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What a difference three years of economics education make: Evidence from lower-track schools in Germany

Mira Eberle and Luis Oberrauch

Abstract

A large body of literature documents that school-based financial education generally improves financial knowledge, yet little is known about the effect of instruction in the broader economic domain. This paper evaluates the effect of a curriculum reform introducing mandatory economic education on economic competence and knowledge in German lower-track schools, in which students have lower socio-economic status and end up having lower incomes when entering the workforce. While we find small but positive effects on basic economic knowledge and interest in economic matters, we observe no effects on competences, i.e., factual and procedural knowledge in the economic domain. Quantile regressions reveal that the effect on students' knowledge is widely consistent across the entire distribution. With regard to socio-demographic characteristics, we observe strong gender differences already before adulthood.

JEL Codes: A21, I21

Keywords: Economic education, economic knowledge, gender gap

Declarations of interest: none

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1 Introduction

Economic and financial knowledge are key requirements for teenagers and young adults to make confident and independent decisions within economically shaped life situations. A large body of literature documents that these domain-specific capabilities are significantly associated with retirement preparedness (Bucher-Koenen and Lusardi, 2011; Lusardi and Mitchell, 2008), stock market participation (Almenberg and Dreber, 2015; van Rooij et al., 2012), and wealth accumulation in general (Lusardi et al., 2017). Thus, national economic and financial education initiatives have been spurred around the globe with the goal to implement domain-specific education into general school curricula (OECD, 2020).

While interventions in the narrower financial domain have shown to improve financial knowledge and enhance financial decision-making among teenagers (see Kaiser and Menkhoff, 2020 for a meta-analysis of school-based interventions), evidence in the context of natural policy experiments is mixed: Some studies conclude that mandatory financial education is ineffective in fostering financial knowledge and long-term credit card behaviors (Brown et al., 2016; Cole et al., 2016), whereas Urban et al. (2018) document positive effects of U.S. high school mandates on both outcomes once heterogeneity in teacher training and quality of implementation are sufficiently addressed in the econometric framework. Nevertheless, most natural experiments on the effectiveness of educational mandates address the narrow financial domain with focus on consumer problems (such as handling debts and savings) without incorporating broader economic phenomena. Also, as most of these studies are conducted in the U.S., due to the growing number of federal states with high school financial education mandates, quasi-experimental evidence stemming from Europe remains particularly scarce.

In Germany, in particular, state-wide implementations of financial or economic education mandates have been limited in the past (Kaiser et al., 2021). Economics was either included in curricula of related subjects (e.g., social sciences) or offered as an elective in certain school tracks. Recently, the German federal state of Baden-Wuerttemberg broke new ground and introduced economics as a mandatory standalone subject for grades 7 to 10 in lower-track schools. We use this exogenous variation in exposure to economic education relative to the previous cohort not affected by this mandate to study its impact on economic knowledge and competence among lower-track secondary school students. For this purpose, we defined three main outcomes. First, we investigate the impact of the new curriculum on factual economic knowledge. Second, as educational large-scale assessments seek to survey competences (i.e., declarative and procedural knowledge in a specific domain) instead of content-oriented knowledge, we additionally explore curriculum effects on economic competences that incorporate cognitive dispositions to cope with economically shaped life situations. Third, we examine the effects of the new mandate on interest in economic matters. Previous studies have shown that interest may serve as a prerequisite to acquiring economic competences (e. g. Lührmann et al., 2015).

By surveying two distinct representative cohorts (those affected and those not affected by the reform) of 9th graders in 2019 and 2020, we seek to investigate differences between the two groups and provide a comparison into the ex-post levels of students' economic capabilities. The natural design of our study alleviates the possibility of self-selection into the treatment group. As opposed to the 9th grade surveyed in 2019, the 9th grade surveyed in 2020 received three years of mandatory economic instruction. We conducted the natural experiment with 1,829 students in 98 schools.

Our study results in four main findings: First, three years after implementing the mandate, we tentatively find positive treatment effects on *economic knowledge* and on *interest in economic topics* of the order of 0.12 and 0.1 standard deviation units, respectively. The extent of these effects is robust to controlling for various individual characteristics, and relying on a matched-sample, but is only statistically significant at the ten-percent level. While the effect sizes on *economic competence* appear similar, the estimated 90-percent confidence interval generally includes the possibility of zero-effects.

Second, quantile regression estimation reports that the effects are consistent along different distribution moments indicating that the mandate may be suitable for students of all ability levels. However, it is noticeable that high-achieving students do not appear to gain knowledge from the subject but to benefit in terms of competence. Third, we observe meaningful variation of economic knowledge scores across socio-demographic characteristics. Specifically, economic knowledge and competence appear to be significantly lower among migrants and students of lower socio-economic status. In line with previous findings (e.g., Amagir et al., 2020; Driva et al., 2016; Kalwij et al., 2019; Lusardi et al., 2010; Oberrauch and Seeber, 2021), we observe a substantial gender gap in favor of male respondents already at these young ages. As we do not observe heterogeneous treatment effects in those potentially disadvantaged subgroups, we conclude that the reform cannot address pre-existing achievement gaps documented in earlier works (Oberrauch and Kaiser 2020).

This paper adds to a body of literature that has recently investigated the impact of the aforementioned curriculum reform on capabilities, financial behavior, and economic preferences among students attending higher-track schools in Southwestern Germany (Kaiser and Oberrauch, 2021). This paper rather focuses on the effect of the reform among students in lower-tier schools. Most adolescents in this specific group are about to finish their school education and therefore face

many important economic decisions that may have a strong influence on their future economic well-being. For instance, they decide whether to continue their schooling, start vocational training, or enter workforce directly. While Kaiser and Oberrauch (2021) find large treatment effects on students' skills in higher-track schools, the effects in lower-track schools appear to be small. Consequently, educational planners need to address this heterogeneity across school types in future curriculum adjustments.

The paper proceeds as follows: The next section describes the curriculum reform. Section 3 provides information about the measurement instruments as well as psychometric procedures to measure economic capabilities. Section 4 describes the used sampling procedures and descriptive sample characteristics. Section 5 presents main results as well as results on heterogeneous treatment effects. Section 6 discusses the results and concludes the paper.

2 Curriculum Reform

The natural experiment relies on a federal state-wide curriculum reform introducing mandatory economic education for all general education schools. The new distinct school subject (Economics / Career and Study Orientation), is taught from grade seven to ten in order to enable students to recognize, cope with, and design economically shaped life situations (KM, Kultusministerium, 2016). While earlier curricula defined competency goals but had deficits in content, this new curriculum is fully based on a competence model described in Seeber and Retzmann (2016), which fulfills the requirements of the Standing Conference of the Ministers of Education and Cultural Affairs of the German federal states.

To guide this teaching of competences, the model offers three different points of view or roles: Firstly, the role of a consumer, secondly being a wage earner and thirdly the perspective of

a citizen. In all of them, adolescents need to handle the economic reality now and later on in their lives. Therefore, the model defines certain basic life situations: consumers of goods and services, employees and self-employed, as well as tax-paying and voting citizens. The curriculum addresses these life situations, in which students are expected to acquire content-related skills referring to the overall goals of general education (Kaiser et al., 2021, p. 230). Further, the model addresses three major perspectives influencing the competencies of these different life situations and roles: First, the model aims to guide students to take on responsibility for their own decisions and actions (*individual perspective*). Second, students need to incorporate and recognize the interests and actions of other individuals (*social perspective*). Third, students need to understand market mechanisms as well as principles of the economic system (*systemic perspective*).

While schools are allowed to decide autonomously on the organization of the curricular contents, the governmental department provides an exemplary sequence beginning with consumer problems including rational choice, price mechanism, and consumer protection. The second year focuses on agents as wage earners and entrepreneurs and year three covers the topic of the individual as a tax-paying and voting citizen. Further, the curriculum is separated into three requirement profiles thus addressing different performance groups across school types. The intensity in lower-track schools is five contact hours in total (i.e., 45 minutes) for grades 7 to 10. The German school system sorts children into different ability tracks at the end of grade 4. While the most sophisticated school type (Gymnasium) (grades 5 to 12) provides in-depth general education and prepares students for future university studies, the lower-tier school types (Realschule and Werkrealschule) usually lead to a vocational entrance qualification (grades 5 to 10). The recently introduced comprehensive school type (Gemeinschaftsschule) seeks to accommodate students of all ability levels.

3 Measurement of economic capabilities

This section briefly describes the main outcomes: content-oriented economic knowledge, economic competence, and interest in economic matters. While interest may serve as a prerequisite to acquire economic competence, domain specific knowledge is important to develop and use cognitive strategies. As the curriculum reform aspires to foster economic competences among adolescents, we additionally capture domain-specific competences using an established competence test.

3.1 Economic knowledge

To measure factual knowledge in the economic domain, we employed a ten-item performance test covering current economic conditions (e.g., unemployment rate) but also content-oriented knowledge (e.g., the required minimum age to take out a loan) (Table B2 in Appendix B). This performance test was especially developed for secondary school students and its ten items showed valid psychometric characteristics (for a translated version of the item set, see Table B2 in Appendix B). We analyze factual knowledge using an Item Response Theory model (IRT) (Baker and Kim, 2017; Hambleton and Swaminathan, 1985) that is frequently employed in international large scale assessments. To extract item characteristics and person abilities, we use a two-parameter logistic model (Birnbaum, 1968), formally expressed as:

$$P(X_i = 1|\theta, \sigma, a_i) = \frac{\exp\{a_i(\theta_v - \sigma_i)\}}{1 + \exp\{a_i(\theta_v - \sigma_i)\}}$$

where θ_v denotes estimated ability for person v , and σ_i estimated item difficulty for item i on a common logit scale. σ_i defines a discrimination parameter evaluating how accurate item i discriminates between low-ability and high-ability students. With regard to model fit statistics (S-

X2) (for a comparison of various fit statistics, see Ames and Penfield, 2015), the chi-square statistics are insignificant for 9 of 10 items indicating that the IRT model with two parameters is suitable for our item set. Table A1 in Appendix A shows item characteristics obtained by the IRT model as well as descriptive statistics of Classical Test Theory (CTT). Overall, the administered test items have shown to have evenly distributed difficulties and to be sufficiently useful for differentiating between high and low-achievers.

3.2 Economic competences

Most educational large-scale assessments (such as PISA or TIMSS) seek to capture competences (i.e., cognitive dispositions to solve domain-specific problems) rather than content-orientated knowledge. To measure economic competences in our sample, we additionally administered the Test of Economic Competence (TEC) which is described and validated in Kaiser et al. (2020). The performance test contained 31 items (selected and constructed responses) and showed valid psychometric properties (i.e., unidimensionality and sufficient internal consistency). Corresponding to the economic knowledge test, we use the two-parameter logistic model displayed in equation (1) to extract a person's abilities.

3.3 Interest in economic matters

To expand the two cognitive outcomes, we additionally captured students' interest in economic matters, as domain-specific interest may serve as a prerequisite to acquire economic knowledge and competences. Specifically, we asked respondents to rate their interest in economic topics on a scale from one (not interested at all) to five (very interested). We standardized this measure to have a mean of zero and a standard deviation of 1.

4 Data

The target population consists of all students in 9th grade attending a lower-track public school in the German federal state of Baden-Wuerttemberg. To draw a representative sample, we stratified the whole population into subgroups by school type and level of urbanization (see Oberrauch and Kaiser, 2020 for details). We then employed a two-stage cluster sampling procedure the selection of schools being the first stage. In the second stage, we randomly drew one 9th grade in each school. The number of selected schools in each stratum is adapted to the proportion of the strata in the target population. To reduce the remaining disproportionalities, we used sampling weights calculated by the inverse of the selection probability.

The final sample contains information on 1,829 secondary school students (1,102 affected by the reform, 727 not affected) out of 107 classes in 98 schools. While the 9th grade not affected by the reform was surveyed in summer 2019, the 9th grade affected by the reform was surveyed one year later in late summer 2020. Due to the pandemic situation in 2020, we administered the survey for affected students two months later than initially planned¹. The study was conducted during regular school lessons and carefully supervised by the teachers. Detailed information on the sample composition in comparison to official school statistics is listed in Table A2 in Appendix A.

Aside from the three outcome-domains (knowledge, competence, and interest), we additionally captured a variety of demographic characteristics (Table 2). To control students' socio-economic status, we used the number of books at students' homes which has been shown to be a reliable predictor of parents' income levels and educational status (e.g., Hanushek and Woessmann,

¹ Due to school closures, we assume lower gains in domain-specific skills among treated students, especially among children of parents of low socio-economic status (Hammerstein et al., 2021).

2011; Schütz et al., 2008). Further, we assessed school performance by asking students for their math and reading abilities on a scale from 1 (very low) to 5 (very high), with students affected by the reform showing slightly higher reading scores. Due to baseline imbalances in variables such as age, gender, reading ability, and geographic region (i.e., whether the school is located in a rural area), we control for all indicators in the subsequent regression analysis (OLS). Since the standard errors are still high, we additionally employed propensity score matching (PSM) to compare two homogenous cohorts as a robustness check (PSM). The matched sample operates with a total of 1,779 observations containing all possible values, not only the nearest-neighbors pairs (Ho et al., 2007, Appendix Table A3).

Table 2: Descriptive statistics and balance on observables

	Full sample (Mean / %) N=1,829	Control (Mean / %) N=1,102	Treatment (Mean / %) N=727	Diff.	t-test (p-value)	N
Age	15.8	15.7	15.9	-0,2	0.000	1,829
Male	51.0 %	53.2 %	47.7 %	5,5	0.031	1,829
Foreign language	42.0 %	42.0 %	42.0 %	0	0.993	1,810
≤ 25 Books	35.4 %	35.7 %	35.0 %	0,7	0.817	1,812
Reading ability	3.81	3.77	3.86	-0,09	0.077	1,828
Math ability	3.37	3.35	3.38	-0,03	0.520	1,825
Rural area	35.42 %	31.67 %	41.17 %	-9,5	0.312	1,821

Notes: This table reports percentages and means of individual characteristics of students affected by the curriculum reform (Treatment) and those who are not affected (Control). Diff. displays the differences between the control and treatment group. P-values are based on a t-test in which the coefficient for Treatment in a linear regression on each characteristic is zero, with standard errors clustered at school-level.

5 Results

5.1 Average effects on factual economic knowledge

This section reports the main effects of the new mandate introduce mandatory economic education on the main outcomes of interest, with results of OLS regressions and Propensity score

matching (PSM) shown in Table 3. To account for the clustered data, we clustered standard errors at school level. The self-assessed ability variables for reading and math are mean-centered. When including several individual-level and school-level variables in the regression, multicollinearity may be a potential problem. Results on bivariate correlations and variance inflation factors (VIF) show that the variables included are widely independent of each other (Table A4 and A5 in Appendix A).

Our data reveal suggestive evidence that exposure to the new curriculum improves students' knowledge scores. Regarding the entire sample, students affected by the reform score higher by 0.12 standard deviation units (column 1). While we find slightly larger, but insignificant effects regarding economic competence (column 3), the effect on interest in economic matters is lower but significant on a 10-percent level (column 5). Regarding socio-demographic characteristics, we find a significant gender gap in favor of male students in both economic knowledge and competence which corresponds with most studies evaluating financial and economic education interventions in schools (e.g., Lührmann et al., 2015; Oberrauch and Seeber, 2021). Next, we document lower test scores among students who spoke a foreign language during their childhood and students of low socio-economic status (i.e., having 25 or fewer than 25 books at home). The latter is significantly lower across all outcome-domains. In the subgroup of students having a migration background, our data show a lower negative value on factual knowledge than on competence (-0.098 SD and -0.319 SD, respectively). By contrast, we do not observe gender or migration differences in economic interest.

Due to sample imbalances described in section 4, we additionally employed propensity score matching (PSM) as a robustness exercise. In the matched sample with 1,410 matched pairs, our results do not change qualitatively. To account for the hierarchical data structure, we

additionally ran a hierarchical regression (random intercept model). As shown in Table A6 in Appendix A, results qualitatively remain the same.

Table 3: Regression estimates

Variable	Economic knowledge		Economic competence		Economic interest	
	OLS	PSM	OLS	PSM	OLS	PSM
<i>Treatment (subject)</i>	0.120 + (0.068)	0.125 + (0.069)	0.125 (0.095)	0.108 (0.095)	0.104 + (0.062)	0.111 + (0.063)
<i>Individual characteristics</i>						
Age (in years)	0.003 (0.032)	0.004 (0.040)	0.021 (0.042)	-0.016 (0.061)	0.011 (0.030)	0.062 + (0.037)
Male	0.254 *** (0.055)	0.274 *** (0.051)	0.167 ** (0.059)	0.215 ** (0.067)	0.090 (0.059)	0.081 (0.061)
Foreign language	-0.098 * (0.048)	-0.102 + (0.053)	-0.319 *** (0.061)	-0.326 *** (0.068)	0.028 (0.050)	0.027 (0.053)
≤ 25 books at home	-0.279 *** (0.054)	-0.276 *** (0.057)	-0.282 *** (0.050)	-0.265 *** (0.059)	-0.223 *** (0.058)	-0.176 ** (0.066)
Reading ability mc (1 = low; 5 = high)	0.146 *** (0.035)	0.209 *** (0.042)	0.160 *** (0.040)	0.191 *** (0.048)	0.241 *** (0.033)	0.207 *** (0.041)
Math ability mc (1 = low; 5 = high)	0.113 *** (0.019)	0.092 *** (0.024)	0.160 *** (0.027)	0.172 *** (0.033)	0.138 *** (0.031)	0.131 *** (0.031)
<i>Rural area</i>	0.166 * (0.063)	0.145 * (0.069)	0.165 + (0.090)	0.116 (0.098)	0.111 (0.069)	0.102 (0.068)
Constant	-0.075 (0.492)	-0.079 (0.612)	-0.217 (0.643)	0.384 (0.939)	-0.163 (0.480)	-0.994 + (0.593)
N	1,792	1,410	1,792	1,410	1,779	1,410
N (schools)	98	96	98	96	98	96
Adjusted R-squared	0.084	0.096	0.116	0.121	0.074	0.053
F-statistic	20.97	20.84	16.91	20.02	14.49	13.60

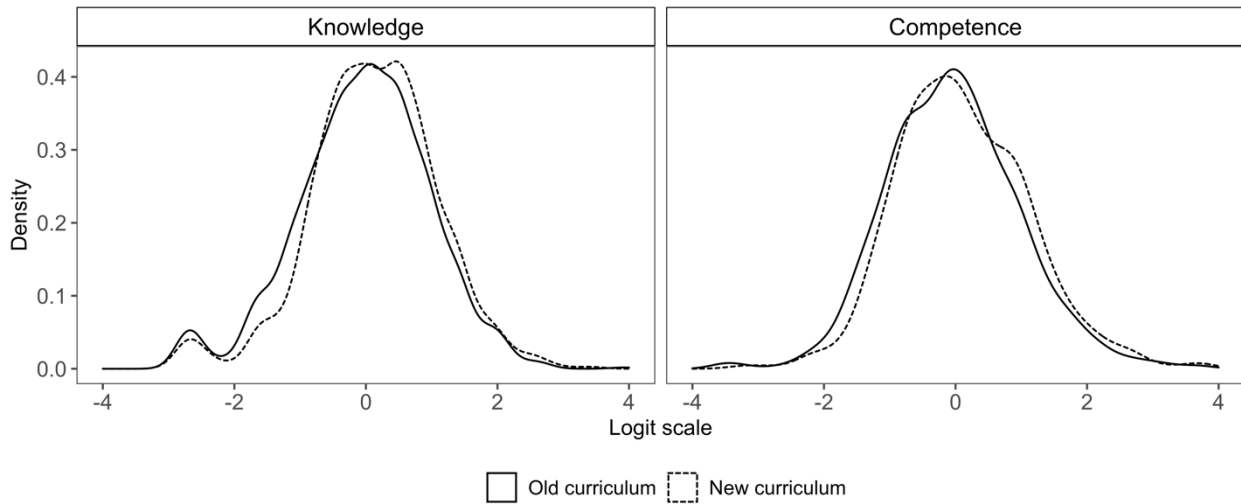
Notes: This table shows OLS regressions and robust standard errors clustered at school level with respect to school track. The dependent variable ‘Economic knowledge’ is derived from the IRT model specified in chapter 2.1., with scores of the control group being standardized to have a mean of 0 and a standard deviation of 1. Control variables (individual and school-level) are defined as presented in Table 2. To emulate randomization, the chosen PSM method follows the approach of Ho et al. (2007) and uses nearest neighbor matching. + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5.2 Distributional Effects

As results in Table 3 only rely on average effects of factual knowledge on factual economic knowledge, we also investigated heterogeneous effects at different moments of the conditional distribution of scores on cognitive tests (i.e., economic knowledge and competence). As shown in Figure 1, across the entire distribution, factual knowledge improved, benefiting both low- and high-

achieving students displayed by the small rightward shift in the distribution, while competence scores are only affected among high-achieving students.

Figure 1: Distribution of knowledge and competence scores



Notes: This figure shows density plots for students' economic knowledge in students affected by the new curriculum (solid line) and the control group (dashed line). Plots for students attending higher-track schools as well as for students attending lower track schools are shown separately.

Additionally, we implemented simultaneous quantile regressions on the conditional distribution moments $M(0.2, 0.4, 0.5, 0.6, 0.8)$, i.e., the 20th, 40th, 50th, 60th, and 80th percentile of all outcome domains, with results shown in Table A7 in Appendix A. The methodical procedure follows the minimization problem specified in Koenker and Bassett (1978). Basically, results mirror the results displayed in Figure 1, with consistent effects on knowledge scores of the order of 0.25 SDs to 0.28 SDs. Regarding competences, the new curriculum only affects test scores in the 80th percentile.

5.3 Heterogeneous treatment effects

This section investigates heterogeneous treatment effects across socio-demographic observables and school tracks, with results shown in Table A8 in Appendix A. We focus on four

subgroups that are known to have different ex-ante levels regarding economic capabilities. First, strong gender differences in economic and financial capabilities among adolescents have been reported in many studies (e.g., Bucher-Koenen et al., 2017; Driva et al., 2016; Kaiser et al., 2021), with male students showing higher average test scores. Second, in line with previous studies (Oberrauch and Kaiser, 2020), Table 2 displayed lower test scores for participants speaking a foreign language at home. Third, we examine heterogeneous treatment effects with respect to the number of books at home. Parental background has been identified as main predictor for acquiring domain-specific capabilities in various contexts (e.g., Grohmann et al., 2015; Schütz et al., 2008).

In line with previous studies (e.g., Oberrauch and Seeber 2021), we find no significant interaction between the new curriculum and being male (*Panel A*). Also, with regard to socio-economic characteristics, the new curriculum does not particularly affect respondents growing up speaking a foreign mother tongue (*Panel B*) and students of low socio-economic status, i.e., having 25 or fewer than 25 books at home (*Panel C*). Collectively, treatment effects of the new curriculum shown in chapter 5.1 appear to be universal across individual characteristics rather than affecting a particular subgroup.

6 Discussion

Recent studies have shown that the implementation of formal economic education in schools is effective in fostering economic competences (Oberrauch and Kaiser, 2020) and interest in economic matters (Oberrauch and Seeber, 2021) among students attending German higher-tier schools. In this paper we added the impact of the new mandate introducing mandatory economic education in lower-track schools to the already existing body of literature. Previous studies have shown that children with parents of lower socio-economic status are more likely to attend lower-track school types and have lower incomes when entering the workforce. Mandatory economic

education may therefore help these individuals to make informed decisions in a demanding economic environment (Lusardi et al. 2010). The study was implemented into a curriculum reform in Southwestern Germany that provides mandatory economic education for all general education schools from grade 7 to 10. The reform allows researchers to leverage exogenous variation in exposure to formal economic education to identify its impact on a variety of outcomes relevant to economic understanding and decision-making in economically shaped life situations.

The new mandate only has small effects on domain-specific knowledge and interest in economic topics for the entire sample of the order of 0.12 and 0.1 standard deviation units, respectively. We find no statistically significant effect on economic competence in the total sample of lower-track students. The effect on knowledge remains widely consistent across all distribution moments, indicating that the mandate is suitable for all ability levels, while competence scores seem to improve only among high ability students. As previous research documented, large positive treatment mostly affects high-achieving students two years after implementing the new mandate (Kaiser and Oberrauch 2021). Therefore, we conclude that the new curriculum appears to be less suited for students in lower-tier schools.

Our research design encounters two major limitations: First, as the estimates are based on a cross-sectional sample, the study is missing a baseline cohort prior to the implementation of the mandate (i.e., knowledge scores at the end of grade 6). A longitudinal setting with panel data may help researchers to identify curriculum effects in a more rigorous way. Second, as students affected by the reform were surveyed one year after the control cohort, exogenous economic or political events may confound our identification strategy. Especially school closures and distant learning during the 1st wave of the COVID-19 pandemic may be associated with losses in learning time and

cognitive skills (Grewenig et al., 2021). Since the treatment group was surveyed in 2020, the average treatment effects shown in chapter 5.2 are potentially downward-biased.

Finally, in line with previous research, our data reveal meaningful variation in economic capabilities across individual observables. Students of lower socio-economic status or migration background score significantly lower in the knowledge and competence test, with larger (negative) effects on economic competences than on knowledge. This indicates that adapting content-oriented knowledge is easier for disadvantaged students than exhibiting broader operational and judging competences. Further, our results indicate that the gender gap remains a worrying phenomenon. As shown by the analysis of heterogeneous treatment effects in chapter 5.3, the new curriculum is not in particular affecting these disadvantaged subgroups. Therefore, future research needs to i) identify relevant factors driving these performance gaps with regard to school types and individual characteristics and ii) investigate the impact of new teaching formats and materials that may have the potential to equalize the disparities.

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Appendix

(Online appendix not intended for print publication)

to accompany

What a difference three years of domain-specific schooling make: Evidence from lower-track schools in Germany

Appendix A

Table A1: Item characteristics based on Classical Test Theory (CTT) and Item Response Theory (IRT)

Itemno.	n	CTT		IRT	
		Frequency	r_{it}	$\hat{\sigma}$ [SE]	$\hat{\alpha}$ [SE]
1	2,843	0.222	0.119	3.177 [0.113]	0.401 [0.015]
2	2,798	0.806	0.293	-1.353 [0.039]	1.402 [0.049]
3	2,788	0.365	0.215	0.854 [0.058]	0.719 [0.036]
4	2,696	0.364	0.255	0.705 [0.046]	0.949 [0.044]
5	2,762	0.467	0.230	0.228 [0.053]	0.774 [0.045]
6	2,807	0.709	0.190	-1.674 [0.075]	0.569 [0.025]
7	2,782	0.493	0.189	0.100 [0.071]	0.552 [0.042]
8	2,784	0.480	0.240	0.119 [0.054]	0.749 [0.045]
9	2,731	0.341	0.236	0.949 [0.053]	0.816 [0.038]
10	2,754	0.355	0.217	0.923 [0.057]	0.735 [0.036]

Notes: This table reports results of Classical Test Theory where r_{it} denotes (corrected) item-total correlations, i.e., point-biserial correlations between item responses and sum scores on all remaining items. Positive correlations indicate that students with high ability (i.e., high test scores) are more likely to solve the item, while students with low ability are less likely to solve it. Difficulty parameter σ and discrimination parameter are estimated by means of the two-parameter IRT model specified in equation (1). A translated version of the entire item set is listed in Table B2 in Appendix B). r_{it} reports the (corrected) item-total correlation, i.e., the point-biserial correlation between solving an item correctly and the total score on all remaining items. Our data show that all test items are moderately, but positively correlated with test scores. Statistics on the two-parameter IRT model mirror these results, with moderate but non-zero slope parameters σ

Table A2: Comparison with official school statistics full data sample

	Data sample				Official School Statistics			
	N	Share school type	Share male students	Share students with migration background	N	Share school type	Share male students	Share students with migration background
School track GMS	275	15.0	49.8	4.79	80,427	24.98	54.5	35.5
School track WRS	173	9.5	53.2	3.21	45,040	13.99	57.5	51.7
School track RS	1,381	75.5	50.1	24.18	196,558	61.04	52.4	28.5

Notes: Shares are given in percent (%). Compared to the Official School Statistics, learners from middle schools (RS; Realschulen) are overrepresented. As a result of the pandemic situation and the subsequent collection of data, lower-performing students may be missing from our sample if they left after 9th grade. Regarding gender distribution, our dataset shows a balanced distribution with differences below 5 %. In our dataset, learners with a migration background are underrepresented across the lower track school types. (Statistisches Landesamt Baden-Wuerttemberg, 2020).

Table A3: Descriptive statistics and balance on observables after PSM

	Full sample (Mean / %) N=1,779	Control (Mean / %) N=1,074	Treatment (Mean / %) N=705	Diff.	t-test (p-value)	N
Age	15.80	15.73	15.94	-0.21	0.000	1,779
Male	50.76	53.07	47.23	5.84	0.023	1,779
Foreign language	41.88	42.09	41.56	0.53	0.895	1,779
≤ 25 Books	35.53	35.85	35.04	0.81	0.797	1,779
Reading ability	3.80	3.78	3.84	-0.06	0.192	1,779
Math ability	3.40	3.37	3.39	0.02	0.706	1,779
Rural area	35.30	31.56	40.99	-9.43	0.316	1,779

Notes: This table reports percentages and means of individual characteristics of students affected by the curriculum reform (Treatment) and those who are not affected (Control). Diff. displays the differences between the control and treatment group. P-values are based on a t-test in which the coefficient for Treatment in a linear regression on each characteristic is zero, with standard errors clustered at school-level.

Table A4: Bivariate correlations

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Treatment (subject)	-								
(2) Age	0.17 ****								
(3) Male	-0.05 *	0.07 **		-					
(4) Foreign language	0	0.16 ****	-0.04						
(5) ≤ 25 books	-0.01	0.11 ****	0.04	0.2 ****					
(6) Reading abilities	0.05 *	-0.06 **	-0.12 ****	-0.04	-0.12 ****				
(7) Math abilities	0.01	-0.05 *	0.25 ****	-0.1 ****	-0.01	0.07 **			
(8) Economic factual knowledge	0.08 **	-0.05 *	0.11 ****	-0.11 ****	-0.17 ****	0.14 ****	0.15 ****		
(9) Economic competence	0.07 **	-0.09 ****	0.08 **	-0.21 ****	-0.19 ****	0.16 ****	0.21 ****	0.43 ****	
(10) Economic interest	0.06 **	0	0.03	-0.04	-0.1 ****	0.17 ****	0.15 ****	0.16 ****	0.17 ****

Notes: This table reports point-biserial correlations as well as Pearson correlations between all indicators described in table 2. **** p<0.0001, *** p<0.001, ** p<0.01, * p<0.05. Correlations that are larger than .25 in magnitude (p < .001) have been highlighted in bold.

Table A5: Multicollinearity

Variable	New curriculum	Age	Male	Foreign language	≤25 books	Reading ability	Math abilities	Rural region
Variance Inflation Factor (VIF)	1.038	1.060	1.11	1.099	1.096	1.136	1.027	1.164
Tolerance	0.962	0.942	0.899	0.909	0.911	0.880	0.972	0.858

Note: The vif-values close to 1 report a widespread absence of multicollinearity. Values around 0.9 of the tolerance confirm independence of variables.

Table A6: Hierarchical regression estimates

Coefficient	Economic factual knowledge			Economic competence			Economic interest		
	Estimates	Conf. Int (95%)	P-Value	Estimates	Conf. Int (95%)	P-Value	Estimates	Conf. Int (95%)	P-Value
Treatment (subject)	0.10	-0.02 – 0.23	0.099	0.13	-0.02 – 0.28	0.100	0.11	-0.00 – 0.22	0.060
Age (in years)	0.00	-0.05 – 0.05	0.915	0.03	-0.02 – 0.07	0.268	0.01	-0.04 – 0.06	0.692
Male	0.25	0.16 – 0.34	<0.001	0.19	0.10 – 0.28	<0.001	0.10	0.00 – 0.19	0.049
Foreign language	-0.07	-0.17 – 0.02	0.119	-0.24	-0.34 – -0.15	<0.001	0.03	-0.07 – 0.12	0.588
≤ 25 Books	-0.26	-0.35 – -0.16	<0.001	-0.25	-0.35 – -0.16	<0.001	-0.22	-0.32 – -0.12	<0.001
Reading ability	0.14	0.08 – 0.20	<0.001	0.16	0.10 – 0.22	<0.001	0.24	0.18 – 0.30	<0.001
Math ability	0.11	0.07 – 0.16	<0.001	0.15	0.10 – 0.20	<0.001	0.14	0.09 – 0.19	<0.001
Rural region	0.19	0.04 – 0.33	0.011	0.19	-0.01 – 0.39	0.066	0.10	-0.03 – 0.23	0.121
Intercept	-0.10	-0.86 – 0.65	0.786	-0.39	-1.14 – 0.36	0.307	-0.15	-0.93 – 0.63	0.709
Random Effects									
σ^2		0.83			0.80			0.92	
τ_{00} Schools		0.06			0.16			0.03	
ICC		0.07			0.16			0.03	
N Schools		98			98			98	
Observations		1,792			1,792			1,779	
Marginal R ² / Conditional R ²		0.082 / 0.143			0.103 / 0.250			0.077 / 0.106	

Notes: Due to slightly shifting confidence intervals below zero no statistically significant evidence for subject-driven improvements is provided.

Table A7: Quantile regression estimates

	(1)	(2)	(3)	(4)	(5)
	20th	40th	50th	60th	80th
<i>Panel A: Economic knowledge</i>					
New curriculum	0.210** (0.085)	0.184** (0.085)	0.173** (0.069)	0.118* (0.063)	0.118 (0.073)
Constant	-0.119 (0.871)	0.426 (0.602)	0.663 (0.488)	0.530 (0.450)	0.950 (0.643)
Observations	1,792	1,792	1,792	1,792	1,792
R-squared	0.089	0.091	0.088	0.090	0.087
<i>Panel B: Economic competence</i>					
New curriculum	0.132 (0.101)	0.137 (0.092)	0.151 (0.093)	0.141 (0.089)	0.164* (0.100)
Constant	0.347 (0.508)	0.676* (0.362)	1.173** (0.544)	1.277** (0.578)	1.124 (0.906)
Observations	1,792	1,792	1,792	1,792	1,792
R-squared	0.124	0.125	0.126	0.126	0.125
<i>Panel C: Economic interest</i>					
New curriculum	0.000 (0.169)	0.000 (0.108)	0.118 (0.125)	0.181* (0.109)	0.000 (0.083)
Constant	-0.540 (0.776)	-0.540 (0.707)	-0.169 (0.675)	0.303 (1.166)	0.873* (0.528)
Observations	1,779	1,779	1,779	1,779	1,779
R-squared	0.000	0.004	0.065	0.065	
Demographic controls	Yes	Yes	Yes	Yes	Yes
Cluster	145	145	145	145	145

Notes: This table reports simultaneous quantile regressions for the impact of the curriculum mandate on economic knowledge as described in chapter 5.2. The output displays treatment effects for the 20th, 40th, 60th, 80th percentile, and the median. The number of observations is slightly reduced due to missing values (item non-response) in covariates. Standard errors (clustered at the school-level) in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table A8: Heterogeneous treatment effects

	(1)	(2)	(3)
	Knowledge	Competence	Interest
<i>Panel A: Gender</i>			
New curriculum	0.078 [0.077]	0.032 [0.093]	0.089 [0.079]
Male	0.221*** [0.078]	0.094 [0.063]	0.078 [0.071]
New curriculum × Male	0.088 [0.105]	0.198 [0.133]	0.035 [0.118]
Intercept	-0.95*** [0.165]'	-0.993*** [0.192]'	-1.369*** [0.185]'
Adj. R-squ.	0,084	0,118	0,074
F-stat	20,74	17,044	14,218
<i>Panel B: Foreign language</i>			
New curriculum	0.135 * [0.077]	0.083 [0.125]	0.048 [0.076]
Foreign	-0.085 [0.059]	-0.356*** [0.077]	-0.021 [0.063]
New curriculum × Foreign	-0.033 [0.087]	0.112 [0.12]	0.138 [0.106]
Intercept	0.969*** [0.169]	-1.013*** [0.203]	-1.357*** [0.183]
Adj. R-squ.	0,084	0,117	0,075
F-stat	20,937	17,036	15,495
<i>Panel C: Socio-economic status</i>			
New curriculum	0.131 * [0.068]	0.078 [0.118]	0.035 [0.067]
≤25 books	-0.268*** [0.067]'	-0.336*** [0.054]	-0.299*** [0.07]
New curriculum × ≤25 books	-0.029 [0.094]	0.148 [0.113]	0.201 * [0.121]
Intercept	-0.97*** [0.167]	-1.003*** [0.2]	-1.34*** [0.18]
Adj. R-squ.	0,084	0,117	0,076
F-stat	20,77	19,359	15,311
Controls	Yes	Yes	Yes
N	1792	1792	1779
N (cluster)	98	98	98

Notes: This table shows heterogenous effects for four different subgroups by means of OLS regressions with 98 clusters. Panel A shows results by gender, with 'Male' indicating male respondents. Panel B shows interaction between the curriculum reform and speaking a foreign language at home. Panel C shows results by socio-economic status, with respondents having 25 or fewer books at home. Overall sample size is reduced due to missing responses in several demographic predictors. We controlled all individual and school-level observables listed in Table 1. Cluster-robust standard errors in square brackets. *** p<0.01, ** p<0.05, * p<0.1

Appendix B

Table B1: Line up question topic and curriculum category

Nr.	Question	Life situation
1	Unemployed	Employed – Worker
2	Marginal Employment	Employed – Worker
3	ECB	Economic Citizen – Shaping Citizen
4	DAX	Consumer – Investor
5	Collective Bargaining	Employed – Worker Economic Citizen – Shaping Citizen
6	Consumer Protection	Consumer – Consumer
7	VAT rate	Economic Citizen – Taxpayer and Beneficiary (only from grade 10)
8	Credit	Consumer – Borrower
9	Inflation	Economic Citizen – Shaping Citizen
10	Fusion	Employed – Entrepreneur (only from grade 10)

Table B2: Items set for measuring factual knowledge

Q1	According to statistics, how many unemployed people are there approximately in Germany?	a. approximately 2 million b. approximately 4 million c. approximately 6 million d. approximately 8 million e. approximately 10 million f. I don't know.
Q2	Which income limit is referred to as "marginal employment"?	a. 320 € b. 380 € c. 450 € d. 520 € e. 580 € f. I don't know.
Q3	Where is the European Central Bank located?	a. in Brussels b. in Frankfurt/Main c. in Strasbourg d. in Paris e. in Berlin f. I don't know.
Q4	What is the "DAX"?	a. the German share index b. an animal c. a measurement unit for currency d. a weight unit e. an intragroup valuation unit f. I don't know.
Q5	Who conducts collective bargaining?	a. government and employers' associations b. trade unions and parties c. employers' associations and trade unions d. the federal government and federal states e. the federal office of labour and entrepreneurs f. I don't know.
Q6	Which of the following institutions does not serve to ensure consumer protection?	a. foundation for product testing ("Stiftung Warentest") b. German Tenants' Protection Association c. Chamber of Industry and Commerce d. foundation for ecological tests of products "Stiftung Ökotest") e. consumer advice centre f. I don't know.
Q7	How high is the VAT rate (Mehrwertsteuersatz)?	a. 14 % b. 15 % c. 17 % d. 19 % e. 20 % f. I don't know.
Q8	A person who wants to take out a loan must be...	a. at least 12 years old. b. at least 14 years old. c. at least 16 years old. d. at least 18 years old. e. at least 21 years old. f. I don't know.

Q9	When does one speak of inflation?	<ul style="list-style-type: none">a. When prices decrease and thus the monetary value increases.b. When prices are stable and the monetary value increases.c. When prices are stable and the monetary value increases.d. When prices increase and thus the monetary value decreases.e. When prices and monetary value are stable.f. I don't know
Q10	What is a merger?	<ul style="list-style-type: none">a. a purchase of subsidiary companiesb. melting of iron orec. expansion of the customer based. a union of the employeese. a business combinationf. I don't know.
