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Understanding subject choices from report card grades: gender and educational level disparities

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ABSTRACT

Pupils' subject choices at the level of secondary education critically determine the tertiary fields of study that they can pursue. This study used multinomial logistic regression models to investigate the extent to which the final report card grades of ninth-grade students predicted their choices of subject combinations at the senior general secondary education ($N = 771$) and pre-university education ($N = 494$) levels. Final report card grades determined 55.4% to 64.1% of the pupils' choices. The most relevant predictors were pupils' grades for mathematics, history, economics, physics, chemistry, and English language. Differential and interaction effects of educational level and gender were evident. For example, at the level of senior general education, mathematics and chemistry were stronger influencers of the choices of girls than of boys, whereas at the pre-university education level, these subjects were stronger influencers for boys than for girls.

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Introduction

Within secondary education, pupils' choices of subjects critically impact their future careers (Korpershoek 2011; Korpershoek et al. 2013). Pupils' subject choices may either facilitate or constrain certain tertiary education options (Hipkins and Vaughan 2019; Iannelli and Duta 2018). If they fail to select the required combination of subjects for admission in tertiary education, they may be barred from enrolling in their desired tertiary educational programme. Furthermore, non-optimal study programme choices may have negative effects on society, as high rates of transfer between tertiary education programmes entail resource consumption and may pose a financial burden. Moreover, given expected shortages of employees trained in the science, technology, engineering, and mathematics (STEM), health care, and education fields (Bakens et al. 2019), it is important that more pupils choose subjects and study programmes in these fields. Girls' untapped potential to contribute to STEM fields highlights the need for particular attention to be paid to gender differences in decision making relating to pupils' academic achievements (Korpershoek 2011). The existing gender gap in participation in STEM

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career paths is substantial, which is of concern both from an economic perspective relating to labour-market shortages and from a societal perspective of gender equity. The relationship between students' cognitive abilities and their educational choices has been extensively studied (e.g. Bergeron and Gordon 2017; Korpershoek et al. 2011; Päßler and Hell 2012; Porter and Umbach 2006; Shea, Lubinski, and Benbow 2001; van Langen, Rekers-Mombarg, and Dekkers 2006; Wai, Lubinski, and Benbow 2009). Domain-specific abilities have been shown to be significant predictors of choices regarding students' educational pathways (Jonsson 1999; Uerz, Dekkers, and Beguin 2004; Volodina and Nagy 2016). For example, students with higher verbal ability more often choose an educational pathway in the social sciences, whereas students with higher mathematical and spatial abilities more often choose educational pathways in the so-called STEM (Science, Technology, Engineering, and Mathematics) fields (Päßler and Hell 2012). Moreover, students with a comparative advantage in mathematics compared to their performance in language courses choose more science subjects than students with more equally distributed skills, in addition to the predictive value of mathematics ability (Uerz, Dekkers, and Beguin 2004).

The present study aimed to examine the importance of report card grades as a factor explaining subject choices and to advance understanding of gender-based differences and differences in educational level in subject choices. To the best of our knowledge, the direct relationship between a wide range of grades in report cards and subject choices has not been previously investigated. Furthermore, the existing literature either focused on rather broad ability domains (e.g. verbal abilities), a small number of ability categories (e.g. only mathematics ability), or on specific career paths (e.g. STEM versus non-STEM career trajectories). By investigating (grades of) a wide range of subjects as individual predictors of students' subject choices, and interactions between gender and educational level, one the one hand, and report card grades, on the other hand, the current study provides insights on the relationship between students' cognitive abilities and their educational choices at a finer level of granularity than the existing literature.

The present study used data on Dutch secondary education pupils, to investigate the relationship between subject choices and report card grades. The overview of the Dutch secondary education system presented below elucidates the context of this study.

The Dutch educational system comprises three levels of secondary education: pre-vocational, senior general secondary (preparing for higher professional education), and pre-university (preparing for university) education. The current study focused on pupils enrolled in senior general secondary and pre-university education. Approximately 50% of Dutch secondary school students are enrolled in these two tracks. In the ninth grade, pupils need to choose subjects for their upper secondary education programmes. Certain subjects like Dutch and English as well as physical education are required for all pupils. Furthermore, pupils are obliged to take a second foreign language (usually German or French). In addition, pupils choose one or two of the following study profiles entailing fixed combinations of subjects: culture and society (CULT), economics and society (ECON), science and health (HEAL), and science and technology (TECH). Each study profile prepares pupils for certain fields of study within tertiary education. All study profiles have compulsory components. Thus, both history and mathematics are mandatory for CULT and ECON at the pre-university education level, and economics is compulsory for ECON pupils. Chemistry and mathematics are both obligatory for

HEAL and TECH profiles. In addition, biology and physics are compulsory subjects for HEAL and TECH, respectively. TECH also includes advanced mathematics. For other study profiles, at least basic-level mathematics should be selected. The study profiles and associated requirements at the senior general education level are similar; however, mathematics is not mandatory for the CULT profile. Along with mandatory subjects, pupils choose one or two optional subjects related to their study profiles along with one other optional subject. In the final year of secondary education (11th grade for senior secondary education and 12th grade for pre-university education), all pupils take their final school examinations in their selected subjects.

Despite their importance in shaping pupils' tertiary education options and future careers, Dutch pupils' subject choices have not been subjected to comprehensive investigations (Korpershoek et al. 2013). A few Dutch studies have shown, for example, that the science profiles, namely, HEAL and TECH, are more often selected by boys (compared with girls), pre-university students (compared with senior general students), pupils of high socio-economic status, and pupils who are proficient at mathematics (van Langen, Rekers-Mombarg, and Dekkers 2006). Furthermore, pupils tend to take their parents' views and the study profile selected by their close friends into consideration (Broekema and Habraken 2012; van Langen and Vierke 2009). Their choices are also guided by their own interests and aspirations (Broekema and Habraken 2012; Rekers-Mombarg et al. 2010).

Boys and girls tend to pick different subjects, resulting in significant gender imbalances in subject choices (Jeffries, Curtis, and Conner 2020; Korpershoek, Guntern, and van der Werf 2014; Uerz, Dekkers, and Beguin 2004; van Langen, Rekers-Mombarg, and Dekkers 2006). In 2020, 7.0% of the senior general boys chose CULT, versus 23.0% of the senior general girls. For pre-university education, 7.7% of the pre-university boys chose CULT, versus 16.7% of the pre-university boys (Centraal Bureau voor de Statistiek n.d.). Several studies have investigated gender imbalances in study choices within tertiary education, which are strongly associated with subject choices within secondary education. Gender differences in attitudes and in socialisation processes have been shown to impact on gender differences in career aspirations (Hyde et al. 2017; Johnson, Stone, and Phillips 2008; Korpershoek, Guntern, and van der Werf 2014; Papastergiou 2008; Raabe, Boda, and Stadtfeld 2019; Sáinz and López-Sáez 2010). Furthermore, gender stereotype endorsement may impact performance levels and students' self-esteem. For example, Schmader et al. (2004) found that gender stereotype endorsement in women's math experiences resulted in lower performance and lower self-esteem in the math domain.

The impact of grades appears to differ among boys and girls within secondary education (Huang, Zhang, and Hudson 2019). The relationship between academic achievement, academic interests and self-concept of academic ability tends to be stronger for boys than for girls (Denissen, Zarrett, and Eccles 2007). In turn, interests and self-concept of ability appear to be predictive of subject choices (Broekema and Habraken 2012; Larose et al. 2006; Rekers-Mombarg et al. 2010). Van der Vleuten et al. (2016) reported that a preference for the TECH profile among boys is more strongly determined by their self-perceptions of proficiency in mathematics than is the case among girls. By contrast, self-perceptions of low levels of verbal competence among girls often lead them to choose the TECH profile. These findings are indicative of the differential effects of gender in predicting subject choices using report cards. However, girls seem to be more

sensitive to the implications of low grades when considering their subject choices (Goldin 2013; Ost 2010; Rask and Tiefenthaler 2008; Sanabria and Penner 2017).

Pupils may use their grades for each subject recorded in their report cards as indicators to select a combination of subjects that fits their capacities. Throughout the school year, Dutch pupils receive grades for different tests and assignments (Peetsma et al. 2005; Wijsman et al. 2016). All of the grades issued in a subject are compiled a couple of times per school year to determine the pupils' performance levels. These average grades are typically communicated to pupils through report cards. Report card grades determine whether a pupil advances to the next grade at the end of the year. If a pupil's grades fall below predetermined acceptance levels, they are usually advised to switch to a lower educational level, or they are forced to repeat the same school grade. Furthermore, report card grades may help pupils to obtain insights into their performance level for each subject. Moreover, school counsellors and teachers tend to base their subject choice recommendations on the report card grades of students (Wichgers et al. 2022).

The mandatory subjects for the four study profiles differ slightly at the senior general and pre-university levels, possibly leading to different relationships with subject choices. For example, unlike pre-university students, senior general level students who choose the CULT profile do not have to take mathematics. Furthermore, admission to universities (after pre-university education) is more restricted by the selected subjects compared with admission to higher professional education (after senior general secondary education). TECH and HEAL study profiles provide more options for pre-university students than they do for senior general students.

The present study investigated whether and to what extent subject choices in the Netherlands could be predicted from end-of-year report card grades of most subjects in the ninth grade. In addition, the differential effects of educational level and gender were investigated. The results of this study provide insights into the role of report card grades regarding subject choices and advance understanding of gender differences as they impact on subject choices. The current study adds to the existing body of knowledge by investigating a wide range of subjects as individual predictors of students' subject choices, and interactions between the gender and educational level, one the one hand, and report card grades, on the other hand. Schools take report card grades into account when advising pupils on their subject choices (Wichgers et al. 2022). Insights into the differential impacts of grades on boys and girls, and on pre-university and senior general students, could help student counsellors and teachers to differentiate between pupils and thereby serve their needs.

Research questions

The research questions addressed in this study were as follows:

(1) To what extent can subject choices (clustered by study profile) at the secondary education level be predicted from end-of-the-year report card grades in the ninth grade?
(2) Which report card grades are the strongest predictors for each of the four study profiles (TECH, HEAL, ECON, and CULT)?
(3) To what extent are differential effects apparent for educational level (senior general level and pre-university level) and gender?

Hypotheses

We hypothesised that the end-of-year report card grades for mathematics and economics would be significant predictors of subject choices (Denissen, Zarrett, and Eccles 2007; van Langen, Rekers-Mombarg, and Dekkers 2006). van Langen et al. (2006) found that pupils who achieved high grades for mathematics chose TECH or HEAL profiles significantly more often than they did CULT or ECON profiles. They also found that teachers' recommendations indicating whether pupils were sufficiently competent to pursue economics at the level of upper secondary education significantly predicted a choice of CULT or ECON over TECH or HEAL profiles. Denissen et al. (2007) found an overlap between academic achievement and interest in school subjects. They also found a high degree of overlap between the self-concept of ability and academic achievement. A positive self-concept strengthens a pupil's career aspirations relating to a specific field, increasing their confidence about their career choice and leading to greater commitment to their studies (Larose et al. 2006; Schmader, Johns, and Barquissau 2004). This may also lead to greater certainty and persistence in the pursuit of subject choices. There have been some changes in the content of study profiles since van Langen et al. conducted their study (Centraal Bureau voor de Statistiek 2010). The most important change was that in the HEAL profile physics was no longer mandatory, and advanced mathematics was replaced by basic mathematics. Therefore, it is unclear whether the findings of van Langen et al. still apply. Furthermore, it seemed reasonable to expect that at least the proficiency in some mandatory subjects of study profiles (e.g. chemistry, mathematics, biology, history, economics, modern foreign languages) will be important predictors of students' subject choices. However, for many mandatory subjects this importance has not been previously studied: van Langen et al. (2006) only considered mathematics, English language, and the mean report card grades for both modern foreign languages and STEM subjects. In studies presented earlier, performance in mathematics and language domains are generally used to predict students' subject choices (using either report card grades or independent performance tests).

We expected to find at least some differences between the tracks based on differences in the content of study profiles and different admission guidelines for university education (after pre-university) and higher professional education (after senior general education). We expected the impact of report card grades on subject choices to be differentiated by gender in at least some respects. Because the literature shows inconsistent findings for gender differences in the relationship between grades and subject and career choices, we did not postulate a specific hypothesis regarding educational level and gender.

Materials and methods

Sample

A stratified sampling design was used. The target population consists of senior general and pre-university students in ninth grade. We aimed for a heterogeneous group of schools in terms of size, urbanity, and denomination. This resulted in a sample of eight Dutch secondary schools. The participating schools were primarily located in the north and east of the Netherlands and broadly represent the Dutch student population as they included all educational levels in a mixture of urban and rural regions.

We used the data of all pupils that were in their final year of secondary education in the school year 2018–2019. The data of nine students were not used, because the students or their parents did not give permission to use the data. This resulted in a sample of 771 senior general students (56.0% girls) and 494 pre-university students (58.7% girls) Table 1 shows in which school years the participating pupils attended ninth grade.

Measures

The dependent variable was the study profile chosen at the end of ninth grade. Pupils can combine different study profiles by choosing specific subjects in the optional part, and some pupils selected more than one study profile. Categories with small frequencies are hard to predict in a statistical analysis. Therefore, pupils who picked both CULT and ECON (14 senior general and 20 pre-university students) were merged with pupils who chose only ECON, pupils who picked both HEAL and TECH (53 senior general and 73 pre-university students) were merged with pupils who chose only TECH, and the pre-university pupil who chose both CULT and HEAL was merged with pupils who chose only HEAL. These choices were based on assignment of pupils to the most STEM-oriented study profile, which offers them the most study options in tertiary education (Korpershoek 2011; Korpershoek, Kuyper, and van der Werf 2008). The final dependent variable was a nominal variable with four categories: CULT, ECON, HEAL, and TECH. Table 2 shows the numbers and percentages of pupils who chose the different study profiles, separated for educational level and gender. We compared these percentages with the national percentages of the respective school years (Centraal Bureau voor de Statistiek, n.d.). We found that the sample was quite representative for the population, with deviations from the national percentages ranging from 0.1% to 5.9%.

The predictors were the end-of-the-year report card grades that the pupils received for various subjects in ninth grade. End-of-the-year report card grades are composed of the grades for all tests that pupils take in a particular school year for a subject. Report card grades range between 1 (*extremely poor*) and 10 (*outstanding*): grades below 5.5 are considered insufficient (i.e. not passing), whereas a grade of 5.5 (usually rounded to 6) or higher is considered sufficient (i.e. passing). For the pupils who attended ninth grade twice, we used their most recent report card grades. All the obligatory subjects of the study profiles were included in this study: that is, Dutch and English language, mathematics, history, economics, biology, physics, and chemistry. We included German and French, too, since pupils must pick one of these in every study profile. We also included geography since this subject is widely offered and was among the optional subjects selected for all study profiles except TECH. Table 3 shows the percentage of

Table 1. When participants attended ninth grade.

School year	Senior general students	Pre-university students
2013–2014	0	1
2014–2015	30[a]	40
2015–2016	136[a]	453
2016–2017	622	0

[a]Seventeen senior general students attended ninth grade in both 2014–2015 and 2015–2016.

Table 2. Numbers and percentages of subject choices for senior general and pre-university students.

	Senior general students (n = 771)		Pre-university students (n = 494)	
	Boys (n = 339)	Girls (n = 432)	Boys (n = 204)	Girls (n = 290)
CULT	15 (5.0%)	69 (16.0%)	13 (6.4%)	46 (15.9%)
ECON	168 (49.6%)	178 (41.2%)	74 (36.3%)	82 (28.3%)
HEAL	63 (18.6%)	144 (33.3%)	29 (14.2%)	90 (31.0%)
TECH	91 (26.8%)	41 (9.5%)	88 (43.1%)	72 (24.8%)

Table 3. Percentage of missing data per subject.

	Senior general students (n = 771)		Pre-university students (n = 494)	
	Boys (n = 339)	Girls (n = 432)	Boys (n = 204)	Girls (n = 290)
Dutch language	0.0	0.0	0.0	0.0
English language	0.0	0.5	0.0	0.0
German language	1.5	0.5	0.5	0.7
French language	7.1	5.3	0.5	0.0
Mathematics	0.0	0.0	0.0	0.0
History	2.7	3.7	0.0	0.3
Economics	5.9	5.8	0.0	0.7
Biology	50.7	50.5	67.2	73.8
Physics	4.4	7.4	15.7	10.7
Chemistry	4.4	6.9	2.0	2.4
Geography	2.7	2.3	0.5	0.0

missing data per subject. There were no missing values for the dependent variable (the chosen study profile), and the report card grades for Dutch and English languages, and mathematics.

Procedures

The current study was part of the research project Flow-vo project at the University of Groningen. The data collection procedures were in accordance with the General Data Protection Regulation (GDPR) and were approved by the ethical committee of the Faculty of Behavioural and Social Sciences. The administration of the tests and assignments was the responsibility of the schools, as it was part of their regular testing schedule. Participating schools were asked for permission to use the ninth-grade report card grades of pupils who were in their final school year in 2018–2019. End-of-the-year report card grades were collected from the school records. To gather the data, the researchers either went to the schools to derive the data on the spot, or the school sent the encrypted data to the researchers.

Analysis

As the school subjects offered in ninth grade differed slightly across the participating schools, not all pupils took the same subjects in ninth grade. For example, biology was not

part of the ninth-grade curriculum of many schools in the sample. Since our statistical analyses required complete data, the missing data of the variables in Table 3 were imputed using the mice package (Version 3.8.0; van Buuren and Groothuis-Oudshoorn 2011) in R. Predictive mean matching was used, which is the default method in the mice package for continuous variables. For senior general boys, senior general girls, pre-university boys, and pre-university girls, five imputed datasets were created (multiple imputation).

To investigate the data, multinomial logistic regression analyses were used. Separate analyses were performed for senior general boys, senior general girls, pre-university boys, and pre-university girls, followed by a qualitative comparison of similarities and differences between the four groups. The multinomial logistic regression analyses were performed using SPSS (Version 26). The number of schools ($n = 8$) was too small to take the school level into account in the analyses (Snijders and Bosker 2012).

To assess the contributions of individual predictors (grades for individual subjects), SPSS provides a chi-square statistic for each imputed dataset. The R function micombine.chisquare from the miceadds package (Version 3.10–28; Robitzsch, Grund, and Hencke 2020) was used to combine the chi-square statistics. The pooled test is the D2 statistic for pooling test statistics across multiple imputations (Li et al. 1991), which is *F*-distributed. To assess the overall performance of the regression models, the pooled classification tables of the actual versus the predicted study profile choices were used. To assess the effect sizes of, and to interpret, the significant predictors, pairwise odds ratios between all study profiles were considered for each significant predictor. The pooled odds ratios were obtained using logarithmic and exponential transformations.

For the interpretation of the odds ratios, we considered it more informative to look at effect sizes, that is, the sizes of the odds ratios, using the interpretation of Ferguson (2009): an odds ratio (OR) of 2.0 is the recommended minimum effect size representing a 'practically' significant effect, 3.0 is a moderate effect, and 4.0 is a strong effect. Nevertheless, the difference between two odds ratios can be tested by considering the ratio between (a) the absolute value of the difference between two log ORs and (b) the standard error of this difference (Higgins et al. 2021, Chapter 6). For the majority of the log ORs in this study, the corresponding standard errors lay between .20 and .40. If both standard errors are equal to .20, the difference between $OR1 = 1$ and $OR2 = 1.8$ and the difference between $OR1 = 2$ and $OR2 = 3.5$ are significant at the 5% level that is commonly used in statistical hypothesis testing. Furthermore, if both standard errors are equal to .40, then both the difference between $OR1 = 1$ and $OR2 = 3.1$ and the difference between $OR1 = 2$ and $OR2 = 6.2$ are significant at the 5% level. We used a significance level of .05 for all statistical tests, and all effects were tested two-sided.

Results

Descriptive statistics

Table 4 shows the means and standard deviations of the report card grades for senior general and pre-university boys and girls. On average, girls tend to have higher report card grades than boys, and pre-university students tend to have higher report card grades than senior general students. The exception is the grade for economics. For both senior general and pre-university students, this grade is slightly higher for boys than for girls.

Senior general students

Table 5 presents the F tests for the predictors of the multinomial logistic regression models for the senior general students. Columns 2–4 correspond to the senior general boys' model; Columns 5–7 correspond to the model for senior general girls. The two models have four significant predictors of the study profile in common: the grades for mathematics ($p = .016$; $p < .001$), history ($p = .023$; $p = .014$), physics ($p = .008$; $p = .003$), and chemistry ($p = .005$; $p < .001$). In the senior general girls' model, economics ($p < .001$) is an additional significant predictor. The pooled overall correct classification rate is 59.4% for the senior general boys' model and 55.4% for the senior general girls' model.

Table 6 gives the pooled odds ratios associated with the significant predictors of the two senior general level models. The columns of Table 6 represent the reference (or second) categories for the odds ratio. Each sub-table of Table 6 contains both the odds ratio of picking one study profile over the other, and the other way around.

The left part of Table 6 presents the pooled odds ratios for the significant predictors of the senior general boys' model. Two effects associated with the grade for mathematics are

Table 4. Average grade (and SD) for all subjects for senior general and pre-university boys and girls.

	Senior general students (n = 771)		Pre-university students (n = 494)	
	Boys (n = 339)	Girls (n = 432)	Boys (n = 204)	Girls (n = 290)
Dutch language	6.3 (.62)	6.7 (.60)	6.6 (.65)	7.2 (.63)
English language	6.6 (.83)	6.8 (.89)	7.0 (.77)	7.2 (.87)
German language	6.4 (.85)	6.7 (.77)	6.8 (.87)	7.3 (.86)
French language	6.3 (.93)	6.8 (.93)	6.6 (1.02)	7.4 (.91)
Mathematics	6.4 (1.00)	6.6 (1.00)	7.0 (.98)	7.2 (1.03)
History	6.5 (.71)	6.6 (.73)	7.0 (.77)	7.0 (.70)
Economics	6.6 (.74)	6.5 (.83)	7.1 (.82)	7.0 (.85)
Biology	6.6 (.70)	6.8 (.73)	7.1 (.77)	7.2 (.74)
Physics	6.4 (.80)	6.5 (.85)	6.9 (.87)	6.9 (.94)
Chemistry	6.5 (.79)	6.6 (.87)	7.1 (.93)	7.2 (.94)
Geography	6.6 (.71)	6.6 (.71)	6.9 (.69)	7.1 (.72)

Table 5. F tests per predictor (grades for subjects) for the senior general level multinomial logistic regression models.

	Senior general boys' model			Senior general girls' model		
Predictor	F value	$df2$	p value	F value	$df2$	p value
Constant	2.14	592.01	.095	3.37	264.96	.019
Dutch language	0.68	1982.94	.564	2.44	38230.93	.063
English language	1.72	589.22	.162	0.17	23787.89	.918
German language	2.59	74.06	.060	0.57	2252.38	.637
French language	0.01	45.31	.998	1.76	173.20	.157
Mathematics*	3.44	2677.09	.016	10.03	165.71	<.001
History*	3.20	1977.55	.023	3.63	242.55	.014
Economics*	1.14	360.11	.334	7.04	498.96	<.001
Biology	0.68	9.17	.587	0.15	13.05	.929
Physics*	4.22	74.72	.008	4.74	272.12	.003
Chemistry*	4.34	333.30	.005	7.16	295.44	<.001
Geography	1.00	2072.06	.413	0.18	114.69	.913

For the F statistic, the first number of degrees of freedom is $df1 = 3$ in each case.
*Significant at $p < .05$ for at least one of the models.

small to medium: TECH versus CULT (*OR* = 2.90) and ECON versus CULT (*OR* = 2.26). The corresponding effects for the senior general girls' model are medium to large: TECH versus CULT (*OR* = 6.27) and ECON versus CULT (*OR* = 3.18). It appears that the grade for mathematics differentiated primarily between CULT, on the one hand, and ECON and TECH, on the other hand. For example, for a 1-point increase in the grade for mathematics we see a 527% increase in the odds of picking TECH over CULT in the senior general girls' model. Mathematics is obligatory for all study profiles, except for CULT.

For senior general boys, a small effect is associated with the grade for history: ECON versus HEAL (*OR* = 2.21). For senior general girls, small to moderate effects are associated with the grade for history: CULT versus HEAL (*OR* = 2.28) and CULT versus TECH (*OR* = 3.84). History is a mandatory subject for both CULT and ECON pupils. The grade for history differentiated predominately between CULT and ECON, on the one hand, and HEAL and TECH, on the other hand.

For senior general girls, a medium effect (ECON versus CULT; *OR* = 2.78) is associated with the grade for economics. Economics is a mandatory subject for ECON pupils. It appears that this grade differentiated first and foremost between ECON and CULT for senior general girls: for a 1-point increase in the grade for economics, we see a 178% increase in the odds of picking ECON over CULT.

Table 6. Pooled odds ratios of the significant predictors of the senior general level models.

Senior general boys' model					Senior general girls' model				
	CULT	ECON	HEAL	TECH		CULT	ECON	HEAL	TECH
Mathematics					**Mathematics**				
CULT		0.44	0.68	0.34	CULT		0.31	0.33	0.16
ECON	2.26		1.54	0.78	ECON	3.18		1.05	0.51
HEAL	1.47	0.65		0.51	HEAL	3.03	0.95		0.48
TECH	2.90	1.28	1.97		TECH	6.27	1.97	2.07	
History					**History**				
CULT		0.84	1.85	1.52	CULT		1.96	2.28	3.84
ECON	1.20		2.21	1.82	ECON	0.51		1.16	1.96
HEAL	0.54	0.45		0.83	HEAL	0.44	0.86		1.69
TECH	0.66	0.55	1.21		TECH	0.26	0.51	0.59	
					Economics				
					CULT		0.36	0.69	0.51
					ECON	2.78		1.92	1.43
					HEAL	1.45	0.52		0.74
					TECH	1.95	0.70	1.34	
Physics					**Physics**				
CULT		1.40	0.93	0.49	CULT		1.27	0.63	0.41
ECON	0.71		0.67	0.35	ECON	0.79		0.59	0.32
HEAL	1.07	1.50		0.53	HEAL	1.59	1.71		0.55
TECH	2.02	2.84	1.89		TECH	2.42	3.08	1.81	
Chemistry					**Chemistry**				
CULT		1.16	0.52	0.49	CULT		0.64	0.36	0.21
ECON	0.86		0.45	0.42	ECON	1.56		0.56	0.33
HEAL	1.93	2.24		0.94	HEAL	2.80	1.80		0.60
TECH	2.05	2.39	1.06		TECH	4.66	3.00	1.67	

The columns are the reference categories.

For both senior general models, small to medium effects are associated with the physics grade: TECH versus ECON ($OR = 2.84$; $OR = 3.08$) and TECH versus CULT ($OR = 2.02$; $OR = 2.42$). Physics is an obligatory subject for TECH, and it appears that for the senior general level, the grade for physics differentiated primarily between TECH, on the one hand, and CULT and ECON, on the other hand. For example, for a 1-point increase in the grade for physics we see for senior general girls a 208% increase in the odds of picking TECH over ECON.

For senior general boys, small effects are associated with the grade for chemistry: TECH versus ECON ($OR = 2.39$), HEAL versus ECON ($OR = 2.24$), and TECH versus CULT ($OR = 2.05$). For senior general girls, medium to large effects are associated with the grade for chemistry: TECH versus CULT ($OR = 4.66$), TECH versus ECON ($OR = 3.00$), and HEAL versus CULT ($OR = 2.80$). Chemistry is an obligatory subject for both HEAL and TECH. It appears that the grade for chemistry differentiated primarily between HEAL and TECH, on the one hand, and CULT and ECON, on the other hand. These effects are much stronger for girls than for boys.

Pre-university students

Table 7 presents the F tests for the predictors of the multinomial logistic regression models for the pre-university students. Columns 2–4 correspond to the pre-university boys' model; Columns 5–7 correspond to the model for pre-university girls. The two models have four significant predictors of the study profile choice in common: the grades for the English language ($p = .033$; $p = .005$), mathematics ($p = .021$; $p = .025$), economics ($p = .001$; $p < .001$), and chemistry ($p < .001$; $p = .025$). In the pre-university girls' model, history ($p = .036$) and physics ($p = .005$) are additional significant predictors. The pooled overall correct classification rate is 64.1% for the pre-university boys' model and 58.0% for the pre-university girls' model.

Table 8 gives the pooled odds ratios associated with the significant predictors of the two pre-university models. The columns represent the reference (or second) categories

Table 7. F tests per predictor (grades for subjects) for the pre-university level multinomial logistic regression models.

	Pre-university boys' model			Pre-university girls' model		
Predictor	*F* value	*df*2	*p* value	*F* value	*df*2	*p* value
Constant	3.09	956.88	.026	2.63	82.21	.056
Dutch language	0.88	192.64	.454	0.77	9315.93	.512
English language*	2.91	3096.31	.033	4.29	331.62	.005
German language	0.50	8.05	.694	0.40	28864.06	.756
French language	1.08	664.47	.359	1.78	3563.95	.148
Mathematics*	3.24	177740.94	.021	3.11	1744.29	.025
History*	1.50	43.80	.227	2.86	1454.13	.036
Economics*	5.94	2082.32	.001	11.97	4418.47	<.001
Biology	0.95	27.04	.428	0.14	19.29	.936
Physics*	0.67	16.19	.583	4.60	102.42	.005
Chemistry*	10.86	376.80	<.001	3.26	94.21	.025
Geography	1.68	138.09	.174	2.17	19151.83	.089

For the F statistic, the first number of degrees of freedom is $df1 = 3$ in each case.
*Significant at $p < .05$ for at least one of the models.

for the odds ratio. Each sub-table contains both the odds ratio of picking one study profile over the other, and the other way around.

The left part of Table 8 presents the pooled odds ratios for the significant predictors of the pre-university boys' model. Two effects associated with the grade for the English language are medium to large: CULT versus ECON (*OR* = 3.20) and CULT versus HEAL (*OR* = 3.34). For the pre-university girls, two small to medium effects are associated with the grade for the English language: CULT versus HEAL (*OR* = 2.76) and ECON versus HEAL (*OR* = 2.03). It appears that the grade for the English language differentiated primarily between CULT and HEAL.

For both pre-university models, medium to large effects are associated with the grade for mathematics: TECH versus CULT (*OR* = 4.29 for boys; *OR* = 3.48 for girls). For pre-university boys, there are two additional small to medium effects: ECON versus CULT (*OR* = 2.66) and TECH versus HEAL (*OR* = 2.35). There is one additional small to medium effect for pre-university girls as well: HEAL versus CULT (*OR* = 2.13). Mathematics is offered at three different levels at the pre-university level, of which the

Table 8. Pooled odds ratios of the significant predictors of the pre-university level models.

Pre-university boys' model					Pre-university girls' model				
	CULT	ECON	HEAL	TECH		CULT	ECON	HEAL	TECH
English language					**English language**				
CULT		3.20	3.34	1.98	CULT		1.36	2.76	1.60
ECON	0.31		1.04	0.62	ECON	0.74		2.03	1.18
HEAL	0.30	0.96		0.59	HEAL	0.36	0.49		0.58
TECH	0.50	1.61	1.68		TECH	0.63	0.85	1.73	
Mathematics					**Mathematics**				
CULT		0.38	0.55	0.23	CULT		0.52	0.47	0.29
ECON	2.66		1.45	0.62	ECON	1.92		0.90	0.55
HEAL	1.83	0.69		0.43	HEAL	2.13	1.11		0.61
TECH	4.29	1.62	2.35		TECH	3.48	1.81	1.63	
					History				
					CULT		1.67	1.65	4.06
					ECON	0.60		0.99	2.42
					HEAL	0.60	1.01		2.45
					TECH	0.25	0.41	0.41	
Economics					**Economics**				
CULT		0.18	0.39	0.41	CULT		0.19	0.99	0.53
ECON	5.67		2.23	2.30	ECON	5.33		5.29	2.81
HEAL	2.54	0.45		1.03	HEAL	1.01	0.19		0.53
TECH	2.47	0.43	0.97		TECH	1.89	0.36	1.88	
					Physics				
					CULT		0.78	0.47	0.15
					ECON	1.28		0.60	0.19
					HEAL	2.13	1.66		0.31
					TECH	6.88	5.36	3.23	
Chemistry					**Chemistry**				
CULT		0.52	0.26	0.11	CULT		1.36	0.57	0.39
ECON	1.91		0.50	0.21	ECON	0.73		0.42	0.28
HEAL	3.84	2.01		0.42	HEAL	1.75	2.38		0.68
TECH	9.03	4.72	2.35		TECH	2.57	3.51	1.47	

The columns are the reference categories.

most proficient level is mandatory in TECH, at least the middle level is mandatory for HEAL and ECON, and the most basic level is an option only for CULT pupils. It appears that the grade for mathematics differentiated most strongly between CULT, on the one hand, and the other study profiles, on the other hand, as well as between TECH, on the one hand, and CULT and HEAL, on the other hand.

The history grade only appeared to be a significant predictor for girls at the pre-university level. The effects were small to medium for ECON versus TECH ($OR = 2.42$) and for HEAL versus TECH ($OR = 2.45$), and strong for CULT versus TECH ($OR = 4.06$). It appears that history differentiated primarily between TECH, on the one hand, and the other study profile choices, on the other hand: a higher grade for history is associated with a decrease in the odds of picking TECH.

For pre-university boys, one very large effect and four small to medium effects are associated with the grade for economics: ECON versus CULT ($OR = 5.67$), HEAL versus CULT ($OR = 2.54$), TECH versus CULT ($OR = 2.47$), ECON versus HEAL ($OR = 2.23$), and ECON versus TECH ($OR = 2.30$). For pre-university girls, two very strong effects and one small to medium effect are associated with the grade for economics: ECON versus CULT ($OR = 5.33$), ECON versus HEAL ($OR = 5.29$), and ECON versus TECH ($OR = 2.81$). Economics is an obligatory subject for ECON, and appeared to differentiate predominantly between ECON, on the one hand, and the other profiles, on the other hand.

Physics is a significant predictor for pre-university girls, with small, medium, and large effects: HEAL versus CULT ($OR = 2.13$), TECH versus CULT ($OR = 6.88$), TECH versus ECON ($OR = 5.36$), and TECH versus HEAL ($OR = 3.23$). For a 1-point increase in the grade for physics, we have increases of 588% and 436% in the odds of picking TECH over CULT and TECH over ECON, respectively.

For pre-university boys, small to very large effects are associated with the grade for chemistry: HEAL versus CULT ($OR = 3.84$), HEAL versus ECON ($OR = 2.01$), TECH versus CULT ($OR = 9.03$), TECH versus ECON ($OR = 4.72$), and TECH versus HEAL ($OR = 2.35$). For pre-university girls, small to medium effects were found: HEAL versus ECON ($OR = 2.38$), TECH versus CULT ($OR = 2.57$), and TECH versus ECON ($OR = 3.51$). The grade for chemistry primarily differentiated between TECH and HEAL, on the one hand, versus ECON and CULT, on the other hand. Furthermore, chemistry grades differentiated much more strongly between TECH and CULT for boys than for girls.

Discussion

The current study investigated the relationships between subject choices (clustered according to study profiles) of Dutch secondary school students and their end-of-year report card grades. The results showed that 55.4%–64.1% of the pupils' subject choices could be predicted from the grades recorded in their report cards. Important predictors were their grades for mathematics, history, economics, physics, chemistry, and English language.

Compared with previous studies, we believe that our study provides a more comprehensive picture of the relationship between report card grades and subject choices. The fact that some report card grades predicted subject choices provides support for our hypothesis. More precisely, we replicated the finding that mathematics and economics are important predictors of most pupils' subject choices (i.e. pre-university boys and girls, and senior general girls; van Langen, Rekers-Mombarg, and Dekkers 2006).

Apparently, pupils' grades for mathematics and economics continue to be important predictors of their subject choices. It is somewhat surprising that mathematics also predicts senior general girls' choices of the HEAL study profile over the ECON profile, for example, as the level of mathematics required for both profiles (basic mathematics) has been the same since 2007 (Centraal Bureau voor de Statistiek 2010), whereas advanced mathematics was required in the HEAL study profile before 2007. Furthermore, the grades achieved for almost all mandatory subjects within the study profiles were found to be important predictors, with the exception of biology grades, which contain much more missing data than those for other subjects. However, even when we conducted the analyses using only complete data rather than imputed data, biology was still not a significant predictor of pupils' subject choices. Although biology is a mandatory subject for the HEAL profile, it appears that grades for other subjects, such as economics and physics, are more relevant for choosing between the HEAL profile and the other three study profiles. Moreover, English language, which is a mandatory subject for all study profiles, is also a relevant predictor for pre-university students. The reason for this particular association is not completely clear.

Grades for mathematics, history, economics, physics, and chemistry were all found to be significant predictors for senior general and pre-university students. Moreover, educational levels were found to have differential effects. In general, the pre-university education level had stronger effects (i.e. higher odds ratios) than the senior general education level. This finding could be attributed to the admission guidelines for tertiary education. TECH and HEAL profiles lead to relatively more options within tertiary education for pre-university students than for senior general students (Studiekeuze123 n.d.). Presumably, pre-university students with higher grades in chemistry or physics are more inclined to choose a study profile that includes these subjects compared with senior general students.

We also found empirical support for the differential effects of gender. For example, for male pre-university students a 1-point increase in their chemistry grades led to an increase of 803% in the odds of choosing the TECH over the CULT option. By contrast, for pre-university female pupils a 1-point increase in their chemistry grades only gave an increase of 157% in the odds of picking the TECH over the CULT option. Previous studies have shown that when making subject choices within tertiary education, girls are more sensitive than boys to low grades (Goldin 2013; Ost 2010; Rask and Tiefenthaler 2008; Sanabria and Penner 2017). This finding also seems to apply to pupils at the secondary education level. Boys with a somewhat satisfactory grade seem to be more easily convinced of their own competence compared with girls, who need more evidence in the form of relatively high grades before choosing a certain combination of subjects. This may only be reflected in a part of our findings, dependent on the subject in question and the educational level. Denissen et al. (2007) found that the relationship between academic achievement and pupils' self-concept of ability is stronger for boys than it is for girls. Moreover, academic achievement and self-concept of ability partially predict subject choices (Broekema and Habraken 2012; Larose et al. 2006; Rekers-Mombarg et al. 2010). Boys seem to be more easily encouraged by their own grades to choose a certain subject compared with girls. Moreover, they tend to consider their perceived competence in mathematics to a greater extent when choosing a combination of subjects than girls, who tend to place more emphasis on their verbal competences (van der Vleuten et al.

2016). Economics and history are two subjects that are more verbally oriented and may therefore be more important for girls than they are for boys.

Grades for some subjects had a stronger influence on boys than on girls, and the converse was also true. For example, mathematics and chemistry grades influenced girls more strongly than boys at the senior general education level, whereas they were stronger influences for boys than for girls at the pre-university level. These results illustrate the interaction effects between educational level and gender. Mathematics is not a compulsory subject for the CULT study profile at the senior general education level, whereas it is compulsory at the pre-university level. Furthermore, choosing the TECH or HEAL study profile opens up more study options for pre-university students than for senior general students. Future studies could investigate the robustness of these results and explore possible explanations for them.

Suggestions for future research

We found that report card grades play an important role in educational decision making, partly determining future options and possibilities relating to pupils' educational trajectories and career paths. Moreover, boys and girls with similar report card grades tend to choose their profiles differently. Pupils appear to consider factors other than grades, as their choices could only be predicted in 55.4% to 64.1% of cases. Therefore, it would be interesting to investigate how subject choices are made and what other factors influence pupils' choices. For example, it would be important to examine how pupils' significant others and student counsellors contribute to the decision-making process (Broekema and Habraken 2012; van Langen and Vierke 2009; Wichgers et al. 2019).

Up till now we have extensively used the word prediction when we considered the relationship between report card grades and students' subject choices. However, it could be the case that we only provided evidence in this study to claim association, not prediction, due to a possible time order effect. Since students already made a decision before the end of the ninth grade, students may have exhibited a certain strategic behaviour in the remainder of the ninth grade: just getting sufficient grades for subjects they will drop in tenth grade. This strategic behaviour would have affected the end-of-the-year report card grades, and if many students adopted this strategic behaviour, then this would provide an alternative explanation for the findings with regard to the research questions. To avoid any time order effect, future research could consider earlier report card grades, for example, report card grades from the eighth grade.

Our findings on gender and educational differences, and on their interaction effects, may advance understanding of the processes whereby pupils make educational choices. They may also contribute to an understanding of interventions in gender differences in certain career paths. For example, chemistry and mathematics grades predict subject choices differently for boys and girls, depending on their educational level. Greater grade sensitivity among girls than among boys could explain this finding (Goldin 2013; Ost 2010; Rask and Tiefenthaler 2008; Sanabria and Penner 2017). van Langen and Vierke (2009) found that among girls and boys whose grades were comparable, the former tended to choose TECH or HEAL profiles less often than the latter. It seems that girls are less easily convinced by their educational results of their STEM capabilities compared with boys. These gender differences may be explained by differences in the cognitive and affective experiences of girls and boys following test situations. Differing from boys with the same educational outcomes, girls may

underestimate their own STEM capacities as a result of their stereotype-consistent self-perceptions regarding STEM-related subjects and study profiles (Nosek and Smyth 2011; Zander et al. 2020). Moreover, we found differences at the senior general education and pre-university levels. The subject choices at these levels have different implications for pupils' future career paths. This finding suggests that the impact of grades on educational choices may be moderated by pupils' educational levels. The differences between boys and girls and between educational levels could be further explored in future studies.

As previously noted, student counsellors tend to take report card grades into consideration in their counselling (Wichgers et al. 2022). The results of this study may facilitate student counsellors in determining whether and to what extent grades for different subjects matter in the decision-making process. They could consider differences between boys and girls relating to grade sensitivity and between pre-university and senior general students when formulating admission guidelines for certain study profiles.

In this study, report card grades, which are highly significant within educational practice, were the independent variable. However, report card grades are also influenced by various factors, such as motivation, effort, and subject content at a school (Lenhard and Schröppel 2014; Wijsman et al. 2016). This means that report card grades cannot be compared one-on-one across schools. Because these grades provide an indication of pupil performance and have also proven to be important predictors within educational trajectories (Wijsman et al. 2016), we nevertheless consider the findings of this study to be highly relevant. The present results show that report card grades for subjects that are mandatory for certain study profiles play an especially important role in the subject choices of Dutch secondary school students.

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Ethical approval

The Ethical Committee Behavioural and Social Sciences of the University of Groningenapproved the current study (approved on 13 March 2018; EC code: 13032018).

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