Disentangling the Predictive Validity of High School Grades for Academic Success in University

To refine selective admission models, we investigate which measure of prior achievement has the best predictive validity for academic success in university. We compare the predictive validity of three core high school subjects to the predictive validity of high school GPA for academic achievement in a liberal arts university program. Predictive validity is compared between the Dutch pre-university (VWO) and the International Baccalaureate (IB) diploma. Moreover, we study how final GPA is predicted by prior achievement after students complete their first year. Path models were separately run for VWO (*n* = 314) and IB (*n* = 113) graduates. For VWO graduates, high school GPA explained more variance than core subject grades in first year GPA and final GPA. For IB graduates we found the opposite. Subsequent path models showed that after students' completion of the first year, final GPA is best predicted by a combination of first year GPA and high school GPA. Based on our small-scale results, we cautiously challenge the use of high school GPA as the norm for measuring prior achievement. Which measure of prior achievement best predicts academic success in university may depend on the diploma students enter with.

Keywords: Comparing curricula; Selective admission; Academic success; Grades; Prior achievement

Introduction

Selective admission to university is commonly used. University programs may be forced to select among applicants due to limited capacity, or they may choose to do so in an effort to serve only the most prepared students. Universities use different procedures as a result of different conceptualizations of the fair selection of students. Most universities choose a merit-based approach in which students are selected on the basis of their prior achievement (Pitman 2016). Nonetheless, discussion remains on whether prior achievement alone is enough for fair selection, as it has been argued to be disadvantageous for males (Olani 2009), ethnic minorities (Kobrin and Patterson 2011; Shulruf, Hattie, and Tumen 2008; Tumen, Shulruf, and Hattie 2008) and groups with lower social economic status (Cantwell, Archer, and Bourke 2001).

A large body of literature looks at how merit-based models are applied in selection procedures of universities to best predict which students will be successful in the program. In these studies academic success is typically regressed on prior achievement (e.g. Cliffordson 2008; Geiser and Santelices 2007; McKenzie, Gow, and Schweitzer 2004; Olani 2009). Academic success is most commonly operationalized as students' first-year grade point average (GPA) as well as final undergraduate GPA, and the effectiveness of selection variables may differ between first-year GPA and final GPA (Geiser and Santelices 2007). Prior achievement on the other hand is almost exclusively operationalized as high school GPA (e.g. Cliffordson 2008; Van Ooijen-Van der Linde, Van der Smagt, Woertman, and Te Pas 2016; Steenman, Bakker, and Van Tartwijk 2016). Often, high school GPA is the only factor used in merit-based selection procedures (Pitman, 2016).

Even though merit-based admission is commonly regarded as fair, politicians, researchers, and administrators debate whether prior achievement should be the *only* factor to base selective admission decisions on or whether other indicators of future academic success should be taken into account as well. Possible additional factors discussed are the Scholastic Aptitude Test (SAT) or measures of creativity, personality and motivation (Ackley, Fallon, and Brouwer 2007). The use of SAT has been criticized as validity and reliability is questioned (e.g. Geiser and Santelices 2007), while the predictive validity of measures of creativity, personality and motivation have shown to be small (Olani 2009; Tumen, Shulruf, and Hattie 2008). This body of literature provides most convincing support for the predictive validity of prior achievement as the best predictor of academic success in university (Cliffordson 2008; Geiser and Santelices 2007; Olani 2009; Tumen, Shulruf, and Hattie 2008). Therefore, high school GPA may be the single most reliable factor to base selection decisions on.

Selective admission before and during the bachelor

Selective admission can take place both before and during the bachelor. First, students can be selected into a program (‘at the gate’). Second, some universities continue to ‘select out’ students during their bachelor, through academic dismissal policies (De Koning et al. 2012, 2014). These policies are most common in the first year of a bachelor program and state that students have to leave the program of study if their GPA drops below a certain standard or when they have failed to accrue a minimum amount of credits (Arnold 2014; De Koning et al. 2012, 2014).

As argued above, prior achievement in the form of high school grades may predict first-year GPA best and is therefore most commonly used in selection procedures at the gate (Cliffordson 2008; Geiser and Santelices 2007; Olani 2009). Furthermore, academic dismissal policies are mostly based on prior achievement in university (Arnold 2014), as first-year GPA may predict final GPA best (Tumen, Shulruf, and Hattie 2008). Nonetheless, some evidence suggests prior achievement in high school should also be taken into account in academic dismissal policies. Studies have shown that high school GPA is predictive of final

GPA, even if first-year GPA is already included as a predictor of final GPA (e.g. Harackiewicz et al. 2002). This implies that to best predict the final GPA of bachelor students, both first-year GPA and high school GPA should be taken into account.

How to measure prior achievement

How prior achievement should be operationalized when using it to select students is not much discussed. Discussions that do focus on the operationalization of prior achievement focus on the question of whether or not to use the average or a weighted high school GPA. The differences between both are minimal. Shulruf, Hattie and Tumen (2008) show that when predicting the GPA of first-year students, weighing high school GPA for the amount of credits or for the amount of subjects does not increase or decrease the predictive validity of high school GPA for academic success.

An approach that has received less attention in deciding how to operationalize prior achievement but that should be at the heart of the discussion is whether high school GPA, when it is operationalized as the average of all grades, validly captures prior achievement. Even though high school GPA may summarize all grades neatly in one variable that reflects the overall achievement score of a student and can be seen as a variable with little measurement error, this variable is actually built upon different standards of achievement. Bowers (2011), Reed (2014), and Thorson and Cliffordson (2012) show that the grades of different subjects cannot be validly captured in one factor (represented by high school GPA), as the fit of a one-factor model is not satisfactory. Moreover, different students often graduate in different subjects from secondary school, which means that measures upon which high school GPA is calculated differ between students. For this reason, the validity of high school GPA can be questioned even more (Steenman, Bakker, and Van Tartwijk 2016). This is problematic because different subjects may draw upon divergent skills and knowledge. For example, to get a good grade in mathematics, analytical skills and problem-solving skills are used, whilst to excel in English, literacy and decision making skills are necessary (Ofqual 2012). Consequently, high school GPA may have diverse predictive validity for academic success in different bachelors or even in the same bachelor for different students (Bacon and Bean 2006).

Cliffordson (2008) suggests that, in order to find a valid measure of prior achievement, it should be investigated how separate grades affect performance in university. When students follow diverse subjects it is impossible to model the effect of all subjects. Nonetheless, some subjects may be mandatory for all students. Klapp Lekholm and Cliffordson (2008, 2009) mention three core subjects Swedish students have to take in secondary school: English, mathematics and their mother tongue. Comparing curricula, these core subjects can be identified in all European curricula (Ofqual 2012). The one difference that can be found is that core subjects for English speaking students consist of English and mathematics only, as their mother tongue is English.

The grades received for core subjects may even predict academic success better than high school GPA does. Klapp Lekholm and Cliffordson (2008, 2009) show that when trying to capture the three before mentioned core grades in a factor model, grades could be better modeled separately than by one factor that measured academic achievement. On the other hand, an important part of the skills of students in other subjects may be missed when only including the three measures of the core subjects in selection procedures. This may imply that the use of only the core subject grades may result in a less valid measure of secondary school achievement than when using high school GPA. To conclude: it remains unclear whether core subjects or high school GPA may more accurately predict academic success in university.

Selection and students with different high school diplomas

Another factor that might affect the predictive validity of core subjects and high school GPA for academic success that should be taken into account is the curriculum followed by the students. As a result of internationalization, universities increasingly select among applicants with a broader range of high school diplomas (Reumer and Van der Wende 2010). Different curricula may incorporate different subjects as well as different goals and skills for similar subjects (Ofqual 2012). Fu (2012) showed that the predictive validity of high school GPA for academic success differs for students with different high school diplomas.

Even though the predictive validity of high school grades for academic success may differ between curricula, most research that focuses on the predictive validity of high school grades does not take the diploma students enter university with into account. Students that enter university with a different diploma than the default national diploma, are almost always excluded in research that evaluates the predictive validity of high school grades (De Gruijter, Yildiz, and ‘t Hart 2006). When students with different diplomas are included, researchers review the predictive validity of language of instruction ability tests (e.g. TOEFL) rather than the possibility of a different predictive validity of high school grades. This may be because students with different diplomas in practice are mostly international students (e.g. Feast 2002; Mathews 2007). Some studies have evaluated the relation between high school grades and academic success of students with different diplomas. Unfortunately, sample sizes of students with another diploma than the default diploma were rather small in these cases (e.g. Fu 2012; Reumer and Van der Wende 2010).

Present study

To uncover the most effective way of selecting high school students for university programs, we compare the predictive validity of high school GPA (HSGPA) to the predictive validity of core subjects for first-year GPA (FYGPA) and final GPA to determine whether HSGPA or core subject grades can best be used in selection procedures. Furthermore, we analyze whether these predictors equally affect academic achievement in university for students with different high school diplomas. As the predictive validity of HSGPA has not yet been compared to the predictive validity of core subjects for academic success, and no studies have validly compared the predictive validity of high school grades across different curricula, no specific predictions are postulated. Rather, the following research questions were formulated:

1. Is academic success on both short term (FYGPA) and long term (final GPA) better predicted by prior achievement in terms of HSGPA or by core subject grades? A sub-question is: Do HSGPA and core subject grades have similar predictive validity when comparing students with different diplomas?
2. After the first year in university, do HSGPA or core subject grades contribute more to the prediction of final GPA by FYGPA? A sub-question is: Do HSGPA, core subject grades, and FYGPA have similar predictive validity when comparing students with different diplomas?

Method

Participants

The study was carried out at a university college in the Netherlands (UC), which offers an undergraduate liberal arts program. As the language of instruction at UC is English, UC attracts students with different high school diplomas. UC applies both selection at the gate as well as academic dismissal policies. Every year, 25 percent of the applicants are admitted to UC (approximately 225 students are admitted); they are selected based on HSGPA, English proficiency, motivation, and recommendation letters. Final decisions regarding admittance are also based on cohort considerations such as a distribution of academic interests, gender balance and the ratio of international versus national students, but the emphasis remains on the academic achievement and motivation of students. During their bachelor program students are required to maintain a GPA above 2.0. If a student is not in good academic standing for two consecutive semesters, they are requested to leave. Every year, between zero and five students are dismissed from UC.

Data were extracted for three cohorts of students who completed UC (2009-2012 until 2011-2014). Only students with the Dutch pre-university secondary education diploma (*Voortgezet Wetenschappelijk Onderwijs*, henceforth referred to as VWO) (n = 377) and the International Baccalaureate (IB) diploma (n = 146) were eligible for analyses, due to small sample sizes of other diplomas. Examples of these other diplomas with which students entered UC are English A-levels, German Arbitur and French baccalaureate.

Students with a VWO diploma were on average 18.5 years old (SD = 0.72) at the start of their studies and 62% of the students were female. The average starting age at UC of students with an IB diploma was 18.9 years (SD = 0.86) and 63% of the students were female. The majority of the students with a VWO diploma were Dutch (99%), some students, however, were of Belgian or German nationality. For the IB diploma, the highest proportion of students was also Dutch (49%). Other students who entered UC with an IB diploma came from a total of 24 other countries.

Descriptions of local (VWO) and IB high school curricula

VWO

After 8 years of elementary school, Dutch students are sorted in different high school tracks around the age of twelve. Approximately the top 20% of all students are selected for the six-year VWO high school program (Ministerie van Onderwijs, Cultuur en Wetenschap 2013). The first three years are similar for all VWO students, as they all take classes in thirteen or fourteen different subjects (i.e. four languages, three social science subjects, four science subjects, physical education and one or two arts subjects; Reed 2014). After these three years students choose between subjects. Students can choose between four clusters of subjects that are referred to as profiles. Consequently, students graduating from VWO, have taken exams in different subjects. Notwithstanding, all students are required to take Dutch, English, and mathematics (Marginson et al. 2008).

IB

The IB diploma program takes two years and students enroll after tenth grade around the age of sixteen. Students are selected based on their motivation and academic achievement. The program is seen as challenging and suited for gifted students (Callahan 2003). It is the most widely available international high school program in the world and the proportion of students attending IB is growing annually (IBO, 2014). The program is standardized and goals and aims of subjects are determined by the International Baccalaureate Organization (IBO). Students are required to take six subjects: a first language (often the mother tongue of the student), a second language (usually English), a humanities subject, a science subject, mathematics and an art or elective subject (Van Oord 2007).

Procedure

VWO graduates

Data were extracted from UC databases. HSGPA was calculated based on all grades of the high school transcript. Core subject grades for Dutch, English, and mathematics were derived from these transcripts as well.

VWO students can choose between four different mathematics subjects; two of these focus on probability problems and statistics (known as mathematics A and C) and the other two focus on algebra (known as mathematics B and D; Onderwijsraad 2011). Following the aims of the mathematics subjects (Onderwijsraad 2011), mathematics A and C were grouped together in the variable applied math, and mathematics B and D in the variable mathematics.

IB graduates

Grades for mother tongue, English, and mathematics were derived from high school transcripts. HSGPA was calculated based on all grades on the transcript. As not all transcripts were stored in the system (approximately 7 per cent of the transcripts were incomplete or missing), sample sizes may differ per analysis. As requirements and standards for different languages are similar, it was deemed appropriate to construct one variable that reflected the academic achievement in mother tongue. English was the mother tongue for nine students; this grade was used for the variable mother tongue and not for English. Three different mathematics subjects were encountered in students' data: mathematical studies focus on probability problems and statistics, mathematics standard level and mathematics higher level with a focus on algebra (IBO 2012a, 2012b, 2012c). In accordance with the distinction made in the VWO sample, mathematical studies was coded as applied math, and mathematics standard level and mathematics higher level were grouped together and coded as mathematics.

Transformation

As different grading systems are used in the VWO and IB curriculum and to make measures of prior achievement more comparable between VWO and IB graduates, high school grades were transformed. Grades for mother tongue, English, applied math, mathematics, and HSGPA were transformed to percentile scores based on grade distribution tables from Nuffic (2013, 2014). Moreover, as scores are now corrected for the grade system, it may be argued these percentile scores reflect more truly students' normative prior achievement.

FYGPA and final GPA

FYGPA and final GPA were based on weighted grades. As each course in UC had the same course load (7.5 ECTS), FYGPA and final GPA were the average of the obtained grades. Both FYGPA and final GPA were extracted from UC databases and ranged from 0.00 to 4.00, similar to commonly used GPA scales. FYGPA is the cumulative GPA at the end of the first year at UC, whereas final GPA reflects the cumulative GPA of only the second and third year at UC. Final GPA commonly consists of only the second and third year at Dutch universities: grades that are obtained in the first year are not taken into account when calculating their final GPA. Several students quit UC or did not finish their studies at the moment of analysis (VWO n = 62, IB n = 33), resulting in the following final sample sizes: VWO n = 315, IB n = 113.

Analyses

First, descriptive statistics of all grades were obtained and compared with independent *t*-tests between VWO and IB graduates. To answer the first research question and its sub-question, path models in Mplus 7.2 (Muthén and Muthén 1998-2012) were specified. We assessed whether core subject grades predict FYGPA and final GPA better than HSGPA for VWO and IB graduates separately. Except for two students, students only took applied math *or* mathematics in high school, hence these variables could not be used in the same model.

The specified models with corresponding sample sizes can be found in Table 1. Unfortunately, the second model (i.e. FYGPA and final GPA regressed on mother tongue, English, and applied math) could not be specified reliably due to a small sample size (n = 18; Kline 2011). Based on the explained variance of the models, it was determined for VWO and IB graduates separately which model fitted best. Model fit was not taken into account since saturated models were specified (Byrne 2011).

[Table 1 near here]

Constraining models

To test whether the predictive validity of transformed VWO and IB grades were comparable, models were constrained to be equal. For example, we can indicate with these tests whether students who enter in the 70th percentile in VWO and IB are predicted to have the same FYGPA and final GPA. This test is different from the *t*-tests mentioned earlier. *t*-Tests are able to uncover whether mean differences exist between VWO and IB graduates on one variable, whereas constraining allows us to investigate whether similar relations are present between variables for VWO and IB graduates.

First, to determine whether similar slopes were present for grades, betas of the models were constrained to be equal (e.g. MacCann, Fogarty, and Roberts 2012). Second, to determine whether similar intercepts are present for FYGPA and final GPA, intercepts were constrained to be equal. Based on the chi-square difference test, subsequent model fit was assessed (Byrne 2012). When both the intercepts and slopes in the regression equation are similar for VWO and IB graduates, transformed grades are roughly comparable between both groups of students. Constraints were applied to the model that included HSGPA as predictor (model 1) and to the model that included mother tongue, English, and mathematics (model 3). Constraints were not applied to model 2, as the model with applied math could not be specified for IB graduates.

Predicting final GPA by FYGPA and high school grades

To answer the second research question and its sub-question, the predictive validity of the combination of FYGPA and HSGPA, and FYGPA and core subject grades for final GPA were assessed. Similar path models as described above were specified for VWO and IB graduates separately, with the slight difference that a regression path between final GPA and FYGPA was added to each model (three VWO models and two IB models). A schematic overview of the most complex models (additions to models 2, 3a, and 3b; FYGPA and final GPA regressed on core subjects, and final GPA regressed on FYGPA) can be found in Figure 1. Subsequently, the model containing HSGPA and the model containing mathematics were constrained to be equal between VWO and IB graduates following the same procedure as described above.

[Figure 1 near here]

Results

First, assumptions for path models in structural equation modeling were checked. All assumptions regarding normality, homoscedasticity, linearity, and multicollinearity were met. Several univariate and multivariate outliers were identified in the VWO sample. Outliers were inspected and were all deemed reasonable scores, hence outliers were not excluded.

Descriptive statistics and correlations

[Table 2 and 3 near here]

Average percentile scores for the independent variables and average scores for the dependent variables for both VWO and IB graduates can be found in Table 2. A significant difference exists between the FYGPA and final GPA of VWO versus IB graduates in this sample: on average, VWO graduates obtain a higher GPA in university. After transforming high school grades of VWO and IB graduates, VWO graduates generally enter with a higher percentile rank than IB graduates. As these means now reflect percentile scores, lower scores do not represent failing grades, but relative academic achievement. Table 3 reports all correlations for the total sample and for VWO and IB graduates separately.

The predictive value of high school grades for FYGPA and final GPA

Predicting FYGPA and final GPA by HSGPA versus core subject grades

[Table 4 and 5 near here]

VWO graduates. To test whether HSGPA or core subject grades are better predictors of FYGPA and final GPA (research question 1), just-identified path models were specified. Table 4 shows that model 1a, in which HSGPA is used to predict FYGPA and final GPA, explains more variance than model 2 and 3a in which core subject grades are used to predict FYGPA and final GPA. Betas presented in Table 5 show that both applied math and mathematics have a stronger relation with FYGPA and final GPA than mother tongue or English.

IB graduates. Core subject grades (model 3b) explain more variance in FYGPA than HSGPA (model 1b). HSGPA and core subject grades explain roughly the same amount of variance in final GPA. The comparison of the core subject grades' standardized beta coefficients shows that mathematics is the strongest predictor for FYGPA, but mother tongue is an equally strong predictor when looking at final GPA. The effect of English on FYGPA and final GPA is non-significant.

Similarities and differences between models for VWO and IB graduates

[Table 6 near here]

Constraining betas of FYGPA and final GPA on HSGPA, and constraining intercepts of FYGPA and HSGPA both resulted in good model fits (respectively $\Delta\chi^2 = 0.84$, $\Delta df = 2$, $p = .66$; $\Delta\chi^2 = 2.91$, $\Delta df = 2$, $p = .23$).

Constraining the betas of FYGPA and final GPA on mother tongue, English, and mathematics resulted in an acceptable model ($\Delta\chi^2 = 11.66$, $\Delta df = 6$, $p = .07$). Constraining intercepts of FYGPA and HSGPA resulted in a model that fitted the data significantly worse ($\Delta\chi^2 = 6.75$, $\Delta df = 2$, $p = .03$). Allowing the intercept of FYGPA to vary across VWO and IB graduates ($M_{dif} = 0.08$), resulted in an acceptable model fit ($\Delta\chi^2 = 2.76$, $\Delta df = 2$, $p = .10$).

As becomes clear in comparing Table 4 with Table 6, the explained variance increases slightly for VWO graduates, but decreases for IB graduates in both constrained models.

The predictive validity of high school grades and FYGPA for final GPA

Predicting Final GPA by FYGPA and high school grades

[Table 7 near here]

By adding FYGPA as a predictor of final GPA (research question 2), explained variance increased by 19-27% for all specified models. All models of VWO and IB explained approximately the same amount of variance in final GPA. In all models FYGPA was the best predictor of final GPA (see Figure 2, 3, 4). A direct effect of HSGPA on final GPA was found for both VWO and IB graduates when controlling for the indirect effect of HSGPA through FYGPA on final GPA (see Figure 2). Modeling the effects of core subject grades, VWO models show a significant effect of applied math (Figure 3) and mathematics (Figure 4) after controlling for indirect effects. The direct effect of mathematics is not significant for IB graduates. For mother tongue and English only indirect effects were found.

[Figures 2, 3, 4 near here]

Similarities and differences between the models of HSGPA and FYGPA, and core subject grades and FYGPA for VWO and IB

[Table 8 near here]

Constraining the betas of the model including HSGPA, FYGPA and final GPA, and constraining intercepts of FYGPA and final GPA both resulted in good model fits (respectively $\Delta\chi^2 = 1.33$, $\Delta df = 3$, $p = .72$; $\Delta\chi^2 = 2.96$, $\Delta df = 2$, $p = .23$).

Constraining betas of the model including core subject grades, FYGPA and final GPA resulted in good model fit ($\Delta\chi^2 = 12.43$, $\Delta df = 7$, $p = .09$). Constraining intercepts of FYGPA and final GPA resulted in an unacceptable model fit ($\Delta\chi^2 = 6.64$, $\Delta df = 2$, $p = .04$). Allowing the intercept of FYGPA to vary across both samples ($M_{dif} = 0.13$) resulted in a good model fit ($\Delta\chi^2 = 0.001$, $\Delta df = 1$, $p = .97$).

Comparing the explained variance of the models before and after constraining (see Table 7 and 8), it becomes clear that explained variance slightly increased for VWO graduates when looking at FYGPA, whilst explained variance decreased when considering final GPA. Explained variance for IB graduates decreased for both FYGPA and final GPA.

Discussion

We explored how academic achievement in university could best be predicted based on previous academic achievement. The predictive validity of HSGPA for academic achievement in university was compared to the predictive validity of three core subject grades in high school. Moreover, the predictive validity of these predictors was studied separately for students with different diplomas.

Predicting FYGPA and final GPA by HSGPA or core subject grades

HSGPA was a better predictor for FYGPA and final GPA than core subject grades for VWO graduates. For IB graduates however, core subject grades predicted FYGPA better, while final GPA was almost equally well predicted by HSGPA versus core subject grades.

The differences in the predictive validity of high school grades of VWO and IB graduates can be explained by the characteristics of both diplomas. HSGPA is based on eight to eleven subjects for VWO graduates and on only six subjects for IB graduates (Marginson et al. 2008; Van Oord 2007). Moreover, IB subjects often incorporate interdisciplinary knowledge. For example, mathematics in VWO focuses on basic mathematical knowledge, while IB mathematics also incorporates basic physics and chemistry (Ofqual 2012). Consequently, three broad subjects may reflect academic achievement well when students take exams in six subjects (as is the case for IB graduates), whereas three relatively narrow subjects may not accurately reflect academic achievement when students take exams in eight to eleven subjects (as is the case for VWO graduates).

To determine which core subject best predicts FYGPA and final GPA, the predictive validity of core subject grades was compared. Both applied math and mathematics were better predictors of FYGPA and final GPA than mother tongue or English for IB as well as for VWO graduates. Mathematical subjects include more problem-solving and reasoning than languages subjects do (Faas and Friesenhahn 2014; Ofqual 2012). These higher order thinking skills become increasingly important in university (Steenman, Bakker, and Van Tartwijk 2016), which might explain why grades for mathematical subjects tend to predict FYGPA and final GPA better than the grades for languages do.

For IB graduates, the grade for courses in the mother tongue seemed to be a good predictor of FYGPA and final GPA, whereas the grade for English (the language of instruction at UC) was not. These results differ from other studies showing that measures of language of instruction are important determinants of academic success (Feast 2002; Mathews 2007). Nonetheless, Thorsen and Cliffordson (2012) have found similar results: English had a low predictive validity for university GPA when students' mother tongue was included in the model. It is possible that the grade for mother tongue courses reflects high school achievement in languages well enough. Including a second language in selection models may be redundant.

Predicting final GPA by FYGPA and HSGPA or FYGPA and core subject grades

Our results have shown that the added value of inclusion of either HSGPA or core subject grades next to FYGPA as predictors for final GPA, is similar. As FYGPA is by far the best predictor of final GPA, most of the variance is already explained by this predictor. Nonetheless, HSGPA adds to the prediction of final GPA for all students when FYGPA is already included as a predictor. This finding is in accordance with Harackiewicz et al. (2002) who found that HSGPA explains variance in final GPA that was not explained by FYGPA. A plausible explanation may be that students may have to get used to college life during their first year at university, which may become visible in the grades they obtain (Andrade 2006; Mohamed 2012). In their second and third year, students are more used to college life and consequently receive grades that are more in accordance with their actual achievement level, which may be better reflected in their HSGPA. This finding may also be explained by the relative importance of FYGPA and final GPA. At UC, FYGPA is not included in the final GPA. Therefore, it may be that students do not perform to their ability in their first year (as this has no implications for their final GPA).

Looking more specifically at the added value of the core subjects on final GPA when FYGPA is included as predictor, it becomes clear that for VWO students mathematical subjects affect final GPA more than mother tongue and English. As argued earlier, mathematical subjects involve the application of problem-solving skills and reasoning. Problem-solving skills and reasoning become increasingly important in the undergraduate years (Steenman, Bakker, and Van Tartwijk 2016). Therefore, mathematical subjects may predict final GPA differently than FYGPA.

No significant relations were found between the core subjects and final GPA for IB graduates when FYGPA was included as a predictor of final GPA. No plausible explanation was found that would explain the effect of HSGPA on final GPA, whereas no effects of core subjects were found. Possibly, the power in the tested IB model may not have been sufficient to detect small effects (Kline 2011).

Similarities and differences between students with different high school diplomas

As almost all intercepts and slopes could be constrained between students with different diplomas, we may conclude that high school grades of these two curricula have similar predictive validity. In other words, a VWO graduate who scores in the 70th percentile of HSGPA is predicted to have a similar FYGPA and final GPA as an IB graduate scoring in the 70th percentile of HSGPA.

Nonetheless, not all intercepts could be constrained. Moreover, unequal sample sizes of VWO and IB graduates may have slightly affected the constraining results. Small differences between VWO and IB graduates are less likely to be detected and consequently constraints could have been falsely accepted, although constraints would have been rejected when large differences existed between VWO and IB graduates in the models (Chen, 2007). When specifically looking at the predictive validity of high school grades of both IB models, explained variance decreased when relations between variables were constrained, possibly because small differences could not have been detected. As the aim of selective admission is to choose the best way to predict academic achievement in university (Geiser and Santelices 2007), we suggest that different selection variables for IB and VWO students should be used in the UC context.

Limitations and directions for future research

Due to the small size of the IB sample, it was not possible to examine the predictive validity of applied math for IB graduates. Moreover, the small sample size may have led to non-significant findings of small effects. The relatively small sample size of IB graduates compared to the sample size of VWO graduates may have decreased power in constraining analyses (Chen 2007), which may have led to wrongly accepting constraints, as in truth constraints may not be applicable between VWO and IB graduates. For future research it is important to see whether a similar predictive model for FYGPA and final GPA may underlie the prior achievement of students with different high school diplomas, by comparing large enough and roughly equal groups.

Finally, the specific context of this research may affect generalizability. Students in these cohorts had already been partially selected on high school grades. UC applies selection at the gate; therefore only students with strong high school grades were admitted. Moreover, academic dismissal policies are applied by UC. Consequently, HSGPA, core subject grades, FYGPA, and final GPA were restricted in range, as low grades were not present in the data. Hence, results will probably not be generalizable to all students, as grades have a different predictive validity for university GPA when the entire range of grades is taken into account (De Gruijter et al. 2006; Kobrin and Patterson 2011). Moreover, results are based only on one liberal arts bachelor program. It can argued that different bachelor programs across different institutes should be studied to make the findings more generalizable. To overcome these limitations, further research could investigate whether high school grades similarly predict

FYGPA and final GPA across different programs and at universities that do not use selective admission and academic dismissal procedures.

Practical implications for selection practices

Based on the models of graduates with different high school diplomas we can tentatively state that a different selective admission procedure for students that enter with different high school diplomas for the specific UC context is desirable. As findings may be context dependent, we advise universities to analyze their selective admission procedures to see which measure of prior achievement, HSGPA or core subjects, is most effective for predicting academic achievement in university. Moreover, they are advised to take into account the effect of different diplomas and, if necessary, alter selection procedures accordingly. When research is not feasible, admission boards are advised to take different grading systems of high school diplomas into account, in order to make grades more comparable across diplomas.

Moreover, if universities endorse academic dismissal policies, it is recommended that next to FYGPA, HSGPA is also taken into account as HSGPA adds substantially to the prediction of final GPA for both VWO and IB graduates. Nonetheless, this tentative recommendation should be validated in the specific context.

Conclusion

In sum, whether high school grade point average or core subject grades are the most valid measure of high-school achievement to be used for selection procedures in higher education remains unclear, as the best predictor of academic achievement in university seems to be dependent on the students' high school diploma.

Universities that have implemented academic dismissal policies may want to consider including high school grade point average in addition to first year grade point average, as this study showed an added predictive effect on final grade point average.

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Table 1.

Overview of the analyses performed to uncover whether HSGPA or core subjects better predict FYGPA and final GPA.

Model	IB/VWO	Independent variable(s)	Dependent variables	Sample size
1a	VWO	HSGPA	FYGPA & final GPA	315
1b	IB	HSGPA	FYGPA & final GPA	113
2	VWO	Applied math, mother tongue & English	FYGPA & final GPA	119
3a	VWO	Mathematics, mother tongue & English	FYGPA & final GPA	198
3b	IB	Mathematics, mother tongue & English	FYGPA & final GPA	55

Table 2.

Descriptive statistics of all variables for VWO and IB students and results of the t-tests comparing VWO and IB means of all variables.

	VWO			IB			t-test		
	M	*SD*	*n*	*M*	*SD*	*n*	*t*	*df* [a]	*p*
Final GPA	3.48	0.36	315	3.20	0.42	113	6.27	175.38	<.001
FYGPA	3.42	0.37	314	3.01	0.48	113	8.09	162.50	<.001
HSGPA	72.55	15.18	315	52.22	15.22	113	12.21	426	<.001
Applied Math	56.37	32.45	119	43.31	26.90	28	2.22	47.39	0.03
Mathematics	66.33	30.58	198	37.11	25.39	85	8.33	189.82	<.001
Mother tongue	67.87	22.36	314	65.08	21.53	73	0.97	385	.34
English	81.33	18.74	315	56.92	18.27	104	11.74	179.88	<.001

Note. [a] Degrees of freedom differ depending on whether equality of variances is assumed or not.

Table 3.

Correlation matrix of all variables for all students, VWO graduates, and IB graduates.

All students	1	2	3	4	5	6	7
1. Final GPA	-						
2. FYGPA	.74***	-					
3.HSGPA	.62***	.72***	-				
4. Applied Math	.46***	.47***	.70***	-			
5. Mathematics	.48***	.55***	.74***	-	-		
6. English	.37***	.52***	.64***	.27**	.36***	-	
7. Mother Tongue	.33***	.41***	.57***	.39***	.18**	.37***	-
VWO							
1. Final GPA	-						
2. FYGPA	.71***	-					
3.HSGPA	.58***	.68***	-				
4. Applied Math	.46***	.50***	.72***	-	-		
5. Mathematics	.40***	.44***	.67***	-	-		
6. English	.29***	.43***	.52***	.22*	.16*	-	
7. Mother Tongue	.31***	.42***	.62***	.41***	.21**	.43***	-
IB							
1. Final GPA	-						
2. FYGPA	.71***	-					
3.HSGPA	.55***	.60***	-				
4. Applied Math	.23	.24	.75***	-			
5. Mathematics	.42***	.52***	.67***	-	-		
6. English	.23*	.35***	.56***	.47*	.31**	-	
7. Mother Tongue	.41***	.43***	.57***	-.01	.08	.22	-

*Note.** p <.05, ** p <.01, *** p <.001

Table 4.
Explained variance of the models with only FYGPA as dependent variable.

	Independent variable(s)	VWO (models a)		IB (models b)	
		R^2 FYGPA	R^2 final GPA	R^2 FYGPA	R^2 final GPA
Model 1	HSGPA	.46	.33	.36	.31
Model 2	Applied math, mother tongue & English	.37	.25	.	.
Model 3	Mathematics, mother tongue & English	.38	.25	.44	.30

Table 5.
Standardized betas and standard errors of the models with only FYGPA as dependent variable.

		VWO (models a)		IB (models b)	
Independent variable(s)		FYGPA	Final GPA	FYGPA	Final GPA
Model 1	HSGPA	.68 (.03)***	.58 (.04)***	.60 (.06)***	.55 (.07)***
Model 2	Applied math	.37 (.07)***	.39 (.07)***	.	.
	Mother tongue	.15 (.06)*	.07 (.07)	.	.
	English	.29 (.05)***	.18 (.06)**	.	.
Model 3	Mathematics	.36 (.05)***	.36 (.06)***	.48 (.08)***	.38 (.09)***
	Mother tongue	.24 (.05)***	.17 (.06)**	.37 (.09)***	.38 (.09)***
	English	.26 (.05)***	.15 (.06)**	.07 (.09)	-.03 (.10)

*Note.**p<.05, **p<.01, *** p<.001

Table 6.
Explained variance of models with only FYGPA as dependent variable after constraining VWO and IB models.

	Independent variable(s)	VWO		IB	
		R^2 FYGPA	R^2 final GPA	R^2 FYGPA	R^2 final GPA
Model 1	HSGPA	.49	.34	.32	.27
Model 3	Mathematics, mother tongue & English	.42	.29	.26	.19

Table 7.

Explained variance of the models with both FYGPA and final GPA as dependent variables.

Independent variable(s)	VWO R^2 FYGPA	VWO R^2 final GPA	IB R^2 FYGPA	IB R^2 final GPA
HSGPA (FYGPA) [a]	.46	.52	.36	.53
Applied math, mother tongue & English (FYGPA)	.37	.52	-	-
Mathematics, mother tongue & English (FYGPA)	.38	.52	.44	.52

Note. [a] FYGPA is between brackets as it only predicts final GPA

Table 8.

Explained variance of models with both FYGPA and final GPA as dependent variables after constraining VWO and IB models.

Independent variable(s)	VWO		IB	
	R^2 FYGPA	R^2 final GPA	R^2 FYGPA	R^2 final GPA
HSGPA (FYGPA) [a]	.49	.51	.32	.52
Mathematics, mother tongue & English (FYGPA)	.41	.52	.25	.50

Note. [a] FYGPA is between brackets as it only predicts final GPA