generally been finalized, however, the time frame was extended to 2008/2009. Some of the Länder already possess individual data sets with student identification numbers while others have not yet begun to change their statistics. Moreover, the Länder typically concentrate on public schools, and it is not clear whether the collection of individual school data will be extended to private schools in the future.

The conversion of school statistics to individual-level data is in line with international standards. Informal interviews with representatives from several Northern European countries (including Austria and Switzerland) in the technical group of the OECD's Educational Indicators Project indicate that individual-level data are the rule (Hetmeier and Leidel 2007). Among the 11 countries included in the interviews, five (Austria, Denmark Israel, the Netherlands, Switzerland) collect individual-level data for students in elementary schools and all countries except Poland and Spain for students in secondary schools. Moreover, the data sets in these countries typically include identification numbers, thus making it possible to capture educational careers over time. Austria, the Netherlands, and – starting in 2011/2012 – Switzerland use the social security number for this purpose; Denmark, Finland, Norway, Poland, and Sweden a general person registration number.

In Germany, the data protection commissioners of some Länder resist the introduction of pupil identification numbers as well as the establishment of a centralized national data pool. In an attempt to find a compromise solution for this issue, a hashcode is considered which would be derived from data that typically remains unchanged throughout a students' school career (e.g. date of birth, sex, name), thus making it possible to capture educational pathways longitudinally. However, it is highly uncertain whether such a solution will, in fact, be accepted and implemented by all Länder. Unclear is also if the individual-level data will be integrated into a national data pool and whether it will cover the entire school system, including private schools and vocational schools.

2.2. The National Educational Panel Study (NEPS)

Carried out by a consortium of researchers from all disciplines concerned with education (education, psychology, sociology as well as economics), the National Educational Panel Study (NEPS) promises to provide a data set that meets the criteria outlined above (Blossfeld et al. 2008). It will include comprehensive information on participants' educational careers, competencies, and family background, and it will collect this information longitudinally. The panel is designed as a multi-cohort sequence study with eight stages that cover important transitions within the educational system. Secondary schooling will be analyzed in stage 3 (from elementary school to lower secondary school), in stage 4 (from lower secondary to upper secondary school), and in stage 5 (from lower secondary school to higher education, occupational training, or the labor market). The assessments will focus on five themes that are of particular relevance within research on education. These are (1) competence development

across the lifespan, including German-language competencies and reading literacy, mathematical literacy, scientific literacy, foreign-language competencies, and social competencies; (2) education processes in life-course-specific learning environments; (3) social inequality and educational decisions in the life course; (4) education acquisitions of immigrants and their descendants across the life span; and (5) education returns. The first assessments within the NEPS will start in 2009/2010 such that first results can be expected to be available in 2011/12.

Again, the implementation of an educational panel study is in line with international developments, as several countries already have similar longitudinal studies in place, such as the 1970 Birth Cohort, the Millennium Cohort, and the Youth Cohort Studies in the UK; the National Longitudinal Survey of Children and Adolescents (NLSCY) in Canada; or the Survey of Children and Youth on "Competence and Context" (COCON) in Switzerland. However, the scope of these studies tends to be more limited than that of the German NEPS, both in terms of the age range included in the assessments and in terms of the covered research foci. A particularly innovative and challenging feature of the NEPS is that it aims at assessing central domain-specific competencies across the lifespan. In addition, while it would be possible to study educational careers based on adequate individual-level school statistics, NEPS will allow for more detailed and in-depth analyses of these careers within contexts. Thus, the NEPS is a highly ambitious program which goes beyond what is currently available internationally. If successful, the study will yield an important data base for analyses of educational processes and outcomes.

3. Data access

Data from the Mikrozensus and such surveys as the SOEP or ALLBUS are typically available in the form of scientific use files. Within the limits of data protection regulations, researchers are free to use the data for scientific analyses. Similarly, the NEPS data will be made accessible to the scientific community as soon as the necessary data cleaning and scaling procedures have been completed. While the international data set from such studies as TIMSS and PISA can be downloaded from the Internet, moreover, access to national data from assessments of student performance has been more restricted. The National Ministry of Education (BMBF) is funding a Research Data Centre (FDZ) at the Institut zur Qualitätsentwicklung im Bildungswesen (IQB) which is designed to make data from student

assessment studies available to researchers and to provide training and support in using these data (IQB 2008). Researchers who want to work with a specific data set have to submit a proposal, describing their research questions and the analyses they plan to carry out. Whether or not access is granted depends on the following criteria (IQB 2009):

1. The data will be used for scientific purposes, not commercially.
2. Individual data protection is secured.
3. The planned analyses are in line with contractual agreements made with the owner of the data (such as the KMK). Comparisons between the German Länder, which have not yet been conducted, need to be approved by the KMK.
4. The planned analyses do not threaten theses (such as dissertations) or publications that are currently being written. The topics of these projects have to be specified at the time the researchers who have collected the data submit them to the FDZ. These topics are blocked for analyses with the respective data set for at least nine months. This time lag may be extended to up to three years.
5. No additional issues are in conflict with the intended use of the data.

If these conditions are met, the research data centre at the IQB will provide the researcher with a Scientific Use File. Researchers who want to use sensitive data (e.g., the Länder codes) have to perform their analyses at the IQB or via remote computing.

Unlike the initial regulations of the FDZ at the IQB, which included an evaluation of proposals in terms of their theoretical and methodological soundness, the current procedure largely complies with the standards for Research Data Centers defined by the German Council for Social and Economic Data (RatSWD). Nevertheless, a few open questions remain, such as who decides whether or not a proposal “threatens” theses or publications on the blocked topics and which “additional issues” may be “in conflict with the intended use of the data.” The transparency of the decision process should be increased by publishing a list of specified research questions that would be rejected on the grounds of the third or forth criteria. This would prevent researchers from investing time and effort on writing proposals that are bound to fail and it would further increase the perceived fairness of the application process.

4. Current challenges and future development

Although the data base for analyses on secondary schooling has improved considerably, a number of challenges remain. Most of these issues are not only virulent in Germany but also at the international level, such as the problems associated with modeling input-process-output associations in education.

Variables of educational research can be categorized in terms of whether they pertain to the input, to the process, or to the output of education (Konsortium Bildungsberichterstattung, 2006). While more work is needed on the systematization and operationalization of variables in all three categories, the process dimension is the most challenging. From the perspectives of both, educational research and educational reporting, it would be highly desirable to generate data and indicators capturing the process character of education. This pertains, on the one hand, to characteristics of *interactions* in educational settings that are related to the actual learning processes, such as approaches to structuring the teaching and learning process or the use of instruction time by teachers and learners, and on the other hand, to aspects that are directly relevant to the governance of educational *institutions*, such as the implementation of curricular requirements or measures of quality development and quality control. The central question is whether it will be possible to develop indicators for basic dimensions of processes that can be measured across different educational institutions and across the 16 Länder in reliable and valid ways. Because such measures are necessary to study the black box between the input and the output of education, it would certainly be worthwhile to invest into their development.

Within the output dimension, further work is needed on the assessment of so-called soft skills, such as various facets of social competence (e.g., the ability to communicate and cooperate with others). There is unanimity that these skills present important determinants of learning processes as well as outcomes of schooling, and it has repeatedly been argued that they should be taken into account in educational monitoring. Thus far, however, no reliable and valid measure has been developed that could be included in such studies as PISA (Kanning 2003; Kunter and Stanat 2002). This is partly due to the fact that the appropriateness of social behavior is highly dependent on situational requirements, such that a specific behavior may be quite competent in one situation yet largely counterproductive in another. As it is typically not feasible to employ systematic observations in large-scale surveys or assessment studies, it would be necessary to develop more indirect measures. One promising approach might be to

work with computerized scenarios that elicit students' responses to simulations of various social situations. Yet, again, it will be a challenge to come up with scoring systems for the appropriateness of these reactions.

Even aspects of the output dimension for which well established measures exist (e.g., reading, mathematics, and science), however, require further development for long-term longitudinal analyses. Most of the existing instruments were specifically designed for groups of students within a restricted age range, such as students in 9th grade or 15-year-olds. A major challenge the NEPS will have to tackle is to model these competencies and link the measures across the life-span. If successful, however, the study will provide important insights into the ways in which competencies in the domains of language, mathematics, and science unfold and interrelate at different developmental stages.

The question of how to model change is a more general challenge in educational research that has only been partly resolved. It is virulent not only for the level of individual development, but also for the development of individual schools and school systems. In Germany, there is a dearth of research on the extent to which schools change over time and on factors determining this change (Klieme and Steiner, in press). This is mainly due to the lack of longitudinal data at the school-level. Although the *Vergleichsarbeiten* could be used to perform such analyses, their results should be validated with studies employing more controlled data collection and scoring procedures. Several analyses of this type will be necessary to derive reliable estimates of changes occurring at the institutional level, the stability of these changes, and the effect sizes associated with potential determinants of developmental trajectories.

Even more complex is the attempt to capture and explain change at the level of school systems. The trend design of PISA aims at providing information on the extent to which school outcomes in the participating countries improve or do not improve over time, yet the interpretation of the findings has been controversial (Carstensen et al. 2008). This complexity is partly due to the changing focus of the PISA assessments, such that in each project cycle one of the three assessment domains (reading, mathematics, and science) is measured more comprehensively than the other, and to the multi-matrix design employed in the study. In PISA 2000 the focus was on reading, in PISA 2003 on mathematics, and in PISA 2006 on science. As a consequence, the overlap of items across the cycles has, so far, been limited. In addition, the composition of the test booklets varied in the different cycles, making it difficult

to tease apart possible changes in item difficulty and changes in performance levels.

Still more complicated than estimating changes at the levels of schools and school systems is the attempt to explain the observed developments with multi-level analyses. Multilevel modeling presupposes that the variables included in the model are comparable across the units of analyses. This is particularly questionable for analyses of data from international assessment studies, as specific features of individual countries, such as approaches to ability grouping or types of curricula within the tracks, will almost inevitably be neglected (see Stanat and Lüdtke 2008 for a discussion of multilevel issues in international assessment studies). It is typically impossible to take such complex between-country differences into account in multilevel analyses. Therefore, it is important to supplement quantitative multilevel analyses with qualitative data in order to generate more in-depth information on single cases (e.g., Döbert and Sroka 2004). One approach, for example, would be to submit countries deviating substantially from their predicted value in a multilevel analysis (Bowers and Drake 2005) to a intensive ideographical analyses. In additional to structural features of the school system, these analyses should also take into account the country's historical complexity as well as cultural factors that are likely to affect teaching and learning processes (Stanat and Lüdtke 2007).

5. Recommendations

Based on the current situation outlined above, the following recommendations result:

School statistiscs

- School statistics should be changed to individual-level data in all Länder.
- To allow for longitudinal analyses of educational careers, the school statistics should include a student identification code that remains the same across core educational stages. In the short run, the feasibility of different approaches to deriving such a code should be evaluated.
- Core characteristics, such as students' socioeconomic and immigrant backgrounds, should be represented by the same indicators in all Länder.
- More generally, the measures for core characteristics should be harmonized in the available statistical data sets (e.g., school statistics, youth welfare statistics, vocational training statistics).
- Data should also be collected for private schools.

Large-scale assessments (with Länder comparisons)

- Participation in international large-scale assessment studies, especially IGLU, TIMSS, and PISA should be continued.
- In order to use the potential of these studies more fully, it should remain possible to add national options to the international designs.
- Assessments of competencies should be extended to the beginning of elementary school (including language skills) and to the transition into the labor market.
- In addition to the large-scale assessment studies, the Zeitbudgetstudie („Time Budget Study") and the Freiwilligensurvey („Volunteer Survey") should be continued as well. The Zeitbudgetstudie is the only source of reliable data on the time people invest in education, and the Freiwilligensurvey allows for analyses of relationships between background factors and non-formal as well informal learning.
- Data from large-scale assessments and similar studies should be made available to the scientific community as soon as possible after they have been collected, cleaned, and scaled.
- The procedure of granting individual researchers access to data from large-scale assessments and similar studies should be completely transparent, also with regard to limitations in terms of the content of analyses. Such content-related limitations should be avoided.

Conceptual work and instrument development

- Theoretical models specifying the structure of competencies need to be refined or developed as well as tested in various domains.
- In some domains, such as social or vocational competencies, the development of conceptual models is still in its very early stages and should be intensified.
- Substantive conceptual work is also needed with regard to the theoretical specification and empirical operationalization of process and context factors determining competence development and school success.
- Measures are needed that can be used to study competence development in longitudinal analyses over longer periods of time.
- Similarly, measures that are sufficiently sensitive to change are required in order to estimate the effects of interventions.
- Statistical methods need to be refined or developed for capturing change in data over time, not only at the individual level but also at the levels of schools and school systems.

- Technology-based assessment systems are needed to allow for the use of more complex and innovative test formats and, in the long run, to reduce the costs of testing.

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Glossary:

ALLBUS Allgemeine Bevölkerungsumfrage der Sozialwissenschaften [General Social Survey]
BIJU Bildungsverläufe und psychosoziale Entwicklung im Jugend- und jungen Erwachsenenalter [Learning Processes, Educational Careers, and Psychosocial Development in Adolescence and Young Adulthood]
BiKS Bildungsprozesse, Kompetenzentwicklungen und Selektionsentscheidungen im Vor- und Grundschulalter [Educational Processes, Competence Development, and Selection Decisions at Preschool and Elementary School Age]
DESI Deutsch Englisch Schülerleistungen International [German English Student Performance International]
ELEMENT Erhebung zum Lese- und Mathematikverständnis [Study on Competencies in Reading and Mathematics]
IGLU/PIRLS Internationale Grundschul-Leseuntersuchung / Progress in International Reading Literacy Study
KESS Kompetenzen und Einstellungen von Schülerinnen und Schülern [Competencies and Attitudes of Students]
KOALA Kompetenzaufbau und Laufbahnen im Schulsystem [Competence Acquisition and Educational Careers in the School System]
LAU Aspekte der Lernausgangslage und der Lernentwicklung [Aspects of Learning Prerequisites and Learning Development]
MARKUS Mathematik-Gesamterhebung Rheinland-Pfalz: Kompetenzen, Unterrichtsmerkmale, Schulkontext [Rhineland-Palatinate Comprehensive Assessment in Mathematics: Competencies, Characteristics of Instruction, School Context]
PISA Programme for International Student Assessment
QuaSum Qualitätsuntersuchung an Schulen zum Unterricht in Mathematik [Study on School Quality in Mathematics Instruction]
SCHOLASTIK Schulorganisierte Lernangebote und die Sozialisation von Talenten, Interessen und Kompetenzen [Organized Learning Opportunities at School and the Socialization of Talents, Interests, and Competencies]
StEG Studie zur Entwicklung von Ganztagsschulen [Study on the Development of Whole-day Schools]
TOSCA Transformation des Sekundarschulsystems und akademische Karrieren [Transformations of the Secondary School System and Academic Careers]
ULME Untersuchungen der Leistungen, Motivation und Einstellungen zu Beginn der beruflichen Ausbildung [Study on Achievement, Motivation, and Attitudes of Students at the Beginning of Vocational Education]
TIMSS Trends in International Mathematics and Science Study