Discussion Paper No. 10-011

Are We Spending Too Many Years in School? Causal Evidence of the Impact of Shortening Secondary School Duration

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Non-technical Summary

In international comparison, German university graduates are elder on average when they enter the labor market. Apart from the longer duration time of study at university, one fundamental reason is the long secondary schooling time. Therefore, almost all of the German federal states have introduced a reform of shortening the length of secondary schooling by one year while holding the curriculum almost constant. Hence, the reform has increased the learning intensity ratio, i.e. the ratio of academic curriculum content per unit of instructional time, for the treated students considerably. The educational policy reform was at first enacted in 2003 and realized in 2007 with a double cohort of graduates in the German state of Saxony-Anhalt.

We use this reform as a natural experiment to evaluate the causal effects of higher learning intensity ratios on student performance. Identical final written exams for both cohorts allow us to assess school performance directly. We use achievement grades at graduation in mathematics, German literature and English to approximate the effects on human capital accumulation. The effects of increasing learning intensity ratios on student performance depend on subjects and differ by gender. We find significant negative effects on student performance in mathematics for females and more pronounced negative effects for males. Student performance in foreign language has also decreased due to the reform, but only for females. In contrast to that, no differences are obtained on grades in German literature for both genders.

Our findings suggest inefficient learning intensity ratios in the acquisition of linguistic skills. However, increasing the academic content considerably in a predefined period of instructional time in mathematics cannot compensate for shortening schooling time. Moreover, some students are not able to cope with the increase in learning intensity. Perhaps, lowering the learning intensity ratio in such demanding subjects like mathematics by additional instructional time at the expense of subjects with low learning intensity is a reasonable recommendation. In addition, a revision of the curricula could be an appropriate response. Our results suggest that institutional features, such as learning intensity, matter. Policy makers should turn their attention from raising the quantity of education to raising the quality.

Das Wichtigste in Kürze

In nahezu allen Bundesländern mit 13jährigem Abitur wurde eine Verkürzung der Gymnasialschulzeit um ein Jahr beschlossen. Ein wichtiges Argument für diese Reform waren erwartete Wettbewerbsnachteile deutscher Absolventen beim Eintritt in den Arbeitsmarkt aufgrund der im internationalen Vergleich zu langen Ausbildungszeiten. Durch die Reform sollen diese möglichen Nachteile verringert werden, da die Schüler den gleichen Wissensstand bereits nach 12 Jahren erreichen sollen.

Sachsen-Anhalt hat diese Reform als erstes Bundesland umgesetzt. Die Verkürzung wurde im Jahr 2007 mit dem Doppelabitur abgeschlossen. Obwohl sich bei Schülern, Eltern und Politikern Zweifel an der Wirksamkeit des „Turbo-Abiturs" im Hinblick auf die angestrebte verbesserte Wettbewerbsfähigkeit regte, liegen bislang keine wissenschaftlichen Ergebnisse zu den Auswirkungen der Verkürzung der Schulzeit bei nahezu unveränderten Anforderungen und der damit verbundenen Erhöhung der Lernintensität (definiert als Lernstoff pro Unterrichtszeit) auf das Wissen, die Fähigkeiten und Kompetenzen der Absolventen vor.

In der vorliegenden Studie werden die Wirkungen der Schulzeitreform auf die Leistungen der Absolventen empirisch untersucht. Die Reform, die 2003 angekündigt und umgesetzt wurde, stellt für die betroffenen Schüler eine Art natürliches Experiment dar. Während die Absolventen mit 12 Schuljahren eine deutliche Erhöhung der Lernintensität erfahren haben, hat sich für die Absolventen mit 13 Schuljahren kein Unterschied ergeben. Der Vergleich beider Jahrgänge erlaubt daher die Identifikation der Wirkungen der Erhöhung der Lernintensität bzw. die Evaluation der Reform. Basierend auf einer Primärerhebung werden zunächst die Einflüsse der Erhöhung der Lernintensität auf das Wissen in Mathematik, Deutsch und Englisch analysiert. Hierbei dienen die im schriftlichen Abitur erreichten Punkte als Maß, da beobachtbare Unterschiede in diesen aufgrund der für beide Jahrgänge identischen, zentral vorgegebenen Abiturprüfungen kausal auf die Reform zurückzuführen sind.

Die empirischen Ergebnisse unterscheiden sich hinsichtlich der Fächer und des Geschlechts. Insbesondere in Mathematik schneiden die Absolventen des 12. Jahrgangs signifikant schlechter ab als diejenigen des 13. Jahrgangs. Der durchschnittliche Absolvent muss einen erwarteten Punkterückgang von 11% (von 7,8 auf 6,9) hinnehmen, während der Rückgang für die durchschnittliche Absolventin bei 8% (von 7,7 auf 7,1) liegt. Zudem hat die Reform einen signifikant negativen Effekt auf die Englischkenntnisse bei Frauen. Im Fach Deutsch können keine statistisch signifikanten Unterschiede zwischen beiden Jahrgängen festgestellt werden. Die Ergebnisse weisen darauf hin, dass es Ineffizienzen in den Lernintensitäten gibt. Darüber hinaus zeigt sich, dass nicht alle Schüler der gestiegenen Lernintensität gewachsen sind, sondern ein Jahr länger bis zum Abitur benötigen oder mit einem niedrigeren Abschluss die Schule verlassen.

Aus der signifikanten Verschlechterung der Mathematikkenntnisse der Abiturienten ergeben sich veränderte Anforderungen für die post-sekundäre Bildung, insbesondere in den Universitäten. Die Ergebnisse verdeutlichen zudem die zentrale Bedeutung der Lernintensität für den Bildungserfolg. Das künftige Augenmerk der Bildungspolitik muss daher weniger auf die Bedeutung der Bildungsquantität sondern stärker auf das Verständnis der Faktoren gerichtet werden, die die Qualität der Bildung beeinflussen.

Are We Spending Too Many Years in School? Causal Evidence of the Impact of Shortening Secondary School Duration*

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Abstract

This paper analyzes the impact of shortening the duration of secondary schooling on the accumulation of human capital. In 2003, an educational policy reform was enacted in Saxony-Anhalt, a German state, providing a natural experimental setting. The thirteenth year of schooling was eliminated for those students currently attending the ninth grade. Tenth grade students were unaffected. The academic curriculum remained almost unaltered. Using primary data from the double cohort of *Abitur* graduates in 2007, significant negative effects were discovered for both genders in mathematics and for females only in English. The effects on literature were not statistically significant.

Keywords: student performance, school duration, learning intensity, natural experiment

JEL Classification: I21, J18, C21

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1 Introduction

The enactment of educational policies designed to foster scholastic achievement must be a national priority. The schooling opportunities available to the nation's young people are essential ingredients for the cognitive skill formation process. Given today's accelerating technological change, together with an increasingly competitive global economic environment, the importance of cognitive skills has become recognized as essential for increases in individual earnings and aggregate economic outcomes.[1]

Previously, public educational policy has been concerned principally with issues relating to the quantity of schooling. The implementation of compulsory education, raising the minimum school drop out age, and lengthening the time allotted for the completion of the necessary university entrance qualifications were enacted to enhance educational outcomes.[2] The opportunity costs associated with these quantity related policies, however, are high. They tend to reduce the time available for graduate studies, for the accumulation of work experience, for the earning of income, and for the starting of a family. Consequently, a superior educational policy should be one whose focus is to promote the quality of the educational experience and not one that simply adds to its quantity.[3]

An important question, however, remains unanswered. Is it possible to achieve this goal by increasing the learning intensity ratio, i.e., the ratio of academic curriculum content per unit of instructional time? If the length of time students spend in school is reduced, while at the same time the curriculum content remains the same, is that the optimal way to shorten the duration of schooling without affecting the overall quality of education? Presently, little is known about the relationship between learning intensity, an essential element in the quality of education, and the academic achievement of students, a measure of their human capital accumulation. In this paper, the relationship between increased learning intensity ratios and the student academic achievements that result are investigated.

International comparisons have shown that *Gymnasium* (secondary school) graduates in Germany are comparatively older than their counterparts in comparable countries.[4] As a result,

[1]Hanushek and Woessmann (2008) provided an excellent survey about the impact of cognitive skills on individual income and their central role in economic development.

[2]Moreover, previously published international studies of student performance such as TIMSS and PISA show significant performance differences among students in two adjacent grades in literacy, mathematics, and science for most of the OECD countries (Woessmann, 2003; Fuchs and Woessmann, 2007; OECD, 2002, 2004, 2007). Students in higher grades scored considerably better than students in lower grades.

[3]An increasing body of educational and economic research investigates how school policy, teaching quality, and the educational environment effect achievement. See, for example, the educational research reviews by Teddlie and Reynolds (2000) and Creemers and Kyriakides (2006) concerning school effectiveness, or Hanushek (2005) on the economics of school quality.

[4]The ages at graduation from secondary schooling are provided by OECD (2005); in Germany, students are

almost all of the German states implemented policies designed to reduce the time spent in secondary school by eliminating the thirteenth year. This was done, however, without commensurately reducing the scholastic requirements for graduation. The academic curriculum remained almost unaltered and, therefore, the learning intensity ratio for the twelve-year students was considerably increased. This change was announced in 2003 and was enacted for the first time in 2007 in the state of Saxony-Anhalt. Subsequently, similar changes were implemented in almost all other German states. This educational reform provides a natural experimental setting where comparisons in the scholastic achievement of graduates in this double cohort of students can be compared.

Using primary data from the Saxony-Anhalt double cohort of 2007 *Abitur* graduates, yields the following results: The estimated effects of increased learning intensities on the scholastic achievements of students depend on the specific academic subjects considered. In addition, the effects differ by gender. Significantly negative effects were discovered in mathematics for both genders, however, it was much more pronounced for males. Scholastic performance in foreign language was also decreased due to the reform for females, but the effect for males was statistically insignificant. No differences were discovered in German literature.

There exists only very few published studies where the effects of increased learning intensity are related to scholastic achievements. Pischke (2007) investigated the impact of shortening the instructional time by two short school years 1966-7 in West Germany on grade repetition, secondary schooling opportunities, earnings, and employment. He found no negative effects on earnings and employment but there was an increase in grade repetition and lesser academic track choice. It is, however, the only study considering policy-induced variation in schooling time without a commensurate alteration in the curriculum. As there existed no standardized testing system in Germany at the time, he could not estimate the effect directly on student performance. Consequently, the opportunity for deriving insights concerning the development of human capital is limited for that reason. Furthermore, translating these results into today's world may be difficult, as the composition of the student body has changed substantially. Today there is a trend towards more students seeking diplomas in the highest level of secondary education. Further evidence was provided by Skirbekk (2006) who looked at the effect of variation in the duration of schooling on human capital using test scores from TIMSS for different Swiss cantons. He discovered that differences in the length of the Swiss academic program across regions had no influence on the scholastic achievement in mathematics and

aged 19 whereas, e.g., in the Netherlands graduation age is 17-18 years, 18 years in the US, and 17 years in Russia.

science when school specific effects were taken into account.

Marcotte (2007), Lee and Barro (2001), and Woessmann (2003) examined the impact of considarable lower reductions in instructional time on student performance. Using Canadian data, Marcotte (2007) used the variation in school days caused by inclement winter weather to identify the impact of increased learning intensity on test scores. His findings are in line with the results presented herein. Students with less instructional time perform significantly worse than their peers most notably in mathematics. Lee and Barro (2001) investigated the effects of school resources on student performance as measured by internationally comparable test scores across countries. They found significant positive effects of the length of the school term on the mathematics and science scores, but significantly negative effects for reading. Woessmann (2003) discovered significantly positive, albeit relatively small, effects of instruction time on student performance in mathematics and science. This evidence suggests that the effect of increasing learning intensity on the accumulation of knowledge depends on the kind of subject.

In the Province of Ontario, Canada, an educational reform similar to the German took place. In this instance, the length of schooling in high school was reduced by one year. The major difference compared to the German experience, however, consists in a more modified academic curriculum. In Ontario less courses in main subjects like mathematics and the English language were made available for the treatment group and, therefore, the impact of the reform on learning intensity is not determinable. Moreover, the thirteenth year was not a full-fledged academic grade like it was in Germany. Students in Ontario were able to graduate from high school after the twelfth year. Before the educational reform was enacted, students could complete their schooling by utilizing this additional year or not. Morin (2010) estimated the effect of abolishing the thirteenth year on the academic performance of high-ability students in their first year at the university. He found only small effects on student performance. However, Krashinsky (2006) found larger negative impacts on academic performance at the university analyzing the impact of the same educational reform on students with lower high school grade averages. In addition to the differences with respect to learning intensity their analysis varies from the one presented here because we control for more of the student's personal background information. Another advantage of our study is the fact that the measurements of scholastic achievement were made at the completion of schooling. All of the students were required to take the final exams and so there is no potential for a self-selection problem as with Morin (2010) and Krashinsky (2006) who measure the performance later and only for university students.

The present study contributes to the existing literature in several respects. It analyzes a policy-induced large-scale variation in the length of secondary schooling with only minor changes in the academic curriculum, which resulted in a considerably increased level of learning intensity. Identical final written exams for both grades allow for the direct assessment of school performance. Primary data was collected from the double cohort of the 2007 graduating class. The estimation model controlled for a number of student performance influencing factors such as family background, student ability, and school fixed effects. Furthermore, a check was made of the reliability of the assumptions inherent in the natural experiment used to identify the educational reform effect.

The paper is organized into seven sections. Section 2 provides background information regarding the educational reform that took place in Germany. A presentation of the natural experiment and the estimation approach is provided in Section 3. The data set used for the empirical analysis is explained in Section 4 together with some selected sample statistics. The empirical estimates of the educational reform on the scholastic achievement of students are provided in Section 5. Section 6 provides a discussion of the implications from these results. The final section concludes.

2 Background

On average, university graduates in Germany are older when they enter the labor market than their counterparts in other comparable countries. This is the result of a longer university curriculum coupled with a prolonged period of secondary schooling (OECD, 2005). As the result of the Bologna Process, originating with the signing of the Bologna Declaration in 1999, pressure upon Germany to reform its educational system has increased.[5] The responsibility for educational policy, however, including the funding of public schools, is entrusted to the *Bundesländer* (the German Federal Republic consists of sixteen states).

2.1 Schooling in Germany

The German educational system tends to differ from state to state. In the majority of states, however, students are enrolled in primary school at the age of six and remain there for four years. Upon completion, they are guided, according to their cognitive skills, into three available types of secondary schooling: the basic, the intermediate, and the university preparatory. The *Hauptschule* is the basic secondary school and provides educational instruction through the

[5] The Bologna Process is the process of creating a European Higher Education Area (EHEA) by 2010, one that includes the adoption of the academic degrees (Bachelor, Master, and Doctorate) together with the introduction of a credit transfer system that recognizes higher educational course work done at other locations.

ninth grade, the minimal required length of schooling. The *Realschule* provides the intermediate level of instruction through the tenth grade. Afterwards, the graduates from both of these schools usually commence some sort of vocational training in the apprenticeship program. Until recently, all states (with the exception of Saxony and Thuringia) provided thirteen years of university preparatory schooling in their *Gymnasium* leading to the *Abitur* (university admittance qualification). In addition to these three types of schools, several states provide an additional type of comprehensive schooling, the *Integrierte Gesamtschule* (an integrated comprehensive school). In this school, students can graduate after nine, ten, or thirteen years. As such, they are able to obtain the same corresponding academic degrees as offered by the other three types of secondary schooling. The significant difference in this type of schooling is that the students were not guided into a specific academic path before hand.

As a consequence of the German political reunification, the existing West German schooling system was adopted in the early 1990's by most of the former East German states. Subsequently, a number of additional reforms were implemented as well. Previously, the German Democratic Republic (GDR) had a system of compulsory education, but students were not selected according to scholastic ability before the tenth grade. After the tenth grade only those who demonstrated a high level of cognitive skills in conjunction with an inclination towards the socialist ideological activities promoted by the regime were eligible for admittance into a two-year *Gymnasium*. Subsequently, university entrance qualifications were obtained after the twelfth grade. Two of the East German states, Saxony and Thuringia, introduced a student selection procedure before the tenth grade but retained the twelve-year graduation policy. The scholastic achievement of students in these states has proven to be quite good (PISA-Konsortium Deutschland, 2008) and this has added support to the debate concerning the abolishment of the thirteenth *Gymnasium* year in most German states.

2.2 The Educational Reform

Saxony-Anhalt was the first German state to initiate an educational policy reform that shortened the length of secondary schooling by one year. The change was announced in 2003 and was implemented some months later at the beginning of the 2003/2004 academic year. The first students to be effected by this change were at that time in the ninth grade and were the first to receive their *Abitur* after completing twelve years of schooling. Consequently, in the spring of 2007, Saxony-Anhalt students in the twelfth grade (henceforth referred to as G12) and the thirteenth grade (G13) participated in a joint commencement ceremony.[6] The change was implemented as follows.

For the G12 students, the thirteenth year had been eliminated. The academic requirements for the *Abitur*, however, remained unaltered. In Germany, only the last two years of secondary schooling are considered when the eligibility for the *Abitur* is determined. Consequently, the academic curriculum of the twelfth and thirteenth grades now had to be pushed forward. During the transition period, schools had the opportunity to create new classes and/or to teach students from the double cohort jointly. The majority of schools did not establish new classes but provided combined courses for students from both cohorts in some subjects. For the G12 students, the curriculum of the former eleventh grade, called the preliminary grade, was distributed throughout the lower grades. The whole curriculum of instruction was moved forward in German literature as well as in the foreign languages. Only minor reductions were implemented in mathematics and chemistry whereas in some other subjects, (e.g., biology and history) parts of the eleventh grade curriculum were transformed into additional elective courses. The total instructional time for the G12 students had been reduced by one academic year. This loss was eased, however, by the addition of some extra classroom hours. Three instructional hours per week were added in the ninth grade and three in the tenth grade. Individual schools were allowed to decide, however, which subjects would receive these additional instructional hours.

This educational reform, consisting of the loss of a whole instructional year without a compensating reduction in the graduation requirements, must have affected the students involved in a myriad of ways. This research, however, concentrates on the affects of human capital accumulation as measured by the final examination test grades in three different subjects areas: mathematics, German literature, and foreign language (English). Differences might be expected since abolishing one whole year results in less time for instruction and homework, thus increasing the learning intensity. In addition, the time available for extracurricular and leisure activities is also reduced, resulting in the reduced accumulation of some important noncognitive skills. These are capable of improvement at least until the age of twenty (Dahl, 2004) or later (Caspi and Roberts, 1999) and relate to the formation of important human qualities such as self-reliance and discipline.

[6]Currently, all German states except one have decided to eliminate the last year of secondary schooling. The *Kultusministerkonferenz*, KMK, (a conference consisting of the Secretaries of Education and Cultural Affairs) accentuated the importance "The responsible handling of the lifetime and the educational time spent by young people is of central concern" (press release, March 2008).

3 The Natural Experiment

The experiences of Saxony-Anhalt in educational policy reform provides a natural experimental setting for the investigation of the effects of shortening the duration of schooling while holding the content of the academic curriculum approximately constant.[7] Standardized written exams were employed and the same academic grading scheme, provided by the state Department of Education, were used to evaluate all of the students involved. The examinations in mathematics and German literature are mandatory. In addition, a foreign language is also required. Students are allowed, however, to make their own selection. The vast majority chooses to take this examination in the English language.

The assignment of students to the treatment group, G12, and to the control group, G13, can be assumed to be random. This is due to the fact that the public announcement and the policy implementation occurred simultaneously. The impacted students in the treatment group had been enrolled in secondary school for a number of years already and simply received the notification without being required to initiate any actions. If there had been some degree of selection bias between groups this should be observable when comparing the pre-treatment characteristics of the sample. Anticipation of the reform could have created an incentive for parents to move within a very short time span to a different state within Germany. The opportunity cost of such a move, however, would be extraordinarily high. Therefore, this type of anticipation effect is very unlikely. On the other hand, if students attempted to commute to a school in a neighboring state, the closest border is far away (about 50 km) and this option is equally unattractive.

Assuming that the estimates have internal validity, there still may be concerns with respect to the external validity of the natural experiment, i.e., translating the specific findings from the study into a more general setting (Meyer, 1995). A serious obstacle could be the existence of a general time trend in the accumulation of human capital. If this were the case, the models presented here would not capture the causal effect of shortening the duration of secondary schooling. Although a time trend in cognitive achievement is perhaps likely in younger children, it is not very likely to be present in the later periods of educational development considered in this study.

[7] Pischke (2007) analyzes the effects of the German short-school years during the 1960's in a similar way.

3.1 The Theoretical Relationship

Assume that the final examination test grades attained by students are the outcomes of a discrete random variable $Y = y, y = \{0, 1, 2, ..., 15\}$, capable of taking only sixteen non-negative integer outcomes. This academic grading scheme consists of ordinal numbers that rank levels of scholastic achievement in increasing order from zero denoting failure to fifteen, the highest level of scholastic excellence. The students receiving these grades are differentiated from one another by numerous personal distinguishing characteristics, originating from a variety of socioeconomic, demographic, and geographic sources. For estimation purposes, these specific characteristics must be observable, measurable, and appropriate for all of the students considered. The columns of the matrix $\mathbf{X}$ consist of random variables denoting these characteristics and its rows contain all possible combinations of their outcomes. A joint population probability distribution exists consisting of all the variables heretofore defined. Therefore, the discrete univariate conditional random variables $(Y|\mathbf{X})$, one for each row of the $\mathbf{X}$ matrix, have conditional expectations. Assume that these expectations are linearly related to each other:

$$E(Y|\mathbf{X}) = \mathbf{X}\boldsymbol{\lambda}. \tag{1}$$

where vector $\boldsymbol{\lambda}$ determines how the average value of Y changes as elements of $\mathbf{X}$ change. In the population the single valued Conditional Expectation Function (CEF) assigns to each possible combination of student characteristics a conditional mean grade.

3.2 The Basic Model

In order to facilitate estimation of the impact of the educational policy reform in question on the observed scholastic achievements attained by the students in the G12 and G13 groups, some additional specification is required. In addition to the pooled data, the grades were also sorted by gender, $g = \{\text{pooled, female, male}\}$. Green and Oxford (1995) confirm that females and males prefer different learning strategies, while De Bellis et al. (2001) included differences in biological and mental development, to conclude that altering the instructional time may lead to differing gender specific results.[8] Subsequently, the sample was also divided into three academic subject areas, $s = \{\text{M, L, E}\}$, Mathematics (M), German Literature (L), and the English Language (E). The matrix $\mathbf{X}$ is partitioned as follows: $\mathbf{X_1} = [\mathbf{e}|\mathbf{d}|\mathbf{D}|\mathbf{P}]$. The column vector $\mathbf{e}$ is the all-ones vector, the vector $\mathbf{d}$ contains dichotomous elements that equal one corresponding to a grade earned by a student belonging to the G12 group and zero for one in the G13 group, the

[8] See also OECD (2009) for a comparison analysis of student performance for boys and girls, fifteen years old.

matrix $\mathbf{D}$ consists of eleven columns of dummy variables that identify the school in which the grades were earned (there are twelve schools in the sample and school number eleven is taken as the reference), and, finally, the matrix $\mathbf{P}$ contains certain relevant personal characteristics describing the students involved.

$$E_g^s\left(Y|\mathbf{X_1}\right) = \mathbf{X_1}\boldsymbol{\lambda}_{\mathbf{1}g}^s \text{ for } g = \{\text{pooled, female, male}\} \text{ and } s = \{\text{M, L, E}\}\,. \tag{2}$$

The transpose of the column coefficient vector are: $\left(\boldsymbol{\lambda}_{\mathbf{1}g}^s\right)' = [\alpha|\beta|\boldsymbol{\gamma}|\boldsymbol{\delta}]$, where α is an intercept term, β is the coefficient used to highlight differences in the conditional mean grades attributable to the educational policy change, the coefficients in the vector $\boldsymbol{\gamma}$ capture school specific effects, and the coefficients in the vector $\boldsymbol{\delta}$ adjust the conditional mean grades for the personal distinguishing characteristics of students. The estimated Sample Regression Functions are:

$$\widehat{\mathbf{y}}_{\mathbf{g}}^{\mathbf{s}} = \mathbf{X_1}\widehat{\boldsymbol{\lambda}}_{\mathbf{1}g}^s \text{ for } g = \{\text{pooled, female, male}\} \text{ and } s = \{\text{M, L, E}\}\,. \tag{3}$$

According to the hereinbefore-stated assumptions, unbiased estimates of the coefficients in the vectors, $\widehat{\boldsymbol{\lambda}}_{\mathbf{1}g}^s$, are obtained by performing Ordinary Least Squares (OLS) regressions utilizing the observed scholastic grades and the corresponding explanatory variables. Individual regressions were performed as well as gender-pooled regressions. The estimated conditional mean grades obtained, $\widehat{\mathbf{y}}_{\mathbf{g}}^{\mathbf{s}}$, are minimum Mean Squared Error (MSE) predictions. The estimated coefficients, $\widehat{\beta}_g^s$, are of primary interest, however, for they capture the scholastic achievement differences between the students belonging in the treatment group, G12, and those in the control group, G13, due to the policy reform.[9]

3.3 The Expanded Model

The expanded version of the model includes additional information concerning the specific school where the members of the G12 and G13 groups earned their grades. The scholastic achievements that were obtained on the centralized exams are likely to be school dependent. Consequently, a twelve-column (one for each school) matrix named $\mathbf{D_2}$ is utilized rather than the dummy vector $\mathbf{d}$. The school-specific columns of the $\mathbf{D_2}$ matrix are dichotomous variables taking one indicating when members of the G12 group earn their grades in particular school and zero for the G13

[9]Since the students in this sample come from a distinct number of classes within schools, the correlation of in-class outcomes may be interpreted as the treatment effect. For this reason, a cluster-robust variance estimator suggested by White (1980) is used.

group. This is surmised to be the case because school-specific factors are deemed to influence the impact of the educational reform. For example, differences can exist in the inherent quality and experience level of the teaching staff, differences in the overall academic climate prevailing that can stimulate students to undertake scholastic achievement, curriculum planning differences leading to the most efficient timing of the instructional periods, differences in the availability of up-to-date academic facilities, or simply differences in the socioeconomic makeup of the student body, to name but a few relevant factors. Therefore, it was deemed necessary to control for these school-specific influences as well. Commensurate with these additional considerations, the Expanded Model is:

$$E_g^s\left(Y|\mathbf{X_2}\right) = \mathbf{X_2}\boldsymbol{\lambda}_{\mathbf{2}g}^s \text{ for } g = \{\text{pooled, female, male}\} \text{ and } s = \{\text{M, L, E}\}. \tag{4}$$

The matrix $\mathbf{X}$ is now partitioned as: $\mathbf{X_2} = [\mathbf{e}|\mathbf{D_2}|\mathbf{D}|\mathbf{P}]$. The column vector $\mathbf{e}$ is the all-ones vector, the matrix $\mathbf{D_2}$ consists of twelve columns of dichotomous variables that equal one in the school where a G12 student earned the final grade and zero if that grade was earned by a student in the G13 group, the matrices $\mathbf{D}$ and $\mathbf{P}$ remain as heretofore defined. Correspondingly, the transpose of the coefficient vector are: $\left(\boldsymbol{\lambda}_{\mathbf{2}g}^s\right)' = [\alpha|\boldsymbol{\beta_2}|\gamma|\boldsymbol{\delta}]$, where the vector $\boldsymbol{\beta_2}$ contains coefficients that provide school specific measurements of the scholastic achievement differences due to the educational reform. The other coefficients remain unaltered. Utilizing this form of the model individual as well as a gender-pooled regression estimates were made.

4 Data Description

4.1 The Questionnaire

The empirical results are based on primary data obtained from a written questionnaire that was administered to the 2007 *Abitur* class of twelve secondary schools. Ten of these schools are located in the city of Magdeburg[10] (eight *Gymnasium* and two *Integrierte Gesamtschulen*) and two in Halberstadt[11] (*Gymnasium*). The questionnaire consisted of 101 questions relating to various aspects of the student's personality, social background, and educational experiences. They were distributed in February and March of 2009 with a response deadline stipulated for the end of April.

[10] Magdeburg (pop. 230,000) is located near the center of Saxony-Anhalt and is the state capital. For post-secondary education, it has a university, a university of applied sciences, and several research institutes.

[11] Halberstadt (pop. 75,000) is a rural community located in a mountainous area, surrounded by villages and smaller cities. The secondary schools are located in the larger population centers and a university of applied sciences is available.

The combined graduating class in 2007 consisted of 1,628 students from the G12 and G13 groups. Unfortunately, however, only 1,464 questionnaires could be administered because the names and/or addresses of 164 students were unavailable. In the end, 805 responses were returned yielding a response rate of 55%. In order to maintain consistency within the sample, only those students who were continuously enrolled in Germany during their complete schooling were included. Those students who took advantage of an exchange abroad or repeated a grade are excluded from the analysis.[12] This reduced the sample by 81 students, resulting in a final sample size of 724 observations. It should be noted that the numbers of observations in the estimations presented below may differ due to item non-response in some variables. A description of the items collected by the questionnaire is provided in the Appendix.

4.2 The Sample

The proportional distribution of the students in the G12 and G13 groups by gender within the twelve schools is provided in Table 1. It is noteworthy that the share of male students (37%) is much smaller than that of female students (63%). This finding is not the result of an imbalance in the response rates but it reflects a trend in university preparatory schooling that began in Germany more than a decade ago (destatis, 2009). Moreover, the schools differ significantly in regards to the size of their student body. Geographic location, academic reputation, and/or certain school specific forms of specialization give rise to these differences. Specialized schools usually focus upon the natural sciences, sports, or have a particular religious orientation. The distribution of students between the G12 and G13 groups within specific schools does not differ significantly. Only a slight difference is observed, however, in the male sample for schools number 6. This imbalance within the sample, however, does not affect the estimated effects of the reform because school specific effects are provided for in the model.

Include Table 1 about here

Mean values for a selection of student-specific variables by gender are presented in Table 2. At the top of this table are the means of the final grades obtained in mathematics, German literature, and English by the students in the G12 and G13 groups. These grades are significantly different for both genders in mathematics. The magnitude of these differences, however, cannot be solely attributed to the reform due to the presence of other relevant factors. Below these values are the analogous grades achieved by these same students in the seventh year of schooling.

[12]These students were excluded due to the fact that for the G12 cohort the students who went abroad as well as the students who repeated a grade did the final exams one year later.

These seventh grade achievements display no significant differences for both genders in the three subjects considered. This provides support to the assumption of the natural experiment.

Include Table 2 about here

The published literature indicates that the degree of intellectual support that the student receives from the family environment is an important ingredient for educational success (Fuchs and Woessmann, 2007, as well as Todd and Wolpin, 2007). Mean values of certain variables characterizing the family background of the graduates are presented in Table 3. These variables relating to characteristics of the mothers, the fathers, and other home related items show no great differences between the treatment and control groups of students. Therefore, there is no reason to expect any systematic differences in the outcomes due to the student's home environment.

With respect to the occupational training, more than half of the parents have finished some form of apprenticeship training. A very small percentage of the parents involved possess no occupational training. Furthermore, the share of university graduates and parents with doctoral degrees are clearly above the societal average.[13] Moreover, the parents are quite active in various areas. Around 70 percent indicated that they are active in community affairs and about half of the parents participate in regular sporting exercise activities. In view of the fact that only those graduates from university preparatory schooling are considered, these findings are not surprising. Political and religious engagement, on the other hand, is reported for a only small fraction of parents.[14]

Include Table 3 about here

Looking at the items available in the homes of the students shows that on average the households are adequately equipped. There are no significant differences in any of the items between grades. Hence, this further supports a picture of comparability between the treatment group (G12) and the control (G13) group.

[13]According to destatis (2009), on average, 20.1% of the population possesses a university degree and only 0.5% holds a PhD.

[14]One reason for the limited religious engagement is due to the low rate of people who are affiliated with religious denominations in East Germany.

5 Empirical results

5.1 The Basic Model

The three academic subject areas considered can be construed as proxies for important intellectual capabilities required by students for further study. Mathematics requires logical thinking and a capacity for abstraction. Literature promotes the linguistic instinct and is useful for developing competence in communication. English demonstrates the ability of German students to acquire foreign language skills. Although one could think of other relevant proficiencies, these three subject areas are considered capable of capturing the main prerequisites for a successful university education. They are, therefore, of vital interest when evaluating the effects caused by a reduction in the length of secondary schooling.

The Basic Model was estimated both gender specific and pooled. Furthermore, two versions of the matrix **P** were considered. An abridged version, hereafter referred to as Basic Model (1), contained only three variables while the matrix utilized in Basic Model (2) contained these plus an additional eleven. These variables relating to specific family background characteristics of the students involved have proven to be relevant in the empirical literature (see, e.g., Fuchs and Woessmann, 2007).

5.1.1 Mathematics

The estimated coefficients in the pooled sample of approximately $\widehat{\beta}^M = -0.7$ reveal the highly significant negative effect of the educational reform in both of the Basic Models (1) and (2), see Table 4. Consider the average student calculated as the average of the individual means. Basic Model (1), estimated with gender-pooled data, would predict that the conditional mean final grades earned by this student would be reduced by 9.1 percent (7.75 to 7.04) as a result of the educational reform. This is a significant reduction. The reform that was implemented reduced the instructional time but not the content of the curriculum. In the case of mathematics, there seems to exist limitations in the ability of young people to accelerate the accumulation of knowledge. It is reasonable to assume that those students possessing the highest potential to achieve arising from such innate factors as intelligence, self-discipline, scholastic motivation, social background, etc., would fare better than the others. Nevertheless, a reduction in the final grade should be expected.

Include Table 4 about here

When male and female students are considered separately, gender differences become quite apparent. Although students graduating after 12 years experience a decrease in grades in mathematics independently of gender, the negative effect tends to be almost twice as large for males compared to females. Males are on average slightly about 1 point worse off, whereas females are worse off about 0.5 points. Nevertheless, the estimated effects for both genders are significant. For the average male student this translates into a 10.9 percent reduction in his conditional mean final grade (7.79 to 6.94) while the average female student experiences only a 7.9 percent reduction (7.72 to 7.11). These findings clarify the different effects of shortening schooling duration for both genders beyond the gender-specific constant regarded in the pooled estimation. Males and females react differently to the applied changes in learning intensity.

Regarding the estimates of the further control variables, the first thing to note is the between-school variation in grades. This variation reflects differences in teaching quality, differences in infrastructure, class sizes, and differences in peer groups. As expected, the grades earned by students in their seventh year are highly significant when predicting the final conditional mean grades. The negative sign is due to the inverse relationship that exists between the two grading schemes.[15] The age at initial enrollment has a negative effect on grades, i.e. students that have started schooling at a younger age have a slightly better achievement score in mathematics at graduation. Muehlenweg and Puhani (2009) have shown that this should not be interpreted simply as caused by the age of enrollment, but is more likely to provide a proxy for unobserved ability in the sense that persons with lower unobserved abilities tend to enroll later on average. The presence of a large private book collection at home seems to have a significantly positive influence on the grades of male students, whereas their female counterparts are impacted to a lesser degree. In addition, with regard to the further variables considered to capture details of the background of the student all coefficients show the expected signs.

5.1.2 German Literature

The estimated coefficients $\widehat{\beta}^L$ in the pooled sample (Table 5) reveal a non-significant negative effect of about -0.1 in Basic Model (1) and slightly larger in (2). Basic Model (1), estimated with gender-pooled data, would predict that the conditional mean grade earned by the average student calculated as above would almost remain constant (with an increase by 0.4 percent from 8.55 to 8.59 points).

Include Table 5 about here

[15] From year 2 to 10 students receive grades defined between 1 (excellent) and 6 (failure), the scale after year 10 is defined reversely from 15 (excellent) down to 0 (failure).

When male and female students are considered separately, once again gender specific differences are apparent. Although females earn on average higher grades, gender specific regressions show that female students would experience no change in their conditional mean final grade (8.82 to 8.83), while the average male student would experience a negligible increase by 1.7 percent (8.08 to 8.22).

In contrast to the effect on the grades in mathematics, there are no significant effects due to shortening the schooling duration on those in German literature. School specific factors remain important with female grades less affected than males. The age of the student at initial enrollment has a non-significant negative impact for the male students. The estimated coefficients for female students are positive but not significant either. The presence of large private book collections at home has a significantly positive influence on the grades of the female students, whereas males are impacted to a lesser degree.

5.1.3 English Language

Since the English language is not a mandatory subject, there could exist some grade specific self-selection that would affect the outcomes. There are, however, only slight differences in the personal characteristics of the students in the G12 and G13 groups as well as small differences in the grades earned in the seventh grade. Furthermore, the estimated models take this into account and the parameters estimated should be unbiased as a result.

Include Table 6 about here

The estimated coefficients $\widehat{\beta}^E$ in the pooled sample provided in Table 6 reveal a non-significant negative effect of about -0.29 in both Basic Models (1) and (2). Similar to the results for German literature, the parameter estimate of the treatment effect is negative but not statistically significant in the pooled sample. Hence, although students experienced the same amount of education in a different time span this has no effect on the written examinations. Nevertheless, when considering gender differences, heterogeneity in the estimates could be revealed. For females, reducing the schooling duration by one year leads to a significant decrease in achievement scores in English of about 0.6 points. In contrast, males are not affected and the point estimates even show a positive (but insignificant) effect of earlier graduation. Gender specific regressions show that the average female student would experience a significant 4.3 percent reduction in her conditional mean final grade (8.70 to 8.32), while the male counterpart would fare much better with a non-significant 4.7 percent increase (7.56 to 7.91).

The age of initial enrollment has no significant impact for students. The English language grade earned in the seventh grade is a highly significant variable for both genders. This indicates that some people possess a higher inate ability to learn foreign languages than do others. Having learned the basics early on is an essential ingrediate for a good final grade. The age of students at initial enrollment as well as the existence of private book collections in the home do not exhibit significant effects.

5.2 The Expanded Model

The Expanded Model was estimated to investigate whether there exists a differential effect of the educational reform attributable to specific schools. This type of effect is likely since schools differ not only with respect to the proficiency of their teachers, the existing social interaction within the peer groups, the geographic location, but also due to differences in the administrative implementation of the reform itself. Schools may well have adjusted to the change very differently. The Expanded Model was estimated both gender specific and pooled. Once again, two versions of the matrix P were considered. An abridged version, hereafter referred to as Expanded Model (1), contained only three variables while the matrix utilized in Expanded Model (2) contained these plus an additional eleven.

5.2.1 Mathematics

Starting with the results for mathematics (Table 7), the estimates establish some heterogeneity in the effects between schools. Almost all of the point estimates are negative in the pooled sample, however, depending on the model specification only four (Exp. Model (1)) and five (Exp. Model (2)) parameter estimates are significantly different from zero.

Include Table 7 about here

When male and female students are considered separately, gender differences once again become quite apparent. Gender specific regressions show that male students experienced a more pronounced negative effect compared to females and the importance of school specific factors in the prediction of the conditional mean final grades is more important. In some of the schools, students graduating after 12 years obtained even about 3 points lower achievement scores due to the reform.

5.2.2 German Literature

No apparent effect of the shortening of secondary schooling on the scholastic achievement scores in German literature was discovered (Table 8). There exists no real difference between students graduating in the G12 and G13 groups. Although the results establish some differences in the effects across schools, only a few estimates are clearly significantly different from zero in the pooled and gender-specific samples. Moreover, the signs of the parameter estimates vary across the schools, and in some cases the students graduating in the G12 group were better off compared to those in the G13 group, whereas in others the picture is reversed.

Include Table 8 about here

5.2.3 English Language

In the gender-pooled as well as in the female only estimation results, graduates in the G12 group are slightly worse off (Table 9). This finding, however, is not supported by the results for males. Here, despite the differences in the effects significant estimates indicate benefits for males in the G12 group from the educational reform. As only three of the point estimates are statistically significant, this finding is not at all conclusive for the improved human capital achievement.

Include Table 9 about here

5.3 The Robustness of the Estimation

Basic Model (2) was estimated under a variety of data restrictions in order to determine the robustness of the empirical results presented. For the sake of brevity, only those results obtained utilizing gender-pooled data in the subject areas of mathematics (Table 10) and German literature (Table 11) are presented.

Include Tables 10 and 11 about here

First of all, the data was sorted by city. The model was estimated separately for Magdeburg (MAG) and for Halberstadt (HAL). The estimation results indicate that the effects of the educational reform on the scholastic achievement scores in mathematics differ slightly between regions. The reform, however, made a slightly bigger negative impact in the city of Halberstadt. Despite this small difference, the estimated coefficients are very similar indicating that no strong regional variation is present that is not captured by the school specific effects already accounted for in the model. The results for German literature are quite similar. The estimated coefficient, although insignificant, is a bit lower for the city of Magdeburg.

Second, the sample was sorted according to the type of school attended. The model was estimated using data only from *Gymnasium* (GYM) type schools located in the city of Magdeburg (MAG). In this case, the estimated coefficients show a similar effect compared to that when all schools in the city of Magdeburg were considered. This is true for mathematics as well as for German literature, even though the latter effect was insignificant.

Finally, the model was estimated using data only from the larger (LAR) schools, i.e., those with more than eighty observations. The estimates demonstrate that the effect on the scholastic achievement grades in mathematics is the smallest yet. This could indicate that the larger schools are more flexible and capable of adjusting to a new situation than are their smaller counterparts. Nevertheless, this result is true only for mathematics. In German literature, the point estimate is positive. It is, however, statistically insignificant.

6 Discussion

Shortening the length of secondary schooling by twelve months without making a commensurate reduction in the academic curriculum affects the behavior of the impacted students in numerous ways. The time available for instructional purposes is reduced in almost all subject areas and only a limited number of additional hours are added in the core subjects. Consequently, the time available for absorbing the relevant material, for accomplishing the necessary homework, for comprehending the essentials, and reiterating the pertinent subject matter declines, while the same academic requirements remain. The learning intensity, the quantity of material to be learned per time period, increases dramatically. This acceleration in the tempo of learning will affect student performance in various ways. Some students may not be able to cope with the increased requirements per year. Therefore, dropout ratios, switching to special schools where graduation is still possible after thirteen years, or repeating grades might become increasingly likely scenarios. Although these behaviors existed before the educational reform was enacted, they may well be reinforced and become increasingly prevalent.

In order to analyze these reform affects, the number of school dropouts, grade repeaters, and those who changed schools would be required. Unfortunately, access to these numbers is restricted. Therefore, the fraction of students who complete a university qualifying secondary education after the compulsory period of schooling is all that is available.[16] Mandatory schooling in Germany ends after nine years. Thus, students can depart and commence vocational training if they desire. This departure behavior could also be influenced by the educational reform enacted. Therefore, the number of ninth grade students attending the *Gymnasium* was compared to those who completed the secondary school final examinations in regular time. In the G13 group 78.3 percent of the students graduated. In the G12 group a lower amount, 69.7 percent, was observed. Approximately half of this difference rests on the fact that the rules for spending a year abroad differ in these groups. Students in the G12 group who studied a year abroad had to graduated one year later in 2008 whereas students of the G13 group were allowed to return to their old class. The remaining difference incorporates those students who were not able to cope with the increased learning intensity.

If especially low ability students disappeared from the G12 group, the average grades of the G12 students would probably be higher than the average grades of the G13 students at the time of final examinations. Estimation of the effects of student performance in the analyzed subjects would have been biased and the results should have been interpreted as the lower bound of the reform effects. However, nothing indicates biased estimators. For the results presented above the difference is relevant if dropout rates are non-random across the grades, since the data used in the empirical analysis comprise retrospective information surveyed from the graduates. As shown above, however, when comparing the pre-reform characteristics of the students, no observable differences with regard to ability or background variables could be established. Therefore, there is no indication that the estimates are biased due to possible self-selection.

The empirical results suggest substantial differing effects resulting from the shortening of the secondary schooling by one year on human capital accumulation. The impacts are significantly negative on student performance in mathematics for both genders and in foreign language for females only. The effects, however, are insignificant in German literature. One possible explanation for these findings can be the existence of different requirements in higher grades for the subject areas considered here. Whereas, the curriculum in mathematics requires exposure to new fields, e.g., statistics, accompanied by the learning of new methods and the understanding of the underlying concepts. The curriculum in literature and in the foreign languages, however, focuses upon the refinement of familiar concepts and on the application of these concepts. Eren and Henderson (2009) make a similar argument regarding the effects of additional homework on test scores. They find evidence of positive and significant effects of homework on mathematics

[16] The Statistical Office of Saxony-Anhalt has provided this data uniquely for the purpose at hand.

test scores (see also Aksoy and Link, 2000; Eren and Henderson, 2007), but little or no impact on test scores in other subjects like literature. There is no educational reform effect discovered in literature. This result does not indicate whether the level of education is satisfying. All in all, however, the marginal contribution of the thirteenth year to native language skills appears to be negligible.

The marginal contribution to the mathematical skills, however, is highly significant and may have serious consequences on labor demand and supply. To fill the existing shortage of engineers and graduates from the natural sciences, society urgently needs people with excellent mathematical skills. The negative impact of the educational reform indicates that additional responsibility for the preparation of students will be passed on to the universities. Unfortunately, in light of the limitations of instructional time already at the universities, a change in the academic curriculum of the secondary schools will become necessary. The long-term effects of this cannot be evaluated as yet. Due to the fact that graduates from the G12 group perform comparatively worse in mathematics, probably less of them will enroll in engineering or in the natural sciences and the shortages will increase in the future. This will require a change in the allocation of the instructional time across academic subject areas in the schools.

7 Conclusion

It is recognized that an adequate amount of instructional time is an essential ingredient in the development of human capital. A sufficient understanding concerning the relationship between these instructional hours and their impact on the human capital enhancement of students, however, is still in its infancy. The gain in human capital that can be attributed to the instructional hours received in schools depends on a diverse set of factors. The innate ability of students to absorb the available knowledge, the amount of effort they expend in this intellectual endeavor, the possibility to interact with stimulating teachers, an amiable social contact with peers, availability of up-to-date academic resources in the school, to name but a few, all play an important role. Presently, there is little evidence concerning the function of the academic curriculum as an important institutional factor in this process of human capital accumulation. The implementation of academic curriculum affects human capital accumulation by its impact on the learning intensity ratio. Consequently, it is useful to study the link between learning intensity and student scholastic achievement. The current lack of evidence in the literature is due to the difficulty in collecting suitable data. This paper attempts to fill this gap and to contribute in this area.

This study is an econometric examination of a very rare educational policy reform that took place in 2007 in Saxony-Anhalt, Germany. This reform shortened the duration of secondary schooling by one full year while maintaining the academic curriculum requirements for graduation nearly unaltered. This substantially increased the learning intensity ratio experienced by the students involved. The estimated effect of this increased learning intensity on student scholastic achievement depends on the particular subject areas studied and they differ by gender. Significantly negative effects on student scholastic performance in mathematics was discovered that was much more severe for males than for their female counterparts. Scholastic achievement in the English language decreased for females, but the effect for males was statistically insignificant. No differences were discovered on the final grades earned in German literature. These results tend to suggest that linear human capital models where hours of instructional time are positively related to human capital accumulation, represented by test scores, provide an inappropriate explanation of the knowledge gains associated with additional schooling (c.f. Pischke (2007), p. 1240).[17]

Some students are not able to cope with the increased learning intensity. Lowering the learning intensity in such demanding subjects as mathematics by additional instructional time at the expense of less intellectually demanding subjects is a reasonable recommendation. Additional research is required to study the role of the duration of schooling upon the skill formation process. The results presented here suggest that the management of the educational process, relating to academic curriculum planning and, as a result, learning intensity ratios, are important. Public educational policy makers should turn their attention from raising the quantity of education to increasing the quality of its delivery.

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[17] In contrast to rather scarce reforms of shortening schooling, opposed reforms of increasing schooling by compulsory school laws or laws raising minimum school drop out age were more common and their impacts have been widely investigated. Among the extensive literature, there are some studies which find zero returns of additional schooling (Oosterbeek and Webbink, 2007; Pischke and von Wachter, 2008; Grenet, 2009). These findings suggest that inefficiencies in time using for education also exist at other levels of education.

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A Appendix

In order to provide an overview of the available information provided by the survey, the 101 questions can be divided into the following ten categories:

1. *Personal information:* The first set of questions cover certain personal characteristics of the student such as date of birth, gender, legal address, place of residence during schooling, number of relocations, nationality, number of close friends, etc.

2. *Family background:* This category provides details concerning the family of the student, including information about the parents, the siblings, and the household in general. Information about the father and the mother are separate and cover such items as: age, the time of cohabitation with each parent, divorce, deceased, changing partners of the parent, education, occupational degree, unemployment, and personal involvements, e.g., cultural, political, religious, or sport. The family background includes household details including the number of books owned by the parents and other relevant equipment in the household. For these items the use by the student is important, e.g., Internet access, dictionaries, newspapers, reference books, etc. Information about the siblings of the student includes: number, gender, age, education, etc.

3. *Schooling, general information:* General information includes: the time of pre-school, primary, secondary schooling, changes of residence during that time, grade repetition, etc.

4. *Schooling, detailed information:* This contains details of the curriculum of the student. An example are the sequence of enrollment, the grades when courses where started, the duration and the number of foreign languages learned at school. Moreover, information on natural sciences (biology, chemistry, physics) is provided in this category and there are questions covering details of additional in-school education the students attained. Furthermore, a number of questions are devoted to assess the stress and burden of schooling of the students, an assessment of the skills learned at school and the valuation of teaching these skills at school.

5. *Education outside school:* Classes at school provide a relevant part of individual's education but many students participate in a number of educational activities outside school. These activities comprise, e.g., musical classes, sports, journalistic activities such as student newspapers, political activities, etc. Information on different activities and the number of years of these activities is given by in this category.

6. *Last year of school and graduation:* Questions describing the last year of school and graduation cover the class size, the types of the main courses (basic courses and intensified courses taught with more hours per week), the achievement score in each of these courses, the overall achievement score, activities outside school (working, homework, etc.), the state of health during the last year of school, spending of leisure time and leisure activities (dating friends, reading, chatting, etc.), and consumption of alcoholic beverages and smoking behavior.

7. *Support from parents, teachers and other persons:* This category comprises the incidence and amount of support with schooling tasks and homework from close relatives, particularly the parents, teachers, and other persons like friends, siblings and peers.

8. *Education after graduation:* Since students in the survey have graduated in 2007, about 18 months have passed between graduation and the date of interview. The activities that took place during that time are reported in a retrospective monthly calendar covering various states of employment, civil and military service, education, and times spent abroad. In addition, information on the financing of living today, the type of education (apprenticeship, university or university of applied sciences studies), the subject, the aspired degree (e.g., bachelor, master, PhD), and on reasons for the choice of education is provided.

9. *Assessment of school:* In this category the students were asked to assess the value of schooling for different skills: logical thinking, independence, ability to accept criticism, cooperation in teamwork, practical skills, technical skills, etc. In addition, several items evaluating the relationship between teachers and students were collected.

10. *Attitudes and non-cognitive skills:* In the final set of questions information concerning various items was collected in order identify certain aspects of the student's personality. The set of items could be used to derive measures of non-cognitive skill levels.

Tables

Table 1: Distribution of Survey Respondents by Schools, Gender and Years

	Male			Female		
	Year 13	Year 12	*p*-value[a]	Year 13	Year 12	*p*-value[a]
School 1	0.039	0.035	0.868	0.013	0.023	0.431
School 2	0.086	0.085	0.967	0.034	0.041	0.721
School 3	0.055	0.106	0.127	0.060	0.059	0.955
School 4	0.055	0.070	0.597	0.082	0.104	0.409
School 5	0.063	0.106	0.206	0.073	0.095	0.397
School 6	0.164	0.063	0.008	0.103	0.104	0.970
School 7	0.102	0.127	0.518	0.103	0.136	0.282
School 8	0.133	0.106	0.492	0.133	0.154	0.528
School 9	0.031	0.035	0.857	0.047	0.023	0.156
School 10	0.063	0.099	0.281	0.073	0.059	0.545
School 11	0.102	0.077	0.489	0.155	0.127	0.396
School 12	0.109	0.092	0.627	0.124	0.077	0.094
N	128	142		233	221	

[a] *p*-value from *t*-test on equality of shares.

Table 2: Means of Selected Characteristics by Year and Gender

	Male			Female		
	Year 13	Year 12	*p*-value[a]	Year 13	Year 12	*p*-value[a]
Grades at Graduation[b]						
Mathematics	7.792	6.935	0.020	7.695	7.085	0.035
German Literature	8.088	8.194	0.764	8.810	8.880	0.805
English	7.478	7.863	0.263	8.602	8.348	0.422
Grades in Year 7[b]						
Mathematics	2.189	2.121	0.476	2.288	2.326	0.567
German Literature	2.394	2.279	0.161	2.057	1.995	0.296
English	2.480	2.343	0.149	2.268	2.133	0.061
Year repeated	0.093	0.021	0.009	0.053	0.052	0.948
Year skipped	0.000	0.021	0.087	0.004	0.013	0.291
Age at school enrollment	6.227	6.218	0.885	6.189	6.119	0.064
No. of siblings	0.922	1.028	0.341	0.940	0.905	0.652
Choice of School for Reason						
Close distance	0.575	0.669	0.112	0.627	0.661	0.451
Reputation	0.709	0.669	0.485	0.622	0.738	0.009
No. of own books						
0 to 50	0.391	0.423	0.596	0.236	0.253	0.668
51 to 100	0.336	0.373	0.524	0.421	0.335	0.060
101 to 200	0.133	0.120	0.747	0.219	0.262	0.278
201 to 500	0.125	0.063	0.082	0.099	0.136	0.220
More than 500	0.016	0.021	0.739	0.026	0.014	0.353
N	128	142		233	221	

[a] *p*-value from *t*-test on equality of means.
[b] Grades until year 10 range from 1 (excellent) to 6 (failed) and are reverted from grades in years 12/13 ranging from 0 (failed) to 15 (excellent).

Table 3: Means of Selected Background Characteristics by Year and Gender

	Male			Female		
	Year 13	Year 12	p-value[a]	Year 13	Year 2	p-value[a]
Characteristics of father						
Age	49.085	48.323	0.254	49.204	47.784	0.004
Unemployment[b]	0.266	0.218	0.366	0.313	0.226	0.037
Occupational degree						
No occupational training	0.000	0.000	1.000	0.004	0.009	0.532
Apprenticeship training	0.525	0.578	0.405	0.597	0.598	0.987
University/University of Applied Sciences	0.407	0.363	0.477	0.341	0.346	0.911
PhD	0.068	0.059	0.782	0.058	0.047	0.612
Activities						
Cultural	0.225	0.244	0.733	0.203	0.227	0.559
Sports	0.518	0.461	0.381	0.407	0.497	0.071
Societal	0.755	0.775	0.709	0.731	0.830	0.016
Politics	0.056	0.033	0.408	0.040	0.043	0.874
Religious	0.083	0.085	0.941	0.019	0.020	0.955
Characteristics of mother						
Age	46.646	46.279	0.441	46.748	46.219	0.228
Unemployment	0.273	0.324	0.368	0.283	0.271	0.780
Occupational degree						
No occupational training	0.008	0.000	0.294	0.017	0.009	0.447
Apprenticeship training	0.492	0.626	0.028	0.532	0.550	0.710
University/University of Applied Sciences	0.452	0.338	0.057	0.424	0.395	0.535
PhD	0.048	0.036	0.637	0.026	0.045	0.265
Activities						
Cultural	0.394	0.375	0.756	0.322	0.336	0.742
Sports	0.464	0.551	0.159	0.482	0.517	0.472
Societal	0.705	0.806	0.058	0.764	0.848	0.026
Politics	0.024	0.008	0.297	0.022	0.029	0.656
Religious	0.081	0.122	0.268	0.039	0.065	0.213
Items at home						
Desk	0.914	0.887	0.466	0.906	0.937	0.222
Place for handicraft	0.180	0.085	0.020	0.335	0.353	0.684
Experiment kit	0.352	0.352	0.992	0.202	0.240	0.329
Cell phone	0.914	0.901	0.721	0.953	0.932	0.345
Computer	0.758	0.704	0.324	0.541	0.471	0.135
Internet access	0.922	0.901	0.557	0.918	0.887	0.257
Classical literature	0.438	0.338	0.094	0.506	0.484	0.636
Poetry	0.148	0.113	0.384	0.193	0.226	0.387
Reference book	0.906	0.866	0.304	0.944	0.937	0.734
Dictionary	0.945	0.923	0.456	0.953	0.950	0.899
Newspaper (regional)	0.672	0.577	0.111	0.571	0.588	0.708
Newspaper (national)	0.164	0.183	0.682	0.124	0.104	0.496
N	128	142		233	221	

[a] p-value from t-test on equality of shares.
[b] Occurrence of unemployment during the years until reform

Table 4: Mathematics (Regression Estimates, Basic Model)[a]

	Pooled Sample		Female Sample		Male Sample	
	(1)	(2)	(1)	(2)	(1)	(2)
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
$\widehat{\beta}^M$	-0.710***	-0.654***	-0.573**	-0.457*	-0.901***	-0.942***
School fixed effects						
School 1	-2.579***	-2.228***	-2.655***	-2.267***	-2.392***	-2.055**
School 2	-0.334	-0.458	-1.045	-1.006	0.256	-0.139
School 3	-1.935***	-1.517***	-1.880**	-1.629**	-2.002***	-1.000
School 4	-1.435***	-1.217***	-1.545***	-1.294***	-1.269**	-0.654
School 5	-1.111**	-1.001**	-1.514**	-1.253**	-0.459	-0.344
School 6	-0.823**	-1.110***	-0.868	-1.452**	-0.862	-0.874
School 7	-1.259**	-1.109**	-1.625***	-1.374***	-0.656	-0.690
School 8	-1.128**	-1.055**	-1.306**	-1.119**	-0.803	-1.114
School 9	-2.956***	-2.627***	-2.713***	-2.328***	-3.194***	-3.476***
School 10	-0.461	-0.211	-0.751	-0.592	-0.027	0.265
School 12	-1.346***	-1.075***	-1.686***	-1.405***	-0.766	-0.425
Sociodemographic variables						
Age (enrolment at school)	-0.709***	-0.705***	-0.643*	-0.649*	-0.847**	-0.767*
Male	-0.204	-0.366*	0.000	0.000	0.000	0.000
Grade in mathematics (year 7)	-1.659***	-1.741***	-1.952***	-1.936***	-1.298***	-1.415***
Father unemployed	–	-0.048	–	0.212	–	-0.360
Occupational degree of father (reference: apprenticeship or no occupational training)						
Grad. from Univ./Univ. of Appl. Sciences	–	0.716***	–	1.074***	–	0.019
PhD	–	0.736	–	2.208***	–	-1.706**
Help with homework from father (reference: no support)						
Frequently	–	-0.509	–	-0.299	–	-1.348**
Infrequently	–	-0.654**	–	-0.725*	–	-0.496
Rarely	–	0.065	–	0.233	–	-0.188
No. of books of parents (reference: less than 50 books)						
51 to 100	–	0.532	–	0.147	–	1.496**
101 to 250	–	0.991***	–	0.402	–	2.426***
251 to 500	–	0.922**	–	0.435	–	2.003***
501 to 2,000	–	0.945**	–	0.375	–	2.188***
More than 2,000	–	1.766***	–	0.993	–	3.345***
Constant	17.020***	16.227***	17.405***	16.557***	16.692***	14.938***
Statistics						
R^2	0.233	0.284	0.257	0.313	0.226	0.329
N	692	643	430	406	262	237
No. of clusters	93	93	87	87	83	80

[a] All standard errors are clustering-robust based on class as the sampling unit. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5: German Literature (Regression Estimates, Basic Model)[a]

	Pooled Sample		Female Sample		Male Sample	
	(1)	(2)	(1)	(2)	(1)	(2)
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
$\widehat{\beta}^L$	-0.095	-0.155	-0.102	-0.175	0.034	0.004
School fixed effects						
School 1	0.815*	1.520**	1.270*	2.495**	0.115	0.096
School 2	1.431**	1.174**	0.711	0.948*	1.654	1.121
School 3	1.025**	1.278**	1.002**	1.203**	0.664	0.825
School 4	0.740*	1.173***	1.447***	1.996***	-0.948	-0.744
School 5	0.624	0.604	1.269*	1.420**	-0.691	-0.897
School 6	0.781**	0.637*	0.639*	0.343	0.702	0.600
School 7	0.586	0.723*	1.003**	1.290***	-0.261	-0.254
School 8	1.062***	1.170***	0.957**	1.270***	1.139	0.947
School 9	1.020	1.249	1.068	1.308	0.747	0.785
School 10	1.986***	2.120***	2.451***	2.596***	0.964	0.833
School 12	0.514	0.693	0.542	0.784	0.237	0.406
Sociodemographic variables						
Age (enrolment at school)	-0.002	0.094	0.356	0.402	-0.507	-0.500
Male	-0.242	-0.216	0.000	0.000	0.000	0.000
Grade in German literature (year 7)	-1.704***	-1.719***	-1.723***	-1.754***	-1.661***	-1.752***
Father unemployed	–	0.199	–	0.380	–	-0.027
Occupational degree of father (reference: apprenticeship or no occupational training)						
Grad. from Univ./Univ. of Appl. Sciences	–	0.367	–	0.388	–	0.239
PhD	–	0.117	–	0.854	–	-0.435
Help with homework from father (reference: no support)						
Frequently	–	-0.584	–	-0.999**	–	0.274
Infrequently	–	-0.221	–	-0.171	–	-0.105
Rarely	–	0.045	–	0.140	–	0.246
No. of books of parents (reference: less than 50 books)						
51 to 100	–	0.444	–	0.628	–	-0.154
101 to 250	–	0.887**	–	0.652	–	1.006
251 to 500	–	1.205***	–	1.275***	–	0.782
501 to 2,000	–	1.016**	–	1.037*	–	0.743
More than 2,000	–	1.805***	–	1.784**	–	1.626
Constant	11.576***	9.985***	9.264***	7.856***	14.785***	14.290***
Statistics						
R^2	0.170	0.206	0.172	0.222	0.208	0.249
N	688	639	426	402	262	237
No. of clusters	93	93	87	87	83	80

[a] All standard errors are clustering-robust based on class as the sampling unit. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6: English (Regression Estimates, Basic Model)[a]

	Pooled Sample		Female Sample		Male Sample	
	(1)	(2)	(1)	(2)	(1)	(2)
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
$\widehat{\beta}^E$	-0.285	-0.291	-0.652**	-0.559*	0.297	0.203
School fixed effects						
School 1	-1.518*	-0.738	-0.849	-0.466	-2.119***	-1.208
School 2	-1.673**	-1.799***	-2.849***	-2.733***	-1.062	-1.328
School 3	-1.844***	-1.535**	-2.089***	-1.759**	-1.918***	-1.375**
School 4	-1.424**	-1.352**	-1.154	-1.033	-2.018**	-2.035**
School 5	-0.621	-0.591	-0.435	-0.447	-1.061	-1.029
School 6	-0.045	-0.187	-0.024	-0.359	-0.143	-0.161
School 7	-0.859	-0.610	-0.491	-0.216	-1.486*	-1.529*
School 8	-1.088*	-0.985*	-0.924	-0.798	-1.364**	-1.534**
School 9	-2.675***	-2.516***	-3.391***	-3.025***	-1.709**	-1.337**
School 10	-0.601	-0.433	-0.287	-0.007	-1.476*	-1.479**
School 12	-0.485	-0.156	-0.514	-0.364	-0.609	-0.121
Sociodemographic variables						
Age (enrolment at school)	-0.001	0.135	0.308	0.496	-0.480	-0.432
Male	-0.276	-0.312	0.000	0.000	0.000	0.000
Grade in English (year 7)	-1.915***	-1.892***	-1.992***	-1.984***	-1.826***	-1.757***
Father unemployed	–	-0.073	–	-0.105	–	-0.041
Occupational degree of father (reference: apprenticeship or no occupational training)						
Grad. from Univ./Univ. of Appl. Sciences	–	0.525**	–	0.782**	–	0.282
PhD	–	0.383	–	1.026	–	-0.679
Help with homework from father (reference: no support)						
Frequently	–	-0.454	–	-0.046	–	-1.330**
Infrequently	–	-0.471	–	-0.592	–	-0.114
Rarely	–	-0.060	–	-0.111	–	0.082
No. of books of parents (reference: less than 50 books)						
51 to 100	–	0.191	–	-0.096	–	0.466
101 to 250	–	0.354	–	0.601	–	-0.113
251 to 500	–	0.877**	–	0.847*	–	0.797
501 to 2,000	–	0.690*	–	0.607	–	0.799
More than 2,000	–	0.841	–	0.636	–	0.898
Constant	13.699***	12.235***	12.089***	10.232***	16.108***	15.198***
Statistics						
R^2	0.340	0.364	0.365	0.398	0.341	0.403
N	571	529	336	315	235	214
No. of clusters	92	92	85	85	80	78

[a] All standard errors are clustering-robust based on class as the sampling unit. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Mathematics (Regression Estimates, Expanded Model)[a]

	Pooled Sample		Female Sample		Male Sample	
	(1)	(2)	(1)	(2)	(1)	(2)
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
D_{s1}	-2.113***	-2.314**	-1.463	-1.827**	-2.298***	-2.276**
D_{s2}	-1.262	-1.706**	-1.922	-1.622	-0.847	-1.444
D_{s3}	-0.768	-0.611	1.155	0.931	-3.018***	-3.170***
D_{s4}	-0.698	-0.793**	-0.966*	-0.788*	-0.227	-1.175***
D_{s5}	0.603	0.598	-0.727	-0.527	2.695*	2.393**
D_{s6}	-0.716	-0.452	-0.559	-0.344	-1.016	-0.635
D_{s7}	-0.824*	-0.660	-0.617	-0.604	-1.215	-1.361*
D_{s8}	-0.685	-0.797**	-0.604	-0.654*	-0.858	-1.088
D_{s9}	0.524*	0.568	1.501***	1.184**	-0.200	-1.123
D_{s10}	-0.621	-0.435	-0.321	-0.146	-0.976*	-0.333
D_{s11}	-0.422	-0.246	-0.347	-0.206	-0.570	0.134
D_{s12}	-1.773***	-1.651***	-1.557**	-1.084**	-2.007***	-2.078***
School fixed effects						
School 1	-1.677***	-0.951	-2.001**	-1.184*	-1.553**	-0.785
School 2	0.066	0.228	-0.274	-0.307	0.372	0.614
School 3	-1.776**	-1.374**	-2.582**	-2.172*	-0.435	0.900
School 4	-1.316*	-0.965**	-1.247	-0.999	-1.525**	-0.047
School 5	-1.814**	-1.587**	-1.325	-1.109	-2.774*	-2.103*
School 6	-0.693	-1.004*	-0.779	-1.373	-0.704	-0.486
School 7	-1.063	-0.933	-1.504*	-1.196	-0.328	0.035
School 8	-1.008*	-0.817	-1.194	-0.919	-0.673	-0.552
School 9	-3.377***	-2.927***	-3.356***	-2.807***	-3.451***	-2.988***
School 10	-0.381	-0.157	-0.768	-0.628	0.141	0.305
School 12	-0.794	-0.518	-1.240	-1.086	-0.099	0.606
Sociodemographic variables						
Age (enrolment at school)	-0.734***	-0.739***	-0.646*	-0.637*	-0.932**	-0.862**
Male	-0.208	-0.358	0.000	0.000	0.000	0.000
Grade in mathematics (year 7)	-1.631***	-1.729***	-1.956***	-1.940***	-1.280***	-1.425***
Father unemployed	–	-0.031	–	0.211	–	-0.363
Occupational degree of father (reference: apprenticeship or no occupational training)						
Grad. from Univ./Univ. of Appl. Sciences	–	0.703***	–	1.043***	–	-0.128
PhD	–	0.742	–	2.130***	–	-1.689**
Help with homework from father (reference: no support)						
Frequently	–	-0.580	–	-0.286	–	-1.440**
Infrequently	–	-0.675**	–	-0.674*	–	-0.632
Rarely	–	0.048	–	0.272	–	-0.346
No. of books of parents (reference: less than 50 books)						
51 to 100	–	0.441	–	0.118	–	1.461**
101 to 250	–	0.966**	–	0.448	–	2.532***
251 to 500	–	0.897**	–	0.489	–	1.973***
501 to 2,000	–	0.843**	–	0.383	–	2.058***
More than 2,000	–	1.686***	–	0.957	–	3.473***
Constant	16.982***	16.304***	17.334***	16.350***	17.045***	15.250***
Statistics						
R^2	0.244	0.295	0.271	0.323	0.268	0.373
N	692	643	430	406	262	237
No. of clusters	93	93	87	87	83	80

[a] All standard errors are clustering-robust based on class as the sampling unit. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 8: German Literature (Regression Estimates, Expanded Model)[a]

	Pooled Sample		Female Sample		Male Sample	
	(1)	(2)	(1)	(2)	(1)	(2)
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
D_{s1}	-1.022	-2.458***	-1.229	-4.237***	-1.020	-0.777
D_{s2}	0.436	-0.217	0.078	0.031	0.463	-0.731
D_{s3}	-1.415**	-1.435*	-1.735***	-2.026***	-1.341*	-1.378
D_{s4}	-0.312	-0.696	-0.111	-0.338	-0.638	-1.754
D_{s5}	-1.100	-1.329*	-1.450*	-1.634*	-0.021	-0.075
D_{s6}	-0.139	-0.182	0.048	-0.022	0.038	0.122
D_{s7}	-0.848*	-0.647	-1.049	-0.730	-0.531	-0.363
D_{s8}	0.226	0.180	-0.105	-0.327	0.936	1.213
D_{s9}	1.541	2.017**	3.170***	3.113***	-0.771	-0.027
D_{s10}	0.525	0.614	1.290	1.183	-0.024	0.016
D_{s11}	0.265	0.516	-0.382	-0.087	2.003**	2.366**
D_{s12}	0.755	0.781	1.452*	1.519*	-0.228	-0.150
School fixed effects						
School 1	1.488***	3.348***	1.865**	5.455***	1.529**	1.616
School 2	1.331*	1.506*	0.489	0.868**	2.313	2.430
School 3	1.923***	2.250***	1.656***	2.092***	2.503***	2.853***
School 4	1.014***	1.768***	1.339**	2.133**	0.337	1.367
School 5	1.411*	1.610**	1.960**	2.293***	0.241	0.187
School 6	0.964**	0.931**	0.468	0.275	1.591	1.615
School 7	1.170**	1.276**	1.407*	1.581**	0.937	0.934
School 8	1.067***	1.294***	0.872**	1.415***	1.604*	1.337
School 9	0.476	0.738	-0.186	0.205	2.080*	1.858
School 10	1.827***	1.998***	1.739**	2.001**	1.897***	1.846*
School 12	0.339	0.604	-0.110	0.201	1.250	1.552
Sociodemographic variables						
Age (enrolment at school)	0.003	0.107	0.311	0.312	-0.467	-0.470
Male	-0.233	-0.200	0.000	0.000	0.000	0.000
Grade in German literature (year 7)	-1.755***	-1.760***	-1.869***	-1.881***	-1.632***	-1.647***
Father unemployed	–	0.228	–	0.510**	–	-0.034
Occupational degree of father (reference: apprenticeship or no occupational training)						
Grad. from Univ./Univ. of Appl. Sciences	–	0.376	–	0.481	–	0.137
PhD	–	0.158	–	0.997	–	-0.563
Help with homework from father (reference: no support)						
Frequently	–	-0.590	–	-0.911*	–	0.110
Infrequently	–	-0.250	–	-0.183	–	-0.177
Rarely	–	-0.011	–	0.039	–	0.250
No. of books of parents (reference: less than 50 books)						
51 to 100	–	0.279	–	0.299	–	-0.141
101 to 250	–	0.849**	–	0.618	–	1.127
251 to 500	–	1.174***	–	1.137**	–	1.032
501 to 2,000	–	1.023**	–	0.994*	–	0.907
More than 2,000	–	1.646***	–	1.463**	–	1.638
Constant	11.491***	9.771***	9.946***	8.701***	13.575***	12.787***
Statistics						
R^2	0.185	0.226	0.203	0.258	0.229	0.280
N	688	639	426	402	262	237
No. of clusters	93	93	87	87	83	80

[a] All standard errors are clustering-robust based on class as the sampling unit. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 9: English (Regression Estimates, Expanded Model)[a]

	Pooled Sample		Female Sample		Male Sample	
	(1)	(2)	(1)	(2)	(1)	(2)
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
D_{s1}	-0.386	-2.153	-1.513	-3.050	0.510	-1.355*
D_{s2}	0.601	0.324	-1.296	-0.434	1.414	1.079
D_{s3}	-1.313***	-1.419***	-2.555***	-2.754***	-0.196	-0.257
D_{s4}	-1.152**	-1.241**	-1.856***	-1.690**	0.079	-0.526
D_{s5}	0.503	0.277	-1.368**	-1.809**	3.427***	2.952***
D_{s6}	0.298	0.243	0.019	0.278	1.035*	0.647
D_{s7}	-0.834*	-0.541	-1.036**	-0.916**	-0.578	-0.624
D_{s8}	-0.577	-0.586	-0.339	-0.329	-0.897	-0.752
D_{s9}	0.075	-0.000	0.007	0.314	-0.790	-1.107*
D_{s10}	0.074	0.245	0.243	0.358	0.799	2.389**
D_{s11}	-1.503	-1.306	-1.667	-1.447	-0.961	-0.630
D_{s12}	1.334**	1.453**	2.359***	2.705***	-0.010	-0.357
School fixed effects						
School 1	-1.965**	0.042	-0.858	0.627	-2.701***	-0.398
School 2	-2.560***	-2.478***	-3.047**	-3.250**	-2.017*	-1.947
School 3	-1.755***	-1.378***	-1.634**	-1.123	-2.049***	-1.456*
School 4	-1.482**	-1.282**	-1.022	-0.820	-2.370**	-2.004
School 5	-1.615*	-1.367	-0.475	-0.148	-3.635***	-3.104**
School 6	-0.757	-0.830	-0.775	-1.204*	-0.788	-0.564
School 7	-1.069	-0.917	-0.746	-0.477	-1.484	-1.373
School 8	-1.454**	-1.271**	-1.496**	-1.290*	-1.236	-1.355
School 9	-3.331***	-3.051***	-4.046***	-3.679***	-1.575*	-1.195
School 10	-1.306**	-1.192**	-1.119	-0.870	-2.317	-3.407***
School 12	-1.675***	-1.325**	-2.124***	-2.021***	-0.934	-0.183
Sociodemographic variables						
Age (enrolment at school)	-0.003	0.115	0.313	0.439	-0.494	-0.456
Male	-0.276	-0.301	0.000	0.000	0.000	0.000
Grade in English (year 7)	-1.944***	-1.929***	-2.074***	-2.107***	-1.865***	-1.822***
Father unemployed	–	-0.029	–	0.075	–	-0.068
Occupational degree of father (reference: apprenticeship or no occupational training)						
Grad. from Univ./Univ. of Appl. Sciences	–	0.538**	–	0.900***	–	0.229
PhD	–	0.437	–	1.206	–	-0.573
Help with homework from father (reference: no support)						
Frequently	–	-0.284	–	0.107	–	-1.326**
Infrequently	–	-0.511	–	-0.688*	–	-0.086
Rarely	–	-0.149	–	-0.233	–	-0.114
No. of books of parents (reference: less than 50 books)						
51 to 100	–	0.158	–	-0.528	–	0.627
101 to 250	–	0.354	–	0.400	–	-0.000
251 to 500	–	0.849**	–	0.556	–	0.691
501 to 2,000	–	0.681*	–	0.500	–	0.645
More than 2,000	–	0.870	–	0.314	–	1.096
Constant	14.282***	12.905***	12.691***	11.454***	16.758***	15.890***
Statistics						
R^2	0.365	0.388	0.415	0.454	0.390	0.450
N	571	529	336	315	235	214
No. of clusters	92	92	85	85	80	78

[a] All standard errors are clustering-robust based on class as the sampling unit. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 10: Robustness Checks of Estimation: Mathematics[a]

	MAG Coeff.	HAL Coeff.	GYM Coeff.	LAR Coeff.
$\widehat{\beta}^M$	-0.603**	-0.784***	-0.610**	-0.580**
School fixed effects				
School 1	-2.308***	0.000	0.000	0.000
School 2	-0.514	0.000	-0.532	0.000
School 3	-1.554***	0.000	-1.533***	0.000
School 4	-1.201***	0.000	-1.197***	0.000
School 5	-1.107**	0.000	-1.103**	0.000
School 6	-1.048***	0.000	-1.136***	0.000
School 7	0.000	-0.064	0.000	-0.964**
School 8	0.000	0.000	0.000	-0.945*
School 9	-2.723***	0.000	0.000	0.000
School 10	-0.230	0.000	-0.180	0.000
School 12	-1.105***	0.000	-1.100***	0.000
Sociodemographic variables				
Age (enrollment at school)	-0.464	-1.416***	-0.456	-1.171***
Male	-0.406	-0.253	-0.348	-0.414
Grade in mathematics (year 7)	-1.656***	-1.843***	-1.670***	-1.740***
Father unemployed	0.023	-0.109	0.008	-0.165
Occupational degree of father (reference: apprenticeship or no occupational training)				
Grad. from Univ./Univ. of Appl. Sciences	0.764***	0.577	0.944***	1.020***
PhD	0.695	4.247***	0.834	3.550***
Help with homework from father (reference: no support)				
Frequently	-0.166	-1.353**	-0.171	-1.531**
Infrequently	-0.222	-1.667***	-0.293	-1.197***
Rarely	0.679*	-1.515**	0.584	-0.829*
No. of books of parents (reference: less than 50 books)				
51 to 100	0.250	0.724	0.137	0.423
101 to 250	0.652	1.145	0.589	1.069
251 to 500	0.501	1.090	0.596	1.177
501 to 2,000	0.546	1.618	0.522	0.766
More than 2,000	1.335**	2.370***	1.549***	1.498**
Constant	14.472***	20.543***	14.422***	19.410***
Statistics				
R^2	0.275	0.393	0.253	0.348
N	483	160	447	243
No. of clusters	73	20	63	29

[a] All standard errors are clustering-robust based on class as the sampling unit. See text for details. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 11: Robustness Checks of Estimation: German Literature[a]

	MAG Coeff.	HAL Coeff.	GYM Coeff.	LAR Coeff.
$\widehat{\beta}^L$	-0.129	-0.084	-0.160	0.062
School fixed effects				
School 1	1.378**	0.000	0.000	0.000
School 2	1.119**	0.000	1.135**	0.000
School 3	1.190**	0.000	1.166**	0.000
School 4	1.115**	0.000	1.125***	0.000
School 5	0.531	0.000	0.548	0.000
School 6	0.602*	0.000	0.578*	0.000
School 7	0.000	-0.410	0.000	0.922**
School 8	0.000	0.000	0.000	1.366***
School 9	1.118	0.000	0.000	0.000
School 10	2.058***	0.000	2.066***	0.000
School 12	0.629	0.000	0.595	0.000
Sociodemographic variables				
Age (enrollment at school)	0.328	-0.479	0.274	-0.188
Male	-0.223	-0.243	-0.162	0.023
Grade in German literature (year 7)	-1.650***	-1.870***	-1.723***	-2.107***
Father unemployed	0.158	0.278	0.324	0.395
Occupational degree of father (reference: apprenticeship or no occupational training)				
Grad. from Univ./Univ. of Appl. Sciences	0.208	0.811	0.345	0.952**
PhD	-0.122	3.063***	-0.060	1.607*
Help with homework from father (reference: no support)				
Frequently	-0.210	-2.118***	0.002	-1.885***
Infrequently	-0.035	-0.628	-0.013	-0.471
Rarely	0.188	-0.268	0.113	-0.362
No. of books of parents (reference: less than 50 books)				
51 to 100	0.154	0.674	0.001	0.591
101 to 250	0.493	1.329**	0.249	1.226**
251 to 500	0.869*	1.558***	0.745	1.439***
501 to 2,000	0.687	1.536*	0.503	1.124*
More than 2,000	1.957***	0.820	1.903***	1.198
Constant	8.654***	14.915***	9.182***	12.116***
Statistics				
R^2	0.185	0.336	0.199	0.341
N	478	161	442	242
No. of clusters	73	20	63	29

[a] All standard errors are clustering-robust based on class as the sampling unit. See text for details. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$