British Journal of Education, Society & Behavioural Science
4(4): 440-455, 2014

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The Effect of Ability-based Tracking in Secondary School on Subsequent School Achievement: A Longitudinal Study

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Authors' contributions

Author SP designed the study, performed the statistical analyses, and wrote the drafts of the manuscript. Author KF read and approved the final manuscript.

Original Research Article

Received 30th September 2013
Accepted 3rd December 2013
Published 20th December 2013

ABSTRACT

Aims: Using propensity-score matching, we matched students with similar prior-school achievement and demographical data who attended either an academic or vocational track during the first two years of secondary school.
Methodology: In a two-factorial between-subject analysis of variance, we compared standardised school achievement test scores of propensity-score matched prior high- and low-achieving students who attended either an academic or vocational track.
Results: Results showed that for the subjects German and French, prior high-achieving students performed significantly better than prior low-achieving students, and students who attended the academic track performed significantly better than students who attended the vocational track. For the subject Mathematics we found a main effect of prior-achievement level. However, we did not find an interaction between prior-achievement level and track-level.

Keywords: Ability-based tracking; school achievement; propensity-score matching; secondary school.

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1. INTRODUCTION

Ability-based tracking in school has been investigated by researchers since the beginning of the 20th century [1]. Numerous findings underline the advantages of tracked school systems for high achieving students who attend an academic track [2,3,4]. However, a consensus has not been found whether tracking is effective with regard to the enhancement of performance of all students.

The aim of the present work was to investigate the effect of the attended school track in secondary school on subsequent school achievements of students in Luxembourg. Moreover, we sought to know whether students showing rather low or high achievements in primary school would be differentially affected by the track they attended in secondary school. Answering these questions seems important, as previous research [5] has indicated that the orientation of students to the different tracks of secondary school is not solely based on previous primary-school achievement. If results of the present study indicate that students who were oriented onto an "unfitting" track might suffer from further disadvantages during their school career, this could underline the importance of putting the orientation procedure in question.

In the following sections, we will first present empirical findings on tracking, before our research questions, methods and results are presented and discussed.

1.1 Tracking and Grouping in the Educational System

Grouping students into different schools, classes, courses or learning groups is practised in many countries [cf. 6]. In the present work, we define tracking as the separation of students into different school systems with different curricula. As some schools provide different forms of curricula, students from different tracks might attend the same school but not the same courses.

In the present study, students are divided into two groups (i.e., tracks) in secondary school according to their academic abilities. We therefore use the term "tracking" instead of ability grouping when describing the ability-based separation of the students in secondary school. Whereas the overarching idea behind grouping is creating homogeneous groups of students, the implementation of grouping or tracking as well as the allocation of students onto different tracks or ability groups takes different shapes in different countries. With regard to the implementation, the scope ranges from "opt-in tracking", where the choice is given to parents and/or students themselves, to pure achievement-based grouping [c.f. 7]. Maaz and colleagues [6] make a distinction between implicit tracking (students attend a certain school because they live in the neighbourhood), explicit tracking (students are obliged to attend a certain school based on their previous achievement level), and curricular tracking (students attend all the same school but different courses based on their previous achievement level). Other categorisations were made for example by Van Houtte and colleagues [4] who differentiate between within- and between-school tracking (students attend different tracks in the same school or they attend different schools but the same track within one school). A similar distinction was made by Reuman [8].

The objective of ability-grouping or tracking (ability-grouping being seen as more common in primary school, whereas tracking occurs more frequently in secondary education) has been described as the stimulation of an improvement in regard to school achievement by more

individualised and adapted educational methods [9]. Furthermore, educating a class where students have a similar achievement level has been seen as more efficient and less demanding for the teacher than educating a class with students with very heterogeneous achievement levels [10]. Although most experts agree that high-ability students tracked into a homogeneous high-ability group benefit from the tracking, considerable evidence has been brought that low-ability students tracked into a low-ability group do not [11,12,13], even if previous academic achievements and other individual student characteristics are controlled [14].

Becker and colleagues [2] investigated the effect of tracking in the German secondary school system and showed that students who attended an academic track achieved higher scores in an intelligence test than students who attended a vocational track, even though prior achievement and intelligence level were controlled. Becker and colleagues [2] attributed these differences to the higher educational quality of academic tracks, compared to vocational tracks. Comparing the growth rates of reading comprehension and decoding speed of academic-track students and vocational-track students, Retelsdorf, Becker, Köller and Möller [15] found similar growth rates for reading comprehension for both groups, but students who attended the academic track displayed larger growth rates for decoding speed.

1.2 The Situationin Luxembourg

In Luxembourg, students are oriented to an academic or a vocational track at the end of their last year of primary school (which is in 6^{th} grade). A binding tracking decision is made by a committee composed of school administrators, primary school teachers, and secondary school teachers. Main tracking criteria are previous school marks and results achieved in a standardised school achievement test [17]. However, previous research concerning the quality of the orientation decision taken by the committee indicated that non-achievement related student characteristics are also taken into consideration by the committee [5]. Immigrant students or students showing a rather low socioeconomic background are more likely to be oriented to the vocational track than to the academic track, even when their academic achievement is controlled for.

Students assigned to the academic track are supposed to attend it for the next seven years. The academic track ends with a final examination, and the obtained degree is seen as a higher education entrance qualification. Students who are allocated to the vocational track are expected to attend this track for the next three years. Thereafter, students are assigned to one of three branches of the vocational track, which are the “régime technique” (highest branch within the vocational track, 4-5 years), the “régime de la formation de technician” (medium branch within the vocational track, 4 years), or the “regime professional” (lowest branch within the vocational track, 3 years). The assignment to these branches depends on the students’ school marks and their aspirations to different occupations, since the different branches prepare students for different professions and qualifications [17].

Students with substantial school difficulties are oriented to the “regime preparatoire” at the end of primary school. This track consists of a special program which students can attend for the first three years of secondary school. The goal is to integrate students with severe learning difficulties back to the vocational track [17].

The importance of the orientation decision for students' further educational career is eminent, as it largely determines the degree a student will earn at the end of his or her school career. Only 5% of the students who are oriented to the academic track change to the vocational track during secondary school [18], even fewer change from the vocational to the academic track. Klapproth, Krolak-Schwerdt, Hörstermann and Schaltz [19] found the achievement level on the academic and the vocational track to be quite heterogeneous after the first two years of secondary school. In a standardised school achievement test at the beginning of the third year of secondary school, 21% of the students obtained scores more similar to students from the other track than to their peers from the same track. Thus, one could suspect that the low percentage of students changing from one school track to the other could be a consequence of an impermeable system. But changing the track is not the only opportunity students are given when they encounter difficulties at school. The repetition of a school year is a possibility for many students to compensate for lower achievements. Only 40.5% [20] of the students achieve a school degree without repeating at least once a school year. Another 30.3% achieved a degree up to two years later [20], meaning that they repeat at least twice during their school career, others take even longer, and about 20% leave school without obtaining a degree [20].

1.3 Research Questions and Hypotheses

The aims of the present work were (1) to investigate the effect of the attended school track on subsequent school achievement level, (2) and to test if the effect differed for previously higher and lower achieving students in particular. As all students in the Luxembourgish school system are administered with two standardised school achievement tests (in the last year of primary school and at the beginning of the third year of secondary school), the data of both tests granted an opportunity to compare school achievement of students before and after two years of following a tracked school system.

However, drawing a causal inference based on a simple comparison between test scores of students attending either an academic or a vocational track could lead to problematic conclusions as the assignment of the students to the different tracks was not randomized. To minimize potential biases due to the non-randomization in the present sample, we applied the method of propensity-score matching [21] which is often used by economists when making causal analyses [22]. Using this procedure, we were able to compare two groups of students who differed in relation to the track they attended during the first two years of secondary school, but not in regard to their mean prior school achievement level and their mean socioeconomic background, nor with respect to the distribution of age, gender, and nationality. Furthermore, propensity-score matching allowed us to focus on students whose orientation decision at the end of primary school could be questioned as at least one student with a very similar profile (the matching partner) was oriented to a different track. A comparison of these groups allowed us to investigate the average effect of attending the academic track compared to attending the vocational track for students who could have had, based on their profile, the same chance to attend the opposite track.

In line with previous empirical findings from other countries [2,14,15], we expected that students who attended the academic track achieved higher scores in a standardised school achievement test at the beginning of the third year of secondary school than their matched peers who attended the vocational track. Furthermore we expected the occurrence of an interaction between the attended track and previous school-achievement level. If the academic track is specifically adapted to high achieving students, previously higher achieving students attending the academic track should achieve higher scores in the

standardised school achievement test than their higher achieving matched peers attending the vocational track (see Fig. 1). These hypotheses should be valid for the subjects French, German and Mathematics.

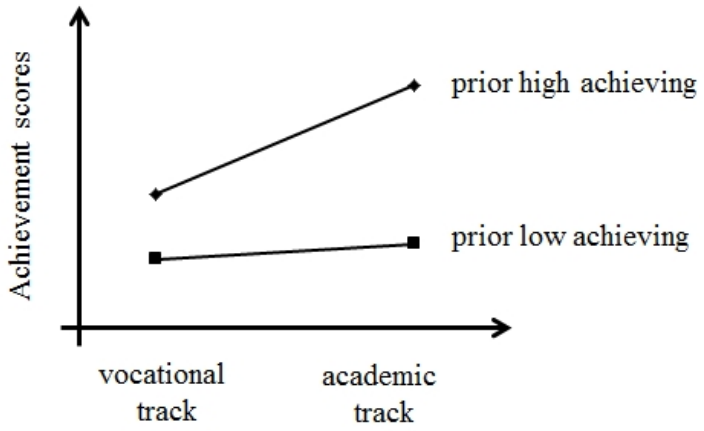

Fig. 1. Hypotheses of the study

2. METHODS

2.1 Sample

We analysed data of a cohort of students who attended the last year of Luxembourgish primary school in 2008/2009 (N = 3204). Data was provided by the Ministry of Education (Ministère de l' Education nationale et de la Formation professionnelle) and by the National School Monitoring [23,24].

As we aimed to compare students who attended either the academic or the vocational track in secondary school, we had to omit students who had changed the track during the first three years of secondary school (n=240), and students for whom information about the attended track during this time interval was missing (n=193). Furthermore, we omitted students who repeated at least one year of secondary school (n=304) during this period. Finally, as the “regime préparatoire” followed a special pedagogical concept, we excluded all students who attended this track (n=111) from our analyses.

This left a sample of n=2356 students who finally were examined. The distributions of the demographic data for the sample as well as for the whole cohort are displayed in Table 1. As the distributions of the whole cohort and of the sample were quite similar, the sample can be seen as representative for the cohort.

Table 1. Demographic data (gender and nationality as well as the track attended) of the full age-cohort of students and of the sample that was used for the analyses

		n	% sample (*n* =2356)	% cohort (*N* = 3204)
Gender	Girls	1210	51.4	50.3
	Boys	1146	48.6	49.7
Nationality	Luxembourgish	1599	67.9	64.5
	Portuguese	418	17.7	19.8
	German	20	0.9	0.9
	French	64	2.7	3.1
	Belgian	36	1.5	1.9
	Italian	46	2.0	2.0
	Other	173	7.3	7.8
Track	academic	1077	45.7	41.6
	vocational	1279	54.3	53.0
	"préperatoire"	/	/	5.4
Age	Mean (SD)		12.5 (0.5) years	12.6 (0.5) years
HISEI	Mean (SD)		49.87 (17.1)	51.41 (16.8)

2.2 Propensity Score Matching

As the assignment of the students to either the academic or the vocational track was not randomized, treatment effects could not be estimated by simple comparison of the mean achievements of the students in secondary school. Therefore, a causal inference from the treatment (academic versus vocational track) to the outcome (school achievement) could not be made, as other student characteristics could have affected the outcome.

Matching treated participants to similar non-treated participants is one approach to reduce the resulting differences due to confounding student characteristics if, like in observational studies, randomisation of participants is not possible [25]. Propensity-score matching allows for summarising a large number of pre-treatment characteristics of each participant into a single-index score [26]. This score (the propensity score) reflects the likelihood that a participant would be selected for the treatment group [27].

The actual matching of participants from the treatment group with participants from the control group is done after the propensity score for each individual is estimated. Caliendo and Kopeinig [25] presented an overview of different matching algorithms. Most commonly [27], matching algorithms match one participant from the treatment group to one participant from the control group based on the similarity of the estimated propensity scores. To control for the quality of the matching, the maximum distance allowed between the two propensity scores of a potential matching pair (the caliper value) is fixed by the researcher. A small caliper value ensures a high similarity of the propensity scores of the matched pairs, but reduces the number of possible matches as only very similar participants are matched. A successful matching should result in a sample of matched pairs which only differ in relation to the received treatment. All other in the estimation of the propensity score included variables should be balanced between the treatment and the control group.

The amount to which the bias due to confounding characteristics of participants is reduced by the propensity-score matching depends on the quality and quantity of the variables included in the matching procedure [26]. Caliendo and Kopeinig [25] stated that only variables that simultaneously influence the admission decision to the treatment and the outcome variables, but are unaffected by admission to the treatment, should be included. This could be ensured by measuring them before participation in the treatment [25]. Furthermore, the measurements of the variables should be the same for participants and non-participants [28]. Concerning the number of included variables, Bryson, Dorsett and Purdon [29] stated that an over-parameterisation should be avoided, as the inclusion of non-significant variables in the matching could increase their variance. Caliendo and Kopeinig [25] concluded that the choice of variables included in the model should be based on theoretical arguments and previous empirical findings.

2.3 Design of the Study

Taking the previously presented arguments into account, we decided to include student characteristics into the propensity-score matching that have been shown to influence on the one hand the orientation to the academic or the vocational track [30,31,32,33,5], and on the other hand school achievement in general [34,35]. Moreover, to ensure that the variables included were unaffected by the admission to the treatment, we chose only variables that had been measured prior to the tracking decisions. Finally, all quantitative variables that were included were measured by the same instruments.

We included the following variables into the propensity-score matching procedure: Mean school marks from the last year of primary school (6th grade) in French, German and Mathematics; mean scores from the standardised school achievement test (6th grade) in French, German and Mathematics; mean scores of the students' working and learning habits rated by the teachers in 6th grade; and the students' gender, age, nationality and socioeconomic background.

The propensity score was estimated by means of logistic regression analysis. Based on the propensity score, which indicates the probability for attending the academic track, the students of both tracks were matched. The estimation of the propensity scores as well as the matching procedure was done by using "psmatching" in SPSS, Version 19.0 [27]. For the matching procedure, students attending the academic track were matched to students attending the vocational track via nearest neighbour matching method with calliper [cf. 15]. The caliper, indicating the maximum distance between the propensity scores of two potential matches, was fixed at calp. = 0.08. At this maximum distance between the propensity-scores of matched pairs, all included variables were balanced between the two groups.

Using the method of propensity-score matching allowed us, in contrast to using a linear regression model, to compare students' performance after two years of being in a tracked system as if they would have been randomly selected for one of the two tracks. As previous research showed [cf. 5], prior achievement is not the only factor determining the tracking decision. Due to this finding, the matching sample contained both higher- and lower-achieving students who were oriented to both tracks. A distinction between prior achievement levels of these students could still be made in this sample, albeit the difference between prior higher- and lower-achieving students was reduced in the matching sample compared to the original sample.

Differences were examined by using a two-factorial between-subjects analysis of variance. Included factors were the track the students attended in secondary school (academic track versus vocational track) and prior school achievement (below versus above the median test scorein 6^{th} grade). To operationalise prior school achievement, a mean score of the standardised school achievement test administered at the end of primary school was calculated for each student of the matched sample. The students whose scores were above the median (Md = 0.3057) of the sample were assigned to the high-achievers group, and students scoring below the median were assigned to the low-achievers group.

2.4 Variables Included Into the Propensity-score Matching

School achievement at the end of primary school was measured by the students' school marks and results from three standardised school-achievement tests (German, French and Mathematics). School marks varied between 0 and 60, with values below 30 indicating insufficient achievements. School marks were recorded for the main subjects German, French, Mathematics. For each school subject, mean scores for all received school marks during the last year of primary school were calculated. Mean scores and standard deviations for the school grades as well as for the test scores are displayed in Table 2.

During the last year of primary school at the end of each trimester, students' working and learning habits were rated on 14 items by primary school teachers using a scale from 1 (rarely) to 4 (frequently). Cronbach's alpha of the entire scale varied between .92 and .93 for each trimester. The mean of the 3 x 14 items was entered into the propensity-score matching procedure as an indicator of students working and learning habits. The mean score and its standard deviation are displayed in Table 2.

Information about students' gender, age, nationality and socioeconomic background was provided by the Ministry of Education [24]. The distributions of the variables are displayed in Table 2.

Gender was included as a dichotomous variable into the matching procedure.

In regard to age, students were divided into two groups relative to their age: students who were born before September 1996 and students born in September 1996 or later. The date of September 1st as a cut-off date was chosen since in Luxembourg students born after that date traditionally start primary school one year later than students born before this date. The resulting variable was included as a dichotomous variable into the matching procedure.

Nationality was included as a categorical variable. Students were divided into three groups, which were Luxembourgish students, Portuguese students, and students from other nationalities. For the propensity-score matching procedure, two dummy variables (Luxembourgish versus Portuguese and others, and Portuguese versus Luxembourgish and others) were inserted as covariates.

Students' socioeconomic background was estimated as the families' Highest International Socioeconomic Index (HISEI) (cf. [36]), using information about the parent's professional situation. HISEI-values can range from 16 (e. g., cleaning worker) to 90 (e. g., judge). If information about the professional situation of both parents was available, the highest index of the family was included. The mean score and the standard deviation are displayed in Table 2.

School achievement at the beginning of the third year of attending a tracked school system was operationalized through the results of a standardised school achievement test that was administered to all students in 9th grade in secondary school. The subjects of this test were German, French and Mathematics. Although different versions of the test were administered depending on the different tracks, common scales of the versions were established according to item response theory. Results from each test subject were transformed to standardised test scores, with a mean score of M = 500 and a standard deviation of SD = 100. Mean scores and standard deviations are displayed in Table 2.

Table 2. Variables used for propensity score matching, collected at the end of primary school (6th grade)

		Initially missing values	**Academic track (*n* = 1077)**	**Vocational track (*n* = 1279)**	χ^2	***P***	***phi***
Gender	Girls	0%	576	634	3.58	.06	-.04
	Boys	0%	501	645			
Age	before 1996	0%	1054	348	277.04	<.001	.34
	1996 or later	0%	23	931			
Nat.	Lux.	0%	864	735	177.93	<.001	.27
	Port.	0%	75	343			
	Other	0%	138	201			
			M (SD)	**M (SD)**	**t**	**P**	**d**
HISEI		66.6%	58.38 (14.40)	42.70 (15.87)	25.12	<.001	1.04
School grades	French	10.3%	51.80 (3.59)	41.99 (6.11)	48.30	<.001	2.02
	German	10.3%	52.99 (3.56)	43.27 (6.03)	48.44	<.001	2.03
	Math.	10.2%	52.68 (4.76)	40.62 (7.70)	46.39	<.001	1.93
Stand. Test scores	French	11.4%	0.70 (.56)	-0.27 (.67)	38.341	<.001	1.58
	German	11.2%	0.77 (.48)	-0.24 (.65)	43.34	<.001	1.79
	Math.	11.2%	0.88 (.64)	-0.30 (.69)	42.488	<.001	1.77
Learning behaviour		11.6%	3.80 (.26)	3.41 (.48)	24.88	<.001	1.05

2.5 Missing Data

To avoid losing potential matching pairs due to missing values, missing values were replaced by multiple imputation using the software NORM (Version 2.03; [37]. As multiple imputation seems to be able to generate reliable results even if a significant amount of data is missing [38], we decided to also replace missing values for the variable “HISEI” although more than 60% of the data were missing (cf. [5]). Table 2 displays the percentages of missing values the variables initially entailed. The means and standard deviations displayed in Table 2 were calculated after the missing values were replaced by imputed values.

3. RESULTS

3.1 Propensity Score Matching

All variables which were included into the propensity-score matching procedure were collected at the end of primary school in 6th grade. The included variables as well as their

descriptive statistics are displayed in Table 3. Moreover, Table 3 shows inferential statistics with respect to the differences between students of the vocational and the academic track.

Prior to propensity-score matching, we tested all included variables for significant differences between students of the two tracks. The results of χ^2-tests showed that the distribution of students' age and nationality differed significantly between the academic and the vocational track. Students who were oriented to the academic track were on average born later than students oriented to the vocational track. With respect to students' nationality, more Luxembourgish students were oriented to the academic track than to the vocational track, whereas more Portuguese students and students from other nationalities were oriented to the vocational track than to the academic track. Although the test did not reach significance in regard to the distribution of students' gender, a trend indicated that more girls than boys were oriented to the academic track. Moreover, the mean HISEI of students oriented to the academic track was significantly higher than the mean HISEI of students oriented to the vocational track.

With respect to variables related to school achievement, t-tests showed significant differences between students from the different tracks. Students attending the academic track showed significantly higher school marks and test scores than students assigned to the vocational track.

The propensity-score matching procedure, applying nearest neighbour matching with caliper, resulted in 145 matched student pairs. The means and distributions of the included variables are shown in Table 4. After the matching procedure, the distribution of gender, age, and nationality as well as the means regarding the socioeconomic background (HISEI) and prior school-achievement variables did not significantly differ in the matching sample.

Table 3. Variables used for propensity score matching after the matching procedure

		Academic track (*n* = 145)	**Vocational track (*n* = 145)**	χ^2	***P***	***phi***
		n	n			
Gender	Girls	71	72	0.01	.91	.01
	Boys	74	73			
Age	before 1996	137	138	0.07	.79	-.02
	1996 or later	8	7			
Nationality	Lux.	108	104	0.31	.86	.03
	Port.	21	24			
	Other	16	17			
		M (SD)	**M (SD)**	**t**	**P**	**d**
HISEI		52.45 (15.38)	52.22 (15.73)	1.20	.23	0.01
School grades	French	48.28 (4.06)	47.78 (3.49)	1.12	.26	0.13
	German	49.59 (3.97)	49.16 (3.49)	0.98	.33	0.11
	Math.	48.12 (5.48)	47.78 (5.30)	0.94	.59	0.06
Stand. test scores	French	0.27 (.56)	0.21 (.52)	0.81	.42	0.11
	German	0.39 (.54)	0.33 (.46)	0.87	.39	0.12
	Math.	0.36 (.63)	0.28 (.56)	1.17	.24	0.13
Learning behaviour		3.74 (.28)	3.69 (.31)	1.58	.15	0.17
Propensity score		.51 (.29)	.49 (.28)	0.58	.56	0.07

3.2 The Effect of Tracking, Estimated after Propensity-score Matching

Descriptive results (see Table 4) indicate that students who were classified as prior high-achieving students had on average higher scores in all three standardised achievement tests (French, German and Mathematics) than their peers from the prior low-achieving group. With regard to the attended track, students who attended the academic track achieved higher test scores in French and German than their peers who attended the vocational track. This was true for both the prior high- and low-achieving groups. However, in Mathematics, students from the prior low-achieving group who attended the vocational track achieved higher test scores than their prior low-achieving peers who attended the academic track.

To estimate the effects of tracking and prior achievement level, we conducted two-factorial between-subjects analyses of variance for each school subject (French, German and Mathematics) separately. Included factors were the track the students attended in secondary school, and prior school achievement level. In regard to the subject French, results indicated a main effect for track, $F(1, 286) = 8.91$, $P < .001$, $\eta^2 = .03$, and a main effect for prior school-achievement, $F(1, 286) = 5.20$, $P = .02$, $\eta^2 = .02$. The interaction was not significant, $F(1, 286) = 1.28$, $P = .26$. For the subject German, both the effect for track, $F(1,286) = 5.79$, $P = .02$, $\eta^2 = .02$, and for prior school-achievement level, $F(1, 286) = 19.63$, $P < .001$, $\eta^2 = .06$ were significant, but the interaction was not, $F(1, 286) = .885$, $P = .35$. For the subject Mathematic, the main effect for prior school-achievement level, $F(1, 286) = 14.54$, $P < .001$, $\eta^2 = .05$, was significant, but the main effect for track, $F(1, 286) = 0.14$, $P = .712$, and the interaction, $F(1, 286) = 2.225$, $P = .137$, were not.

Table 4. Mean scores (and standard deviations) of the standardised school achievement test at the beginning of the third year of secondary school after the propensity matching procedure, separated for students of different tracks and different levels of prior school achievement

		n		Academic track 145	Vocational track 145
				M (SD)	***M (SD)***
Prior school achievement	Low	145	French	527.1 (70.1)	510.8 (75.4)
			German	531.6 (64.1)	519.7 (70.5)
			Math.	516.8 (64.4)	535.0 (77.3)
	High	145	French	557.4 (85.8)	520.9 (68.4)
			German	575.2 (72.6)	548.0 (68.5)
			Math.	568.6 (95.2)	557.6 (91.9)

To summarise, we found significant main effects of prior school-achievement level for the school subjects French, German, and Mathematics. Main effects of track level were found for the subjects French and German, but not for Mathematics. No significant interactions could be found. However, students from the prior low-achievement group who attended the vocational track achieved higher scores than their previously low-achieving peers who attended the academic track. Yet, the difference was not significant.

4. DISCUSSION AND CONCLUSION

The aim of the present study was to compare school achievement of students who attended an academic track with the achievement of students who attended a vocational track for two years. We assumed that students who attended the academic track would on average achieve higher scores in a standardised school-achievement test than their peers attending the vocational track. Since students who show high school-achievements in primary school are in general oriented to the academic track, whereas students showing rather low school-achievements are usually oriented to the vocational track, educational methods should have been adapted to the needs of students of different tracks. However, some students with rather low achievements in primary school may have been assigned to the academic track, whereas others with rather high achievements in primary school may nevertheless attend the vocational track (see, for example, [5]. If this were the case, we expected an interaction to occur between the attended track and students' prior school achievements. Low achieving students in primary school who were oriented to the vocational track should perform equally as or better than prior high achieving students oriented to the vocational track.

As students were not randomly assigned to the different tracks, confounding variables that were not related to students' achievements had to be controlled for. To reduce potential biases due to confounding variables, we performed a propensity-score matching [21]. The matching of students who attended the academic track to those who attended the vocational track was based on their propensity score and resulted in a sample of 290 students who did not significantly differ in relation to their school grades and test scores in primary school, and in relation to age, gender, nationality and socioeconomic background.

Results showed that, after attending the Luxembourgish secondary school system with hierarchical tracks for two years, students who attended the academic track achieved significantly higher scores in a standardised school-achievement test in the subjects French and German, but not in Mathematics. The test scores in Mathematics did not differ significantly between students attending the academic track and those attending the vocational track. However, no interaction between the attended track and prior school-achievement could be found. Prior high-achieving students also achieved higher scores than prior low-achieving students in all three subjects, regardless of the track.

In regard to the main effects of tracking, our findings were congruent with previous findings [11,9,10]. Furthermore, our results point in a similar direction as the findings from Becker and colleagues [2] and Retelsdorf and colleagues [15] who found that students who attended an academic track achieved higher scores in an intelligence test or showed higher growth rates of reading comprehension compared to their peers who attended a vocational track. Thus, students who attend an academic track seem to benefit from attending this track even if previous achievement levels and other student characteristics were controlled for. Different researchers have argued that tracking students based on their prior achievement level prevents lower achieving students to interact with higher achieving peers and to see them as a role model [e.g. 39]. Others have argued that students who attend a vocational track would be confronted to a poorer learning environment, less experienced teachers, and to less demanding but also less motivating curricula [e.g. 40,41,3]. This might explain why students attending a vocational track would benefit less from their time at school than their peers. Hattie [42] (p.464) pointed to the same direction when he stated that those students who attend vocational tracks could achieve a higher school achievement level if the educational quality of these tracks would be improved.

However, we did not find this effect for the subject Mathematics. One could argue that the educational content of the vocational track is more technically orientated, whereas the educational content of the academic track is more focused on languages. If so, this could explain why students attending the academic track achieved higher scores in French and German, but not in Mathematics, which is a more technical subject. Klapproth and colleagues [5] found that the school marks students achieve in the subject French in the last year of primary school is, compared to other school achievement variables, the strongest predictor for an orientation to the academic track. This could underline the assumption that teachers may believe that the academic track is best suited for students with high achievement levels in languages while the vocational track may be more appropriate for students less talented in languages or more interested in technology.

Our assumption about an interaction between the attended track and prior school-achievement could not be confirmed. In fact, students who attended the academic track achieved higher scores in German and French than students who attended the vocational track. This was true for all students regardless of their prior achievement level.

The propensity-score matching procedure we used, with nearest neighbour matching with caliper, resulted in a sample of students whose prior school-achievement level was, compared to the achievement level of the whole cohort, close to the average achievement level of the cohort. Hence, the matching sample did not include students with a very low or very high prior achievement level. The vast majority of students with very low or very high prior school-achievements were oriented to the vocational or to the academic track, respectively. Therefore, we did not find suitable matching partners for these students on the opposite track, so that they were not part of the matching sample. Thus, the variance of prior school-achievement in the matching sample was artificially reduced, and we can therefore not exclude the possibility that an interaction between prior school-achievement and the attended track might have occurred if the variance between high- and low-achieving students had been larger.

The latter argument points to the most important limitation of the present study. Since the matching sample only contained students with average prior school-achievement, we do not know if students with very low levels of achievement in primary school would also benefit from attending the academic track, or instead be more successful when attending the vocational track.

Taking the previous limitations into consideration, further research should focus on the question whether a significant interaction between school achievement level prior to the tracking and the attended track could be found, if the variance of prior school achievement level in the sample is larger than in the present study, e.g. if students with very low and very high prior achievement levels are included in the sample.

In summary, we found that students who attended an academic track for two years achieved higher scores in a standardised school achievement test in the subjects' German and French than students with similar prior achievement levels who attended a vocational track. However, we could not find an interaction between prior school achievement and the attended track level.

ACKNOWLEDGEMENTS

This study was supported by grant FNR/C11/LM/1201911 from the Fonds National de la Recherche Luxembourg.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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