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The effect of the language of instruction on academic performance[☆]

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A B S T R A C T

Education in a language other than the mother tongue is common. This is increasingly relevant in tertiary education, due to the growing international mobility of students. While the advantages of foreign language skills on the labour market are well-studied, literature on the cost of non-native learning is still not well established. To fill this gap, we explore the impact of the language of instruction on grades by using administrative data provided by the Free University of Bozen-Bolzano. We exploit the fact that students whose mother tongue is for the most part Italian or German learn and take exams in English, German, and Italian. Our results, controlling for student fixed effects, show that taking an exam in a second language leads to a loss in grade points of approximately 9.5% (or 0.22 within-student standard deviations). These results are confirmed relying on an identification strategy that leverages on course language assignments in the standard study plan, circumventing the potential non-compliance of students selecting out of languages other than the mother tongue. A high proficiency in the non-native language mitigates - but does not eliminate - the loss. Moreover, also the number of failed attempts increases.

1. Introduction

Education in a language other than the mother tongue is a common phenomenon. First of all, there are many multilingual societies[1] where the use of multiple languages for educational purposes is common, either vertically, with different languages used, for instance, in elementary vs tertiary education, or horizontally, when multiple languages are used as media of instruction within the same class. India and its more than 250 million students, 22 official languages and hundreds of minority languages (Groff, 2017),[2] represents a particularly prominent case with the country being currently amid a lively policy debate about the language of education (Karthik and Noblit, 2020).

In addition, the growing international mobility of students implies that it is becoming more and more common to study in a second language. For instance, in the academic year 2019/2020 despite the impact of Covid-19, 237,800 students went abroad to study in higher education institutions thanks to the Erasmus+ programme of the European Commission.[3] International migration, as far as it involves school-aged children, also may imply a language other than the mother tongue as medium of education, and UNICEF estimates that, as of 2020, 36 million children were international migrants.[4]

It is therefore important to understand the impact of the language of instruction on students' performance. This is what we do in this paper using some unique features of the Free University of Bozen-Bolzano (henceforth, the University), a university located in the bilingual Italian province of South-Tyrol, where 65% of the population has German and 27% has Italian as mother tongue.[5] The university was founded in 1997 with the mission of trilingual education, with three official lan-

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1 Alesina et al. (2003) calculate for a sample of 185 countries an average index of linguistic fractionalisation of 0.385.

2 https://www.statista.com/statistics/1175285/india-number-of-enrolled-students-by-school-type/.

3 https://op.europa.eu/en/publication-detail/-/publication/381dc9a5-3f4d-11eb-b27b-01aa75ed71a1/language-en.

4 https://data.unicef.org/topic/child-migration-and-displacement/migration/

5 Ladin, a Romance language of the Rhaeto-Romance subgroup, is also present and officially recognised, while there are of course people with other mother tongues. See: https://www.provinz.bz.it/familie-soziales-gemeinschaft/integration/images/899470_sprachbarometer_2014.pdf.

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guages - Italian, German and English. This means that students learn and take exams in all three languages. An economics student may read, for instance, introduction to management in German, microeconomics in Italian, and econometrics in English. Each course is offered only in one language, that is determined by the University with the aim of ensuring a balanced share of the three languages during the students' course of studies, subject to supply constraints, i.e., to the language skills of lecturers, who are, for the vast majority, not trilingual and are able to teach in English and in either Italian or German. Students, who come also from other Italian regions as well as from abroad, have for the vast majority either Italian or German as their mother tongue. Using administrative data from the University, we are therefore able to observe the performance of students speaking German or Italian as their mother tongue as they take exams in courses they attended together, and which are taught and assessed in Italian, German, and English.

Our hypothesis - grounded in the cognitive neuroscience and psycholinguistics literature that we will briefly review in the next section - is that studying in a language other than the mother tongue entails a cognitive cost. Consistent with this, we show that students put in place a series of strategies to reduce their exposure to courses in a second language, despite having enrolled in a trilingual degree. These strategies involve the postponement or anticipation of courses compared to the standard curriculum when a specific course switches language from one year to the next (e.g., economic policy being delivered in German in 2019, but in Italian in 2020), as well as the choice of courses that students take at other universities, for instance as part of Erasmus exchanges. From a quantitative perspective, however, these strategies do not alter the language composition of the course of study in a significant manner. The choice of optional courses could also be affected, and for this reason we focus our analysis on mandatory courses only.

We then estimate the cost of studying in a language that is not the mother tongue using models with student fixed effects. To account for the potential endogeneity of course language implied by the strategies described above, we use the curricular language - that is, the language of the course as envisaged by the standard curriculum - as an instrument for the actual one, as the two may differ because of anticipation, postponement, or taking the exam while in Erasmus. These complementary IV estimates are, however, very similar to our baseline. We estimate that performance when taking an exam in a course that is not in the mother tongue is 9.5% (or 0.22 within-student standard deviations) lower. We also show that the number of failed attempts is positively affected by the language mismatch between student's mother tongue and language of the course.

This paper contributes to the literature looking at the impact of language of instruction on educational outcomes. Angrist and Lavy (1997) exploit a variation in Morocco, where in 1983 the language of instruction in secondary school changed from French to Arabic. They find a significant decline in French writing skills, as well as of earnings. Angrist et al. (2008) find instead no effect in English proficiency due to a policy change moving the language of instruction in Puerto Rico from English to Spanish. Ivlevs and King (2014) exploit a reform in Latvia in 2004, where the language of the Russian minority schools switched from 100% Russian to 60% Latvian and 40% Russian and show that results in the centralised exam - in Latvian, but with the option to reply in Russian - significantly deteriorated across the board. Jain (2017) looks at colonial India and finds that linguistically mismatched districts, i.e., districts where the official language at the provincial level did not match the district's language, had 18% lower literacy rates and 20% lower college graduation rates compared to linguistically matched districts. The difference disappears after the 1956 reorganisation of Indian states on linguistic lines. These last two papers points to a difficulty in acquiring education in a language other than the mother tongue, but, differently from this paper, they are exploiting reforms that can impact educational dimensions other than the language itself.

Also very related is the literature on the educational effects of bilingual education. Anghel et al. (2016), for instance, evaluate a program introducing bilingual education - in English and Spanish - in primary schools in Madrid and find, for children of parents without a college education, a reduction of 0.2 standard deviations in General Knowledge, the only subject taught in English (but assessed in Spanish). On the opposite, Admiraal et al. (2006) find no negative impact of bilingual secondary education in the Netherlands in terms of results of school leaving exams for Dutch and subject matters taught through English. In this paper we study education at the university level, where the learning and teaching practices are clearly different from primary or secondary schools.

There is also a growing literature on the role of language of instruction on the educational (and other) outcomes of immigrant children. Lleras-Muney and Shertzer (2015) look at the effect of the introduction of statutes requiring English as the language of instruction in the US in the period 1910–1930, finding modest effects on literacy and no effect on labour market outcomes and on measures of social integration. Similarly, no or modest effects are reported by Slavin et al. (2011) and Chin et al. (2013). In her review article of US evidence, Chin (2015) concludes that "bilingual education programs (which use some native language instruction) and English-only programs are not significantly different in their impact on standardised test performance". The context we study is of course very different, as it mostly involves non-migrants.

Also relevant is the literature looking at the impact of multilingualism on labour market outcomes. Fry and Lowell (2003) and Saiz and Zoido (2005), for instance, conduct their analyses on US data and find only a negligible wage differential for workers and employees who master languages other than English, whereas Cappellari and Di Paolo (2018) exploit the reform of 1983 that introduced Catalan alongside Spanish as the official language of education in Catalonia and find that bilingual education increases earnings, but has no effect on employment and hours of work. Also Ginsburgh and Prieto-Rodriguez (2011) show that language proficiency positively affects wages in a study involving nine European countries. The return to foreign language skills is often observed to be conditional to matching language demand and supply in the job market, which is in line with the body of research in Chiswick and Miller (2007) on dominant language proficiency among immigrants in several countries such as the USA, Canada, Israel, and Bolivia (see also Chiswick, 2009 for an overview). Our focus is on academic performance, as the administrative data we use do not follow students in the labour market.

To summarise, there is a wide interest in the impact of language on outcomes in education and other areas like the labour market. We contribute to this by studying the issue in a new context, tertiary education. This is particularly relevant because of the growing importance of international mobility of university students, also due to policies like Erasmus. Moreover, we use an empirical strategy - described in more details in Section 4 - that exploits some unique features of the institution we study and that, to the best of our knowledge, has not been used before.

The remainder of the paper is structured as follows. The next section briefly discusses some relevant literature in cognitive neuroscience and psycholinguistics. Section 3 describes the institutional framework of the University, while Section 4 discusses the empirical strategy. Section 5 describes the data, while results are shown in Section 6. Section 7 concludes, also discussing some policy implications.

2. Cognitive neuroscience and psycholinguistics literature

As mentioned in the introduction, our hypothesis that studying in a language other than the mother tongue entails a cost is grounded in the cognitive neuroscience and psycholinguistics literature. This literature provides some interesting insights into how language and language processing affect cognition and reasoning. Venkatraman et al. (2006) and Grabner et al. (2012), for example, use functional magnetic resonance imaging (fMRI) on bilingual subjects to show how language-switching costs could impact on the efficacy of non-mother-tongue learning. Language-switching costs apply to those situations in which the student has to mentally retrieve information that was previously acquired in a different language than the current learning language. One example are math skills that might have been acquired during high school in the student's mother tongue and which are now needed (i.e., need to be mentally retrieved) to pass an exam in microeconomics in a second language. The mere cost of switching from one language to another, even when the student is perfectly bilingual, represents an additional cognitive effort compared to a situation in which the language of information retrieval does not differ from the language of learning.

Furthermore, Cunnings (2017) gives a new interpretation of the mechanism underlying native (L1) and non-native (L2) language processing, which differs from the shallow structure hypothesis (SSH) of Clahsen and Felser (2006) according to which differences in native and non-native processing are due to a mechanism of shallow parsing.[6] Rather than qualitative differences, and in line with the idea of the aforementioned language-switching costs, Cunnings (2017) interprets L1/L2 differences as a consequence of retrieval inferences during sentence processing from memory for non-native speakers.[7] Costa et al. (2017) also suggest that foreign-language processing reduces intuition as it forces the speaker to slow down and think more carefully about forthcoming actions, a further possible source of cognitive costs when studying in a language other than the mother tongue.

3. Institutional framework

The Free University of Bozen-Bolzano[8] was founded in 1997 as a multilingual, internationally oriented institution. Its main campus is in Bozen-Bolzano, the capital of the autonomous province of South Tyrol, in northern Italy, with two other campuses in the nearby cities of Bressanone-Brixen, where the Faculty of Education is located, and in Brunico-Bruneck, home to the tourism department of the Faculty of Economics and Management. The adjective “Free” in the name is due to the fact that the University is non-state funded, as it is mostly financed by the Province Alto Adige-Südtirol. The formerly Austrian-Hungarian county was annexed to the Kingdom of Italy in 1919 and is today officially trilingual, as, beside German and Italian, the romance language Ladin is spoken in a few municipalities. From kindergarten to high school, there are two parallel educational systems in the province, one Italian and one German, where the other language is taught as the first foreign language.[9]

The University has five faculties (Economics and Management, Education, Computer Science, Science and Technology, Design and Art) and offers courses in German, Italian and English. This means that students enrolled in bachelor's degrees (lasting three years) and also students enrolled in some master's degrees (lasting two years) have study plans including courses in the three languages. As mentioned in the introduction, an economics student may read, for example, introduction to management in German, microeconomics in Italian, and econometrics in English. The Faculty of Education represents an exception, as its main aim is to train schoolteachers and therefore a student's study plan tends to focus on one language. Also, in the period under consideration the small Faculty of Computer Science offered degrees only in English. For these reasons, we do not include students from these two faculties in our analysis.

Each course is offered only in one language, that is determined with the aim of ensuring that students face a balanced share of the three languages during their course of studies. This objective, however, is subject to supply constraints, i.e., to the language skills of lecturers, who are, for the vast majority, not trilingual and are generally able to teach in English and in either Italian or German. In the period we study, there are fewer German-speaking professors than Italian native speakers. Another constraint is that students, who come also from other Italian regions as well as from abroad - including Germany and Austria - have for the vast majority either Italian or German as their mother tongue and not all of them are fluent enough to take a university course in each of the three languages as they join the university. For this reason, in the first year of study many degrees offer more courses in English. As a result, the University does not generally offer a study plan that is perfectly balanced, i.e., with each of the three languages accounting for one third of offered courses. Indeed, as we will show in the data section, in our dataset mandatory exams offered in German make up for 17% of the total, while 35% of the exams are taught in Italian, and the remainder 48% are exams taught in English. From time to time, a course changes the language in which it is delivered. This can be due to personnel changes, in terms of permanent, temporary, or contract professors, as well as to rebalancing within degrees of the language portfolio. It may thus happen that, for example, economic policy changes from German to Italian as a new professor joins the university. For few courses, mostly those dealing with Italian law, there is an obvious disciplinary constraint that requires them to be delivered in a specific language.

The minimum entry requirement for trilingual bachelor programs is a language level B2 in the first and in the second language, while there are no requirements for the third language.[10] After one year the student has to reach level B1 also in the third language. The exit requirements by the end of the third year are language level C1 in the first and in the second language and B2 in the third language. Prospective master students for trilingual programs have to provide proof of level C1 in the first language and B2 in the second. By the end of the second year, levels C1 for the first and the second language and level B1 for the third language have to be reached. The University supports the students in the language acquisition process through tailored language paths, which are intensive language courses either during the semester or during the summer and winter breaks.

In Italy, students pass an exam if they get a grade of at least 18 in a scale that goes up to 30 cum laude (31). The course GPA calculated over all years concurs to determine the final degree classification. Differently from many Italian universities, at the University a student who receives a mark above 18 cannot reject it, for instance hoping to do better in a subsequent attempt. If a student fails an exam, retake opportunities are available, but, again differently from many Italian universities, the University offers few exam sessions in an academic year and there are restrictions on the number of retakes per year. For instance, the Faculty of Economics and Management currently offers three exam sessions per year and a student can retake an exam only once in an academic year. This is the case even if a student withdraws during an exam. This means that students are generally not “trying their luck” and sit an exam only after some preparation. Exams are written and there is a strict requirement that the language of examination coincides with the language of the course.

In each degree, some courses are mandatory, others are optional, and a certain number of credits is free choice. For instance, in the bachelor's in Economics and Social Sciences, most of the courses, including for example mathematics, statistics, micro and macroeconomics, European and public law, economic policy, are mandatory and every student must pass them to graduate - it is possible though to pass equivalent courses in another university, e.g., during Erasmus. For optional courses, students choose within a predefined set, e.g., one of either international economics or growth and development economics, and the

[6] Shallow parsing (or “chunking”) in second-language acquisition refers to a coarse syntactic computation of the non-native language, where the person identifies noun, verb, preposition phrases, and so forth in a sentence, without identifying the syntactic function of each word or phrase part of the sentence.

[7] See Abutalebi and Clahsen (2017) for an overview of the current state-of-the-art in the psycholinguistics of bilingual learning.

[8] https://www.unibz.it/en/home/profile/.

[9] Ladin schools are also present in the Ladin municipalities, with a more balanced presence of the three official languages.

[10] See for details on this classification system: https://www.coe.int/en/web/common-european-framework-reference-languages/level-descriptions.

courses within the choice set are not necessarily delivered in the same language. Finally, 12 credits,[11] corresponding generally to two courses, are free choice, meaning that students can choose from the courses offered by the University (as well as from other institutions, for instance during Erasmus). In our analysis, we consider only mandatory courses, because, once enrolled in a degree in a given year, the curricular language of mandatory courses, i.e., the language as envisaged by the standard curriculum, does not depend on a student's choices. Something that is important for the empirical strategy we discuss in the next section.

4. Empirical strategy

It would not be possible to identify the effects of the language of instruction on academic performance by simply regressing exam marks on an indicator of linguistic mismatch, because the coefficient would possibly be biased by the presence of unobserved correlated factors. Students of different mother tongue may differ also in terms of ability, for instance in the case of South Tyrol because German or Italian speaking students face distinct alternative study opportunities (e.g., in terms of distance or quality of other universities offering instruction in their own language). Moreover, within the University, there may be differences among faculties (or even among degrees within faculties) in terms of the linguistic background of the students they attract, as well as in terms of the linguistic mix of their courses and of grading standards.

One way to account for individual-specific and degree-specific confounding factors is to rely on within-student variation in language of instruction across various subjects of study.[12] By including individual fixed effects, we can see whether differences in the performance of students between courses are systematically associated with differences between courses in terms of the language of instruction. In this way, we can account for students' characteristics that can be considered constant during the period under consideration, e.g., innate ability or socioeconomic background, as well as characteristics of degrees. We observe 40 students both in a bachelor and in a master. For them, the individual fixed effect is not enough to control for degree characteristics, so we have also included degree fixed effects. We therefore aim at estimating the following linear fixed-effects model

$$y_{ij} = \rho NotMT_{ij} + X'_{ij}\beta + E'_j\gamma + \alpha_i + u_{ij} \quad \text{for} \quad j = 1, \dots, M \quad \text{and} \quad i = 1, \dots, N \tag{1}$$

where the dependent variable y_{ij} is the rescaled (minmax normalized) exam mark, calculated as $\frac{exam\,mark-18}{31-18}$, received by student i in exam j. The main variable of interest $NotMT$, exam not in mother tongue, is a dummy variable taking the value of 1 if there is a linguistic mismatch, i.e., if the student native language is different from the exam language. In some specifications, we use a finer indicator of linguistic mismatch, in which we differentiate between intermediate and advanced knowledge of the non-native language. X'_{ij} is the vector of variables observed for student i and exam j, for instance "year of study" or "external", if student i passed exam j in another university. E'_j are the exam-specific observable variables such as professor type, exam language, or a dummy for quantitative exams. We will describe these variables in more details in the data description section, while in the results section we will indicate which control variables are included in the different specifications. α_i is the student fixed-effect and u_{ij} is the error term.

As mentioned in our institutional setting, students have some leverage on how to structure their study plan, with the ability to choose some courses, either within a limited menu or, to a lesser extent, freely, and the ability to anticipate or posticipate courses compared to the curricular prescription. Moreover, students can also undertake some courses in other universities, for instance by participating to Erasmus exchange programmes. From an econometric perspective, this flexibility would not be an issue, if students' choices along these dimensions were orthogonal to the linguistic match between their own mother tongue and the language of instruction of the different courses. This is unlikely to be the case, if, as we claim, there is indeed a cost in terms of grade points in case of linguistic mismatch. Students who want to maximise their GPA are therefore likely to try to minimise this linguistic disadvantage, for instance by choosing courses that are delivered in their own mother tongue, even if these courses may be a worse match given the student's academic interests and proclivities. A student with Italian as mother tongue, for example, may elect to read Italian administrative law, delivered in Italian, even if he or she may be more interested in European administrative law, delivered in German. Similarly, students may choose to postpone an exam with the expectation that the language of instruction may change in subsequent academic years, even if this may entail a cost in terms of having an incoherent sequence of courses. A student with German as mother tongue, for instance, could posticipate the first-year course of statistics if this is delivered in Italian and do it in the second semester of the second year in English during an Erasmus exchange, but in the meanwhile take econometrics if, for instance, this is delivered in English in the first semester of the second year, without the necessary statistical knowledge, something that is generally allowed in our institutional setting. Students who want to maximise their GPA may therefore try to balance the costs due to linguistic mismatch with these other costs and, in the empirical analysis, we show evidence of such behaviours.

Because of this dynamic selection, our fixed effect estimates would represent a lower bound of the actual disadvantage of studying in a language that is not the mother tongue. To improve on this, we use two strategies. First of all, we restrict our sample to mandatory courses. Being mandatory, students cannot include or exclude them from their study plan on the basis of their linguistic preferences. This eliminates the impact of the first type of behaviour exemplified above, that is, choosing optional courses on the basis of the linguistic match. A second approach is to use, instead of the actual language in which a student undertook an exam, the curricular language, that is, the language of the course that a student of a given cohort[13] would have faced if he or she followed the standard study plan, without anticipating or postponing exams, and without taking exams in other universities, e.g., in Erasmus. To use the language of clinical trials, a student of a given mother tongue that faces an exam in another language may be non-compliant and take the exam in a language that is not the assigned one via postponement, anticipation, or mobility to other universities. By replacing in the regressions the actual language with the curricular language, we can recover the intention-to-treat effect, that is, the effect of having an exam not in the mother tongue in the study plan. We also instrument the language of the exam with the curricular language to recover the effect on the treated, i.e., on those who undertook an exam not in the mother tongue. As we will see in the results section, however, this type of dynamic selection, while present, is not a quantitatively important issue.

5. Data description

The University provided anonymised administrative datasets, reaching up to the first exam session of the academic year 2018/2019. Each student is identified by an individual student ID and an enrolment number for the chosen degree which allows us to control for individual fixed

[11] By law undergraduate degrees should reserve at least 12 credits out of 180 for free choice courses, while master's degrees 8 out of 120.

[12] See Lavy (2015), on which parts of this section draw, for a similar approach regarding the impact of instruction time on students' outcome.

[13] Cohorts are based on the study course and the year of enrolment, so that all students within the same cohort face an identical study plan, as well as common institutional and pedagogical circumstances.

Table 1
Distribution of Native Language Assignment Methods.

	High School		Country of Origin		Communication Language		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
German	1198	95.53	3	0.24	53	4.23	1254	100.00
Italian	1668	98.12	2	0.12	30	1.76	1700	100.00
Total	2866	97.02	5	0.17	83	2.81	2954	100.00

Notes: The table reports the distribution of language assignment methods (columns) by native language status of the students. Native language status was for the most part assigned by drawing from the language of the high school and, in case of missing information, by looking into the language of the country of origin and the preferred communication language chosen at the moment of enrolment.

effects and to identify the 40 students who have been enrolled in more than one program at the University, e.g., a bachelor and a master's degree.[14] For each student ID, we know socio-demographic information such as birth province, gender, age, and high school type[15], as well as, for each course attended by the student, the date of each exam to which the student enrolled, including failed attempts, and the final grade. We also know whether the student took the exam at the University or in some other institution, e.g., during Erasmus. For courses at the University, we know the teaching language of the courses and the instructor's linguistic and socio-demographic characteristics. For courses passed at other institutions, we know the title of the course from which we can infer the language of instruction.[16] Starting from the year 2011, we also have reliable information on the type and date of language certificates or exams as a proof of the student's language level and are thus able to control for the students' language skills when they took the exam. For this reason, we consider only exams taken since 2011.

As mentioned in the section on the institutional background, we have courses of students enrolled in the trilingual degrees offered by the Faculties of Economics and Management, Science and Technology, and Design and Art. Finally, we excluded incoming exchange students, students with an irregular enrolment status, and students whose mother tongue is neither Italian nor German. Our final data set for our main models consists of 2954 students and 26,807 passed mandatory exams, out of which 25,844 were passed at the University.

The University does not ask directly to students what their mother tongue is at the moment of enrolment. To determine the student's first language (L1), it uses instead the high school degree, assigning Italian, German or English if the high school degree is in Italian (Maturità), German (Abitur) or English.[17] We follow the University policy to assign the native language.[18] In case the information is not available, for just 5 cases we use the language of their country of birth, that is, we assigned German for students born in Germany or Austria, and Italian for students born in Italy (with the exclusion of South Tyrol). For 83 students from South Tyrol for whom we have no information about the high school language, we considered the preferred language of communication at enrolment which is a choice students, instructors and personnel are given at the moment of registration within the University system. The distribution of assignment methods is reported in Table 1, where we can see that we exploited the information on high schools for 97% of the sample.[19]

Table 2
Correlation between Native Language Assignment Methods.

	High School	Country of Origin	Communication
High School	1		
Country of Origin	0.962***	1	
Communication	0.802***	0.803***	1

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. *Notes*: The table reports correlation coefficients for the three native language assignment methods. The correlation sample excludes students from South Tyrol, as their country of birth is not informative of their native language.

In Table 2 we test whether the alternative language assignment methods are consistent and can confirm a strong correlation between the three proxies for a student's native language.

Language proficiency levels follow the *Common European Framework of Reference for Languages* from A1 (Beginner) to C2 (Proficiency).[20] The student's language skills at the point of taking an exam were determined by matching the most recent language certificate date available with the date of the exam. Table 3 shows the language levels for passed exams in Italian, German and English. What emerges is that the majority of students passing an exam in a language other than their mother tongue have an intermediate proficiency in that language.

In terms of faculty split, 71% of the students of our final sample are enrolled in the Faculty of Economics and Management, 14% at the Faculty of Science and Technology and 15% at the Faculty of Design and Art. A little more than two thirds of the students are female in the faculties of Design and Art and Economics of Management, whereas we observe the opposite for the Faculty of Science and Technology with 71% of the students being male. 38% of the exams were taken by students born in South Tyrol.

Exam Language. Reflecting the mission of the trilingual educational policy of the University, 29.50% of the exams were given in the students' native language and 70.50% were given in a foreign language, with English being the dominant one.

Professor types. In order to account for the instructor's characteristics, we created Professor Types which are grouped by gender (Male, Female), country of birth (Italy, Germany/Austria, Other) and the chosen

[14] The number of multiple enrolments refers only to the trilingual courses that are part of our sample. The true number of students who continue their study career with the Free University of Bozen-Bolzano would also include those students who attended excluded programs, e.g., in the faculties of Education or Computer Science.

[15] The high school types of the students were categorised into four main types: Gymnasium, Arts and Music School, Technical and Vocational School, and Foreign Diploma.

[16] For instance, we know whether during an exchange at the University of Mannheim a student took Development Economics - in English - or Entwicklungsökonomie - in German.

[17] A student is automatically assigned a C1 level in his or her first language, without need to pass a language exam or produce further language certificates. We exclude from our sample 58 students who attended a bilingual - e.g., Italian and English - high school.

[18] Notice that this policy is also consistent with the characterisation of cognitive costs as retrieval costs when having acquired knowledge in a different language, as discussed in Section 2. A student who attended high school in Italian, for instance, has acquired mathematical knowledge in Italian and would suffer a cognitive cost when retrieving it for a statistics course delivered at the University in English or German.

[19] As a robustness check we ran our analyses with the same sample of students, but using as native language the one derived by the language of communication chosen at the moment of enrolment. Results differ only very slightly in terms of coefficients and are available upon request.

[20] https://www.coe.int/en/web/common-european-framework-reference-languages/level-descriptions.

Table 3
Language Level by Exam Language.

	Exam in English		Exam in German		Exam in Italian		Total	
	No.	Col.%	No.	Col.%	No.	Col.%	No.	Col.%
Language Level B1 or B2	10090	77.62	1682	37.25	2358	25.37	14130	52.71
Language Level C1 or C2	2909	22.38	512	11.34	1348	14.51	4769	17.79
Native Speaker	n.a.		2321	51.41	5587	60.12	7908	29.50
Total	12999	100.00	4515	100.00	9293	100.00	26807	100.00
N	26807							

Notes: The table summarizes the student's language level at the point of taking an exam. English native speakers are not available as we have excluded from the sample students whose mother tongue is neither Italian nor German. Exams in English are mostly taken by students with a medium language level (B1 to B2), more than 50% of all exams in German are taken by German native speakers, 11.34% of all students have a high (non-native) language level, whereas 37.25% pass the exam with language level B1 or B2. We observe a similar distribution for exams in Italian with a slightly higher share of native Italian exam-takers.

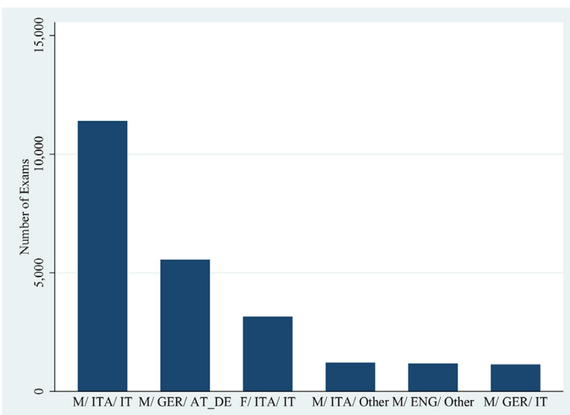

Fig. 1. Distribution Professor Types. *Notes:* The figure shows the six main professor types (more than 1500 exams per type). The first position refers to the instructors' gender (M/F), then we group by their native languages ITA, GER and ENG and finally the country of origin Italy (IT), Germany or Austria (AT_DE) and Other.

language of communication (Italian, German, English). In total we have 12 professor-types, and the most frequent types are shown in Fig. 1 with the number of exams they graded on the y-axis. The types that taught the highest number of courses are male professors who were born in Italy and chose Italian as their language of communication and male professors born in Germany or Austria with German as their preferred language of communication. On the third place we find female professors born in Italy with Italian as their preferred language.

Grade Distribution. Fig. 2 shows the distribution of exam marks for the three faculties, as well as for exams taken outside the University. Grades for the Faculty of Design and Art (7% of the sample) and grades for external exams appear slightly skewed towards higher levels. The peak at 30 for external exams could be explained by exams for exchange students offered by other institutions having lower standards or better students taking part to exchange programs like Erasmus.

In Table 4 we report the summary statistics of our main variables of interest. As mentioned, in Italy a student needs to achieve a minimum grade of 18 to pass an exam, while the maximum is 30 with honours (31). We have information about failed attempts, but do not know the corresponding mark, i.e., we cannot distinguish a fail with a "virtual mark" of 4 from one with a "virtual mark" of 16. To ease interpretation, we re-scale marks on passed exams over the range 0–1, where the minimum value 0 corresponds to 18, the first passing grade, and 1 represents the maximum achievable grade of 31 (30 with honours), using the formula:

$$y_{ij} = \frac{exam\,mark_{ij} - 18}{31 - 18},$$

Table 4
Summary Statistics.

	Mean	Std. Dev.	Min	Max	Obs.
Exam Mark (norm.)	0.517	0.279	0	1	26807
between students		0.185			
within students		0.227			
Exam Mark	24.72	3.633	18	31	26807
Exam not in mother tongue	0.705	0.456	0	1	26807
Female student	0.622	0.485	0	1	26807
Native German (d.)	0.432	0.495	0	1	26807
Native Italian (d.)	0.568	0.495	0	1	26807
Exam in English (d.)	0.485	0.500	0	1	26807
Exam in German (d.)	0.168	0.374	0	1	26807
Exam in Italian (d.)	0.347	0.476	0	1	26807
External Exams	0.036	0.186	0	1	26807
Quant. Exam	0.325	0.468	0	1	26807

Notes: The table reports summary statistics of our main variables of interest. *Exam Mark (norm.)* is the dependent variable in most regression analyses and represents the rescaled (minmax normalized) version of the variable *Exam Mark*. We also report between- and within-student standard deviations which we need when we control for student fixed-effects. We also report statistics of the students' mother tongues (Native German speaker and Native Italian speaker), as well as on Exam Languages. *External Exams* reports the share of exams taken with national or international mobility programs, whereas *Quant. Exams* are exams of quantitative nature.

so that our coefficients can be interpreted with reference to an outcome variable that goes from 0 to 1. This means that the average grade translates from the original 24.72 to 0.517, once transformed. This is the figure we use as denominator when we express the effects we find in %. We also report between- and within-student standard deviations as we will be controlling for student fixed-effects in most of our regression models, and we will express the main effects also in terms of share of the within standard deviation, so 0.227 is the relevant figure in this case.

Female students took 62% of the exams. We observe a slightly higher number of exams taken by Italian natives compared to German native speakers (56.8% versus 43.2%), but the two categories are quite balanced. In terms of exam language, non-mother-tongue exams make up for more than 70% of our sample. English is the most represented exam language with 48.5% of all exams, 17% of the exams are in German, whereas more than one third of the courses are taught in Italian. External exams account only for 3.6% of the total, with 90.5% due to international and 9.5% due to national mobility. Finally, nearly one third of the exams are of quantitative nature, where we classified as quantitative courses in mathematics, physics, statistics, econometrics, finance, informatics, and related subjects. In what follows, we will also explore whether there is a differential impact of language of instruction for quantitative courses, where one could think that linguistic skills are less important.

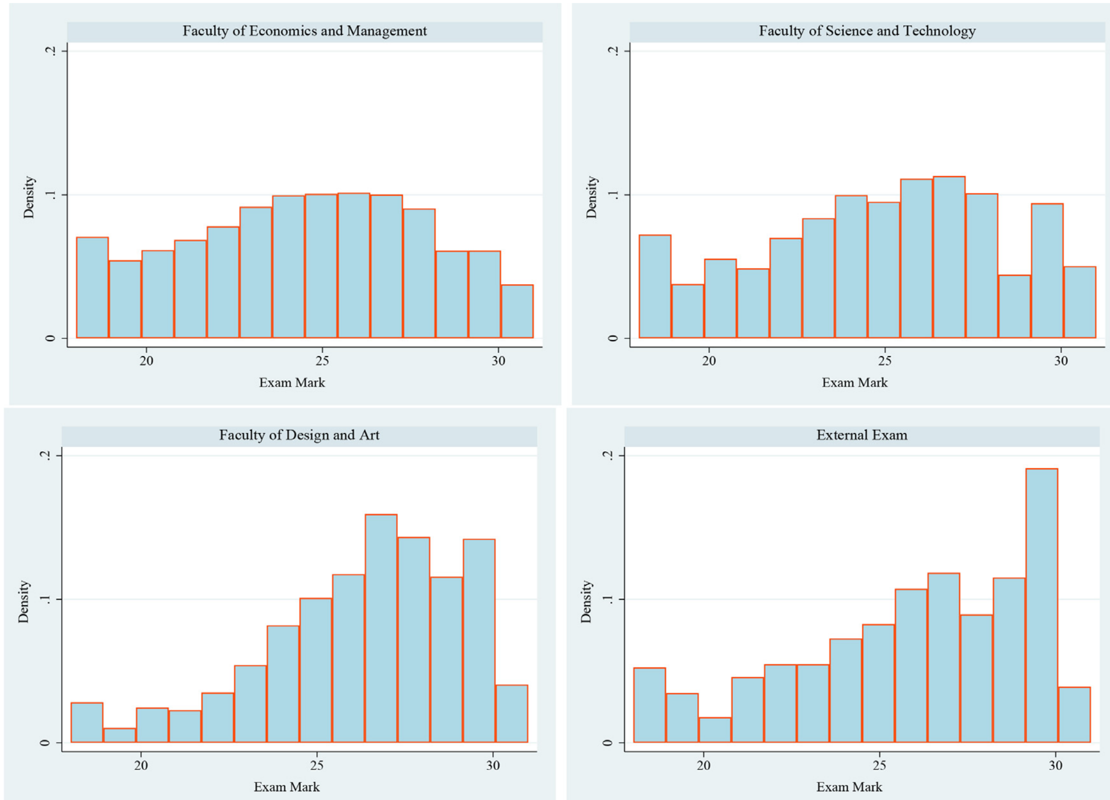

Fig. 2. Grade Distribution over Faculties. *Notes:* The figures show the overall distribution of sufficient grades (18 to 31) for the Faculties of Economics and Management, Science and Technology and Design and Art. The last sub-figure shows the grade distributions for exams taken with international or national mobility programs.

6. Results

In this section, we start with a preliminary assessment of the correlates of exam marks, using pooled regressions. We then move to analyse the "elusion strategies" put in place by students to avoid taking mandatory exams in a language that is not their mother tongue. To this end, we look at the likelihood of deferring or anticipating an exam offered in a language that is not the mother tongue when there is a language switch from one academic year to the next, and at whether the likelihood of taking an exam in another university (e.g., in Erasmus) depends on the language mismatch between the student and the course offered at the University. We show evidence that students indeed put in place such elusion strategies, even if the quantitative impact is rather limited. In the main part of our analysis, we look at the impact of language mismatch on final marks. We start with an analysis using student fixed effects. Considering the elusion strategies described above, we then instrument the actual language of the exam with the curricular language and show that the results for this complementary analysis are very similar to fixed effect regressions. We also conduct some heterogeneity analysis to better understand our finding of a penalty if an exam is taken in a language different from the mother tongue. Finally, we will show that the language mismatch also affects the likelihood of failing exams, using zero-inflated Poisson regressions to model the number of failed attempts.

6.1. Preliminary assessments

For an initial exploratory analysis, we ran a pooled regression model (Table 5) with the exam grade as dependent variable and standard errors clustered at the individual student level. In model (1) of Table 5 we show the overall negative effect on grades when the exam is not in the student's native language, controlling only for the year of study. In models (2) and (3) we extend our analysis by including gender, native language and exam language (German is the omitted category in both cases), and a dummy for exams taken abroad or with another Italian university. In order to show the effect of the language level, in model (3) instead of controlling for the exam not being in the student's mother tongue, we introduce a finer distinction, using a categorical language level variable with *Native Speaker* as the reference category and separate indicators for the student level of proficiency in the foreign language. In model (4) we also control for high school type (Arts and Music, Gymnasium, Vocational and Technical School, Foreign High School Diploma), cohort, and professor type. In addition, we also introduce an interaction term between the negative effect of not taking an exam in the own mother tongue and the exam being of quantitative nature (e.g., mathematics, statistics, econometrics). We do not observe professor type for external exams, so in this case the sample size is slightly smaller and we cannot add the dummy for external exams.

Throughout all model specifications we observe a robust negative effect on grades for exams that are not in the student's mother tongue. In the unconditional regression, exam marks in a non-native language are approximately 8%[21] lower than marks of exams in the native language, or, to use another metric, 0.043/0.28=0.15 standard deviations. The negative effect holds even after including a strict set of controls in terms of high school type, cohort, faculty and professor type. The difference with the unconditional effect is mostly due to English exams. These are "not in mother tongue" for all the students in our sample, but, as it is evident in columns (2) to (4), they generally have a higher mark.

Furthermore, and in line with previous literature, female students perform slightly better than their male colleagues. Being an Italian na-

[21] This is obtained from -0.043/0.517, where 0.517 is the mean value of the rescaled exam mark variable as reported in Table 4.

Table 5
Pooled Regression Models.

	(1) Exam Mark	(2) Exam Mark	(3) Exam Mark	(4) Exam Mark
Exam not in mother tongue	-0.043***	-0.083***		-0.080***
	(0.004)	(0.005)		(0.005)
Language Level B1 to B2			-0.101***	
			(0.005)	
Language Level C1 or C2			-0.044***	
			(0.007)	
Female student		0.015*	0.013*	0.021**
		(0.007)	(0.007)	(0.007)
Native Italian		0.029***	0.027***	0.013
		(0.006)	(0.006)	(0.008)
Exam in English		0.098***	0.102***	0.107***
		(0.006)	(0.006)	(0.007)
Exam in Italian		0.052***	0.050***	0.054***
		(0.005)	(0.005)	(0.007)
External Exams		0.124***	0.120***	
		(0.011)	(0.011)	
Quant. Exam=1				-0.063***
				(0.007)
Quant. Exam=1 × Exam not in mother tongue				0.003
				(0.008)
Constant	0.650***	0.586***	0.582***	0.481***
	(0.010)	(0.011)	(0.011)	(0.046)
Number of Exams	26,807	26,807	26,807	25,844
Additional Controls				
Year of Study	Yes	Yes	Yes	Yes
High School Type	No	No	No	Yes
Cohort	No	No	No	Yes
Professor Type	No	No	No	Yes

Notes: The dependent variable is "Exam Mark (norm.)", which are passing grades of mandatory exams on a minmax scale from 0 (Italian minimum passing grade: 18) to 1 (Italian maximum grade: 30 cum laude). The method of estimation is OLS. Robust standard errors are clustered at the individual student level. Reference categories (top to bottom): Exam in mother tongue, Native Language Level, Male Student, Native German, Exam in German, Exam taken with the University, Qualitative Exam Type. The lower number of observations in model (4) is due to professor types which exclude exams taken outside the University by construction. $* \ p < 0.05$, $^{**} \ p < 0.01$, $*** \ p < 0.001$.

tive speaker as opposed to the reference category of being a German native speaker yields a positive and significant effect in models (2) and (3), effect which however disappears in the full model (4). The lack of a statistically significant coefficient for the variable Native Italian shows that, after controlling for course language and other factors like the high school attended and the cohort, there are no differences in the overall academic performance between students of different linguistic background.

With regards to the exam language, English and Italian exams are graded higher than German exams, a difference that also persists once we include professor type as control variable. In models (2) and (3) we show that grades of exams taken with other universities (i.e., Erasmus and free mover programs) are approximately 0.123/0.517=24% higher than grades of exams taken at the University. This could be due to lower standards for exchange students in other universities or a self-selection of better students into such programs.[22] In model (3) we differentiate the effect of exams not in the mother tongue according to the level of language proficiency and show that the negative effect of language mismatch decreases with higher language levels. Finally, in model (4) we allow for a heterogeneous impact between quantitative and qualitative courses, finding that, while overall students perform worse in quantitative exams, having such exams not in the mother tongue has no differential effect.

[22] These external exams are excluded by construction in model (4) as we control for professor characteristics, an information available only for exams taken at the University.

6.2. Elusion strategies

If taking an exam in a language other than the mother tongue is costly, then students could actively try to evade the trilingual language policy, for instance, by anticipating exams or deferring them to a later point, in case of a change in the teaching language from one academic year to the next. Alternatively, they could try to take mandatory exams that at the University are offered in a language other than their mother tongue at another university by participating to national or international mobility programs.

To analyse potential elusive behaviour, we look at passed exams and exploit the information on the curricular exam language (i.e., the exam language according to the study plan) and compare it to the actual exam language. We estimate all these models using OLS, but the results are robust when we use Probit instead. Model (1) in Table 6 shows the results for the likelihood of deferring an exam to a later point in time. We do find a significant and positive effect if the original exam language was not the student's mother tongue, but the actual (later) exam language was. In other words, when the exam language changes, which usually happens if the instructor changes, and becomes a match for the student mother tongue, a student is more likely to postpone taking the exam. It is important to bear in mind, however, that this is not a common occurrence. In total, we have only 159 exams for which the interaction term in the regression equals 1. Model (2) reports the mirror phenomenon, anticipating an exam compared to the standard course of studies, when there will subsequently be an "unfavourable" change. We find only weak evidence of this behaviour.

Students could also decide to avoid non-mother-tongue exams with the University by taking the exam abroad or with another Italian uni-

Table 6
Likelihood of Exam Language Elusion.

	(1) Deferring	(2) Anticipating	(3) Mobility
Curricular Language not MT=1	-0.661***	-0.030	0.015***
	(0.023)	(0.023)	(0.002)
Exam Language MT=1	-0.728***	0.012	
	(0.023)	(0.023)	
Curricular Language not MT=1*Exam Language MT=1	1.329***	0.078*	
	(0.039)	(0.040)	
Native Italian	0.014*	0.006	0.016***
	(0.007)	(0.004)	(0.003)
Constant	0.819***	0.031	-0.015***
	(0.035)	(0.030)	(0.003)
Number of Exams	25,844	25,844	26,807
Number of students	2954	2954	2954
R^2	0.107	0.074	0.048
Additional Controls			
Cohort	Yes	Yes	Yes

Notes: The dependent variables are “Exam deferred=1 (d.)” for model (1), “Exam anticipated=1 (d.)” for model (2) and “Exam taken in mobility=1 (d.)” for model (3). Samples include mandatory exams with a passing grade. Samples of models (1) and (2) include only exams taken with the University. The method of estimation is OLS (Probit models confirm the results and are available upon request). Robust standard errors are clustered at the individual student level. $* \ p < 0.05$, $** \ p < 0.01$, $*** \ p < 0.001$.

Table 7
Testing for endogeneity: Fixed-Effects ITT and IV.

	(1) Baseline FE	(2) ITT	(3) IV	(4) IV (I Stage)
Exam not in mother tongue	-0.049***		-0.049***	
	(0.004)		(0.004)	
Exam not in mother tongue (curr.)		-0.047***		0.975***
		(0.004)		(0.002)
Constant	0.632***	0.631***	0.632***	0.011**
	(0.024)	(0.024)	(0.024)	(0.004)
Number of Exams	25,844	25,844	25,844	25,844
Number of students	2954	2954	2954	2954
R^2	0.023	0.023	0.023	0.951
ρ	0.37	0.37	0.37	0.15

Notes: In columns (1)–(3) the dependent variable is the normalized final mark. Model (1) includes student fixed-effects. Model (2) is the same as model (1) but considers curricular exam language rather than actual exam language to construct the variable “Exam not in mother tongue”. In Model (3) we instrument the variable “Exam not in mother tongue” with the alternative version based on the curricular exam language. Model (4) reports the first stage, with the dependent variable being “Exam not in mother tongue”. Samples include mandatory exams with a passing grade. In all regressions, we control for year of study and professor type. Robust standard errors are clustered at the individual student level. $* \ p < 0.05$, $** \ p < 0.01$, $*** \ p < 0.001$.

versity. Model (3) shows the likelihood of taking an exam elsewhere and also in this case we observe a positive and significant effect, so that students are more likely to take an exam elsewhere when this is offered in a language other than their mother tongue at the University. As shown in the descriptive statistics only 3.6% of exams are external, so this type of behaviour, even if we can detect it, does not have a strong quantitative impact on the overall language composition of exams.

Given the possible endogeneity of the exam language due to the above behaviours, in our analysis of the impact on the final mark, we will instrument the exam language with the curricular language. Consistently with the very small quantitative impact that we report here, however, the instrumental variable approach leaves the overall picture unchanged.

6.3. Impact on the final mark

In Table 7 we assess the impact of language on exam marks. To account for student-specific effects, we start with a linear regression model with student fixed-effects, in column (1). In model (2), we use an intention-to-treat approach. In this case, to create the “exam not in the mother tongue” variable, we replace the actual exam language with the curricular exam language. Therefore, the match or mismatch between student mother tongue and exam language is based not on the actual exam language, but on the curricular one. The two languages may indeed differ, and the difference may be systematic, biasing our estimates, if many students apply the elusion strategies discussed above. The two coefficients, however, are very similar, consistent with the fact that students do not manage to change the language portfolio envisaged by the degree study plan in a quantitatively significant manner. Finally, in model (3), we instrument the variable “Exam not in mother tongue” with the alternative version described above based on the curricular exam language, reporting the first stage in model (4). Note that the instrumental variable is implemented with individual fixed effects.[23] In all regressions, we control also for professor type, and this implies that only exams at the University are included. Results are very similar when we drop this control and include also external exams.

Given the negligible difference between the four coefficients and the high compliance rate (96%), we proceed to perform the analysis using the baseline fixed-effects linear regression model presented earlier in Eq. (1).

[23] The first-stage F-statistic amounts to $3.8e+05$ ($p = 0.000$). The post-estimation endogeneity test fails to reject that “Exam not in mother tongue” (and hence the exam language) are exogenous.

Table 8
Fixed-Effects Regression.

	(1)	(2)	(3)	(4)
Exam not in mother tongue	-0.049***	-0.093***		-0.092***
	(0.004)	(0.005)		(0.005)
Language Level B1 to B2			-0.102***	
			(0.005)	
Language Level C1 or C2			-0.072***	
			(0.006)	
Exam in English		0.107***	0.110***	0.115***
		(0.007)	(0.007)	(0.007)
Exam in Italian		0.048***	0.047***	0.049***
		(0.007)	(0.007)	(0.007)
Quant. Exam=1				-0.059***
				(0.007)
Quant. Exam=1 × Exam not in mother tongue				0.000
				(0.008)
Constant	0.632***	0.607***	0.598***	0.556***
	(0.024)	(0.024)	(0.024)	(0.022)
Number of Exams	25,844	25,844	25,844	25,844
Number of students	2954	2954	2954	2954
R^2	0.023	0.032	0.037	0.015
ρ	0.37	0.38	0.37	0.44
Additional Controls				
Year of Study	Yes	Yes	Yes	Yes
Professor Type	Yes	Yes	Yes	Yes
Student Course	No	No	No	Yes

Notes: The dependent variable is “Exam Mark (norm.)”, which are passing grades of mandatory exams on a minmax scale from 0 (Italian minimum passing grade: 18) to 1 (Italian maximum grade: 30 cum laude). The method of estimation is linear regression with fixed effects. Robust standard errors are clustered at the individual student level. Reference categories (top to bottom): Exam in mother tongue, Native Language Level, Exam in German, Qualitative Exam Type. The additional control “Student Course” controls for the within-student variation of having done two degrees with the University (e.g., BA and MA). $* \ p < 0.05$, $** \ p < 0.01$, $*** \ p < 0.001$.

First of all, we replicate the preliminary analysis using a model with student fixed effects. Of course, we cannot anymore control for characteristics like gender and student native language as these are invariant over exams passed by the same student. Column (1) in Table 8 corresponds to column (1) in Table 7. In all model variations of Table 8, we obtain clear evidence of the negative effect of giving exams in a non-native language. Similarly to the pooled model, we find that in the unconditional regression grades are on average 9.5% lower when the exam is taken in a foreign language which corresponds to 0.22 (within-student) standard deviations. The fixed-effects model confirms that exams in English and in Italian are graded higher than exams in German. In model (3) we differentiate the impact by the students’ proficiency in their non-native language. The baseline level is *Native Speaker*, so the coefficient of *Language Level C1 or C2* shows the impact on grades if the student masters the language very well, despite being a non-native speaker. The negative effect on grades is still highly significant and of considerable size compared to the average effect in models (1) and (2), even if the students master the language at a very high level (C1 and C2). Finally, column (4) confirms that there is no differential effect for quantitative courses.

To assess whether there are asymmetries in the effect of higher language levels, in Table 9 we divide our sample into German native speakers (models (1) and (2)) and Italian native speakers (models (3) and (4)). Using *Native Speaker* as the reference category, we look separately at the impact of a non-native language known at the *Language Level C1 or C2* or at the language level *Language Level B1 or B2*.

Models (1) and (3) show the effect on grades of learning in German and Italians for Italian or German native speakers. We find that for German native speakers who take an exam in Italian, only those with lower proficiency in Italian get a lower grade compared to the exams in their mother tongue German. Conversely, Italian natives have a strong disadvantage in terms of grades for exams in German, with no significant difference between proficiency levels (the Wald test fails to reject equality of coefficients *Language Level C1 or C2* and *Language Level A1 or B2* in model (3) with $p = 0.15$).

In models (2) and (4), instead, we compare the native language to English, and show that German natives who are proficient in English appear to do somehow better compared to their performance in German exams. Italians experience a negative effect on grades when taking exams in English, but this is true only for low proficiency levels.

So, there is heterogeneity in terms of impact. These results on exam mark, however, need to be considered in conjunction with the results on failed attempts that we present in what follows, where we will show that in those instances in which there is no negative impact on marks, there is actually an impact in terms of failed attempts.

6.4. Failed attempts

A further indicator of interest concerning the effect of language on performance is the number of failed attempts to pass exams. To this end, here we analyse the number of failed exams and see whether it depends on linguistic mismatch. In the zero-inflated Poisson regressions models in Table 10, we run the analysis on number of failed exams per student at the exam language level, counting failed attempts for each student by exam language. We control for the high number of zero-counts (57%) of failed attempts with the students’ GPA. The exposure variable is given by the total study time, or the maximal year of study, and coefficients are shown as incidence rate ratios (IRR). Models (1) and (2) are run on the full sample, with both native Italian and native German speakers, whereas the samples of models (3) and (4) are native German speakers only and native Italian speakers only, respectively. In model (1), the IRR for exams given in a language different than the native language is greater than one and strongly significant, meaning that exams in a second language compared to exams in the mother tongue, while holding all other variables constant, are expected to have a rate of 1.3 for failed attempts. In model (2) we observe that native Italian speakers have a lower fail rate for exams not in their mother tongue compared to native German speakers. Finally, models (3) and (4) show that native German speakers are more prone to failure in exams in both Italian and English compared to exams in their mother tongue. On the other hand,

Table 9
Fixed-Effects Regression: Between-native comparison.

	(1) Native GER GER and ITA exams	(2) Native GER GER and ENG exams	(3) Native ITA ITA and GER exams	(4) Native ITA ITA and ENG exams
Language Level B1 to B2	-0.066***	0.002	-0.140***	-0.033***
	(0.009)	(0.007)	(0.008)	(0.005)
Language Level C1 or C2	-0.008	0.036*	-0.116***	-0.011
	(0.012)	(0.014)	(0.016)	(0.008)
Constant	0.498***	0.495***	0.568***	0.566***
	(0.005)	(0.005)	(0.002)	(0.002)
Number of Exams	5929	7627	7568	12,555
Number of students	1120	1238	1512	1693
Year of Study	Yes	Yes	Yes	Yes

Notes: The dependent variable is "Exam Mark (norm.)", which are passing grades of mandatory exams on a minmax scale from 0 (Italian minimum passing grade: 18) to 1 (Italian maximum grade: 30 cum laude). The method of estimation is linear regression with fixed effects. Robust standard errors are clustered at the individual student level. Reference category is Native Language Level. No external exams, mandatory only.
The first model refers to exams in German or in Italian taken by native German speakers, the second column refers to exams in German or in English taken by native Germans, similarly for native Italians in columns 3 and 4. $* \ p < 0.05$, $** \ p < 0.01$, $*** \ p < 0.001$.

Table 10
Failed attempts (Incidence Rate Ratio).

	(1) Full Sample	(2) Full Sample	(3) Native GER	(4) Native ITA
Exam not in mother tongue	1.303***	1.954***		
	(0.06)	(0.13)		
Native Italian		1.673***		
		(0.13)		
Exam not in mother tongue × Native Italian		0.525***		
		(0.04)		
Exam in English			1.912***	1.136*
			(0.13)	(0.06)
Exam in Italian			1.997***	
			(0.14)	
Exam in German				0.885
				(0.06)
inflate				
GPA	1.932***	1.975***	2.193***	1.905***
	(0.04)	(0.05)	(0.10)	(0.05)
Number of Student-Language clusters	7358	7358	3205	4153
Number of students	2954	2954	1254	1700
Zero observations	4175	4175	1767	2408

Notes: The dependent variable is Failed Attempts (at the student and exam language level). The method of estimation is Zero-Inflated Poisson Regression. Exposure Variable: Year of studies. Zero-rate predictor: Average Grades. Robust standard errors are clustered at the individual student level. For better comparability we excluded 103 students with failed exams only in their records. Reference categories: Exam in mother tongue, Native German, Exam in German for model (4) and Exam in Italian for model (5). $* \ p < 0.05$, $** \ p < 0.01$, $*** \ p < 0.001$.

native Italian speakers fail more often only in English, whereas they fail somewhat less in exams in German.

Putting together the analysis on failed attempts and on final marks, it appears that both native Italian and native German speakers suffer when studying in a language that is not their mother tongue, albeit the mechanism may differ. In particular, German speakers appear to fail more exams in Italian and English (and also get a lower mark for exams in Italian unless they have a very high proficiency level). Italian speakers get a much lower final mark in German exams, and for exams in English they get a combination of a slightly higher failure rate and a slightly lower mark when not highly proficient. In the conclusions, we will discuss some policy implication of these findings.

7. Conclusions

Numerous studies underline the advantages of foreign language skills in terms of labour market outcomes and social equality. Our analysis adds to the existing literature on multilingual education and multilingual societies by shedding light on the other side of the coin: the difficulties of non-native learning. We do this in the context of tertiary education, where the increasing international mobility of students makes the issue particularly relevant. The aim of our work is to complete the picture, enabling policies to be designed in a more targeted manner once the impact of learning in a non-mother-tongue language is acknowledged.

Our data stems from the Free University of Bozen-Bolzano which has a trilingual study policy (German, Italian and English) and is populated mainly by native German speakers and native Italian speakers. We do observe an average loss of approximately 9.5% in terms of passing grades for exams that are not taken in the student's mother tongue, equivalent to 0.22 within-student standard deviations.[24] This represents quite a significant impact, considering, for example, that the literature on the impact of class size in higher education usually finds an implied

[24] This is quite similar to the reduction of 0.2 standard deviations documented by Anghel et al. (2016) in the context of Spanish primary schools. See the introduction for details.

effect size of around -0.1, meaning that an increase of one standard deviation in class size is associated with a decline of 0.1 standard deviations in marks (see, for instance, Bandiera et al., 2010; De Giorgi et al., 2012; Kara et al., 2021). Such a substantial impact is remarkable, given that students freely choose to enrol in a trilingual university, while more traditional options are available in nearby regions. One should expect such students to be better suited than the average to pursue an education in a language other than the mother tongue. On the other hand, the fact that the University is not bilingual, but trilingual may pose a particularly strong strain on students' cognitive skills.

Overall, with these results in mind, governing bodies of higher education institutions should therefore explicitly address the topic of non-native learning and develop targeted policies in order to avoid inequalities in terms of grades between students of different linguistic backgrounds. Furthermore, in terms of post-graduate effects, job application procedures should put particular attention on integrating standardised GPA assessments with further information on the applicant's linguistic curriculum during the years of education to lower the risk of excluding those candidates with a lower GPA solely due to an educational path undertaken in a non-native language. For educational institutions, particular attention should be given to lowering the cost of multilingual learning by equally granting access to mobility programs and programs for second language acquisition, for example through scholarships and incentive schemes. Our results indeed show that a high proficiency level can be effective in mitigating the costs of acquiring education in a non-native language.

In fact, policy makers around the world have started to address linguistic diversity[25] by looking into mother tongue-based multilingual education (MTB MLE) strategies to overcome the language gap migrant children and adolescents face and to grant them a fair access to schooling (Grin et al., 2018). Thailand, for instance, approved a national language policy in 2010 that secures the right to Thai children of receiving mother-tongue education. This applies not only to the country's more than 70 ethnic minorities, but also to children of foreign immigrants.[26]

In conclusion, the aim of our work was to show the effect of non-native learning on academic performance and we document a negative impact in terms of marks. The advantages of multilingual learning and the added value offered by a polyglot curriculum in terms of skills is an aspect which is of fundamental importance, yet beyond the scope of our paper.

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[25] In this sense, in December 2017, a special session of the *Salzburg Global Seminar Series* has produced *The Salzburg Statement for a Multilingual World* (Regester and Norton, 2018). The meeting brought together experts from the private and the academic sector and looked specifically at multilingualism and its importance to dynamic and entrepreneurial societies, as well as the importance of language rights for minority groups around the world. The issue was assessed from a number of different perspectives, such as policy making, language rights, social cohesion and language teaching. Policy recommendations specifically addressed the need of "*utilizing insights from educational and cognitive research for mother tongue and other-tongue learning*".

[26] The policy states as follows: "It is the policy of the government to promote bilingual or multilingual education for the youth of ethnic groups whose mother tongue is different from the national language [Thai], as well as those from other countries who enter Thailand seeking employment." (www.nationthailand.com/perspective/30219853).