IMPROVING THE GUIDANCE AND SUPPORT OF TRANSFER STUDENTS IN ENGINEERING:

A VALIDATED DIAGNOSTIC TEST AND EFFECTIVE INTERVENTIONS

Lynn VAN DEN BROECK

Examination Committee:
Prof. dr. ir. D. Debruyne & Prof. dr. ir. J. Ivens, chair
Prof. dr. G. Langie, supervisor
Prof. dr. ir. T. De Laet, co-supervisor
Prof. dr. M. Lacante, co-supervisor
Prof. dr. C. Van Soom, co-supervisor
Prof. dr. C. Kautz
Prof. dr. ir. J. Van den Bossche
Mevr. J. Vanhoudt
Prof. dr. ir. W. Daems
Mr. W. Lutin

Dissertation presented in partial fulfilment of the requirements for the degree of Doctor of Engineering Technology (PhD)

February 2019

Uitgegeven in eigen beheer, Lynn Van den Broeck, Jan De Nayerlaan 5, B-2860 Sint-Katelijne-Waver & Willem de Croylaan 56, B-3001 Heverlee (Belgium).

PREFACE

Tijdens mijn studies tot industrieel ingenieur op Campus De Nayer (ondertussen mijn tweede thuis), merkte ik dat ik geen typische industrieel ingenieur zou worden. In mijn masterjaar chemische procestechnologie ontdekte ik dat ik niet alleen interesse had in chemie, maar ook in het onderwijs. Toen er plots een mail voor een onderwijskundig project over de overgang van PBA naar IIW werd rondgestuurd, was ik zeer nieuwsgierig naar de inhoud. Nu, meer dan vier jaar later, ben ik ongelooflijk blij dat ik mij voor dit project heb kunnen inzetten. Ik heb mezelf beter leren kennen en weet nu dat mijn passie zowel bij de opleiding aan onze faculteit ligt, als bij het onderwijs zelf. Tijdens mijn doctoraat heb ik dan ook kunnen doen waar elke industrieel ingenieur van droomt: een probleem met beide handen vastpakken, oplossingen zoeken en toepassen.

Dit alles was nooit mogelijk geweest zonder mijn promotor, Greet Langie. Greet, ongelooflijk hard bedankt voor alle kansen die je mij hebt gegeven, alle schouderklopjes, aanmoedigingen, knuffels en goede raad. Bedankt ook om me steeds weer een duwtje in de juiste richting te geven als ik even het noorden kwijt was en om me regelmatig te verplichten wat dagen vrij te maken in mijn agenda zodat ik aan papers kon werken. Ik heb genoten van onze samenwerking!

Ook een welgemeende dankjewel aan mijn drie co-promotoren: Tinne, Carolien en Marlies. Bedankt voor al het nalezen en jullie feedback doorheen mijn hele traject. Ook al weten we nu dat drie co-promotoren best veel is en ik dus een heleboel suggesties kreeg bij alles wat ik schreef, ik zou het niet anders gewild hebben!

Maarten, ik beschouw je als mijn verborgen co-promotor! Bedankt om me onder te dompelen in de pedagogische wereld, me (een beetje) te leren relativeren, me soms gewoon ook te laten ventileren, me tips te geven over hoe we al die papers in godsnaam gepubliceerd krijgen en gewoon voor de leuke babbeltjes zowel op het werk als daarbuiten. Wat er ook was, ik kon altijd ook bij jou terecht, echt merci! Ik trakteer alvast een rondje of twee, drie als we nog eens op café gaan ;-).

Johan en Joke, dank je wel voor alle hulp tijdens mijn doctoraat. Joke, jullie kennis op Dienst Studieadvies over interventies was voor mij van onschatbare waarde. Christian, thank you for all your feedback, inviting me to Hamburg and flying to Belgium for my preliminary defence. I really appreciate everything you did for me. Walter Daems en Wouter Lutin, bedankt voor het grondig nalezen van mijn manuscript en voor jullie constructieve feedback. Walter, ik kan alleen maar dromen van zo’n oog voor detail als dat van jou.

LESEC, bedankt om de afgelopen jaren een klankbord te zijn, financiering te bieden, om een summer school voor doctoraatstudenten te organiseren, … Het is fijn om te weten dat onderwijskundig onderzoek leeft aan de groep W&T. Ook de Associatie KU Leuven wil ik bedanken, enerzijds voor de OOF-middelen, maar anderzijds ook voor de ontzettend belangrijke data-aanlevering. Bedankt, Karen, om mij elk jaar opnieuw een mooie dataset te bezorgen.

Lieve collega's van de G-gang, merci voor de aangename sfeer, de G-gang feestjes, en uitstapjes. In het bijzonder Diane en Inne, jullie waren er altijd voor mij, zowel op de hoogtepunten, als ik enthousiast en lopend kwam vertellen over iets dat gelukt was, als op de dieptepunten, als ik het allemaal even niet meer zag zitten. Zeker die laatste maanden heb ik veel in het deurpostje gestaan tussen jullie bureaus. Kurt, merci om soms 's ochtends te wachten voor die eerste koffie, om te discussiëren over onderwijskundige zaken, om je gevatte opmerkingen, om me af en toe te voorzien van de nodige snackjes uit jouw schuif, om mij mijn extraverte zelf te laten zijn wat de perfecte combinatie was met jou 'zen'-zijn.

Sofie, ik ben blij dat je in onze onderzoeksgroep bent gekomen. Je gaat dat doctoraat knallen! Lise, het was fijn om jouw een half jaar in onze onderzoeksgroep te hebben, ik wens je alle succes met je verdere carrière. Jullie zijn allebei topmadammen!

Gorik, bedankt om me te leren dat een probleem eigenlijk gewoon een uitdaging is. Els, ik vond het super om samen het monitoraat op te starten, we mogen fier zijn op wat we al gerealiseerd hebben! Bedankt, Jan, om ons hierin te steunen.

Af en toe kwam ik ook eens binnen waaien op het decanaat, merci collega's voor de fijne babbels, de aangename middagpauzes, en de antwoorden op één van mijn vele vragen.

Het psychodiagnostisch centrum van Thomas More Antwerpen, Walter, Annemie, en Marlies, dank je wel om mij mee te nemen in de boeiende wereld van testontwikkeling. Ik keek altijd uit naar onze vergaderingen en heb veel bijgeleerd.

Big thanks to the MOOC team: Marc, Dimitri, Guy, Pedro, en Kenny! Zonder jullie was de MOOC er nooit geweest. Ik apprecieer enorm wat jullie gedaan hebben en we kunnen wel stellen dat onze MOOC een succes is! Het was fijn om met jullie samen te werken. Bedankt ook aan alle mensen op de verschillende campussen die ik (meer dan één keer per jaar) heb lastiggevallen voor het afnemen van vragenlijsten. Mede dankzij jullie hebben we veel informatie kunnen verzamelen over de schakelstudenten. Ook de mensen van de professionele bachelors wil ik graag bedanken voor het mee organiseren van de positioneringstest, voor het zoeken naar geschikte momtenten (wat niet altijd even gemakkelijk was) en om reclame te maken bij de studenten om deel te nemen aan de test.

Een groep die ik ook zeker niet mag vergeten zijn de schakelstudenten zelf: zonder jullie was dit onderzoek er natuurlijk niet geweest, maar weet wel dat jullie meer zijn dan gewoon mijn onderzoeksobjecten. Ik vond het fijn om jullie mentor te zijn.

Mijn lieve vriendjes, merci voor de ontspannende ladies nights, de koffie-dates, de pizzafeestjes, de gezelschapspelletjesavonden, de BBQ’s, … In het bijzonder Karen en Hanne, merci voor de peptalks :-)!

Mijn ouders, plusouders, en schoonouders, dank je wel voor al jullie lieve zorgen, het babysitten op Roselie en de vele manden geplooide of gestreken was.

Zusje, ik ben zo trots op wat je allemaal al verwezenlijkt hebt! Binnen enkele maanden kan je jezelf bioloog noemen. Je bent echt groot geworden en ik kan alleen maar fier zijn op een zus zoals jij. Je bent een vrouw met ballen aan haar lijf!

Thomas, lieve schat, ik ben zo blij dat jij al 11 jaar in mijn leven bent. Bedankt voor al je liefde, om me altijd te steunen en om me te leren af en toe wat minder impulsief te zijn. Ik heb onnoemelijk veel respect voor jou. Je bent een lieve, zorgzame, ambitieuze, grappige man waar ik nog steeds stapelgek op ben. De laatste maanden van mijn doctoraat heb jij stevig wat tandjes bijgestoken zodat ik me zoveel mogelijk kon focussen op het afwerken van mijn doctoraat. Wanneer ik ’s avonds en in het weekend zat te werken, zat jij tot ’s avonds laat in ons huis te werken. Ik stoef nog altijd over jou als de perfecte schakelstudent! Because to me, you are perfect! Ik hou van jou!

Roselie, mijn kleine poppemie, ik ben zo blij en trots dat ik jouw mama mag zijn, of zoals jij het tegenwoordig zo schattig zegt: “mijn mamaatje”. Je bent een zalige deugniet, die nog veel harten zal veroveren. Mijn hart heb je alvast voor altijd, ik hou van jou!

SUMMARY

In order to stimulate flexible lifelong learning, the educational system of Flanders provides alternative ways to enter a Master's programme, next to the traditional academic Bachelor's programme. Students who obtained a professional Bachelor's degree can enrol in an academic Master's programme provided that they successfully complete a transfer programme. This dissertation focuses on the transfer students at the Faculty of Engineering Technology (FET), KU Leuven. Unfortunately, around half of the transfer students dropout. This high dropout rate was the principal reason for this research. In general, these students enter university for the first time, just like traditional first-year students. Transfer students were compared to traditional first-year students at FET regarding students pre-university characteristics, experienced transition, and outcome variables. Our results showed that transfer students experience similar adaptation problems as the first-year students at FET. Transfer students feel however significantly less prepared. Nevertheless, their outcome variables (i.e. academic achievement and dropout rate) after one year of enrolment were similar. Transfer students at FET were also compared to transfer students of the Dublin Institute of Technology (DIT). Although the educational context in both countries is fundamentally different, we were able to compare these two groups of students. This study showed that students at DIT feel significantly better prepared for the transfer than the FET transfer students. But, when students graduate, their academic achievement is similar. However, the dropout rates at DIT were close to zero, whereas at FET around half of the students drop out of the programme. It is of paramount importance to improve the guidance of students in their educational choice before enrolment as well as to provide them with the required support once they are enrolled. In order to achieve this, the following steps were performed: (1) development of a validated diagnostic test and (2) development and implementation of effective interventions (i.e. a student support programme).

The diagnostic test is voluntary, non-binding (i.e. if students do not pass the test, they can still enrol in the programme), and preferably organised before enrolment in the transfer programme. The objectives of the test are (1) to provide students with feedback about their skills and capacities and thus to stimulate them to make a well-considered educational choice; and (2) to encourage students to participate in interventions before or during their transfer programme in order to overcome stumbling blocks. The development of the diagnostic test was an iterative process over multiple years, of which the first version was based on (1) an analysis of a diagnostic test for the regular first-year students and (2) students' stumbling blocks, mathematics and study strategies, which were defined during focus group discussions. It is important that the test includes both cognitive and non-cognitive tests, since students need to realise that both are important for study success at university. Given that the aim is to properly inform students before enrolment and support them after enrolment, two types of advisory models, based on pre-entry characteristics (i.e. prior schooling, (family) background, and skills & abilities), are distinguished. The first model, a students' background model, only included fixed variables (i.e. prior schooling and (family) background). This model explained a substantial part of variation in students' grades, but since these variables are fixed, the students' background model is primarily useful before enrolment. The second model, a diagnostic model, only included malleable variables (i.e. skills and abilities) that are measured in the diagnostic test. Although this model did not explain the same amount of variance in students' grades as the students' background model, the diagnostic model is useful both before and after enrolment. When students receive actionable feedback about their test results and are given the opportunity to participate in interventions, they can enhance their skills and abilities, which in turn can improve students' academic achievement.

Eight interventions were developed in this dissertation and combined into a student support programme. This student support programme starts in the third year of the professional Bachelor's programme and ends at the end of the transfer programme. The student support programme aims (1) to attract the right students, (2) to decrease the feeling of unpreparedness at the beginning of the academic year, and (3) to support students after enrolment. Both the effectiveness and efficiency of the eight interventions were examined. The results were combined into an effectiveness/efficiency matrix. This study showed that the most effective interventions are not always the most efficient and vice versa. Students' perceived usefulness was very important when determining the effectiveness. For efficiency the required time to develop and implement an intervention was important, but also scalability was taken into account. For two interventions (mathematics and study strategies), that focus on the students' stumbling blocks, a more in-depth analysis of the effectiveness was performed . In this study there was significant evidence for the effectiveness of the mathematics MOOC. For the time management training the evidence was border insignificant.

The challenge in this dissertation was to decrease dropout rates, though analyses revealed no evidence regarding a significant change in dropout. Nevertheless, this dissertation found some first empirical evidence regarding an improved inflow in the transfer programme, which is considered as a first step towards a lower dropout.

SAMENVATTING

Naast de traditionele academische bacheloropleiding voorziet het Vlaamse onderwijssysteem alternatieve manieren om toegang te krijgen tot een Masteropleiding. Studenten die een professionele Bachelor diploma behaalden, kunnen zich inschrijven voor een academische Masteropleiding, op voorwaarde dat ze een schakelprogramma succesvol voltooien. Dit doctoraatsonderzoek focust op de schakelstudenten aan de Faculteit Industriële Ingenieurswetenschappen (IIW) van de KU Leuven. Helaas behaalt ongeveer de helft van de schakelstudenten het getuigschrift niet. Deze hoge drop-out was de belangrijkste reden voor dit onderzoek. In het algemeen, is het voor deze studenten het eerste jaar aan de universiteit, net zoals voor traditionele eerstejaarsstudenten. De schakelstudenten IIW werden vergeleken met traditionele eerstejaarsstudenten IIW op basis van pre-universitaire karakteristieken, de ervaren transitie naar de universiteit, en output variabelen. Hieruit bleek dat schakelstudenten en eerstejaarsstudenten IIW gelijkaardige transitie problemen ondervinden. De schakelstudenten voelden zich echter significant minder voorbereid voor hun studie aan de universiteit. Desalniettemin zijn de cumulatieve studie efficiëntie en drop-out cijfers na één jaar gelijkaardig. De schakelstudenten IIW werden ook vergeleken met schakelstudenten van het Dublin Institute of Technology (DIT). Ondanks fundamentele verschillen in de pedagogische context, konden de twee groepen studenten vergeleken worden. Deze vergelijking toonde dat DIT studenten significant beter voorbereid waren dan de schakelstudenten IIW, maar wanneer de studenten afstuderen, zijn hun resultaten gelijkaardig. Nochtans is de drop-out aan DIT zo goed als onbestaande, terwijl in IIW een aanzienlijk aantal schakelstudenten uitvalt (ongeveer 50%). De schakelstudenten IIW bezitten reeds een waardevol diploma in Technologie, wat zeer gewild is op de arbeidsmarkt Deze groep studenten kan dus baat hebben bij extra ondersteuning, zowel voor de inschrijving (rond studiekeuze voor een bijkomende masteropleiding) als tijdens het schakelprogramma zelf. Om dit te bekomen, werden volgende stappen ondernomen: (1) ontwikkeling van een gevalideerde positioneringstest en (2) ontwikkeling en implementatie van effectieve interventies (i.e. een begeleidingstraject).

De positioneringstest is vrijwillig, niet-bindend en wordt bij voorkeur georganiseerd vóór de inschrijving in het schakelprogramma. De doelen van de test zijn (1) studenten een beter idee van hun capaciteiten en vaardigheden geven en hen dus stimuleren om een weloverwogen studiekeuze te maken en (2) studenten aanmoedigen om, indien nodig, deel te nemen aan interventies om eventuele tekortkomingen weg te werken. De ontwikkeling van de positioneringstest was een

iteratief proces, waarvan de eerste versie gebaseerd was op (1) een analyse van de ijkingstoets voor de traditionele eerstejaarsstudenten en (2) de struikelblokken van de schakelstudenten, wiskunde en leer- en studeer strategieën, die werden gedefinieerd gedurende focusgroepsgesprekken. Het is belangrijk dat de test zowel cognitieve als niet-cognitieve testen bevat, aangezien studenten moeten beseffen dat beiden belangrijk zijn voor studiesucces aan de universiteit. Daar het de bedoeling is de studenten degelijk te informeren vóór de inschrijving en na inschrijving te ondersteunen, werden twee adviserende modellen onderscheiden. Voor deze modellen werd enkel gebruik gemaakt van instroomkenmerken. Het eerste model, een achtergrondmodel, bevat alleen maar vaststaande variabelen (d.w.z. voorafgaande scholing en familiale achtergrond). Dit model verklaarde een substantieel deel van de variantie in resultaten van schakelstudenten, maar aangezien deze variabelen vaststaand zijn, is dit model alleen nuttig vóór inschrijving. Het tweede model, een diagnostisch model, bevat alleen maar vaardigheden en competenties die werden gemeten in de positioneringstest. Alhoewel dit model minder variantie in studieresultaten kon verklaren in vergelijking met het achtergrondmodel, is het diagnostisch model nuttig zowel vóór als na de inschrijving. Als studenten bruikbare feedback krijgen over hun testresultaten en de opportuniteit om deel te nemen aan interventies, kunnen ze hun vaardigheden en competenties verbeteren, wat op zijn beurt ook een effect kan hebben op hun studiesucces. Acht interventies werden ontwikkeld en gecombineerd tot een begeleidingstraject. Dit traject start in de laatste fase van de professionele Bachelor en eindigt na het schakelprogramma. De interventies hebben als doel om (1) de juiste studenten aan te trekken vóór de start, (2) het gevoel onvoorbereid te zijn aan het begin van het academiejaar te verminderen en (3) studenten te ondersteunen tijdens het schakelprogramma. Zowel de effectiviteit als de efficiëntie van de acht interventies werden onderzocht. De resultaten werden gecombineerd in een effectiviteits-efficiëntiematrix. Deze studie toonde aan dat de meest effectieve interventies niet altijd de meest efficiënte zijn en vice versa. De perceived usefulness volgens studenten was van groot belang bij het bepalen van de effectiviteit. Efficiëntie werd gedefinieerd als functie van schaalbaarheid en ontwikkelings- en implementatietijd. Voor twee interventies, die focusten op de struikelblokken van de studenten, werd nog een diepgaande analyse van de effectiviteit uitgevoerd. Deze studie vond significant bewijs voor de effectiviteit van de wiskunde MOOC. Voor de effectiviteit van de time management training werd net geen significant bewijs gevonden. De uitdaging in dit doctoraat was om de drop-out te verminderen. Analyses toonden geen significante verandering in drop-out. Er is echter wel empirisch bewijs dat er een verbeterde instroom is, wat een eerste stap is naar een lagere drop-out.

LIST OF ABBREVIATIONS

ABA – Academic Bachelor

(C)SE – (Cumulative) Study Efficiency

DIT – Dublin Institute of Technology

ECTS – European Credit Transfer System

ES – Effect Size

FET – Faculty of Engineering Technology

FY – First year

GPA – Grade Point Average

HBO – Hoger Beroepsonderwijs

MA – Master

PBA – Professional Bachelor

STEM – Science, Technology, Engineering, and Mathematics

TR – Transfer

UAS – University of Applied Sciences

WO – Wetenschappelijk onderwijs

ASO – General secondary education

TSO – Technical secondary education

TABLE OF CONTENT

Preface……………………………………………………………………………………………..I

Summary…………………………………………………………………………………………….V

Samenvatting……………………………………………………………………………………VIII

List of abbreviations………………………………………………………………………………XI

Table of contents………………………………………………………………………………XIII

Chapter 1 – General introduction and context……………………………………….1

1 Introduction 1

2 Context 4

2.1 Education system in Flanders 4

2.2 Involved institution 6

3 From problem to challenge 9

3.1 Research questions 10

3.2 Dissertation outline 10

3.3 Defining sample and outcome variables 12

4 Background literature 14

4.1 Prediction 14

4.2 Intervention 18

PART A. EXPLORATION

Chapter 2 - Comparison between transfer and traditional first-year students in Engineering………………………………………………………………………27

1 Introduction..28

1.1 Flemish education system 28

1.2 Transfer programmes 29

1.3 Problem 31

2 Literature overview 31
3 Research questions 32
4 Methodology 33
4.1 Sample 33
4.2 Method 35
5 Results 38
5.1 Pre-university characteristics 38
5.2 Transition to university 40
5.3 Student achievement 41
6 Discussion 44
7 Conclusions 46
8 Future work 47
Appendix 48
A. LASSI 48
B. Perceived fit 49
C. Dropout interview 49

Chapter 3 - Alternative pathways for entering Engineering education: A comparison between two higher education institutions........51

1 Introduction 52
2 Background 53
2.1 Education systems 53
2.2 Description of the involved institutions 55
2.3 Alternative pathways for entering university 56
2.4 Summary of similarities and differences regarding the education systems 58
3 Method 59
3.1 Sample 59
3.2 Variables 59

4 Results 60
4.1 Educational background – Prior achievement 60
4.2 Transition – Perceived fit 60
4.3 Outcome – Dropout rate 62
4.4 Outcome – Academic achievement 63
5 Discussion 64
6 Conclusion 68

PART B. PREDICTION

Chapter 4 - Predicting the academic achievement of students transferring to Engineering: The role of academic background variables and diagnostic testing........73

1 Introduction 74
2 Previous work 75
3 Method 77
3.1 Sample 77
3.2 Collected data 78
3.3 Statistical analysis 81
4 Results 81
4.1 Prediction model: Cohort 2015-2016 (RQ1) 81
4.2 Consistency over time: Cohort 2013-2014, 2014-2015, and 2015-2016 (RQ2) 90
5 Discussion 94
5.1 Prediction model: Cohort 2015-2016 (RQ1) 94
5.2 Consistency over time: Cohort 2013-2014, 2014-2015, and 2015-2016 (RQ2) 96
6 Conclusions and future work 97

Chapter 5 - Advisory models for transfer students in Engineering: The use of a diagnostic test and students' background……………………………………99

1 Introduction 100

2 Literature overview 101

2.1 Tinto's model.. 101

2.2 Students' background 102

2.3 Diagnostic testing 103

3 Method 104

3.1 Sample 104

3.2 Diagnostic test 104

3.3 Students' background 105

3.4 Measurement of academic achievement 107

3.5 Statistical analysis 107

4 Results 108

4.1 Diagnostic model 108

4.2 Students' background model 109

4.3 Summary 111

5 Discussion 113

Appendix 116

A. Test development 116

B. Diagnostic test: mathematics 118

C. Statistics diagnostic model 122

D. Statistics students' background model 123

PART C. INTERVENTION

Chapter 6 - Effectiveness and efficiency of a student support programme for transfer students in Engineering………………………………………………..129

1 Introduction 130

1.1 Literature background 130
2 Method 134
2.1 Sample 134
2.2 Development of the student support programme 134
2.3 Defining effectiveness and efficiency 137
3 Results 140
3.1 Effectiveness 140
3.2 Efficiency 145
3.3 Determining the effectiveness efficiency matrix 146
4 Discussion 148
Appendix 151
A. Meet & Greet workshop 151
B. Perceived usefulness diagnostic test and feedback 152

Chapter 7 - The effectiveness of a MOOC in basic mathematics and time management training for transfer students in Engineering.......... 155

1 Introduction 156
1.1 Interventions 157
1.2 Theoretical framework for effectiveness: The effectiveness scale 158
2 Present study 159
2.1 The need for interventions 159
2.2 Research questions 161
3 Study A: Time management training 162
3.1 Sample 162
3.2 Data 162
3.3 Statistical analysis 163
3.4 Participants' profile 163
3.5 Effect measurement 164
4 Study B: Basic math MOOC 166

4.1 Sample 166
4.2 Data 166
4.3 Statistical analysis 167
4.4 Participants' profile 167
4.5 Effect measurement 169
5 Discussion 172
6 Conclusion 177
Appendix 178
A. Pre- and post-test time management training 178
B. MOOC perception survey 178

Chapter 8 - Discussion 181

1 Exploration 181
1.1 Reflections 181
1.2 Suggestions for future work 188
2 Prediction 188
2.1 Reflections 188
2.2 Research questions answered 198
2.3 Suggestions for future work 200
3 Intervention 201
3.1 Reflections 201
3.2 Research questions answered 210
3.3 Suggestions for future work 211
4 Limitations 213
4.1 Sample 213
4.2 Methodology 214
4.3 Data 215
4.4 Other factors 215
5 Link with actual educational situation 215

6 General conclusion 216

A. Cohort 2013-2014 231

B. Cohort 2014-2015 233

C. Cohort 2015-2016 236

D. Cohort 2016-2017 239

E. Cohort 2017-2018 243

F. Diagnostic test 2015-2016 247

G. Diagnostic test 2016-2017 249

H. Diagnostic test 2017-2018 253

CHAPTER 1 – GENERAL INTRODUCTION AND CONTEXT

1 INTRODUCTION

During the transition from secondary to higher education, a large proportion of new incoming students experiences difficulties (Marra et al. 2012, Lowe and Cook 2003, Holmegaard et al. 2015, Torenbeek et al. 2011). Some of the first-year students feel unprepared (Conley 2007, Lowe and Cook 2003, Carr et al. 2013, Carr et al. 2015). Regardless of students' preparedness, the transition to university always requires adaptation of the student (Holmegaard et al. 2015, Briggs et al. 2012). Each student deals with or experience this transition differently. Astin's Input-Environment-Outcome theory (1993) (Chapter 2), focuses on different outcomes of students' transition to higher education, which is influenced by input and environmental variables (Figure 1). Input variables are students' characteristics at their entry at university such as demographics and their (academic) background. Environment variables include all students' experiences at university after enrolment. Both input and environment variables have an influence on the outcome. Outcome variables refer to desirable outcomes for institutions such as students' knowledge, skills, attitudes, and academic achievement (Chapter 2).

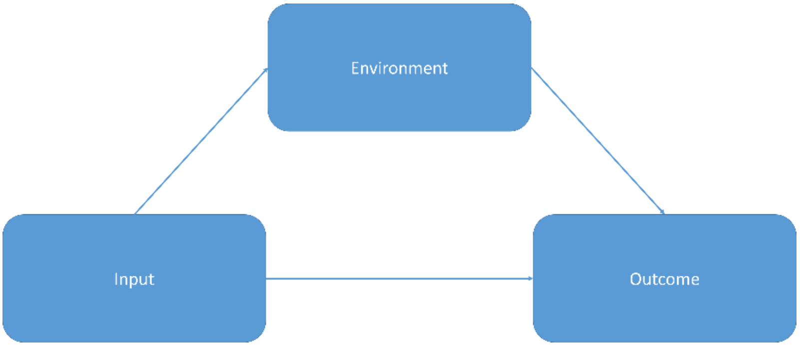


FIGURE 1. ASTIN'S INPUT-ENVIRONMENT-OUTCOME (I-E-O) MODEL (1993)

Schneider and Preckel (2017) describe academic achievement as: "Performance outcomes that indicate the extent to which a person has accomplished specific goals that were the focus of activities in instructional environments, specifically in school, college, and university."

In the literature, different performance outcomes are used:

- Grade point average (GPA): a mean grade, calculated by adding up all the final grades and dividing that by the number of grades awarded.
- Completion rate: relates the number of students who have successfully completed a study programme to the number of students who started the study programme.
- Time-to-degree: average number of years to complete a degree programme.
- Retention rate: the proportion of students, who after entering and starting the study programme, re-enrol in subsequent years of the study programme.
- Dropout/attrition rate: the proportion of students who leave the study programme.

The high dropout rate of transfer students at the Faculty of Engineering Technology is the principal rationale of this research. Therefore, the following paragraphs focus more specifically on dropout (i.e. the proportion of students who leave the study programme). An important model that focuses on dropout is Tinto's longitudinal model (1993). This model (Figure 2) provides a framework for understanding student behaviour during the transition to university. Students enter higher education with pre-entry attributes (Chapter 5) and initial commitments and goals. Once they start in their chosen programme and institution they gather experiences, both academic and social, which affects students' academic and social integration. These integrations can influence their initial goals and commitments. The interaction between the different variables eventually leads to the decision whether or not to leave an institution or study programme.

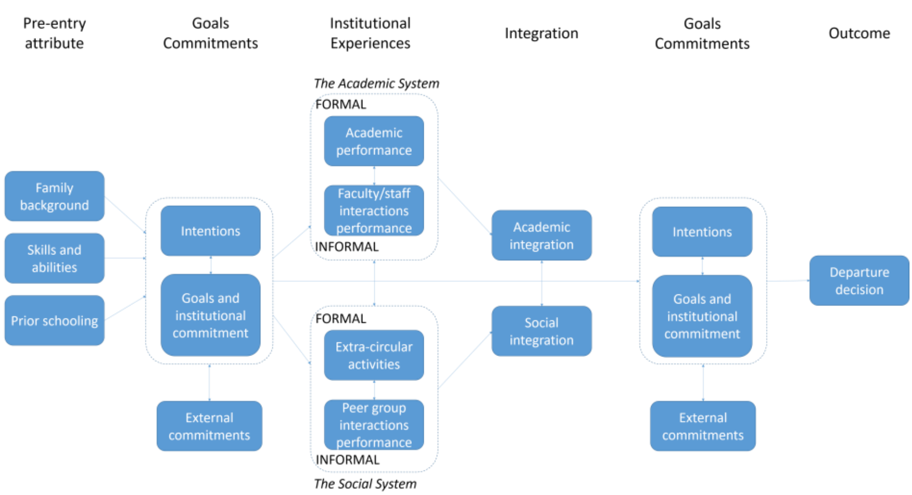


FIGURE 2. TINTO'S DROPOUT MODEL (1993)

Yorke and Longden (2004) distinguished four categories of reasons for students leaving their study programmes: (1) flawed decision-making about entering the programme, (2) students' experience of the programme and the institution generally, (3) failure to cope with the demands of the programme, and (4) events that impact on students' lives outside the institution (Yorke and Longden, 2004, p.104) (Chapter 6). Due to the variety in study programmes, many studies perform in-depth analyses on specific disciplines. In this dissertation, the focus is on the STEM field (Science, Technology, Engineering, and Mathematics) and primarily on engineering. An important STEM-study that examined in detail students' reasons for leaving their STEM programme is the study of Seymour and Hewitt (1997). They concluded that there is always more than one reason before students decide to leave. Prior to the final decision a complex thinking and decisions process takes place.

"We found the decision to leave a Science, Mathematics, Engineering major was always the culmination of a dialogue with self and others over time, in which students were drawn back and forth between the options that seemed open to them. Typically the process began with poor experiences in Science, Mathematics, Engineering classes in their first-year and, for some, the discovery of under preparation. It was deepened by a series of academic crises and disappointments that provoked anger towards particular faculty, advisors or teaching assistants. Students began to experience self-doubt and lowered confidence in their ability to do science. They became disillusioned with science and the science-based careers to which they had aspired, and questioned whether getting the degree would be worth the effort and distress involved." [ ] "The process of moving back and forth between thoughts of leaving and staying lasted from a few months to over two years. However, the final decision was typically triggered by a 'last straw' incident or an institutional deadline." (Seymour and Hewitt, 1997, p.393)

Often the reason for leaving is related to a gap between students' expectations and their actual experiences (Jones 2017, Van Torenbeek et al. 2011). The study of Bailli and Fitzgerald (2000) revealed for instance that students thought the courses would be more practical or interesting, the workload was higher than expected, and the required level of math was higher than assumed. They also concluded that students found the courses not challenging enough, the staff/student or peer interaction was poor, and they were dissatisfied with the teaching approach. In another study (Marra et al. 2012), poor teaching and advising was, together with lack of belonging and curriculum difficulty, an important factor for leaving the study programme. Ahmed et al. (2014) defined, amongst other things, lack of interest and enjoyment, lack of self-knowledge which resulted in the wrong choice of study programme, poor academic performance, and heavy workload as reasons for leaving the programme.

These three studies found similar reasons for students' leaving engineering. It is also clear that both academic and non-academic factors contribute in the decision to drop out.

High dropout rates in engineering are a considerable problem. Approximately 40 to 50% of American engineering students switch to other majors or drop out (American Society for Engineering Education[1]). In Australia the mean graduation completion rate for engineering is 54% (Godfrey et al. 2010). Both America and Australia organise some sort of final exam at the end of secondary education that gives access to higher education. At TU Delft (The Netherlands) approximately 25% of the students drop out of the Bachelor's programme[2]. Admission to a study programme at TU Delft is based on students' secondary education degree. If they do not possess the required degree, they have to address deficiencies. Completion rates can be influenced by the selectivity of the institution. Institutions with an open-admission system can be expected to have lower completion rates than highly selective institutions (European Commission/EACEA/ Eurydice 2015).

This problem of high dropout rates and low completion rates in engineering also occurs for the transfer students at the faculty of Engineering Technology (FET). The FET is a part of KU Leuven (Belgium), which is an open-admission institution. The remainder of this chapter first elaborates on the context of the dissertation (Section 2). Section 3 explains the problem and the scope of this thesis and section 4 provides an overview of important background literature.

2 CONTEXT

First, to fully understand the context of this dissertation, the educational system in Flanders will be explained (see Section 2.1). Section 2.2 provides a description of the involved institution and the examined study programmes.

2.1 EDUCATION SYSTEM IN FLANDERS

In Flanders there is compulsory education until the age of 18. Secondary education[3] starts at the age of 12 and takes six years. During the first (two) year(s) of secondary education, students follow in general the same types of courses. After the second

---

[1] https:/www.asee.org/retention-project/keeping-students-in-engineering-a-research-guide-to-improving-retention

[2] https://www.tudelft.nl/en/about-tu-delft/facts-and-figures/education/bachelor-drop-out/

[3] https://eacea.ec.europa.eu/national-policies/eurydice/content/ belgium-flemish-community_en

year, pupils need to select a track. There are four tracks in secondary education, each with a different objective and approach:

- General secondary education (ASO): aims at a broad general education and prepares pupils for higher education.
- Technical secondary education (TSO): mainly focuses on general and technical-theoretical subjects combined with practical lessons and prepares pupils for a professional career or for higher (technical) education.
- Art secondary education (KSO): combines a general and broad education with active artistic practice and prepares pupils for a professional career or for higher (artistic) education.
- Vocational secondary education (BSO): teaches pupils specific vocational skills in combination with a general education, oriented towards a professional career. Transition to higher education is possible but rather rare.

Within each track, pupils need to choose a specific study programme (e.g. for general secondary education typical programmes are Mathematics and Sciences or Latin and Mathematics; for technical secondary education: Technical Sciences or Industrial Sciences). At the end of secondary education there is no generally organised final exam. If students decide to continue their studies in higher education they are free to enrol in almost any study programme since there are no admission requirements in Flanders, except in medicine, dentistry, and arts.

In the Flemish higher education system[4] (Figure 3), there are two types of Bachelor's degrees namely a professional (PBA) and an academic (ABA) one. Both Bachelors have a total weight of 180 ECTS, resulting in a three-year study programme (60 ECTS/year). The purpose of a professional Bachelor's degree, organised at a University College, is to prepare the student for a professional occupation. An academic Bachelor's degree, organised at a University, is intended to acquire all the necessary knowledge and skills to start a Master's programme (MA). The professional Bachelor's programme has a more practical approach, while the academic Bachelor's programme is more conceptual and theoretical.

[4] http://onderwijs.vlaanderen.be/wegwijs-het-hoger-onderwijs#profiel-opleiding

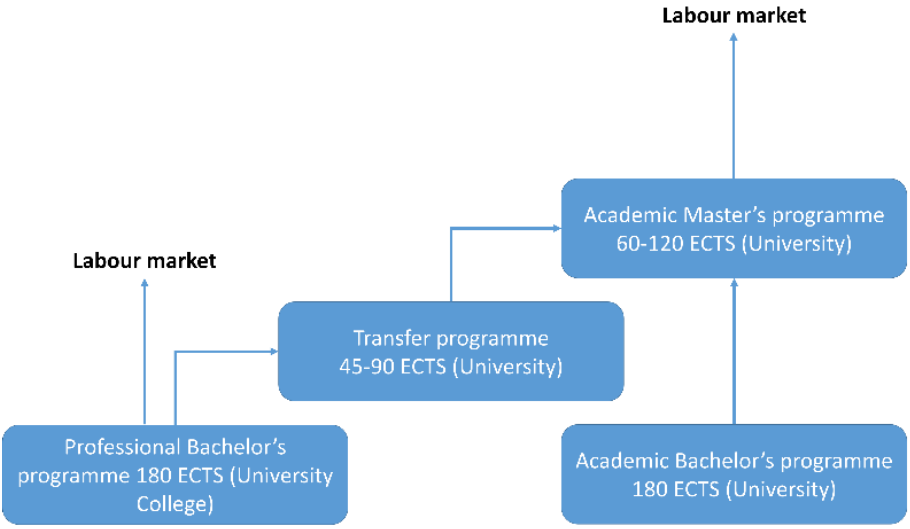


FIGURE 3. SCHEMATIC OVERVIEW FLEMISH HIGHER EDUCATION

In order to stimulate flexible lifelong learning, the Flemish parliament signed a decree for the restructuring of the higher education system in 2003[5]. Since the academic year 2003-2004, the educational system of Flanders provides, in addition to the traditional academic Bachelor's programme, alternative ways to enter a Master's programme. Students who obtained a professional Bachelor's degree can enrol into an academic Master's programme provided that they successfully complete a transfer programme (TR). It is important to point out that (1) not every Master's programme has a transfer programme and (2) only a professional Bachelor's degree obtained in a discipline related to the Master's degree is eligible for transfer. A transfer programme consists of 45 – 90 ECTS, depending on the choice of future Master's programme and the obtained professional Bachelor's degree.

2.2 INVOLVED INSTITUTION

KU Leuven is an institution for research and education and is ranked as the 7th most innovative university in the world[6]. The university distinguishes three main groups: (1) Humanities and Social Sciences, (2) Biomedical Sciences, and (3) Science, Engineering and Technology. Only the Science, Engineering and Technology group offers engineering programmes and is being further subdivided into five faculties: (1) Science, (2) Architecture, (3) Bioscience Engineering, (4) Engineering Science, and (5)

---

[5] http://www.ejustice.just.fgov.be/eli/decreet/2003/04/04/2003035868/staatsblad

[6] www.reuters.com/article/us-amers-reuters-ranking-innovative-univ/reuters-top-100-the-worlds-most-innovative-universities-2018-idUSKCN1ML0AZ

Engineering Technology. Students who complete a programme in one of the last three mentioned faculties get a degree in Engineering. A lot of specializations are possible e.g. Civil Engineering, Mechanical Engineering, Chemical Engineering, and Electrical Engineering [7]. This study only includes the Faculty of Engineering Technology.

2.2.1 FACULTY OF ENGINEERING TECHNOLOGY

In 2013-2014 the academic study programmes (except the arts programmes) of the University Colleges integrated into Universities. As a result, the FET became a multi-campus faculty with seven Flemish campuses in: Aalst, Diepenbeek, Geel, Ghent, Leuven, Sint-Katelijne-Waver, and Bruges. FET offers three academic Bachelor's programmes, 11 transfer programmes, 16 Master's programmes, one advanced Master's programme, one teacher training, and two Postgraduate programmes. A total amount of 80% of the programmes are organized in Dutch, the remainder in English. All campuses, except Aalst, offer transfer and Master's programmes. Each year about 6000 students study at FET. Table 1 shows the total number of students in the different types of programmes.

TABLE 1. NUMBER OF STUDENTS AT FET IN 2018-2019

Programmes at Faculty of Engineering Technology	Total N
Academic Bachelor's programme	3684 (56%)
Transfer programme	806 (12%)
Master's programme	1926 (30%)
Remaining programmes*	121 (2%)
Total	6537 (100%)

*remaining programmes= advanced Master's programme, teacher training, and Postgraduate programmes

Source: KULoket – number of students on 11/10/2018

This dissertation focuses primarily on students that are for the first time enrolled in the transfer programme at FET. Chapter 2 also includes the traditional first-year students (i.e. generation students). Figure 4 presents the total number of new incoming transfer and first-year students (i.e. generation students) at FET over the most recent academic years. On average, 32% of these new incoming students are transfer students[8].

[7] For a full overview see http://set.kuleuven.be/English/education/index.html

[8] The data of 2013-2014 does not include campus Diepenbeek since the data was not uploaded in the administration's database.

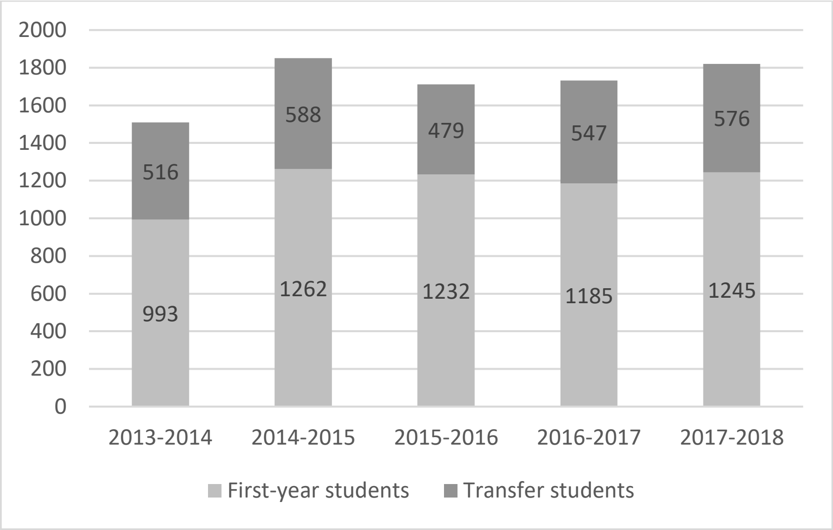


FIGURE 4. YEARLY INFLUX OF INCOMING STUDENTS AT FET BETWEEN 2013 AND 2017

2.2.2 TRANSFER PROGRAMMES AT FET

The transfer programmes at FET have a weight of approximately 60 ECTS. The three general semesters of the academic Bachelor's students are, more or less, reduced to one general semester for the transfer students. The first semester of the transfer programme has thus a general focus with mainly basic science and engineering courses (e.g. mathematics, mechanics, electricity, physics, and chemistry). During the second semester the courses focus primarily on the chosen specialization. Almost all transfer students (96%) have a study programme of 72 ECTS or less[9], meaning that they should be capable to complete the programme in one year[10].

The campus in Ghent also offers a more flexible distance learning programme for students who want to combine the transfer programme with a job or a family. These students are distance learners and are required to spread the programme over two years. During the first semester, they can only enrol in the math courses. If they do not succeed in the exams, they cannot continue in the second semester. On average, 5% of the new transfer students are distance learners.

[9] Average calculated over academic years 2013-2014 to 2016-2017.
[10] Distance learners are not included.

3 FROM PROBLEM TO CHALLENGE

Unfortunately, the transfer programme has a high dropout rate of approximately 50% (Figure 5). This high dropout rate is the principal rationale for this research. These students already possess a valuable degree in Technology, which is very sought-after in the labour market. It is therefore even more important that students are well-informed and convinced they made a well-considered educational choice.

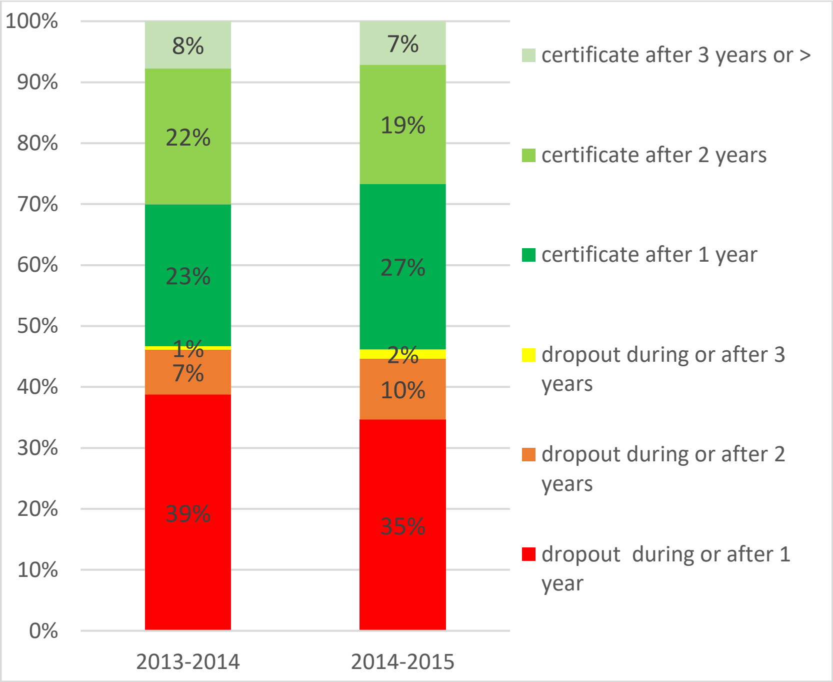


FIGURE 5. COHORT ANALYSIS 2013-2014 (N=516) AND 2014-2015 (N=590) - TIME TO DEGREE AND DROPOUT RATES (SOURCE: KULOKET ONDERWIJSINDICATOREN 11/10/2018)

The challenge of this study is to decrease the dropout rates in the transfer programmes of FET. Improving the guidance of students in their educational choice before enrolment as well as providing them with the required support once they are enrolled, are possible actions that can be taken. By focussing on guidance and support, attention is given to three of the four categories of reasons (Yorke and Longden 2004) for leaving a study programme, namely (1) flawed decision-making about entering the programme, (2) students' experience of the programme and the institution generally, and (3) failure to cope with the demands of the programme. The institution is unfortunately not able to prevent reasons of the fourth and last category: events that impact on students' lives outside the institution. In order to achieve this guidance and support, the following steps are performed:

- Development of a validated diagnostic test
- Development and implementation of effective interventions

The diagnostic test is voluntary, non-binding, and preferably organised before enrolment in the transfer programme. The objectives of the test are (1) to provide students with feedback about their skills and capacities and thus to stimulate them to make a well-considered educational choice; and (2) to encourage students to participate, if necessary, in intervention initiatives before or during the transfer programme.

3.1 RESEARCH QUESTIONS

Within this dissertation four main research questions are distinguished:

1. To which extent can a diagnostic test aid us in predicting students' academic achievement?
2. Can we create a diagnostic test which has a higher predictive value compared to an analysis of (academic) background variables of the students?
3. Can we measure the effectiveness of the interventions that are developed in this research?
4. Is it possible to reduce drop out or assure that reorientation can happen at an earlier stage?

The transfer students are an unstudied group of students in literature, so before heading to the answers on the research questions, first an exploration (Part A) was needed to gain more insight in the target audience. The two first research questions are related to the diagnostic test and are the second part of the dissertation (Part B. Prediction). The remaining two research questions focus on the interventions and are grouped in Part C, Intervention.

3.2 DISSERTATION OUTLINE

The scope of part A (Exploration) was to gain more insight in the transfer students. By means of focus group discussions, drop out interviews, and perception research, the transfer students were compared with traditional first-year students at FET (Chapter 2) and with Irish transfer students at Dublin Institute of Technology (DIT) (Chapter 3). In Chapter 2, the aim was to find out if there are similarities between the transfer students and the first-year students at FET. If so, STEM studies of first-year students can be a source of inspiration for developing a prediction model for transfer students. Since they are both new at university, there was reason to believe that there are some similarities. The first-year students and transfer students were compared in terms of pre-university characteristics such as learning and study strategies, experienced transition, and outcome variables (dropout and cumulative study efficiency after one year). Chapter 3 consists of a comparison between the transfer students at FET and the Irish transfer students at DIT. The goal was to find out how an institution in another country deals with this alternative pathway for entering engineering. First, the different education systems and transfer programmes were discussed. Then, the two groups of transfer students were compared in terms of educational background, experienced transition and academic outcomes.

Part B (Prediction) focused on predicting transfer students' academic achievement. Chapter 4 presents an in-depth analysis of the academic achievement of three cohorts transfer students (2013-2014, 2014-2015, and 2015-2016). This study examined the contribution of a range of cognitive and non-cognitive predictors. The examined predictors are: general characteristics, academic background variables and variables tested in the developed diagnostic test. In Chapter 5, two types of advisory models, based on students' pre-entry characteristics, were distinguished. The first model, a students' background model, only included fixed variables (i.e. prior schooling and (family) background). The second model, a diagnostic model, only included malleable variables (i.e. skills and abilities) that were measured in the diagnostic test. This chapter also includes the development of the diagnostic test throughout the different pilots (2015-2016, 2016-2017, and 2017-2018) in this dissertation.

In Part C (Intervention) the emphasis is on the developed and implemented student support programme for transfer students. Chapter 6 provides an overview of the interventions and the predetermined objectives of each intervention. This study presents an analysis of the effectiveness and efficiency of the interventions of the developed support programme. The sixth and last study, Chapter 7, provides an in-depth analysis of the effectiveness of two interventions of the student support programme. These interventions were developed to train students' basic mathematics knowledge and time management skills, two topics that were identified as major stumbling blocks for success in the transfer programme.

The final chapter, Chapter 8, provides answers on the research questions of this work preceded by reflections about the current work. Attention is also given to suggestions for future work and the limitations of this dissertation.

REMARK: Chapters 2 to 7 are presented as papers. Therefore, some paragraphs will recur. To avoid reading paragraphs multiple times, a reading line is included. If the reader follows the chronological order of this dissertation, each time when a paragraph is reoccurring, this is indicated by a line in the left margin.

3.3 DEFINING SAMPLE AND OUTCOME VARIABLES

This dissertation focuses on transfer students who (1) are new in the transfer programme and (2) have a study programme that is planned to be completed in one year (i.e. maximum 72 ECTS). Since distance learners are required to spread the programme over two years, it is impossible to treat them as regular transfer students. Therefore it was important that they were excluded from the sample. In addition, certain transfer students decide voluntarily to spread their transfer programme over two years (i.e. 30-45 ECTS/academic year). These students have to be excluded as well, since this would result in a distorted image. Therefore, only new transfer students who have minimum 50 and maximum 72 credits in their individual study programme (ISP) are included. By applying these criteria, the dropout rate decreased from almost 50% to 30%[11] (Figure 6).

A further analysis of the cohort 2013-2014 showed that 8% of the new enrolled transfer students at FET officially dropped out before 30th November (i.e. early dropout). As a result these students have an individual study programme of 0 ECTS. Of the distance learners (8% of the new students), 70% obtained a cumulative study efficiency of less than 30% at the end of the academic year. Students who are required to spread their study programme or decide on their own to spread the programme are not taken into account when performing analysis, since this would lead to data contamination[12]. However, at the start of this dissertation, only the KU Leuven dashboard was used, which provided the cohort analysis (Figure 5). In this dashboard it was not possible to select students based on the number of credits in their study programme. As a result, when the dropout rate is included in the chapters, this is the total dropout rate of the transfer programme. This is not considered as a problem since the dropout rates of the sample (Figure 6) are an underestimation, because they do not include the early dropouts.

---

[11] Comparison of the percentages should be done with caution. Since Figure 5 is determined via a KU Leuven Dashboard, whereas for Figure 6 data from SAP directly was analysed. In addition, the data was collected at different moments in time.

[12] Example of data contamination: students who have a study programme with for example only 15 ECTS are not eligible to complete the transfer programme in one year. When they are included in the sample, general statements about study success after one year and predictions will be based on data of students who have totally different programmes.

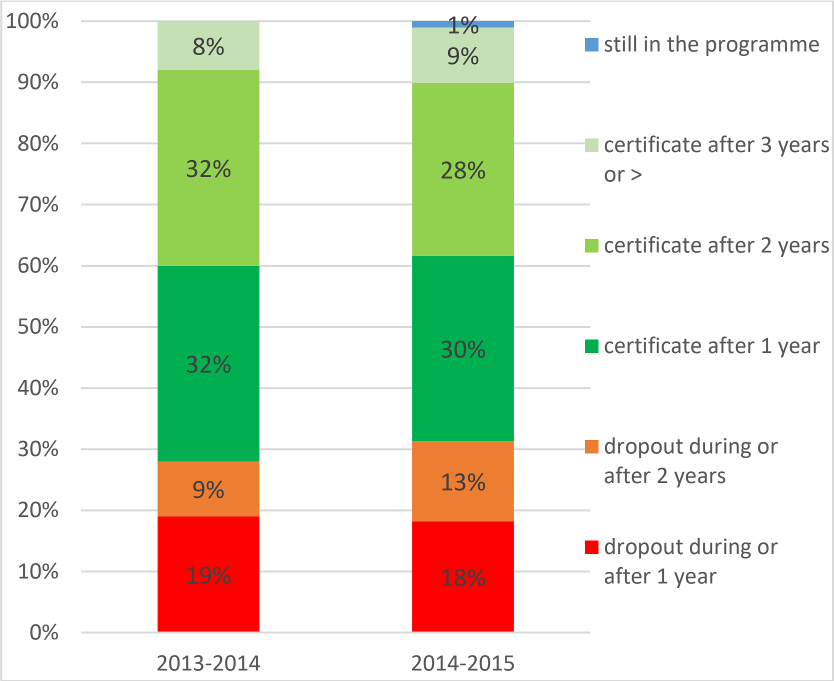


FIGURE 6. COHORT ANALYSIS SAMPLE 2013-2014 (N=339) AND 2014-2015 (N=283) – TIME TO DEGREE AND DROPOUT RATES (SOURCE: SAP 28/07/2017)

To conclude, a regular transfer student is (1) new in the transfer programme and (2) has a study programme of min. 50 and max. 72 ECTS points[13]. Some variation in the number of included students in the different chapters and analyses is possible, due to the manner the required data was gathered and dependent on which information was available. In general, when analyses are performed Diepenbeek is not included, since only the number of enrolled students of this campus is available in the KU Leuven database.

In this dissertation three outcome variables are used: (1) dropout rate (both after one year and the total dropout), (2) cumulative study efficiency (CSE) after one year (i.e. proportion of the number of earned credits and the total number of credits the student enrolled for), and (3) GPA in the transfer programme.

[13] In the chapters, samples are defined as (1) new in the transfer programme and (2) min. 50 ECTS. The maximum of 72 ECTS points is not included in the definition, but in the analyses students with more than 72 ECTS points were excluded.

4 BACKGROUND LITERATURE

This section will provide the reader with the necessary literature for reading this dissertation. Section 4.1 includes important background literature about the prediction of students' academic achievement (Chapter 2, 4, and 5) and the use of diagnostic testing (Chapter 4 and 5). In Section 4.2 the focus is on interventions and how to measure their effectiveness and efficiency (Chapter 6 and 7).

4.1 PREDICTION

Many studies already examined various variables associated with students' achievement. To provide the reader with a comprehensive overview, two relevant and extensive systematic reviews (Hattie 2009-2015, Schneider and Preckel 2017), are discussed in the following paragraph.

Hattie (2009) included about 800 meta-analyses in his systematic review and subdivided the 138 included variables into six groups: (1) Student (e.g., prior achievement, attitudes, and gender), (2) Home (e.g., socioeconomic status and parental involvement), (3) School (e.g., class size and small group learning), (4) Teacher (e.g., teacher training and quality of teaching), (5) Curricula (e.g., writing programmes, mathematics, and social skills programmes), and (6) Teaching approaches (e.g., feedback, peer tutoring, and problem-solving teaching). Since university students are rather diverse, Hattie (2015) formulated in a later study the applicability of his research for higher education and ranked 195 variables that influence students' achievement. About 50% of the variance in achievement was a function of student characteristics. Another 20% of the variance was related to the teacher. The systematic review of Schneider and Preckel (2017), focusing on higher education, analysed 105 variables related to academic achievement. The variables were categorised into two main areas, instruction-related or student-related, which were further divided into categories. The area *instruction* included (1) Social interaction (e.g. teacher's encouragement of questions and discussions), (2) Stimulating meaningful learning (e.g. teachers preparation), (3) Assessment (e.g. peer assessment), (4) Presentation (e.g. teacher's clarity), (5) Technology (e.g. intelligent tutoring systems), and (6) Extracurricular training (e.g. academic skills training). The *student* area included (1) Intelligence and prior achievement (e.g. high school GPA), (2) Strategies (e.g. time/study management), (3) Motivation (e.g. grade goal), (4) Personality (e.g. conscientiousness), and (5) Context (e.g. financial support).

When comparing these two systematic reviews one distinct difference is that Hattie's main study focused on education in general. In a sequel study, he defined which elements were applicable in higher education. Whereas Schneider and Preckel focussed specifically on higher education. This is the first published review of meta-analyses on achievement in higher education so far. Another difference in the two systematic reviews, is the number of meta-analyses. Hattie included about 800 meta-analyses. The systematic review of Schneider and Preckel consisted of 38 meta-analyses. However, it is important to point out that Schneider and Preckel used more selection criteria then Hattie. Hattie included meta-analyses that includes at least four studies and he specifically excluded meta-analysis that used affective or psychological outcomes. Schneider and Preckel (2017) defined the following five selection criteria:

"(a) The study is a meta-analysis, that is, averaged at least two standardized effect sizes obtained from different samples. (b) The meta-analysis included a measure of achievement as defined in our introduction section. (c) The meta-analysis reported a separate effect size for samples in higher education, or more than 50% of the studies included in the meta-analysis had been conducted with samples in higher education, or the meta-analysis explicitly showed that the effect sizes do not differ between higher education and K–12 school education. (d) Of the found meta-analyses, we only included the largest meta-analysis on each topic, which was usually also the most recent one. (e) The meta-analysis was not explicitly limited to a single subject (e.g., medical education), to a specific subgroup of students (e.g., Latino students), to a single country, or to a single test." (Schneider and Preckel 2017, p.18)

Although the focus and selection criteria are different, there is a clear overlap between the included variables. For instance, both reviews analysed (1) cognitive and non-cognitive variables, (2) static and malleable variables, and (3) student-related and teacher-related variables. An important strength of these systematic reviews is their general character, which results in a broad applicability. However, when Fontyne et al. (2017) examined the programme-specific prediction of academic achievement, they found that the predictive power of the different variables varied across the study programmes. Veenstra et al. (2008) compared modelling of first-year engineering students' success to that of non-engineering students, and concluded that there were differences. As prediction of academic achievement is expected to be programme-specific, the paragraph below elaborates on predicting academic achievement in engineering programmes.

This paragraph presents engineering studies that include (1) only cognitive variables, (2) a combination of cognitive and non-cognitive variables, and (3) only non-cognitive variables. The most predictive cognitive variable, by far, is prior achievement. For this reason, a model for predicting students' academic achievement often includes variables such as High school GPA, High school rank, and

ACT or SAT scores (Ackerman et al. 2013, De Winter and Dodou 2011, French et al. 2005, Van Soom and Donche 2014, House 2000, Ting 2011). De Winter and Dodou (2011) focused on high school exam scores and found a strong correlation between high school exam scores in Natural Sciences and Mathematics and GPA (r=.56) at TU Delft (The Netherlands). Non-cognitive variables contain useful information about for example students' behaviour, learning strategies, or commitments. These measures are mostly self-reported and collected via questionnaires. Pinxten et al. (2017) concluded that non-cognitive variables, such as students' learning strategies are related to first-year student success. However, when adding these non-cognitive variables to prior achievement, their incremental value was restricted. Hall et al. (2015) examined the retention of first-year engineering students of East Carolina University (US) by performing a logistic regression. This resulted in four significant predictors: high school GPA, SAT math, ALEKS scores (measurement of math readiness), and conscientiousness (scale of NEO Five-Factor Inventory). Ackerman et al. (2013) developed a regression model that explained 40% of the variance in grades of first-year STEM students at Georgia Institute of Technology (US). The model included high school GPA, SAT scores (verbal and maths), the average Advanced Placement exam score (i.e. courses and corresponding exams during college - AP), and five trait complexes: (1) Math/Science self-concept, (2) Mastery and organization, (3) Openness and verbal self-concept, (4) Anxiety in achievement contexts, and (5) Extroversion. House (2000) asked first-year STEM students at Northern Illinois University (US) to complete the Cooperative Institutional Research Programme (CIRP) Annual Freshman Survey focusing on a variety of topics, such as parental education, high school curriculum, financial goals, social goals, academic self-concept, achievement expectancies, and desire for recognition. When academic background variables were added in the first step of the regression model 28% of the variance was explained. Adding academic self-concept and financial goals to the model resulted in an incremental value of only 1% and consequently, with a total explained variance of 29%. In another study (Ting 2011) the first-year engineering students of North Carolina State University (US) were administered to fill in the Non-Cognitive Questionnaire (NCQ). The model includes, besides a cognitive variable, positive self-concept, leadership experiences, and preference of long-term goals (R^2=12%). When predicting GPA, the first step in the linear regression of French et al. (2005) was significant and included cognitive variables (SAT scores and High school rank) and gender (R^2=18%). When adding non-cognitive variables (i.e. motivation, institutional integration, and orientation class) to the model, the change in R^2 was not significant. When a model only includes non-cognitive variables the explained variance is much higher, then when added to a model with cognitive variables. For instance, in the study of House (2000) the non-cognitive variables alone accounted for an explained variance of 11%, but when combined with academic background variables they only have an incremental value of 1%. The trait complexes in the study of Ackerman et al. (2013) had in insolation an explained variance of 14%. When adding the trait complexes, as a third step in the regression model, the incremental value was 8%. Another study (Van Soom and Donche 2014) found small but significant correlations between academic achievement and academic self-concept (r=.25) for first-year STEM students at KU Leuven (Belgium) on one hand and between academic achievement and autonomous motivation (r=.10) on the other hand. A study at Lappeenranta University of Technology (Finland) focused exclusively on non-cognitive variables. The variables they used are: student's study strategies, orientations, regulations, and perception concerning learning and studying (R^2=37%). The two most important predictors were deep approach study strategy, which was positively correlated with academic achievement, and doubts about one's abilities, which was negatively correlated with academic achievement (Tynjälä et al. 2005).

Variables such as prior achievement are static, but students' knowledge, competences, and attitudes are malleable variables. Organising diagnostic tests is one manner to make an estimation of these variables. Based on the selectivity of the institution, a diagnostic test can have different purposes and can be organised on different moments. At many universities, diagnostic tests are organized at the beginning of the academic year (Carr et al. 2013, Johnson and 'O Keeffe 2016, Lee and Robinson, 2005). Using diagnostic tests is helpful to gather information about a cohort of students, identify students at risk, identify mathematical deficiencies, and to find out which remedial support is needed (Hawkes and Savage 2001, Lawson et al. 1995). For open-entrance systems, organising the diagnostic test before enrolment is preferable. In this way, the test can be used as a tool to identify at-risk students in advance and provide them with this important information before enrolment so that they can participate in remedial pre-university courses or reconsider their educational choice and eventually decide to choose another programme (Vanderoost et al. 2014). If the aim of the diagnostic test is to make an estimation of the students' abilities and determine possible stumbling blocks, it will be important to provide these students with individual and actionable feedback. As stated by Hattie and Timperley (2007) feedback has to answer three questions asked by a lecturer and/or by a student: (1) Feed up: Where am I going? What are the goals?; (2) Feedback: How am I going? What progress is being made toward the goal?; (3) Feed forward: Where to next? What activities need to be undertaken to make better progress? Providing students with effective feedback is one thing, but as Kulhavy (1977) mentioned: "Feedback can be accepted, modified, or rejected.", meaning that at the end, students need to decide if they do something with the feedback, since feedback by itself does not have the power to initiate further action.

To summarise, many studies have examined which variables are predictive for the academic achievement of first-year (engineering) students. Some variables are very commonly used such as students' prior achievement. It was important to first determine if there are similarities with first-year students (Chapter 2), since if there are enough similarities all these first-year studies can be an inspiration source for the prediction of academic achievement of transfer students. In Chapter 4, combing academic background variables and a diagnostic test, with both cognitive and non-cognitive variables, results in a prediction model with the highest predictive value as possible. The distinction between fixed and malleable variables is of great importance for the models in Chapter 5.

4.2 INTERVENTION

A considerable number of the variables mentioned in section 4.1, are static, such as socio-economic status and gender. Although their contributions are important for the prediction of students' academic achievement, the focus in this section is on malleable variables that can be positively influenced, by the student, through the use of interventions. Seymour and Hewitt (1997) concluded that students who decided to stay in their programme, can still encounter similar problems as the students who decided to leave the programme. Therefore, it is equally important to properly guide students in their educational choice before enrolment and provide them with the required support once they are enrolled. To support students both before and after enrolment, higher education institutions organise interventions for students. These interventions can focus for instance on the improvement of students' skills and abilities (pre-entry attributes), students' institutional experiences, or academic and social integration (Tinto 1993). An improvement of one of these aspects can in turn affect students' academic achievement and retention (Hattie 2015, Schneider and Preckel 2017). Effect sizes are used to quantify how large an effect is. A common used effect size is Cohen's d, which is calculated via:

$$d = \frac{mean_1 - mean_2}{s_{pooled}}$$

Where s_{pooled} (pooled standard deviation) is

$$s_{pooled} = \sqrt{\frac{s_1^2 + s_2^2}{2}}$$

The rules of thumb of Cohen (1988) are: "small effect, d =[0.20;0.49]", "moderate effect, d =[0.50;0.79]", and "large effect, d =[0.80; +∞[".

Student characteristics such as performance self-efficacy (ES=1.81), grade goal (ES=1.12), effort regulation (ES=0.75), strategic approach to learning (ES=0.65), and achievement motivation (ES=0.64), have an impact on achievement (Schneider and Preckel 2017). Therefore, it seems worthwhile to develop student-centred interventions that can improve these characteristics. However, when developing interventions, it is important to keep in mind that it is not easy to change a persons' behaviour by organising just one intervention (Michie et al. 2014).

Robbins et al. (2009) examined which types of interventions have an effect on students' academic achievement and retention. They distinguished three main type of interventions: (1) academic skill interventions focusing on study skills, learning strategies, note taking, and academic time management; (2) self-management interventions including programmes mainly aimed at improving skills for effective emotional and self-regulation such as stress management, anxiety reduction, and self-acceptance training; and (3) socialization interventions, which are short but intensive orientation programmes for new incoming students. They found that academic skills interventions have the strongest effect on academic achievement, whereas self-management interventions have the strongest effect on retention. Socialization interventions also have a significant effect on retention, but a smaller effect than self-management interventions.

In their systematic review, Schneider and Preckel (2017) examined the effect on academic achievement and found moderate and small effect sizes for academic skill interventions: academic skills training (ES= 0.48), academic motivation training (ES=0.33), and training in study skills (ES=0.28). A moderate effect was also found for self-management training programmes (ES=0.44). Another study (Hattie 2015) also found moderate and small effect sizes for academic skills interventions: vocabulary programmes (ES=0.62), writing programmes (ES=0.49), and summer schools (ES=0.23) and a moderate effect for a socialisation intervention: social skills programmes (ES=0.40). Malm et al. (2015) examined the effect on academic achievement and retention of a supplemental instruction programme (i.e. academic skills intervention), which is linked to some difficult courses for new incoming engineering students. The study showed that supplemental instruction has a positive influence on academic achievement and retention.

The previous paragraph focused on interventions that can be assigned to one of the three categories of Robbins et al. (2009). However, in practice, many higher education institutions develop and implement interventions that combine the different categories. For example, the meta-analysis of Sneyers and De Witte (2018) examined the effect of mentoring on retention and graduation. Mentoring can include academic help, but also help with study skills or social needs. Mentoring is considered as an aid to improve students' integration and preparedness. They found that mentoring has a positive, significant but small effect on both retention (ES=0.15) and graduation (ES=0.10) in higher education. During the research of Bacon et al. (2018), various sessions were offered to first-year students such as an orientation week (i.e. socialization intervention), group advising, time management (i.e. academic skill intervention), and de-stressing (i.e. self-management intervention). Bacon et al. (2018) examined students' feedback on the organised support programme. An important conclusion is that students prioritise learning actionable skills such as interventions focusing on study skills for higher education, time management, learning styles, and academic strategies. Students prefer interventions that take place in small group settings and their satisfaction is raised when the content is relevant and timely. Researchers (Lazowski and Hulleman 2016, Wilson 2006, Yeager and Walton 2011) have found that interventions can be powerful and long-lasting when they focus on specific motivational processes at crucial time points during the students' educational process. These interventions are then called target interventions. Malm et al. (2015) also concluded that supplemental instruction improves students' self-confidence, gives student a broader study network, and improves their study and problem-solving skills.

The teacher has irrevocably an important role in students' academic achievement. However, in this dissertation the focus will be on student-centred interventions, since the aim is to put students in motion, both before and after enrolment. You cannot force students to learn, therefore most of the interventions in this dissertation are extra-curricular and voluntary. Interventions can be divided into two groups: (1) obligatory and (2) voluntary interventions. Larson (2000) showed that it is important to control for some self-selection factors in case the intervention is on voluntary basis, since not controlling for these factors can result in overestimation of the effectiveness of an intervention (Larson, 2000). Fredricks and Eccles (2006) controlled for possible covariates when analysing whether extracurricular participation was associated with higher study outcomes. They still found a significant relation between the intervention and target variable but the effect sizes were small and relations were weaker than in previous research. 'Response to intervention' (ES=1.07) was a highly ranked variable in Hattie's (2015) review, meaning that students who actually participate in interventions achieve higher grades. To conclude, when participation in interventions is voluntary, self-selection effects have to be taken into consideration when measuring the effectiveness of the intervention.

4.2.1 EFFECTIVENESS AND EFFICIENCY

Efficiency refers to 'doing things right', while effectiveness relates to 'doing the right things' (Drucker, 1967). Thus, an intervention is efficient when the observed outcomes are produced at the lowest level of resources. Morrison et al. (2014) defines efficiency as a measure that includes the required time for achieving a level of effectiveness, whereas, effectivity occurs when the desired objectives are achieved. One of the major conclusions of Morrison et al. (2014) is that educational researches lack efficiency measurements. However, for the examination of the impact of an intervention, both effectiveness and efficiency should be taken into consideration.

Van Yperen, Veerman, and Bijl (2017) developed a theoretical framework for the measurement of the effectiveness of interventions. Their effectiveness scale consists of five levels: (1) Conditional (i.e. descriptive indications), (2) Promising (i.e. theoretical indications), (3) Appropriate (i.e. first empirical indications), (4) Plausible (i.e. good empirical indications), and (5) Operating (i.e. strong empirical indications). Table 2 summarizes the five different levels of effectiveness, their corresponding level of evidence, and the methods that can be used to measure the effectiveness. They state that the effectiveness scale is rather a development model than a hierarchical scale.

TABLE 2. EFFECTIVENESS SCALE

Effectiveness level	Evidence level	Methods
Level 5. Operating	Strong empirical indications	• (Repeated)(Quasi) Experimental designs • Randomized controlled trial
Level 4. Plausible	Good empirical indications	• Standardizations • Benchmarks • Quality research
Level 3. Appropriate	First empirical indications	• Pre and post-test design • Perceived usefulness (only post-test) • Drop-out research
Level 2. Promising	Theoretical indications	• Literature overview • Meta-analyses • Focus group discussions
Level 1. Conditional	Descriptive indications	• Descriptive research • Interviews

When determining the effectiveness of an intervention, performing an experimental design (level 5) does not guarantee that the intervention is effective. It only provides more evidence that if there are differences in the outcomes, these differences are devoted to the intervention. If a study, that used an experimental design, reveals that there are no differences between the experimental group and the control group then there are strong empirical indications that the intervention is not effective.

Van Yperen, Veerman, and Bijl (2017) emphasize the importance of evaluating the developed interventions to guarantee their effectiveness. This is concordant with Billing (1997), who stated that effectiveness of induction needs to be evaluated via surveys and tracking students' progress. Induction is one aspect of student support programmes and includes interventions that are offered when students enter university for the first time.

To summarize, in this dissertation interventions for (prospective) transfer students were developed after determining their needs. These needs were defined via conducting focus group discussions, dropout interviews and a perception research. The focus was primarily on (1) academic skills interventions, as defined by Robbins et al. (2009) and (2) student-centred interventions. If necessary, self-selection was taken into account. To measure the effectiveness of the interventions, the framework of Van Yperen, Veerman, and Bijl (2017) was used in Chapter 6 and 7. In Chapter 6 the focus was also on the efficiency of interventions.

PART A:

EXPLORATION

CHAPTER 2 - COMPARISON BETWEEN TRANSFER STUDENTS AND TRADITIONAL FIRST-YEAR STUDENTS IN ENGINEERING TECHNOLOGY

Van den Broeck, L., De Laet, T., Lacante, M., Pinxten, M., Van Soom, C. & Langie, G. (2017). Comparison between bridging students and traditional first-year students in engineering technology, *European Journal of Engineering Education,* 43 (5): 741-756. DOI:10.1080/03043797.2017.1417357.[14]

To stimulate a flexible lifelong learning system students can enter university via lateral entry. Unlike traditional first-year students, lateral entrance students are not well-studied. Therefore this study focuses on comparing first-year students with a specific group of lateral entrants, namely transfer students at the Faculty of Engineering Technology, KU Leuven. Using Astin's Input-Environment-Outcome model resulted in (1) Input variables, namely prior education and initial learning and study strategies, (2) Environmental influence, measured with a questionnaire focussing on perceived transition to university, and (3) Outcome variables, namely dropout and academic achievement. Analyses resulted in similarities for the outcome variables, but differences in terms of secondary education. Regarding the input (LASSI) and environmental questionnaires, for only two of the thirteen scales a moderate effect was found (perceived preparedness and test strategies). Consequently, research findings of first-year engineering students can be compared, taking into account their specific differences, to the context of transfer students.

[14] Some minor vocabulary changes were made to guarantee the consistency

1 INTRODUCTION

Due to the rather specific context of the target group in this study, namely transfer students at the Faculty of Engineering Technology (FET), it is necessary to first explain the Flemish education system and the possibilities of higher education.

1.1 FLEMISH EDUCATION SYSTEM

Secondary education has a general and a technical track. Both tracks have a different objective and approach:

- General secondary education (ASO): aims at a broad theoretical education and prepares pupils for higher education;
- Technical secondary education (TSO): mainly focuses on general and technical-theoretical subjects combined with practical lessons and prepares pupils for a future career or for higher (technical) education.

If students decide to continue in higher education they are free to enrol in almost every study programme due to the fact that there are no admission requirements in Flanders, except in medicine or dentistry. More specifically for STEM (Science, Technology, Engineering, and Mathematics), even if students followed a programme with little mathematics during secondary education they can still enrol in a STEM study programme at university without any restrictions. Obviously most of these students have some catching up to do, since they lack the appropriate prior training and knowledge.

Figure 7 provides an overview of the Flemish higher education system. There are two types of Bachelor's degrees namely a professional and an academic one. Both Bachelors have a total weight of 180 ECTS, resulting in a three-year study programme (60 ECTS/year). The purpose of a professional Bachelor's degree, organised at an University College, is to prepare the student for a professional occupation. An academic Bachelor's degree, organised at a University, is intended to acquire all the necessary knowledge and skills to start a Master's programme. The professional Bachelor's programme has a more practical approach, while the academic Bachelor's programme is more conceptual and theoretical.

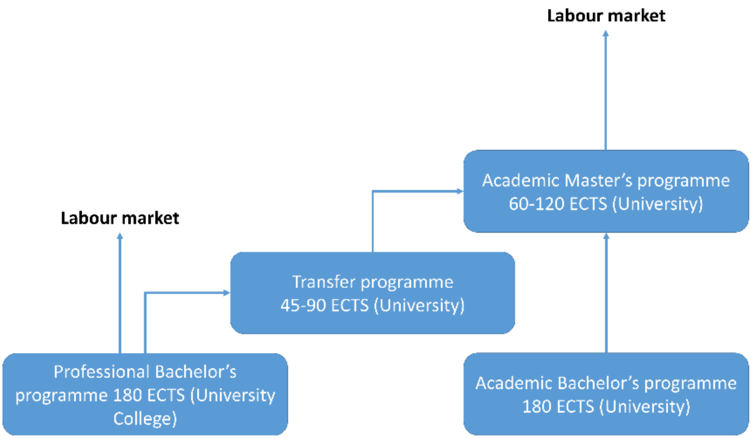


FIGURE 7. SCHEMATIC OVERVIEW FLEMISH HIGHER EDUCATION

The Bachelor students at FET follow the same programme during the first three semesters, independently of their chosen specialization. After these general semesters, the courses become more discipline specific. Many specializations are possible e.g. Mechanical Engineering, Chemical Engineering, and Electrical Engineering. FET is a multi-campus faculty with seven campuses in Aalst, Diepenbeek, Geel, Ghent, Leuven, Sint-Katelijne-Waver, and Ostend. Overall about 6000 students study every year at FET.

1.2 Transfer programmes

In order to stimulate flexible lifelong learning, the educational system of Flanders (and also of other countries, such as Finland[15] and Denmark[16]) provide alternative ways to enter a Master's programme in addition to the traditional academic Bachelor's programme. In Flanders, students who obtained a professional Bachelor's degree can enrol into an academic Master's programme on the condition that they successfully complete a transfer programme. It is important to point out that (1) not every Master's programme offers a transfer programme and (2) only a professional Bachelor's degree obtained in the same discipline as the Master's degree is eligible for transfer. A transfer programme focuses on the missing competences/knowledge that are required to start a Master's programme. Transfer programmes are designed for students who (1) discover during or after the professional Bachelor's programme that they are interested in more conceptual and theoretical knowledge about their discipline or (2) want other job opportunities. It is also a good solution for secondary

[15] http://www.minedu.fi/export/sites/default/OPM/Koulutus/koulutusjaerjestelmae/liitteet/finnish_education.pdf

[16] http://eng.uvm.dk/Education/Overview-of-the-Danish-Education-System

education students with a lack of self-confidence or a low (academic) self-concept. The professional Bachelor's degree can help them to become more self-confident and more mature.

The transfer programmes at FET have a weight of approximately 60 ECTS, depending on the choice of study programme and the professional Bachelor degree. The first semester of the transfer programme has a very general focus with mainly basic science and engineering courses (e.g. mathematics, mechanics, electricity, physics, and chemistry). The three general semesters of the academic Bachelor's students are reduced to one general semester for the transfer students. During the second semester the courses focus on the chosen specialization. Like traditional first-year students, transfer students also enter university for the first time but they are (in general) three years older and consequently have a different educational background.

Figure 8 shows the total number of transfer students (i.e. both new students and students who are registered for the second time) enrolled at FET for the last seven academic years. In the academic year 2015-2016 a total of 1708 students entered the Faculty of Engineering Technology for the first time. Almost 30% of these new students were transfer students (N first-year students= 1232; N transfer students= 476).

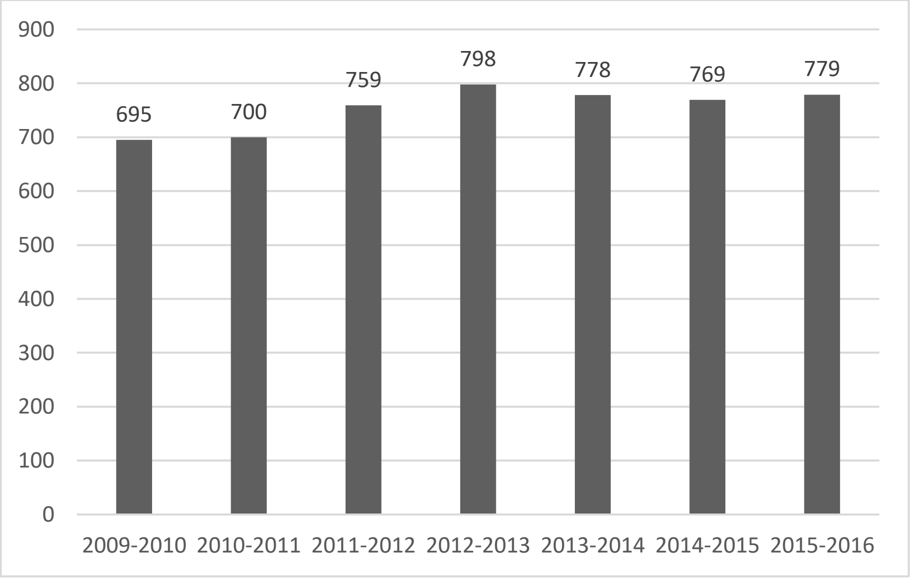


FIGURE 8. NUMBER OF ENROLLED TRANSFER STUDENTS

1.3 Problem

Unfortunately, the transfer programme has a high dropout rate and, as a result, a rather low success rate. The limited number of successful transfer students is the result of (1) the level of difficulty of the programme, and (2) the fact that not all the transfer students have the proper prior knowledge. The low success rate of this large population of students combined with the fact that these students already possess a valuable degree in Technology, results in a high social cost for the Belgian government and thus identifies them as an interesting research population. Unfortunately there is no published study on transfer students, which is in contrast with literature on first-year engineering students. However there is reason to believe that these two groups encounter the same problems during the transition, because for both groups it is their first year at university. In a previous research, focus group discussions with transfer students were organised (Van den Broeck et al. 2015), which revealed that transfer students have difficulties with for example the pace of the courses, the theoretical approach, and the required in-depth learning. Therefore the scope of this study is to explore whether the research findings of studies focusing on traditional first-year students also applies to transfer students (See section 3 for research questions).

2 Literature overview

In most STEM research, the emphasis is predominantly on first-year students entering university from secondary education. Many of these new students experience difficulties during the transition from secondary education to university and sometimes they drop out as a consequence (Georg 2009, Marra et al. 2012). Identifying these difficulties and searching for predictors of retention and/or study success of first-year students is therefore important.

Astin's Input-Environment-Outcome theory (1993) is a frequently used model in educational research. Astin states that students' outcome variables, such as GPA and retention, can be seen as a function of input and environmental variables. Input variables are students' characteristics at their entry at university (e.g. high school GPA) and environmental variables refer to students' experiences at university after enrolment (e.g. interventions and educational experiences). Since input and environment variables have an influence on outcome variables, a well-considered combination of variables will lead to a model. This model can predict academic achievement, retention, or another outcome variable. A study of Araque et al. (2009) showed that there is reason to believe that this prediction model is subject-dependent. Because of Astin's general approach the use of subject-dependent predictors is not a problem. Because of this subject-dependence, several studies focused on the STEM-field as a whole or more specifically, only on engineering. For example, Veenstra et al. (2008) concluded that the modelling of first-year engineering students' success is different from modelling of non-engineering students.

A majority of the STEM studies focuses on: (1) the use of cognitive (e.g. High school GPA and SAT/ACT scores), non-cognitive (e.g. self-concept and motivation), or a combination of both in order to predict academic achievement and/or retention of first-year students (Ackerman et al. 2013, Bernold et al. 2007, Burtner 2005, De Winter and Dodou 2007, French et al. 2005, House 2000, Moses et al. 2012, Pinxten et al. 2015, Ting 2011, Veenstra et al. 2009); and (2) finding reasons and explanations for dropout (e.g. lack of interest, workload higher than expected, and bad results) (Ahmed et al. 2014, Bailli and Fitzgerald 2000, Seymour and Hewitt 1997, Ulriksen et al. 2010).

3 Research questions

The aim of this explorative research is to find out if there are similarities between the transfer students and the first-year students regarding input, environment and outcome variables. If so, STEM studies of first-year students can be a source of inspiration for developing a prediction model for transfer students in a later phase of this research. As input or pre-university characteristics, tracks of secondary education and learning and study strategies were chosen. A more suitable pre-university characteristic, according to literature, is prior achievement. Contrary to many other countries, prior achievement is due to the open admission system not of importance for entering Belgian universities and as a result, the university does not have access to this information. However, taken into account the time gap of three years between the end of secondary education and the enrolment in the transfer programme, it is reasonable that the results of the professional Bachelor's degree are more accurate for the prediction of academic achievement in the transfer programme than the results of secondary education. Van Daal et al. (2013) showed that there are significant differences in obtained credits between the different tracks of secondary education. By comparing the learning and study strategies of both transfer and first-year students before entering university it will be possible to examine if they start their first year at university with the same strategies. Since focus group discussions revealed that transfer students experience various difficulties during the transition and because this problem is also present for first-year students (Ahmed et al. 2014, Torenbeek et al. 2011), the perceived transition to university is selected as environmental variable. The outcome variables in this study are academic achievement and the dropout rate after one year at university.

In the long run the goal is to decrease the dropout rate and increase the success rate of the transfer students. Gaining insight into these two parameters is therefore crucial. To summarize, the scope of this research is to find an answer on the three following research questions:

Are transfer students of FET comparable with the traditional first-year students in the academic Bachelor's programme of FET regarding:

(1) pre-university characteristics?
(2) the perceived transition to university?
(3) achievement after one year of enrolment?

4 METHODOLOGY

4.1 SAMPLE

This study focuses on the new (i.e. enrolled for the first time) transfer (TR) and first-year (FY) students at FET. Data of three different cohorts, namely 2013-2014, 2014-2015, and 2015-2016 were used. Table 3 contains general characteristics, namely gender and age. Both groups have a similar gender distribution, but the mean age is different. In theory, transfer students should be three years older than first-year students, since they already obtained a professional Bachelor's degree. In this study the mean differences are somewhat higher (3.5y and 3.61y). Three possible explanations for this higher age difference are (1) study delay during secondary education; (2) study delay during professional Bachelor's programme; and (3) not immediately started with transfer programme after professional Bachelor's programme. Table 4 gives an overview of the included data for both groups and the three academic years. Only students who finished secondary education or the professional Bachelor's programme in the academic year before the year of enrolment at university were included.

TABLE 3. GENERAL CHARACTERISTICS

General characteristics	Total N		Proportion male (%)		Mean age (y)	
	TR	FY	TR	FY	TR	FY
Cohort 2013-2014	516	960	88%	90%	21.65 y	18.15 y
Cohort 2014-2015	423	1008	85%	89%	21.71 y	18.10 y
Cohort 2015-2016	368	949	86%	87%	/	18.11 y

TABLE 4. DATA OVERVIEW

Data overview	Total N		PRE-UNIVERSITY CHARACTERISTCS				TRANSITION TO UNIVERSITY		ACHIEVEMENT					
			Secondary education		LASSI[1,2]		Perceived fit[1,2]		Dropout Rate		Dropout interviews[1]		Academic achievement[2]	
	TR	FY	TR	FY	TR	FY	TR	FY	TR	FY	TR	FY	TR	FY
Cohort 2013-2014	516	960	x	x					x	x			x (N= 351)	x (N= 809)
Cohort 2014-2015	423	1008	x	x			x (N= 124)	x (N= 136)	x	x	x (N= 36)		x (N= 286)	x (N= 863)
Cohort 2015-2016	368	949	x	x	x (N= 62)	x (N= 443)								

A cell marked with an 'x' implies that the corresponding sample is included in the study (as a whole or partial). [1] Not all the campuses were included and participation was voluntary. [2] Only students with a study programme of ≥ 50 ECTS were included.

4.2 METHOD

The transfer students and first-year students are compared on the basis of three broad characteristics: (1) pre-university characteristics (i.e. input variables: track of secondary education and learning and study strategies at the end of secondary education for first-year students and professional Bachelor's programme for transfer students), (2) transition to university (i.e. environment variable: perceived fit), and (3) achievement indicators (i.e. outcome variables: dropout and academic achievement).

The methodologies of all the performed analyses, are described in this section. An overview of the results is given in section 5.

4.2.1 PRE-UNIVERSITY CHARACTERISTICS

Secondary education. The different tracks were already clarified in Section 1.1. By collecting data of different cohorts of transfer and first-year students (see Table 4), the proportion of the different tracks was calculated and compared for a large group of students.

Learning and study Strategies at the end of (1) secondary education; (2) the professional Bachelor's programme. These strategies are measured with the help of the Learning And Study Strategies Inventory (LASSI; Weinstein and Palmer 2002). The LASSI is a widely used and validated questionnaire (Weinstein and Palmer 2002; Olivier et al. 2015) and at KU Leuven broadly implemented. For example, LASSI is used in the European Ready STEM go[17] project, which aims to increase the retention rates of STEM programmes (Pinxten et al. 2015; 2016). LASSI consists of 77 items, divided into 10 scales:

- Information processing (INP – N items= 8): Deep versus surface learning.
- Selecting main ideas (SMI – N items= 5): Student's ability to select the key message from a text.
- Test strategies (TST – N items= 8): Students' techniques for preparing for and taking tests.
- Attitude (ATT – N items= 8): The importance of going to university in a students' life.
- Anxiety (ANX – N items= 8): Anxiety levels that keep students from performing at the maximum level.
- Motivation (MOT – N items= 8): Students' persistence when confronted with challenging tasks.

[17] https://iiw.kuleuven.be/english/readystemgo

- Self-testing (SFT – N items= 8): Degree to which students monitor/test their progress while studying.
- Concentration (CON – N items= 8): Students' concentration level when in class or studying.
- Time management (TMT – N items= 8): Students' tendency to procrastinate and to meet deadlines.
- Study aids (STA – N items= 8): Students' ability to use and create techniques for meaningful learning.

Students were asked to rate each item on a five-point Likert scale (1= 'Not at all like me' – 5= 'Very much like me'). Sample items for every scale are added in Appendix A. A high scale score on for example *motivation* suggests that a student, according to his/her perceptions, possesses enough motivation to exert the required efforts to successfully complete the chosen study programme. The LASSI was administered at the end of the professional Bachelor's programme for the transfer students and at the beginning of the academic year for the first-year students. The participants (N= 443 FY; 62 TR – see Table 4) were instructed to evaluate their learning and study skills at the end of secondary education (for academic Bachelor students) or at the end of the professional Bachelor's programme (for transfer students) respectively. Therefore the LASSI scale scores are considered to be pre-university characteristics. Independent sample t-test analyses were used to evaluate whether there are significant differences between the first-year students and transfer students on one or more LASSI scales.

4.2.2 Transition to university

Perceived fit. To gather students' perceptions about the transition to university, a validated questionnaire (Torenbeek et al. 2011; Noyens et al.) was administered during the second semester of the academic year 2014-2015 (N= 136 FY; 124 TR – see Table 4). This questionnaire includes the following three scales (For sample items see Appendix B):

- Preparation (PREP – N items= 3): Feeling of preparedness for university
- Adaptation (ADAP – N items= 4): Adaption to the university life
- Resemblance in teaching approach (RESEM – N items= 3): Resemblance in teaching approach between prior and current education.

Each item was rated on a five-point Likert scale (1 = 'Totally disagree' – 5 = 'Totally agree'). A high score on *preparation* means that the corresponding student feels well prepared for the chosen study programme. When a student gives a high score on *adaptation*, it implies that the student did not experience problems when adapting to the new study programme. *Resemblance in teaching approach* receives a high score when the student's perceives a proper similarity in pedagogic approach compared to the prior education. The scores on the three scales are summed up, resulting in a total score for the perceived fit. By performing Independent sample t-test analysis the sum scores of the first-year students and transfer students were compared to detect significant differences.

4.2.3 ACHIEVEMENT INDICATORS

Dropout. A mixed method approach was used to gain insight in dropout rates and reasons for dropping out. The quantitative data considers the dropout rate, therefore four cohort analyses were performed and since the emphasis is on the transition to university, every cohort was followed for one complete year (see Table 4). The qualitative data considers individual dropout interviews. These interviews were restricted to transfer students, who officially dropped out between the beginning of the academic year and the first half of the second semester at the three campuses that are actively involved in this research (N=57). Note that there are more dropout students, but not all of them officially withdrew from the programme. All the dropouts were contacted many times, but not everybody answered. A total of 36 telephone interviews were conducted within five months (February 2015 – June 2015; response rate of 63%). The interview consisted of seven questions and took approximately 10 minutes (see Appendix C). The aim of the interview was to learn more about the reasons why transfer students dropout and what their major stumbling blocks are. During the interview the students' responses were typed and similar answers were grouped together in response categories.

Academic achievement. Cumulative study efficiency (CSE) after one year of study is chosen as the measure of academic achievement. CSE is the proportion of the number of earned credits and the total number of credits the student subscribed for.

5 RESULTS

5.1 PRE-UNIVERSITY CHARACTERISTICS

5.1.1 SECONDARY EDUCATION

Table 5 shows the secondary education tracks taken by the students before entering higher education. 69% of the academic Bachelor students followed a general secondary education and 31% followed technical secondary education. For the transfer students this proportion is reversed (31% ASO vs. 67% TSO).

TABLE 5. SECONDARY EDUCATION

Secondary education	General secondary education (ASO)	Technical secondary education (TSO)
FY	69%	31%
TR	31%	67%

Note. The percentages are means of the three included cohorts

5.1.2 LASSI

Table 6 presents the LASSI results for both first-year students and transfer students. Transfer students have higher mean scores on all ten LASSI scales. Independent sample t-tests resulted in significant group differences on six scales namely, attitude ($p=0.011$), anxiety ($p<0.001$), concentration ($p=0.008$), information processing ($p=0.003$), selecting main ideas ($p=0.011$), test strategies ($p<0.001$). Using the rules of thumb of Cohen (1988), who defined effect sizes as “small, $d =[0.20;0.49]$”, “moderate, $d =[0.50;0.79]$”, and “large, $d =[0.80; +\infty[$”, this results in five significant but small effect sizes (ES) and one moderate effect size. This analysis reveals that transfer students outperform the first-year students regarding learning and study strategies.

TABLE 6. TEN LASSI SCALES (N_{FY} = 443, N_{TR} = 62)

LASSI		ATT	MOT	TMT	ANX	CON	INP	SMI	STA	SFT	TST
FY	M	30.90	27.47	23.59	26.52	26.17	27.75	17.39	23.98	25.02	28.65
	SD	4.06	4.56	4.92	5.22	5.21	4.49	2.99	4.41	4.23	4.19
	α	.64	.77	.76	.84	.84	.81	.73	.73	.71	.71
TR	M	32.29	28.53	24.56	28.94	28.02	29.58	18.42	24.58	24.98	31.34
	SD	3.55	4.59	4.75	4.72	4.38	4.55	2.80	4.60	4.06	4.14
	α	.62	.75	.70	.76	.77	.80	.70	.61	.61	.77
T-test	T	2.562 (p=0.011)	1.713 (n.s.)	1.460 (n.s.)	3.457 (p<0.001)	2.666 (p=0.008)	2.971 (p=0.003)	2.560 (p=0.011)	0.998 (n.s.)	.070 (n.s.)	4.742 (p<0.001)
	ES	0.36	/	/	0.49	0.38	0.40	0.36	/	/	0.65

The maximum scale score is 40, except for SMI the maximum is 25. Scales: Attitude (ATT), Motivation (MOT), Time management (TMT), Anxiety (ANX), Concentration (CON), Information processing (INP), Selecting main ideas (SMI), Study aids (STA), Self-testing (SFT), Test strategies (TST). M=Mean, SD= Standard deviation, α= Cronbach alpha, t= t-value, ES=effect size=Cohens' d.

5.2 TRANSITION TO UNIVERSITY

5.2.1 PERCEIVED FIT

Table 7 summarizes the results obtained on the three scales of the perceived fit questionnaire. The first-year students score, on average, higher than the transfer students.

TABLE 7. THREE SCALES AND SUMSCORE OF THE PERCEIVED FIT (N_{FY} = 136, N_{TR} = 124)

Perceived fit		Preparation	Adaptation	Resemblance	Total perceived fit
FY	Mean	3.58	3.05	2.43	3.02
	SD	0.83	0.82	0.75	0.80
	α	.83	.81	.66	.81
TR	Mean	3.15	2.95	2.25	2.78
	SD	0.71	0.84	0.69	0.75
	α	.64	.79	.48	.76
T-test	T	4.468 (p< 0.001)	0.971 (n.s.)	2.008 (p=.046)	2.489 (p=.013)
	Cohens' d	0.56	/	0.25	0.31

The mean scores should be interpreted as a score on five. SD= Standard deviation, α= Cronbach alpha, t= t-value, Cohens' d= effect size.

Independent sample t-tests revealed significant differences on preparation (p<0.001), and resemblance in teaching approach (p=0.046). For *preparation* a moderate ES was found and for *resemblance in teaching approach* a small ES. In general, traditional first-year students feel better prepared for the first year at university and perceive higher levels of resemblance in teaching approach compared to transfer students. Regarding adaptation to university, first-year and transfer students have similar experiences. For the total perceived fit an independent sample t-test showed a significant difference (p=.013), but small ES, between the transfer and first-year students.

5.3 Student achievement

5.3.1 Dropout rates

Cohort analyses were performed on first-year students and transfer students (Figure 9). These analyses revealed a total dropout rate after one year of 41% (2013-2014) and 35% (2014-2015) in the transfer programme compared to 35% in the academic Bachelor's programme (2013-2014; 2014-2015). Dropout after one year only includes students who did not enrol the next academic year. For the transfer programme the dropout during the year is higher than in the academic Bachelor's programme. No significant differences between the groups were found.

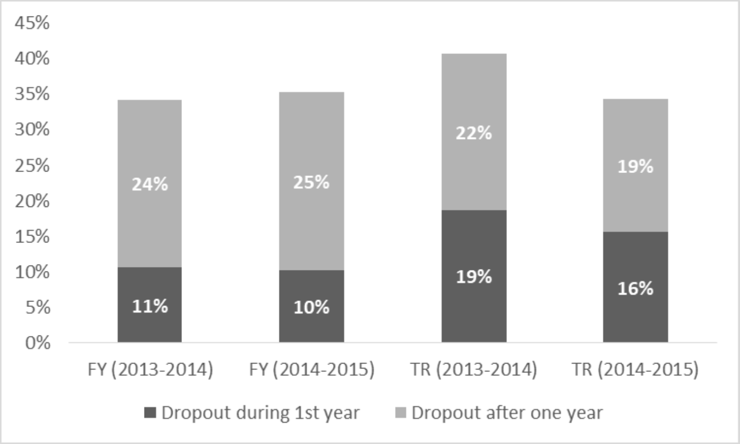


FIGURE 9. DROPOUT RATES FIRST-YEAR AND TRANSFER STUDENTS.

5.3.2 Dropout interviews

The main results of the telephone interviews are summarized below.

Future plans. A total of 75% of the students who dropped out decided to go to the labour market (N=27). Of those who were already working at the moment of the interview (N=20), all but one indicated they found a job within two months. Only a small proportion of students (11%) enrolled in another study programme. The remaining group (14%) already had a full time job during the transfer programme and continued working.

Major stumbling blocks. Most transfer students mentioned more than one stumbling block. A fraction of 60% of the students indicated that they experienced problems with studying basic courses, especially when they needed to learn mathematical proofs or any other mathematical subject. Other major stumbling blocks mentioned by the students are: an excessive amount of study material (13%), difficulties to motivate themselves to study (10%), adaptation problems (10%) and the high pace of the teaching (10%).

Reasons to leave the transfer programme. In general students gave more than one reason for leaving the transfer programme. The most common reasons are: too difficult (30%), fed up with studying (22%), bad results (19%), not in line with interests (16%), and too theoretical (14%). Interestingly, a quarter of the students (25%) indicated that it might have been better if they had immediately started the academic Bachelor programme instead of completing a professional Bachelor programme first.

5.3.3 ACADEMIC ACHIEVEMENT

Table 8 shows three different cumulative study efficiencies of the academic years 2013-2014 and 2014-2015 (see Table 4): CSE January, CSE June, and CSE End are the cumulative study efficiency of the exam period at the end of the first semester, the end of the second semester, and at the end of the academic year respectively. It is important to point out that CSE End also includes resit results.

The biggest difference in CSE between the two groups is for the CSE of January (Mean difference 2013-2014= 3.01%; 2014-2015= 7.30%). The group of first year-students has a higher CSE in January than the transfer students. Only for the academic year 2014-2015 the independent sample t-test revealed a significant difference in CSE ($p = 0.002$). Calculating Cohens’ d results in a small ES. To summarise, transfer students and traditional first-year students have in general a similar CSE.

TABLE 8. ACADEMIC ACHIEVEMENT (2013-2014: N_{FY} = 809, N_{TR} = 351; 2014-2015: N_{FY} = 863, N_{TR} = 286;

Academic achievement		CSE January		CSE June		CSE End	
		2013 –2014	2014 -2015	2013 -2014	2014 -2015	2013 -2014	2014 -2015
FY	Mean	52.24%	54.43%	53.17%	52.14%	64.74%	64.41%
	SD	34.90%	34.96%	30.80%	31.22%	32.31%	33.34%
TR	Mean	49.23%	47.13%	53.00%	51.44%	64.78%	63.50%
	SD	31.80%	32.43%	30.31%	30.87%	32.33%	32.80%
T-test	t	1.385 (n.s.)	3.115 (p=0.002)	.087 (n.s.)	.329 (n.s.)	.020 (n.s.)	.402 (n.s.)
	ES	/	0.22	/	/	/	/

SD= Standard deviation, t= t-value, ES= effect size= Cohens'd.

6 Discussion

In this study traditional first-year students are compared to the transfer students at FET regarding their pre-university characteristics (Input), perceived transition to university (Environment), and achievement (Outcome).

Regarding secondary education, there is a distinct difference between the transfer students and the first-year students. The general track focuses on a general and broad preparation for higher education whereas the technical track has a more practical approach and prepares for a future career or (technical) higher education. Therefore it is no surprise that there are more general track students in the academic Bachelor's programme and more technical track students in the transfer programme, who enter university after obtaining a professional Bachelor's degree. Engineering students, who followed the general track in secondary education, generally outperform their counterparts from the technical track in terms of credits obtained in the first year of the academic Bachelor's programme (FET 2014, Van Daal et al. 2013).

Transfer students indicate that they feel less prepared for university in comparison with traditional first-year students. The lower level of preparation is not odd, since a professional Bachelor's programme aims to prepare students for the labour market and not for an academic study programme. This however does not mean that professional Bachelor's programmes have to be changed. The lower score for the transfer students on the scale resemblance in teaching approach can be the result of a more practical approach of the professional Bachelor's programme and the switch of this practical focus of the professional Bachelor programme to the general focus of the transfer programme.

Adaptation problems were mentioned as one of the major stumbling blocks in the dropout interviews with transfer students and play a role in the higher dropout rate during the year. In general, the total perceived fit of the transfer students is lower than the fit of the first-year students, which is also a possible reason for the higher dropout rate during the year. Combined with the fact that they already possess a higher education degree can definitely lead to a decision to drop out sooner. Some of the dropout students do not even wait until the first exam period and decide to look for a job. Although the dropout rate during the year is higher for transfer students, the cohort analyses showed that the overall dropout rates are very similar. In the qualitative research the majority of students that dropout indicate problems related to the difficulty of the courses, especially mathematics. However, it is clear that there is more than one reason for dropping out. As Seymour and Hewitt (1997) point out, the decision to leave does not happen overnight, but the idea of dropping out will grow until there is a 'last straw' incident (e.g. bad results). Since there are no results of conducted interviews with first-year students, it is necessary to rely on STEM dropout research for a comparison. It is important to bear in mind that there is no hard evidence that all the research findings are directly applicable for the first-year students of FET. Nevertheless, these dropout STEM studies are a relevant source of information. Bailli and Fitzgerald (2000) for instance, confirm that first-year engineering students who dropout, find the level of maths and theory too high. Moreover, students thought the courses would be more practical or interesting and the workload appeared to be higher than they expected. Ahmed et al. (2014) distinguished two meta categories. The first category contains internal or personal reasons for leaving engineering as there are: lack of interest and enjoyment, demotivation, and lack of self-knowledge, which resulted in the wrong choice of study programme. The other category includes external reasons, over which student has limited or no control that place the student in a weaker position. Poor academic achievement and a heavy workload are typical external reasons. Much of the above research findings, were also mentioned during the dropout interviews with transfer students, such as the mathematical and theoretical approach, the lack of interest and motivation, the workload, and bad results. It seems feasible that, due to the mathematical and theoretical approach of the engineering programme, the first-year students of FET, have similar experiences.

Since transfer students had the opportunity to focus very explicitly on the discipline they belong to during their professional Bachelor's programme, the rather general focus of the first semester of the transfer programme may possibly demotivate the students. Nevertheless, this focus is considered to be essential in order to maintain the profile of the engineering programmes. The general and very theoretical first semester is probably also one of the reasons for the lower academic achievement of the transfer students after the first semester. During focus group discussions transfer students also mentioned that the courses were more conceptual and theoretical than they were used to (Van den Broeck et al. 2015). Adaptation problems and a low level of preparedness can be another explanation for the lower academic achievement after the first semester. However, the CSE's of transfer students after one year are similar to those of the first-year students.

Although transfer students experience more problems with transition to university than first-year students, they are more confident regarding their learning and study strategies. Since the students were asked to fill in the LASSI test from their point of view of their prior education (secondary education or professional Bachelor's programme), the success experience in the professional Bachelor's programme and the fact that they are already familiar with a form of higher education are reasonable explanations for the higher scale scores for transfer students. Unfortunately, it is not because they feel confident, that their study and learning strategies are appropriate for university. Two possible reasons why the first-year students have lower scale scores: 1) the study and learning strategies they used during secondary education were sufficient, but during higher education different or new strategies become important, and 2) they are more worried since they have no experience with higher education. Conley (2007) also stated that when students enter university they must adapt their study and learning strategies to be successful in higher education. The significant higher scores for *information processing, selecting main ideas, and test strategies* are in contradiction with the results of the focus group discussions with the lecturers who believe that study strategies is one of the main stumbling blocks for transfer students (Van den Broeck et al. 2015). The transfer students also reported lower levels of *anxiety*, probably because they had an experience of success after receiving their professional Bachelor degree, providing a safe exit road if they fail in the transfer programme. The higher levels of *attitude* and *concentration* indicate that transfer students deem their studies more important and can focus more while studying, which is confirmed during focus group discussions with lecturers of the transfer programme (Van den Broeck et al. 2015).

7 CONCLUSIONS

This study enables a comparison between transfer students and traditional first-year students based on Astin's IEO-model. Both outcome variables, (dropout rate and academic achievement after one year of study), are similar for transfer and first-year students. The difference in one of the input variables, namely secondary education, is not peculiar since an academic Bachelor's programme aims to attract mainly general track students. Students of this general track have more experience with the academic way of thinking, while students of a technical track have more experience with the practical approach. Obtaining a professional Bachelor's degree is a logical continuation for students who followed a technical track and this explains why the proportion of those that followed a technical track in the transfer programme is higher than in the academic Bachelor's programme.

For the self-reported input (LASSI) and environment (perceived fit) variables, the interpretation is less straight-forward. More than half of the scales revealed significant differences but in general, the effects were small. Only for preparation and test strategies a moderate effect was found. Since the results are self-reported and due to the small effect sizes, it is justifiable to say that transfer and first-year students are rather similar with regard to almost all their learning and study strategies, adaptation, and resemblance in teaching approach, but they feel significantly less well-prepared compared to traditional first-year students. Both transfer and first-year students face a difficult first year at university with several transition problems and they probably have to make some adjustments to their study and learning strategies. However, once they overcome this hurdle, the outcome variables (dropout rate and CSE) of both groups are similar. This is an indication that studies of first-year STEM students can be translated into the context of transfer students, provided that the results are treated with caution.

8 FUTURE WORK

For future research it would be worthwhile to link the examined characteristics with exam results and find out which of these variables are significant predictors for study success. It is also important to note that the first exam period at university can be a decisive tipping point. As a consequence it is possible that the perception of the students changes after the exams. Therefore it would be useful to ask students to complete the LASSI a second time after the exam period of the first semester. This research focused on three characteristics, but a further comparison of these two groups can be made by involving other variables e.g. (mathematical) self-concept and mathematical knowledge. And finally, it would be worthwhile to point out not only specific problems (e.g. adaptation) that students encounter, but also to implement and investigate interventions.

APPENDIX

A. LASSI

(1) Anxiety: "When I am studying, worrying about doing poorly in a course interferes with my concentration." and "I feel very panicky when I take an important test."

(2) Attitude: "I do not care about getting a general education, I just want to get a good job." and "I only study the subjects I like."

(3) Concentration: "My mind wanders a lot when I study." and "If I get distracted during class, I am able to refocus my attention."

(4) Information processing: "To help me remember new principles we are learning in class, I practice applying them." and "I try to find relationships between what I am learning and what I already know."

(5) Motivation: "When work is difficult I either give up or study only the easy parts." and "I set goals for the grades I want in my classes."

(6) Selecting main ideas: "I have difficulty identifying the important points in my reading." and "When studying, I seem to get lost in the details and miss the important information."

(7) Self-testing: "I stop periodically while reading and mentally go over or review what was said." and "To check my understanding, I make up possible test questions and try to answer them."

(8) Study aids: "I try to find a study partner or study group for each of my classes." and "My underlining is helpful when I review text material."

(9) Test strategies: "I have difficulty adapting my studying to different types of courses." and "I review my answers on essay tests to make sure I have made and supported my main points."

(10) Time management: "I find it hard to stick to a study schedule." and "I set aside more time to study the subjects that are difficult for me."

Weinstein, C.E., and Palmer, D.R. 2002. *LASSI: User's manual Learning and Study Strategies Inventory.*© Clearwater, Florida: H&H

B. PERCEIVED FIT

(1) Preparation: "There is much overlap between the subjects treated at secondary school/professional bachelor programme and in this programme." and "The subjects at university are well attuned to the subjects at secondary school/professional bachelor programme."
(2) Adaptation: "Until now, the first year is harder than I expected." and "It took quite some time to get used to the way of studying at university."
(3) Resemblance in teaching approach: "In this course the same amount of independent work is requested as at secondary." and "The approach to teaching at university is much similar to that at secondary school."

Torenbeek, M., Jansen, E. P. W. A., and Hofman, W. H. A. 2011. "Predicting first-year achievement by pedagogy and skill development in the first weeks at university." *Teaching in Higher Education*, 16 (6): 655–668

C. DROPOUT INTERVIEW

(1) What are your future plans?
(2) Which prior education did you follow (both professional bachelor programme and secondary education)
(3) Why did you leave the transfer programme?
(4) Did you encounter any specific stumbling blocks?
(5) Could your dropout have been avoided?
(6) Would it have been better if you started immediately with the academic bachelor programme?
(7) Do you have tips for other transfer students?

Chapter 3 – Alternative pathways for entering engineering education: A comparison between two higher education institutions

Van den Broeck, L., Langie, G., De Laet, T., Lacante, M., Van Soom, C. & Carr, M. (2019). Alternative pathways for entering Engineering education: A comparison between an Irish and Flemish higher education institution, *Compare* (under review since 31/01/2019)

In order to stimulate flexible lifelong learning, some educational systems provide alternative ways to enter engineering education in addition to the traditional pathway. This study compares transfer students of two higher education institutions, KU Leuven in Belgium and the Dublin institute of Technology in Ireland, in terms of (1) educational background, (2) their experience of transitioning from an ordinary/professional degree to an honours degree, and (3) academic outcomes. Due to the contextual differences there are differences regarding the perceived fit, dropout rates, and percentage students that graduated on time. For both institutions there was nevertheless a correlation between prior achievement and academic achievement and the transfer students' had similar transition experiences.

1 INTRODUCTION

The demand for engineering graduates continues to grow and employers often struggle to fill their vacancies (Engineering UK report 2018, ECITB 2018, National Academy of Engineering 2004, UNESCO 2010). To meet this demand many attempts are made to increase the number of students in engineering programmes. In order to stimulate flexible lifelong learning, some educational systems provide alternative ways to enter engineering programmes in addition to the traditional pathway. As a consequence, many students do not enter directly into an honours/academic degree in engineering but rather enter the later stages of an honours/academic degree after having completed an ordinary/professional degree. However, the question emerges if all these students are prepared for university. Many studies have already investigated the preparedness of traditional first-year students across countries in Europe (Conley 2007, Lowe and Cook 2003, Jansen and Van Der Meer 2012, Carr et al. 2013, Carr et al. 2015). Whilst this transfer has been studied in the US where students transfer from community colleges to universities (Mc Quay 2000), relatively little has been done on transfer in European universities (Howieson 2012).

Two recent studies (O' Saughnessy et al. 2015, Van den Broeck et al. 2015) examined how students, who entered engineering education via an alternative pathway, experienced the transition. O' Saughnessy et al. (2015) identified, from a series of interviews with Irish transfer students, five main themes: a dip in grades, the expectations of faculty, class integration, study behaviour, and challenges related to the content of the programme. Some students felt their grades had dropped on transition whilst others felt their grades were unchanged or had even improved. They perceived that the material was delivered at a faster pace whilst more theoretical aspects were explored. The students perceived that more self-directed learning was expected and that a higher quality and depth of analysis was required. In addition they reported a greater workload, in particular much more time was spent on continuous assessments leaving less time for ongoing study. On the positive side, transfer students felt that having previously completed a final year project increased their ability to manage their workload. During focus group discussions with Flemish transfer students (Van den Broeck et al. 2015), students shared their experienced difficulties during the transfer programme: In general, the students had difficulties with the pace of the courses, the study load, the theoretical and mathematical approach of the courses, the required in-depth learning, and the fact that they needed to motivate themselves over and over again to open up their books and study after courses. They also mentioned that a course to refresh their mathematical knowledge could help them before the start and during the transfer programme. Comparing the results of these qualitative researches shows that there are many similarities between the experiences of the Irish and Flemish transfer students. Both groups mention the faster pace, the more theoretical approach, the required self-directed learning, the more in-depth studying, and the greater workload in the transfer programme. In an attempt to gain more insight into students who follow alternative pathways to higher education, this study compares transfer students of two European higher education institutions, KU Leuven in Belgium and the Dublin Institute of Technology in Ireland.

2 BACKGROUND

Before heading to the comparison it is important to provide an overview of the Flemish and Irish education system, a description of the involved institutions, and specific information about the transfer programmes.

2.1 EDUCATION SYSTEMS

2.1.1 FLEMISH EDUCATION SYSTEM

In Flanders there is compulsory education until the age of 18. Secondary education starts at the age of 12 and takes six years. During the first (two) year(s) of secondary education, students follow in general the same courses. After the second year, pupils need to select a track. Secondary education has four tracks, each with a different objective and approach:

- General secondary education (ASO): aims at a broad theoretical education and prepares pupils for higher education;
- Technical secondary education (TSO): mainly focuses on general and technical-theoretical subjects combined with practical lessons and prepares pupils for a future career or for higher (technical) education;
- Art secondary education (KSO): combines a general and broad education with active artistic practice and prepares pupils for a future career or for higher (artistic) education;
- Vocational secondary education (BSO): teaches pupils specific vocational skills in combination with a general education, oriented towards a future career. Transition to higher education is possible but rather rare.

Within each track, pupils need to choose a specific study programme (e.g. for general secondary education typical programmes are Mathematics and Sciences or Latin and Mathematics; for technical secondary education: Technical Sciences or Industrial Sciences). Depending on the study programme the hours of mathematics range from 1 hour to 8 hours/week.

At the end of secondary education there is no general organised final exam. If students decide to continue in higher education they are free to enrol in almost every study programme due to the fact that there are no admission requirements in Flanders, except in medicine or dentistry. The admission test consists of two parts: (1) content knowledge about biology, physics, chemistry, and mathematics, (2) generic competences. More specifically for STEM (Science, Technology, Engineering, and Mathematics), even if students followed a programme with little mathematics during secondary education, they can still enrol in a STEM study programme at university without any restrictions.

There are two types of Bachelor's degrees: professional and academic. Both types have a total weight of 180 ECTS, resulting in a three-year study programme (60 ECTS/year). The purpose of a professional Bachelor's degree, organised at an University College, is to prepare the student for a professional occupation. An academic Bachelor's degree, organised at a University, is intended to acquire all the necessary knowledge and skills to start a Master's programme. The professional Bachelor's programme has a more practical approach, while the academic Bachelor's programme is more conceptual and theoretical.

2.1.2 Irish education system

Secondary education in Ireland is compulsory and normally lasts for five or six years. In the first three years students (normally aged 13–15 years old) must study a minimum of 10 subjects whilst senior students (typically aged 16–18) years old must study a minimum of 5 subjects, but this is normally 7 or 8 subjects. To enter into almost all higher education courses students must pass the final exam (Leaving Certificate) in English, Irish, and Mathematics with many colleges requiring a foreign language also. The typical student does these four topics and then chooses three or four other subjects. Mathematics is not a compulsory subject, but due to the matriculation requirements of Higher Education institutes virtually all students study mathematics. For example, in the 2015 state examinations, 97% of students sat the Leaving Certificate (LC) examination (Irish State Examination Commission). Irish students receive an average of approximately 580 hours mathematics tuition across their time in secondary education but there is a wide variation in total tuition time from school to school (Prendergast and O'Meara 2016).

Entry into higher education in Ireland is generally exclusively based on the number of 'points' received in the Leaving Certificate, the final examination in secondary school. Normally, students take seven exam subjects, six of which are included for the purpose of calculating points. A maximum of 100 points can be attained in any one subject (except mathematics which can be worth up to 125 points). A perfect score is 625, which is achieved by about 0.2% of students and the median score is usually around 320–330 points (www.cao.ie). Qualifications are graded according to a scheme devised by the National Qualifications Authority of Ireland (NQAI). In this scheme, Level 7 is an Ordinary bachelor degree, Level 8 is an Honours bachelor degree, Level 9 is a master's degree and Level 10 is a doctorate.

2.2 DESCRIPTION OF THE INVOLVED INSTITUTIONS

2.2.1 FACULTY OF ENGINEERING TECHNOLOGY (FET), KU LEUVEN (KUL)

The Faculty of Engineering Technology (FET) is one of the five faculties within the KU Leuven's Science, Engineering & Technology Group, in addition to the faculties of Engineering Science, Bioengineering Science, Science, and Architecture. FET is a rather new faculty at the KU Leuven. In 2013-2014 the academic study programmes (with exception of arts) of the University Colleges integrated into Universities. As a result FET was erected and became a multi-campus faculty with seven Flemish campuses in Aalst, Diepenbeek, Geel, Ghent, Leuven, Sint-Katelijne-Waver, and Bruges. As mentioned above, there are no admission requirements for entering FET. However each faculty of the Science, Engineering & Technology group organises a voluntary diagnostic test for interested incoming students each year before enrolment. FET offers three Bachelor's programmes, 18 Master's programmes, one advanced Master's programme, and two Postgraduates programmes. Programmes are organised both in Dutch and in English. Each year about 6000 students study at FET.

2.2.2 COLLEGE OF ENGINEERING AND THE BUILT ENVIRONMENT (CEBE), DUBLIN INSTITUTE OF TECHNOLOGY (DIT)

The Dublin Institute of Technology (DIT) has grown organically from a late 19th century group of technical colleges that dealt mainly with craft education, into a degree level institute – initially with degrees awarded by Trinity College Dublin. Since 1993, DIT has been a fully independent institution with degree-awarding powers, covering the full range of higher education courses, from Level 6 certificates all the way to Level 10 doctorates. DIT is split over several campuses in the centre of Dublin with the college of engineering and built environment split between the Bolton St and Kevin St campuses. The college offers 17 Masters programmes, 20 courses at level 8 and 14 courses at level 7. Each year about 3000 students study engineering at DIT.

2.3 ALTERNATIVE PATHWAYS FOR ENTERING UNIVERSITY

2.3.1 TRANSFER PROGRAMMES AT FET

In Flanders, students who obtained a professional Bachelor's degree can enrol into an academic Master's programme provided that they successfully complete a transfer programme (see Figure 10). It is important to point out that (1) not every Master's programme offers a transfer programme and (2) only a professional Bachelor's degree obtained in a comparable discipline as the Master's degree is eligible for transfer. A transfer programme focuses on the missing competences and knowledge that are required to start a Master's programme. Transfer programmes are designed for students who (1) discover during or after the professional Bachelor's programme that they are interested in more conceptual and theoretical knowledge about their discipline or (2) want other job opportunities. The transfer programmes at FET have a weight of approximately 60 ECTS, depending on the choice of study programme and the professional Bachelor degree. The first semester of the transfer programme has a very general focus with mainly basic science and engineering courses (e.g. mathematics, mechanics, electricity, physics, and chemistry). The three general semesters of the academic Bachelor's students are reduced to one general semester for the transfer students. During the second semester of the transfer programme the courses focus on the chosen specialization.

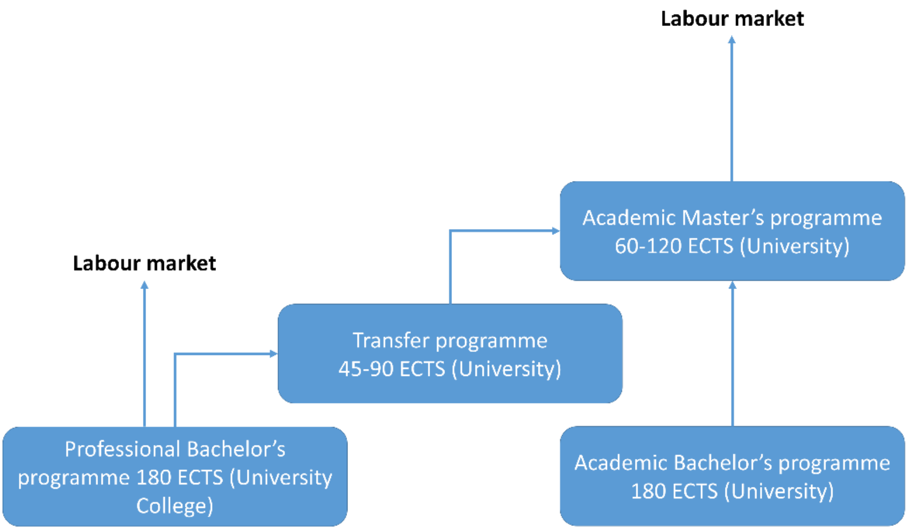


FIGURE 10. SCHEMATIC OVERVIEW OF THE FLEMISH ALTERNATIVE PATHWAY

2.3.2 Level 7 to level 8 at DIT

There are two distinct routes to achieving an Honours degree (Level 8) in engineering in DIT. Students who have achieved a H4 (60%) or higher in Higher Level Mathematics in the Irish Leaving Certificate in secondary school are eligible to enter directly into a four-year Honours degree in engineering. Students who do not have this level of mathematics but have a pass in Ordinary Level Mathematics may enter onto a three-year Ordinary degree (Level 7) in engineering. Upon successful completion of this award, students may progress to the third year of the Honours degree and must complete the third and fourth year of this programme to leave with an Honours degree (see Figure 11). Up until relatively recently an upper merit (60%) was the minimum required to make this transition. Since 2013-2014 this requirement has been relaxed with many students with lower marks being offered the possibility of transition upon successful completion of an interview.

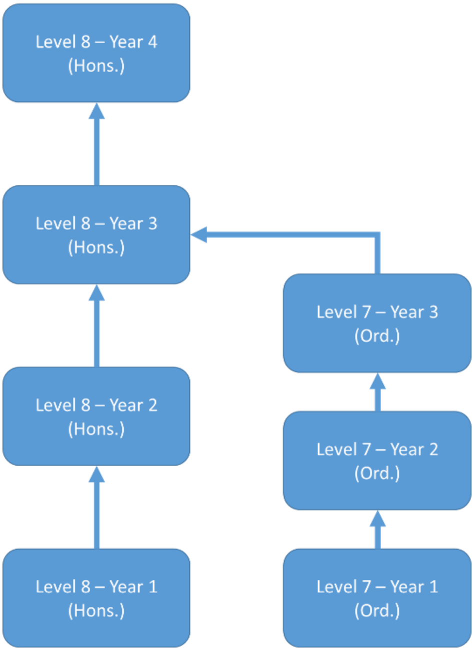


FIGURE 11. SCHEMATIC OVERVIEW OF THE ALTERNATIVE ROUTE TO AN HONOURS DEGREE IN ENGINEERING IN IRELAND, THE MASTER'S DEGREE IS THEN ONE ADDITIONAL YEAR.

2.4 SUMMARY OF SIMILARITIES AND DIFFERENCES REGARDING THE EDUCATION SYSTEMS

Thanks to the European qualification framework (EQF) it is possible to compare both higher education systems. This EQF consists of eight levels. The two levels that are relevant in this study are Level 6, which includes undergraduate higher education (Bachelor's programmes), and Level 7, which includes post-graduate higher education (Master's programme). The Irish level 7 and level 8 are the European level 6. Both the Flemish professional and academic bachelor are included in this level 6. Students that complete an academic Bachelor's programme or honours degree (i.e. Irish level 8) gain direct access to a Master's programme (i.e. European level 7 or Irish level 9), meaning that they are regular students. However, from the Irish level 7 and professional bachelor there is no direct access to the European level 7 (i.e. Irish level 9). Gaining access into this level is only possible via a transfer programme. In both institutions the study programme for transfer students takes one extra year in comparison with regular students (Figure 10 and Figure 11).

Comparing the programmes as a whole is also important. A professional bachelor provides both subject and general knowledge instruction. Students gain the competences necessary to practice a profession. This programme offers direct access to the labour market. An academic bachelor is a theoretical, research oriented degree programme aimed at preparing students for a Master's programme (www.highereducation.be). Historically an ordinary degree (level 7) was the preparation to work as a technician in industry with a small percentage going on to do an Honours degree. Over the last 40 years this percentage has grown with more than 50% of the cohort going on doing an Honours degree in some years. The course itself probably has evolved over the years and whilst still a direct qualification to work as technologist there is also a long term career focus with significant mathematical content that places the Irish Ordinary degree probably half way between the Belgian professional bachelor and the academic bachelor. An honours degree (level 8) is similar to the Belgian academic bachelor.

Comparing the previous sections, also reveals major differences in terms of the education systems. The most important difference are the admission requirements. In Flanders there is no final exam at the end of secondary education. In Ireland, students need to complete the Irish leaving certificate which determines their access into higher education. Also for entering the transfer programme, engineering students at DIT need to obtain a certain grade to enrol in level 8. In 2011-2012, 2012-2013, and all academic years previous to this, students were required to have an average grade of 60% to transfer across to the level 8 programmes. In 2013 this was reduced to 50% being offered the possibility of transition upon successful completion of an interview. At FET, just as in all the other STEM study programmes, there are no admission requirements to enter the bachelor and transfer programme. Students only need to possess a secondary education degree and for transferring a professional bachelor degree in Technology. It is important to keep these differences in mind when reading the following sections which include a data based comparison.

3 METHOD

3.1 SAMPLE

This study includes data of transfer students from the academic years 2011–2012 to 2017-2018. Table 9 provides an overview of the number of new enrolled engineering students at DIT and FET[18] in each cohort.

TABLE 9. COHORTS DIT AND FET

Cohort	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018
DIT*	18	14	19	NA	NA	NA	12
FET**	NA	NA	516	588	479	547	576

*Only mechanical engineering students. ** all disciplines and all campuses. NA= Not available

3.2 VARIABLES

In this study, transfer students are compared in terms of (1) educational background, (2) experienced transition and, (3) academic outcomes.

3.2.1 EDUCATIONAL BACKGROUND

Prior achievement: The results obtained in the year before the transfer programme. For FET students, the prior achievement is based on the obtained overall GPA at the end of the professional bachelor's programme (GPA PBA). For DIT students this is the average GPA of the third year in level 7.

3.2.2 TRANSITION

Perceived fit: To gather students' perceptions about the fit between prior and academic education during transition to university, an existing questionnaire (Torenbeek et al. 2011) was administered at the start of the second semester in the academic year 2017-2018 (N_{FET}= 180[19], N_{DIT} = 10). Each item was rated on a five-point Likert scale (1 = 'Totally disagree' – 5 = 'Totally agree'). The items (N=15) were

[18] All new FET transfer students are included

[19] The perceived fit was administered on the three pilot campuses at FET

adapted to be suitable for transfer students and for FET students it was translated in Dutch.

3.2.3 OUTCOME

- Dropout rate: Total percentage of students that drop out of the transfer programme.
- Academic achievement: Average GPA achieved at the end of the study programme. For DIT students, this is the fourth year in level 8, while for FET students this is the master year. These GPA's are also compared to the GPA's of the regular students.

4 RESULTS

4.1 EDUCATIONAL BACKGROUND – PRIOR ACHIEVEMENT

The correlation between the DIT students' GPA's in level 7 and level 8 in 2013-2014 was moderate (r=.35, N=19). Looking at the linear regression between GPA of the PBA and GPA in the FET transfer programme in 2015-2016[20] revealed a strong correlation (r=.57, N=210).

4.2 TRANSITION – PERCEIVED FIT

Table 10 presents the mean scores on each item of the perceived fit. Five of the 15 items revealed significant differences between the institutions after executing independent sample t-tests (α=.05). At DIT, students found the last year of level 7 a good preparation for the transfer programme (t=5.723, p<.001). On average, FET students find the transfer programme significantly harder in comparison with DIT students (t=3.986, p<.001). The DIT students also agree that the approach to teaching (t=2.976, p=.003) and subjects covered (t=3.429, p=.001) are similar. In addition, they also agree more on the item that they have to work about as hard as in level 7 (t=5.815, p<.001). The FET students experience that they lack content knowledge more than the DIT students (t=5.066, p<.001).

[20] This regression includes transfer students who are new in the programme and have a standard study programme (i.e. minimum 50 ECTS).

TABLE 10. INDIVIDUAL ITEMS OF THE PERCEIVED FIT (M= MEAN SCORE; SD= STANDARD DEVIATION)

Perceived fit	Institution	M	SD	T
1. In general I was well prepared at enrolment.	FET	3.22	.873	1.000 (n.s.)
	DIT	3.50	.850	
2. Until now, the transfer programme is harder than I expected. (R)	FET	3.78	.925	**3.986 (p<.001)**
	DIT	2.60	.516	
3. The last year in PBA/level 7 was a good preparation for the transfer programme.	FET	2.13	.848	**5.723 (p<.001)**
	DIT	3.78	.667	
4. The subjects in the transfer programme are well attuned to the subjects of the PBA/level 7.	FET	3.27	.982	.231 (n.s.)
	DIT	3.20	1.033	
5. It took quite some time to get used to the way of studying in transfer programme. (R)	FET	3.66	.920	1.220 (n.s.)
	DIT	3.30	.823	
6. The approach to teaching in the transfer programme is much similar to that of PBA/level 7	FET	2.36	.978	**2.976 (p=.003)**
	DIT	3.30	.949	
7. I do not have to work very hard to be successful in this programme.	FET	1.98	1.093	1.599* (n.s.)
	DIT	2.78	1.481	
8. I have had problems adjusting to the approach to teaching in the transfer programme. (R)	FET	2.92	1.022	.983 (n.s.)
	DIT	2.60	.699	
9. Before entry I received enough information from the transfer programme on the way of studying in the programme.	FET	2.81	.946	1.295 (n.s.)
	DIT	2.40	1.265	
10. The programme meets the expectations I had beforehand	FET	3.28	.861	.299 (n.s.)
	DIT	3.20	.789	
11. I lack too much content knowledge that is expected of me in the transfer programme. (R)	FET	3.31	.975	**5.066* (p<.001)**
	DIT	2.40	.516	
12. I have the impression that I have too much difficulty with the programme. (R)	FET	2.90	.872	1.767 (n.s.)
	DIT	2.40	.843	

Perceived fit	Institution	M	SD	T
13. I have to work about as hard as in PBA/level 7	FET	1.49	.728	**5.815*** **(p<.001)**
	DIT	3.50	1.080	
14. Before entry I received enough information from the transfer programme on the content of the programme.	FET	3.27	.962	1.553* (n.s.)
	DIT	2.60	1.350	
15. There is much overlap between the subjects treated in PBA/level 7 and in this programme.	FET	2.63	.957	**3.429** **(p=.001)**
	DIT	3.70	1.059	

(R) Reversed items. *Equal variances not assumed. N_{FET}=180, N_{DIT}= 10

Table 11 shows the mean sum scores on the perceived fit of the transfer students at FET and DIT (Cronbach's alpha=.76). Performing an independent sample-t test revealed significant higher scores for the transfer students at DIT (t=3.873, p<.001), meaning that they, in general, report a smoother transition from level 7 to level 8 than the FET students who transfer from university colleges to university.

TABLE 11. SUM SCORE PERCEIVED FIT (M= MEAN SCORE; SD= STANDARD DEVIATION)

Perceived fit	Institution	M	SD	T
Sum score	FET	39.78	6.68	3.873 (p<.001)
	DIT	49.00	3.30	

N_{FET}=180, N_{DIT}=10

4.3 OUTCOME – DROPOUT RATE

Since almost all transfers students at DIT complete the programme in time, the dropout rate is very small or even not present, as opposed to the total dropout rate at FET, which is approximately 50% for each cohort of transfer students (See Table 12).

TABLE 12. TOTAL DROPOUT RATES TRANSFER STUDENTS AT FET

Cohort	2013-2014	2014-2015	2015-2016
Dropout	47%	46%	49%

4.4 OUTCOME – ACADEMIC ACHIEVEMENT

Table 13 shows the average academic achievement (GPA) of the regular (Level 8) and transfer (Level 7) students and the percentages of students that graduated on time. On time graduation for regular students is after four years, for transfer students this is after five years.

TABLE 13. ACADEMIC ACHIEVEMENT OF TRANSFER AND REGULAR STUDENTS IN THE FOURTH YEAR OF LEVEL 8 AT DIT (N= NUMBER OF ENROLLED STUDENTS, SD= STANDARD DEVIATION)

Year graduated	2011-2012	2012-2013	2013-2014
n (Regular/Transfer)	50/18	40/14	65/19
Regular average GPA (SD)	55% (13.1%)	53.9% (13.6%)	51% (19.5%)
Transfer average GPA (SD)	64.6% (7.07%)	60.7% (5.7%)	54.7% (9.4%)
T value between regular and transfer	2.949 (p=.004)	1.807 (p=.080)	0.798 (p=.427)
Effect size (Cohens' d)	0.91	/	/
Regular Graduated on time	90%	88%	83%
Transfer Graduated on time	89%	93%	89%

Transfer students have a higher average mark for all years, and this difference is significantly higher for 1 out of 3 years. The effect size is large. Cohens' d was used to calculate effect sizes. Cohen (1988) distinguished three categories: small effect, d = [0.20; 0.49]; moderate effect, d = [0.50; 0.79]; and large effect, d = [0.80;+∞[. Even with the reduced barrier the transfer students are not significantly worse than their regular entry colleagues and are still more likely to graduate on time. The majority of both the regular (on average 87%) and transfer (on average 90%) students graduate on time. However their average achievements are slowly decreasing.

Table 14 presents the average academic achievement (GPA) of the regular and transfer students at FET and the percentages of students that graduated on time. For regular students graduating on time is after four years. Transfer students that graduate on time have studied for two years at FET.

TABLE 14. ACADEMIC ACHIEVEMENT OF TRANSFER AND REGULAR STUDENTS IN THE MASTER'S PROGRAMME AT FET (N= NUMBER OF ENROLLED STUDENTS; SD= STANDARD DEVIATION)

Year graduated	2014-2015	2015-2016	2016-2017
n (Regular/Transfer)	533/367	540/253	561/188
Regular average GPA (SD)	69.5% (6.5%)	68.5% (6.9%)	69.2% (6.6%)
Transfer average GPA (SD)	67.4% (6.3%)	67.4% (6.1%)	68.5% (6.2%)
T value between regular and transfer	4.823 (p<.001)	2.169 (p=.030)	1.277 (p=.202)
Effect size (Cohens' d)	0.32	0.17	/
Regular Graduated on time	66%	52%	61%
Transfer Graduated on time	35%	42%	40%

For two of the three included academic years, independent sample t-tests showed significant higher academic achievement for the regular students. However, the effect sizes are small. The percentage of regular students (on average 60%) that graduate on time is much higher than the percentage of transfer students graduating without a study delay (on average 39%).

5 DISCUSSION

This study examined and compared transfer students at two European institutions in terms of educational background, experienced transition, and academic outcomes. Previous research (Van den Broeck et al. 2015, O' Saughnessy et al. 2015) revealed that both these students experience a similar transition. However, the contextual differences needed to be taken into account when comparing the transfer students. In both FET and DIT transfer students' prior achievement is correlated to the achievement in the transfer programme. For first-year students, prior achievement (high school GPA) is as well a very strong predictor of academic achievement (Schneider and Preckel 2017, Ackerman et al. 2013, Richardson et al. 2012, Pinxten et al. 2017).

There are however also distinct differences between the transfer students of DIT and FET. The contextual difference is of great importance when comparing transfer students of DIT and FET. Irish students complete the Irish leaving certificate at the end of secondary education. This result determines their permission to start in higher education. Flemish students only need to complete secondary education and afterwards they can enrol in almost every study programme without admission requirements. This difference is also present for entrance in the transfer programmes. FET students can enter the transfer programme after completing successfully an appropriate professional Bachelor's programme regardless of their final grade, while DIT students need to have 50%[21] at the end of level 7 and have to do an interview. Much energy is invested in Flanders to stimulate students to make a well-considered study choice: for example voluntary and non-binding diagnostic tests are organised before enrolment to identify at-risk students in advance and provide the students with feedback (Vanderoost et al. 2014, Chapter 4 and 5). These diagnostic tests are significantly correlated to students' academic achievement (Chapter 5, Pinxten et al. 2017). Due to these major context differences, the differences below, regarding their transition and academic outcomes are not surprising.

The results of the perceived fit questionnaire are significantly different for the two institutions. More precisely, the students at DIT perceive a better fit between level 7 and level 8 than the FET students perceive between the PBA and the transfer programme. The FET students find the transfer programme harder than expected and they disagree that the PBA was a good preparation for the transfer programme. DIT students, on the other hand, do believe level 7 was a good preparation. At DIT, students report that the approach to teaching is similar to the teaching approach at level 7. The mean score on this item is significantly lower for the FET students. A reasonable explanation for this difference is that at DIT students have the same lecturers in level 7 and level 8. At FET the lecturers are different since the PBA and transfer programme are organised at different institutions. When students enter higher education for the first time, they need to adapt to the different teaching approach (Bailli and Fitzgerald 2000, Torenbeek et al. 2011). Additionally FET students state that they lack too much content knowledge, while the DIT students disagree with this. Mathematics has a key role in engineering study programmes. Irish students have had mathematics during all six semesters at level 7. Even so they struggle with mathematics in particular in the first year of transfer (Carr et al. 2015). FET students have had none or only one semester of mathematics in their PBA. During focus group discussions they mentioned mathematics as one of their major

[21] To pass in level 7, students need to have 40% or higher.

stumbling blocks (Van den Broeck et al. 2015). The difference in the perceived fit regarding the feeling of insufficient content knowledge between DIT and FET transfer students suggests that DIT students benefit from the six semesters of mathematics training at level 7. On top of that, the DIT students agree that there is much overlap between the subjects of level 7 and level 8, which is in contrast with the students at FET who experience that there is no overlap between the PBA and the transfer programme. Moreover DIT students perceived they had to work as hard as in level 7, while FET students completely disagree. It is undeniable that preparedness has a major influence on students' attrition and academic achievement (Jansen and van der Meer 2012). Looking at the perceived fit results, it seems that DIT students already have had the transition to higher education during level 7, whilst for the FET students, the major transition to higher education is during the transfer programme. The experiences of FET students are similar to those of first-year engineering students (Marra et al. 2012, Lowe and Cook 2003, Holmegaard et al. 2015, Torenbeek et al. 2011). A previous study even found evidence that the perceived fit for the transfer students is significantly lower than for the first-year students at FET (Chapter 2). Torenbeek et al. (2011) stated that students who perceive a better fit, have a smoother transition and perform better.

Several researchers in the U.S. have identified a phenomenon known as 'transfer shock' (Cejda 1994, Lanaan 2001, Hills 1965). Through transfer shock, community college students who transition to a university typically experience a drop in grades for the first semester or two immediately after transfer. Grade point averages will typically recover by the time that students graduate and the dip in grades is typically attributed to the effort it takes to transition from one educational setting to another. We seem to be observing a similar phenomenon in DIT, whilst there is a temporary dip in the performance of transfer students in the first semester these students quickly recover (Carr et al. 2015). Also at FET, transfer students have a dip in grades in the first semester of the transfer programme, at the end of the transfer programme their grades recover (Chapter 2). The American literature recommends well-defined articulation agreements between the community college and the university as being critical to transfer student success. In DIT, the faculty teaching the ordinary and honours programmes are typically in the same department and, in fact, most faculty teach in both programmes. Thus, it appears that at DIT there are better conditions for successful transition of students between the programmes. At FET, although transfer students study in the same buildings as during their professional bachelor programme, they have different lecturers in both programmes. It is important to point out that in Flanders the aim is not to make the transfer programme a standard trajectory. Transfer programmes rather want to provide a selection of students with this opportunity and therefore it could be beneficial to have admission requirements and more (extracurricular) mathematics for the transfer students at FET.

In terms of academic performance, the transfer students at DIT were in 2011-2012 outperforming the regular students. After the transfer barrier has been reduced significantly in 2013-2014, they average grade dropped compared to the previous year with stronger admission requirements, but transfer students are performing equally well as regular students. This is still a rather interesting result as historically it had been felt that these student would not be able to cope with the rigour of an honours/academic degree but it is now observed that they are coping just as well as their regular entry counterparts. At FET, there is a high dropout rate of transfer students, but the ones who graduate achieve grades similar to the regular students. A previous study of Langie et al. (2012) showed that regular students outperform the transfer students on theory and master thesis, while the transfer students obtain higher results for laboratory assignments. During the PBA the focus is primarily on the practical approach, so it is not surprising that transfer students outperform their counterparts in practical issues. These differences level each other out and result in similar grades at the end of the Master's programme.

Since the rules for passing are different in the two institutions, it seems more appropriate to compare the percentage of students that graduate on time instead of their academic achievement. At DIT almost all students graduate on time. This in contrast to FET where around 60% of the general students graduate on time and only 40% of the transfer students. This lower percentage in Flanders could be a consequence of the differences in admission requirements. The major differences in dropout rates between the two institutions might be related to the observed differences in perceived fit. Also differences in admission and in passing requirements might contribute to the observed differences.

Before heading to the conclusions, we want to point out that in this research the number of Flemish students was much higher than those of the Irish students. In future research it would be interesting to include Irish data of the other engineering disciplines.

6 CONCLUSION

This first comparative research between transfer students at two European institutions, Dublin Institute of Technology (Ireland) and KU Leuven (Belgium), revealed some interesting findings. It is certainly not easy to compare across educational and national contexts due to (1) differences in primary school and secondary school systems, (2) differences in admission requirements, and (3) differences in the programmes themselves. Nevertheless it is a useful exercise since it allows to investigate which factors are important during transition. By doing this comparison it becomes clear that having admission requirements and a sufficient amount of mathematics in the transfer programme is not a barrier for success, but even might contribute to a smoother transition experience.

Giving students the opportunity to transfer to a Master's programme is important and necessary in order to stimulate flexible lifelong learning. However, this does not mean that each student should gain access in the same manner to these programmes. Both FET and DIT give attention to these alternative pathways for entering higher education. We put a lot of effort in informing and supporting (possible) transfer students. Nevertheless, this research reveals that both institutions should work on smoothening students' transition.

PART B:

PREDICTION

CHAPTER 4 - PREDICTING THE ACADEMIC ACHIEVEMENT OF STUDENTS TRANSFERRING TO ENGINEERING: THE ROLE OF ACADEMIC BACKGROUND VARIABLES AND DIAGNOSTIC TESTING

Van den Broeck, L., De Laet, T., Lacante, M., Pinxten, M., Van Soom, C. & Langie, G. (2018) Predicting the academic achievement of students bridging to engineering: the role of academic background variables and diagnostic testing, *Journal of Further and Higher Education*, DOI: 10.1080/0309877X.2018.1431209.[22]

Although the number of engineering students is increasing, the dropout rates remain high. This problem is also present in the Faculty of Engineering Technology (FET) at KU Leuven - Belgium, which resulted in the need for an in-depth analysis of the academic achievement of the transfer students at FET. This study examines the contribution of a range of predictors, both cognitive and non-cognitive. The examined predictors are: general characteristics, academic background variables, and variables tested in a diagnostic test. A multiple linear regression model for the cohort of 2015-2016 accounted for an explained variance of 36% of the students' academic achievement. After combining three cohorts, we managed to explain 43% of the variance in students' academic achievement. As expected, the academic background variables are the most important predictors. The diagnostic tests are less predictive but their role is important, since they encourage students to participate in associated interventions.

[22] Some minor vocabulary changes were made to guarantee the consistency.

1 INTRODUCTION

The demand for engineering graduates is so high that employers struggle to fill the vacancies (National academy of Engineering 2004, UNESCO 2012). Therefore attracting and retaining engineering students is of paramount importance. Globally, the number of engineering students is increasing, but the dropout rates remain high (Moses et al. 2011, House 2000). This problem of high dropout rates is also present at the Faculty of Engineering Technology (FET) at KU Leuven, especially during and immediately after the first year of enrolment (e.g. dropout rate of 35% in 2014-2015).

In Flanders[23], when students decide to start higher education, they can choose, without restrictions or admission requirements[24], between two types of Bachelor's degrees: a professional (PBA) and an academic (ABA) one. The purpose of a professional Bachelor's programme, organised at a University College, is to prepare the student for a professional occupation. An academic Bachelor's programme, organised at a University, is intended to acquire all the necessary knowledge and skills to start a Master's programme. In order to stimulate a flexible lifelong learning system, students with a professional Bachelor's degree can enrol into an academic Master's programme on the condition that they successfully complete a transfer programme (TR). The transfer programme focuses on acquiring the missing competences needed to start a Master's programme and is organized by the university offering these Master's programmes. Just like first-year students, transfer students also enter university for the first time. This paper focuses on the transfer students at FET.

At the beginning of the academic year 2015-2016 the FET counted 783 transfer students. Unfortunately, the overall success rate of the transfer programme is rather low (around 50%) and although the transfer programme is a one-year programme, in practice half of the students who obtain their certificate need two (and sometimes even three) years for completion. The low success rate in this transfer programme combined with the fact that these students already possess a valuable degree in Technology, is causing a high social cost for the Belgian government. This results in the need for an in-depth analysis of the students' academic achievement. The present study examines the contribution of a range of predictors, both cognitive and non-cognitive, in explaining the academic achievement of transfer students at FET.

[23] For a more elaborate description of the Flemish education system and the transfer programme see Chapter 1

[24] Except for medicine, dentistry, and some artistic study programmes.

The development of a non-binding and voluntary diagnostic test[25] for possible transfer students is of great importance in this research project, since it includes potential predictors. The objective of the diagnostic test is to (1) provide students information on their possible future academic achievement in the transfer programme and thus stimulate them to make a well-considered educational choice; and (2) encourage students to participate, if necessary, in intervention initiatives before or during enrolment.

The purpose of this paper is to answer the two following research questions (RQ):

RQ1. Which regression model and corresponding predictors result in the best prediction of academic achievement of transfer students in the FET at KU Leuven? (section 4.1)

RQ2. Are these regression models and corresponding predictors consistent over time (i.e. similar results for three cohorts)? (section 4.2)

2 PREVIOUS WORK

Many researchers have explored predictors of academic achievement. However, most of these studies handle academic achievement of first-year students, therefore a comparison of first-year engineering students and transfer students was made (Chapter 2). This study showed that first-year students and transfer students at FET have a rather similar profile, which resulted in the conclusion that studies of first-year STEM students can be translated to the context of transfer students, provided that results are treated with caution.

In the prediction of academic achievement, two main types of variables are distinguished, namely cognitive and non-cognitive variables. Some studies focus on cognitive variables only (e.g. high school GPA and SAT scores) to model academic achievement (De Winter and Dodou 2011, Cohn et al. 2004). Several researchers combine both cognitive and non-cognitive variables (e.g. motivation and self-efficacy) or include only non-cognitive variables (with or without controlling for prior academic achievement) (Bernold et al. 2007, Tynjälä et al. 2005). Veenstra et al. (2008, 2009) and De Winter and Dodou (2011) acknowledge that the profile of engineering students is somewhat different from that of students in other study fields. As a consequence, other variables need to be taken into account (e.g.

[25] More information section 3.2.1

quantitative skills, confidence in quantitative skills, and scores on scientific subjects). The next paragraph focuses on STEM or more specifically, on engineering studies.

Pinxten et al. (2015) made an overview of important predictors of academic achievement. The most predictive cognitive variable, by far, is prior academic achievement. For this reason, a model for predicting students' academic achievement often includes variables such as High school GPA, High school rank, and ACT or SAT scores (Ackerman et al. 2013, De Winter and Dodou 2011, French et al. 2005, Van Soom and Donche 2014, House 2000, Ting 2011). De Winter and Dodou (2011) focus on high school exam scores and found a strong correlation between high school exam scores in Natural Sciences and Mathematics and GPA (r=.56) at TU Delft (The Netherlands). The regression model of Ackerman et al. (2013) contains three steps. In the first step, High School GPA and SAT scores (verbal and maths) resulted in an explained variance of 23% of the grades of first-year students at Georgia Institute of Technology (US). Adding the average Advanced Placement exam score (i.e. courses and corresponding exams during college - AP) resulted in an incremental R^2 of 9%. In the last step of the model, five trait complexes are included: 1) Math/Science self-concept; 2) Mastery and organization; 3) Openness and verbal self-concept; 4) Anxiety in achievement contexts; 5) Extroversion. This total regression model explained 40% of the variance in the students' grades.

Most of the non-cognitive variables are self-reported measures and collected through questionnaires. For instance, House (2000) asked first-year STEM students at Northern Illinois University (US) to complete the Cooperative Institutional Research Programme (CIRP) Annual Freshman Survey focusing on a variety of topics, such as parental education, high school curriculum, financial goals, social goals, academic self-concept, achievement expectancies, and desire for recognition. The prediction model consisted of two variables, namely academic self-concept and financial goals (R^2=11%). When academic background variables are added in the first step of the regression model 28% of the variance is explained. Adding the two variables (i.e. academic self-concept and financial goals) resulted in an incremental value of only 1% and consequently, a total explained variance of 29%. In another study (Ting 2011) the first-year engineering students of North Carolina State University were administered to fill in the Non-Cognitive Questionnaire (NCQ). The model includes, besides a cognitive variable, positive self-concept, leadership experiences, and preference of long-term goals (R^2=12%). When predicting GPA, the first step in the linear regression of French et al. (2005) was significant and included cognitive variables (SAT scores and High school rank) and gender (R^2=18%). When adding non-cognitive variables (i.e. motivation, institutional integration, and orientation class) to the model, the change in R^2 was not significant. Another study (Van Soom and Donche 2014) found small but significant correlations between academic achievement and academic self-concept (r=.25) for first-year STEM students at KU Leuven (Belgium) on one hand and between academic achievement and autonomous motivation (r=.10) on the other hand.

A study at Lappeenranta University of Technology (Finland) focused exclusively on non-cognitive variables. The variables they used are: student's study strategies, orientations, regulations, and perception concerning learning and studying (R^2=37%). The two most important predictors were deep approach study strategy, which was positively correlated with academic achievement, and doubts about one's abilities, which was negatively correlated with academic achievement (Tynjälä et al. 2005).

To conclude, the numerous amount of studies about first-year engineering students are a good starting point for predicting academic achievement of transfer students. In this study both commonly and rarely used academic background variables are included, complemented by variables of the diagnostic test.

3 METHOD

3.1 SAMPLE

This study includes three cohorts of transfer students of the academic years 2013-2014, 2014-2015, and 2015-2016 at FET (KU Leuven). Table 15 provides an overview of the number of enrolled students in each cohort. This research focuses on transfer students who are new (i.e. enrolled for the first time) and have a standard study programme (i.e. minimal 50 ECTS).

TABLE 15. NUMBER OF ENROLLED TRANSFER STUDENTS

	2013-2014	2014-2015	2015-2016
Total enrolled TR	829	874	783
New TR	516	588	479
New TR with standard study programme	325	278	258

3.2 COLLECTED DATA

3.2.1 INDEPENDENT VARIABLES

Three different types of independent variables are distinguished:

(1) General characteristics

- Gender
- Socio economic status (SES)* [26]: At least one of the parents has a higher education degree (Yes/No).

(2) Academic background variables

- Track secondary education[27] (general track (ASO)/technical track (TSO)).
- Level of mathematics during secondary education*: Item *"How many hours of mathematics/week did you have during the last year of secondary education?"* of which the responses are categorised into three levels of mathematics (1= Low (< 4); 2= Medium (4 or 5); and 3= High (≥ 6)).
- Position in class group for mathematics*: Item "*I was always good in mathematics in comparison with other students during secondary education."* rated on a five-point Likert scale (1='Totally disagree' – 5='Totally agree').
- GPA PBA: the students' obtained overall GPA at the end of the professional Bachelor's programme.
- Study delay during PBA: Did the student finish the professional Bachelor's programme in the allotted time (i.e. three years)? (Yes/No).
- ECTS tolerated during PBA [28]: Did the student tolerate credits during the professional bachelor programme? (Yes/No).
- Resits in the third year of PBA[29]: Did the student participate in resits during the last year of the professional Bachelor's programme? (Yes/No).

---

[26] Variables marked with an * are self-reported and gathered via questionnaires.

[27] In Flanders, secondary education is divided into four possible tracks, namely general secondary education (ASO), technical secondary education (TSO), art secondary education (KSO), and vocational secondary education (BSO). At FET the large majority followed ASO and TSO. For more information see Van den Broeck et al. 2016.

[28] Under certain conditions, in a Bachelor's or transfer programme, students can use tolerance credits (10% of the number of credits that students effectively have to take within a programme) for courses they failed. Students can only use tolerances if their study efficiency is 50% or higher and if the fail mark is 8/20 or 9/20. (Using a tolerance credit is a way of furthering the study progress.)

[29] When students fail one or more exams during the academic year, they get a second chance at the end of the academic year.

- Self-perceived effort PBA*: Item *“How hard did you have to study during the professional Bachelor’s programme?”* rated on a five-point Likert scale (1=‘Not hard at all’– 5=‘Very hard’).
- Contribution of results of PBA in decision process*: Item *“During the decision-making process for the transfer programme, I have kept my study results of the professional bachelor in mind.”* rated on a five-point Likert scale (1=‘Totally disagree’ – 5=‘Totally agree’).
- Moment of decision*: Item *“When did you decide to enrol in the transfer programme?”* (1=Before start of PBA; 2=During PBA, and 3=During summer holiday).

(3) Variables tested in the diagnostic test

In 2013-2014 a diagnostic test, originally designed for first-year students at FET, was given to the transfer students as a pilot run (Langie and Van Soom 2014). Analysis revealed that there must be other determining skills for academic achievement and that this original test was too difficult for the target audience. Therefore an optimized diagnostic test was developed and implemented in 2014-2015 (Van den Broeck et al. 2015). Students had the opportunity to participate voluntarily either before enrolment in the transfer programme or at the beginning of the transfer programme. The test combines both cognitive and non-cognitive variables and consists of three parts, namely a Mathematics Test, four subtests of the Dutch Cognitive Ability Test (CoVaT - CHC) (Magez et al. 2013), and the Learning And Study Strategies Inventory (LASSI) (Weinstein 2016). The variables of the diagnostic test that are included in this study are:

- Mathematics: The Mathematics Test (MATH) consists of 20 multiple choice questions focusing on basic mathematical skills.
- Subtests of CoVaT-CHC[30]: Four subtests of the CoVaT- CHC are selected, namely Logical reasoning (i.e. problems similar to the Einstein problem), Proverbs (i.e. find the most suitable explanations for sayings), Folding boxes (i.e. visualize how an unfolded box (2D) can be folded to a box (3D)), and Point series (i.e. discover the mathematical rule and complete the point series).
- LASSI: LASSI[30] consists of 77 items, divided into 10 scales: Attitude (ATT); Motivation (MOT); Time management (TMT); Anxiety (ANX); Concentration (CON); Information Processing (INP); Selecting Main Ideas (SMI); Study Aids (STA); Self-testing (SFT); and Test Strategies (TST).

[30] In the analyses every subtest or scale is treated as an individual variable.

Students were asked to rate each item on a five-point Likert scale (1='Not at all like me' – 5='Very much like me'). The participants were instructed to fill in the questionnaire with their learning and study skills at the end of the professional bachelor programme in mind.

General characteristics and academic background variables were mainly collected through university (i.e. KU Leuven) and university colleges (i.e. university colleges associated with KU Leuven) records. The remaining variables, marked with an asterisk (*), are self-reported and gathered via questionnaires. In 2014-2015, students were asked to fill in a questionnaire at the end of the academic year (N=114). The cohort of 2015-2016 filled in a more elaborated questionnaire at the end of the first semester (N=161).

Summary. Table 16 gives an overview of the included variables for every cohort in the study. Some variation in the number of included students is possible and depends on available information or for the self-reported variables on the response rates.

TABLE 16. OVERVIEW OF THE INDEPENDENT VARIABLES COLLECTED DURING THREE ACADEMIC YEARS AND THE NUMBER OF INCLUDED STUDENTS.

	2013-2014	2014-2015	2015-2016
Gender	325	278	258
Socio economic status (SES)*			160 (62%)
Track secondary education (Track SE)	318	274	250
Level of mathematics during secondary education (Level of math)*			161 (62%)
Position in class group for mathematics (Position in class)*		114 (41%)	161 (62%)
GPA PBA	263	250	212
Study delay during PBA (Study delay)	283	250	209
ECTS tolerated during PBA (ECTS Tolerated)	283	250	212
Resits in the third year of PBA (Resits)	240	250	212
Self-perceived effort PBA (Effort)*			161 (62%)
Contribution results PBA in decision process (Contribution results)*			160 (62%)
Moment of decision (Decision)*			156 (60%)
Mathematics – diagnostic test			88 (34%)
Subtests of CoVaT-CHC – diagnostic test			88 (34%)
LASSI – diagnostic test			88 (34%)

Variables marked with an * are self-reported. For self-reported and diagnostic variables response rates are included (%).

The most complete dataset was the cohort of 2015-2016, this cohort was therefore used to answer research question one (RQ1). For research question two (RQ2), the data from the three cohorts was combined.

3.2.2 Dependent variable

The dependent variable, namely academic achievement was collected through university records (KU Leuven SAP system). This study uses study percentage, a weighted average of exam results (cf. GPA), as measurement of academic achievement in the transfer programme (GPA). Results after the first semester (GPA January), after the second semester (GPA June), and results at the end of the academic year (GPA End) are included.

3.3 Statistical analysis

As a first step, the predictive value of each independent variable (Table 2) was tested separately by performing Independent Sample t-tests and ANOVA analyses. Only the variables, that were individually significant ($p<.05$), were included in further analysis. Next, multiple linear regression analysis was conducted to examine the influence of the independent, quantitative or dummy, variables on GPA. The variables entered the model one for one, starting with the one with the highest individual predictive value. For every added variable, the change in R^2 was defined. Only the variables that led to a significant change in R^2 were retained in the final model.

4 Results

4.1 Prediction model: Cohort 2015-2016 (RQ1)

4.1.1 Individual variables

Figure 12 shows the linear regression between the GPA of the PBA and the GPA's in the transfer programme. A strong correlation was found (Jan: $r=.57$; Jun: $r= .57$; End: $r=.55$).

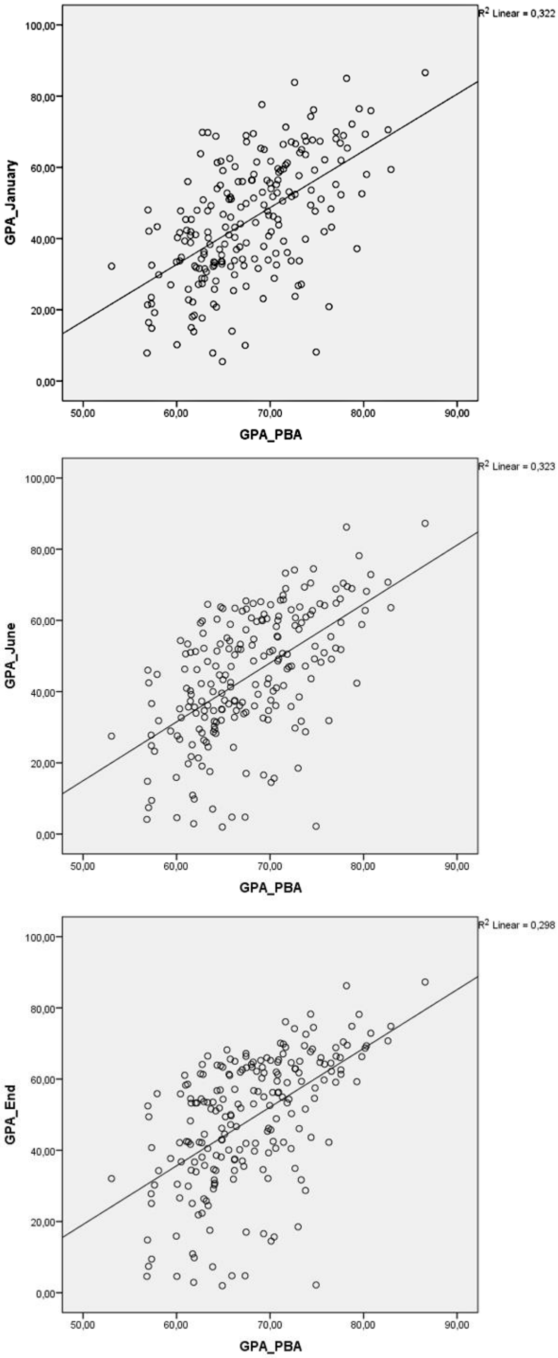


FIGURE 12. GPA PBA VS. (A) GPA JANUARY (N=210); (B) GPA JUNE (N=210); (C) GPA END (N=210).

Table 17 shows the mean GPA's associated with the dichotomous variables. Overall, students who followed a general track in secondary education, students without a study delay, who did not tolerate any courses and did not have resits during the professional bachelor are the ones that obtain higher GPA's in the transfer programme. Performing Independent Sample t-tests result in consistent significant differences for track of secondary education (Jan: $p=.001$; Jun: $p=.003$; End: $p=.012$), ECTS tolerated (Jan: $p=.001$; Jun: $p<.001$; End: $p<.001$) and resits (Jan: $p<.001$; Jun: $p<.001$; End: $p<.001$). Study delay reveals only significant differences in the GPA of January ($p=.044$). For gender and socio-economic status no significant differences were found.

TABLE 17. DICHOTOMOUS VARIABLES AND CORRESPONDING MEAN GPA'S (SD=STANDARD DEVIATION, N=NUMBER OF STUDENTS, T=T-VALUE); COHORT 2015-2016

		GPA January				GPA June				GPA End			
		Mean	SD	N	T	Mean	SD	N	T	Mean	SD	N	T
Gender	M	44%	18%	217	n.s.	43%	18%	217	n.s.	47%	19%	217	n.s.
	F	48%	16%	36		47%	18%	36		52%	19%	36	
SES	Yes	45%	17%	113	n.s.	46%	17%	113	n.s.	50%	18%	113	n.s.
	No	42%	17%	45		42%	20%	45		46%	20%	45	
Track SE	ASO	50%	17%	83	3.386	49%	18%	83	2.959	52%	18%	83	2.530
	TSO	42%	17%	162	(p=.001)	42%	18%	162	(p=.003)	46%	19%	162	(p=.012)
Study delay	Yes	37%	20%	19	2.023	38%	20%	19	n.s.	43%	20%	19	n.s.
	No	46%	17%	189	(p=.044)	45%	17%	189		49%	18%	189	
ECTS tolerated	Yes	39%	17%	60	3.259	37%	18%	60	3.904	41%	19%	60	3.811
	No	48%	17%	151	(p=.001)	47%	17%	151	(p<.001)	51%	17%	151	(p<.001)
Resits	Yes	33%	15%	46	5.674	33%	16%	46	5.253	37%	18%	46	5.006
	No	48%	16%	165	(p<.001)	48%	17%	165	(p<.001)	52%	17%	165	(p<.001)

Table 18 reveals the differences in mean GPA for the categorical variables. The three self-reported variables (i.e. position in class, contribution results, and effort) that were rated on a five-point Likert scale are reduced to variables with three response categories (Disagree, Neither disagree/agree, and Agree; Not hard, Average, and Hard).

The students who disagree with the item "*I was always good in mathematics in comparison with other students during secondary education."* (Position in class) obtain the lowest GPA's and the ones who agree or are impartial the highest. A one-way analysis of variance (ANOVA) showed significant differences for the three dependent variables (Jan: p=.010; Jun: p=.022; End: p=.024). Students who kept their study result of the professional bachelor programme in mind during the decision process (Contribution results) obtain higher GPA's than the ones who did not or are impartial. ANOVA revealed significant differences between the three categories for the dependent variables (Jan: p=.004; Jun: p=.002; End: p=.001). Looking at effort, students who indicated an average effort achieve the highest GPA. Lower GPA's are obtained by the ones with a low effort and the ones who indicated that they studied hard in the professional bachelor programme. Only for the GPA of June (p=.031) and at the end of the academic year (p=.036) significant differences were found. The level of maths and moment of decision revealed no significant differences.

Table 19 includes the Pearson Correlation coefficients between the GPA's and the cognitive variables of the diagnostic test. None of the variables correlates significantly with one of the three GPA's.

TABLE 18. CATEGORICAL VARIABLES AND CORRESPONDING MEAN GPA'S (SD=STANDARD DEVIATION, N=NUMBER OF STUDENTS, F=F-VALUE); COHORT 2015-2016

		GPA January				GPA June				GPA End			
		Mean	SD	N	F	Mean	SD	N	F	Mean	SD	N	F
Position in class	Disagree	37%	14%	42	4.705 (p=.010)	38%	17%	42	3.912 (p=.022)	42%	19%	42	3.805 (p=.024)
	Neither disagree/agree	46%	17%	44		47%	17%	44		51%	17%	44	
	Agree	47%	18%	73		47%	18%	73		51%	19%	73	
Contribution results	Disagree	39%	16%	33	5.682 (p=.004)	40%	18%	33	6.283 (p=.002)	44%	19%	33	7.115 (p=.001)
	Neither disagree/agree	38%	17%	34		38%	18%	34		41%	19%	34	
	Agree	48%	17%	91		49%	17%	91		53%	17%	91	
Effort	Not hard	42%	19%	82	n.s.	42%	19%	82	3.566 (p=.031)	46%	20%	82	3.403 (p=.036)
	Average	47%	16%	67		49%	16%	67		53%	17%	67	
	Hard	38%	12%	10		36%	15%	10		40%	18%	10	
Level of math	Low	41%	18%	31	n.s.	41%	18%	31	n.s.	45%	18%	31	n.s.
	Medium	46%	16%	55		47%	18%	55		50%	18%	55	
	High	44%	18%	73		44%	18%	73		49%	20%	73	
Decision	Before start PBA	45%	17%	25	n.s.	47%	17%	25	n.s.	51%	17%	25	n.s.
	During PBA	44%	17%	109		45%	17%	109		49%	18%	109	
	During summer	42%	19%	20		39%	20%	20		43%	21%	20	

TABLE 19. CORRELATION BETWEEN THE GPA'S AND THE COGNITIVE VARIABLES (N=82, AFTER REMOVING OUTLIERS)

		GPA January	GPA June	GPA End	Math	Point series	Logical reasoning	Proverbs	Folding boxes
GPA January	Pearson Corr.	1							
	Sig.								
GPA June	Pearson Corr.	.913**	1						
	Sig.	.000							
GPA End	Pearson Corr.	.866**	.978**	1					
	Sig.	.000	.000						
Math	Pearson Corr.	.049	.101	.119	1				
	Sig.	.665	.365	.288					
Point series	Pearson Corr.	-.089	-.062	-.062	.139	1			
	Sig.	.427	.580	.582	.207				
Logical reasoning	Pearson Corr.	-.029	-.105	-.119	.130	-.055	1		
	Sig.	.797	.350	.286	.238	.620			
Proverbs	Pearson Corr.	.091	.193	.209	.250*	.168	.156	1	
	Sig.	.417	.083	.059	.022	.126	.157		
Folding boxes	Pearson Corr.	.051	.053	.062	.011	.131	.077	-.070	1
	Sig.	.646	.635	.578	.922	.234	.486	.529	

**.Significant at the 0.01 level (2-tailed). *.Significant at the 0.05 level (2-tailed).

Table 21 shows the correlations between the GPA's and the ten LASSI scales. Only for concentration (CON) the correlations are consistently significant (Jan: p=.007; Jun: p=.017; End: p=.020). For self-testing (SFT) a significant correlation was found with the GPA of January (p=.019) and for study aids (STA), a negative but significant correlation, with the GPA of June (p=.037).

4.1.2 MULTIPLE REGRESSION MODELS

Combining the individually significant variables in a multiple regression analysis resulted in a regression model for the three dependent variables. Table 20 shows the regression coefficients for each model. For the GPA of January (N=124), the GPA of the PBA accounted for 29.8% of the variance. Adding the position in class group for mathematics, with an incremental added value of 6.5%, resulted in the highest explained variance (R^2=36.3%). Finding a prediction model for the GPA of June resulted in a model (N=124) with three variables (R^2 =34.2%): GPA PBA, position in class group for mathematics, and effort during the PBA. For the GPA at the end of the academic year (N=124), the GPA of the PBA explained 25.3% of the variance. The addition of effort during the PBA resulted in an incremental R^2 of 3.7% (R^2=29.0%).

TABLE 20. STATISTICS REGRESSION MODELS 2015-2016

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	SE	β	t	Sig.
GPA January	(Constant)	-58.437	15.151		-3.857	.000
	GPA PBA	1.539	.221	.512	6.972	.000
	Position class; Disagree	-9.118	3.496	-.226	-2.608	.010
	Position class; Agree	1.787	3.037	.051	.588	.557
GPA June	(Constant)	-47.855	16.250		-2.945	.004
	GPA PBA	1.430	.233	.471	6.144	.000
	Position class; Disagree	-5.772	3.660	-.141	-1.577	.117
	Position class; Agree	3.197	3.225	.090	.991	.324
	Effort; Not hard	-7.320	2.776	-.207	-2.637	.009
	Effort; Hard	-5.164	5.437	-.076	-.950	.344
GPA End	(Constant)	-51.385	17.017		-3.020	.003
	GPA PBA	1.539	.245	.491	6.290	.000
	Effort; Not hard	-7.316	2.918	-.201	-2.508	.013
	Effort; Hard	-4.205	5.737	-.060	-.733	.465

TABLE 21. CORRELATIONS BETWEEN THE GPA'S AND THE LASSI SCALES (N=51, AFTER REMOVING OUTLIERS); ATTITUDE(ATT); MOTIVATION(MOT); TIME MANAGEMENT(TMT); ANXIETY(ANX); CONCENTRATION(CON); INFORMATION PROCESSING(INP); SELECTING MAIN IDEAS(SMI); STUDY AIDS(STA); SELF-TESTING (SFT); TEST STRATEGIES (TST)

		GPA January	GPA June	GPA End	ATT	MOT	TMT	ANX	CON	INP	SMI	STA	SFT	TST
GPA January	Pearson Corr.	1												
	Sig.													
GPA June	Pearson Corr.	.910**	1											
	Sig.	.000												
GPA End	Pearson Corr.	.862**	.977**	1										
	Sig.	.000	.000											
ATT	Pearson Corr.	.245	.209	.185	1									
	Sig.	.084	.141	.193										
MOT	Pearson Corr.	.140	.099	.123	.516**	1								
	Sig.	.326	.491	.388	.000									
TMT	Pearson Corr.	.236	.177	.200	.563**	.600**	1							
	Sig.	.095	.214	.160	.000	.000								
ANX	Pearson Corr.	.022	-.009	.001	.401**	.137	.082	1						
	Sig.	.881	.952	.996	.004	.337	.569							
CON	Pearson Corr.	.374**	.334*	.324*	.566**	.539**	.623**	.211	1					
	Sig.	.007	.017	.020	.000	.000	.000	.138						
INP	Pearson Corr.	.150	.016	.038	.247	.226	.282*	.264	.225	1				
	Sig.	.294	.913	.792	.080	.111	.045	.061	.113					
SMI	Pearson Corr.	-.100	-.200	-.199	.116	-.038	.083	.099	.057	.302*	1			
	Sig.	.485	.159	.162	.418	.792	.562	.491	.693	.032				
STA	Pearson Corr.	-.118	-.293*	-.268	.044	.285*	.278*	.106	.022	.332*	.298*	1		
	Sig.	.408	.037	.058	.760	.042	.048	.458	.876	.017	.034			
SFT	Pearson Corr.	.328*	.227	.211	.492**	.555**	.604**	.141	.521**	.501**	.277*	.421**	1	
	Sig.	.019	.109	.137	.000	.000	.000	.324	.000	.000	.049	.002		
TST	Pearson Corr.	.185	.178	.199	.540**	.382**	.452**	.410**	.545**	.461**	.278*	-.135	.453**	1
	Sig.	.193	.211	.163	.000	.006	.001	.003	.000	.001	.048	.346	.001	

**.Significant at the 0.01 level (2-tailed). *.Significant at the 0.05 level (2-tailed).

4.2 Consistency over time: Cohort 2013-2014, 2014-2015, and 2015-2016 (RQ2)

4.2.1 Individual variables

After merging the data of different cohorts into one larger dataset, it was necessary to create a new independent variable, namely cohort, and examine if this variable influences the dependent variable. Linear regression analysis revealed that cohort is not a significant variable so the different cohorts can be treated as one sample.

A strong correlation was found between prior academic achievement (GPA PBA) and the GPA's obtained in the transfer programme (Jan: $r=.60$; Jun: $r=.59$; End: $r=.55$). Table 22 shows the mean GPA's for the dichotomous variables that are measured in the three cohorts. Independent Sample t-tests reveal consistent significant differences for all the variables, except for the GPA of January no significant difference was found for gender. Table 23 presents data of the students' self-reported position in the class group for mathematics for the cohort of 2014-2015 and 2015-2016. ANOVA resulted in consistent significant differences between the categories for GPA (Jan: $p<.001$; Jun: $p<.001$; End: $p=.001$).

TABLE 22. DICHOTOMOUS VARIABLES AND CORRESPONDING MEAN GPA'S (SD=STANDARD DEVIATION, N=NUMBER OF STUDENTS, T=T-VALUE); COHORT 2013-2014, 2014-2015,2015-2016.

		GPA January				GPA June				GPA End			
		Mean	SD	N	T	Mean	SD	N	T	Mean	SD	N	T
Gender	M	44%	18%	700	n.s.	44%	19%	743	2.271	48%	19%	743	2.621
	F	47%	17%	98		48%	18%	103	(p=.023)	53%	18%	103	(p=.009)
Track SE	ASO	49%	17%	237	4.277	48%	19%	257	3.325	52%	19%	257	3.131
	TSO	43%	17%	544	(p<.001)	43%	18%	570	(p=.001)	47%	19%	570	(p=.002)
Study delay	Yes	37%	17%	56	3.604	37%	17%	58	3.638	41%	18%	58	3.415
	No	45%	17%	644	(p<.001)	46%	18%	677	(p<.001)	50%	19%	677	(p=.001)
ECTS tolerated	Yes	38%	16%	166	5.954	37%	17%	176	7.285	41%	18%	176	6.917
	No	47%	17%	537	(p<.001)	48%	18%	562	(p<.001)	52%	18%	562	(p<.001)
Resits	Yes	35%	15%	106	7.002*	34%	16%	112	7.236*	38%	17%	112	6.929
	No	47%	17%	566	(p<.001)	47%	18%	584	(p<.001)	51%	18%	584	(p<.001)

*Equal variances not assumed.

TABLE 23. CATEGORICAL VARIABLE AND CORRESPONDING MEAN GPA'S (SD=STANDARD DEVIATION, N=NUMBER OF STUDENTS, F=F-VALUE); COHORT 2014-2015,2015-2016.

		GPA January				GPA June				GPA End			
		Mean	SD	N	F	Mean	SD	N	F	Mean	SD	N	F
Position in class	Disagree	39%	13%	73	11.542* (p<.001)	42%	15%	73	8.035 (p<.001)	46%	17%	73	7.243 (p=.001)
	Neither disagree/agree	46%	17%	82		48%	16%	82		53%	15%	82	
	Agree	51%	18%	118		52%	18%	118		56%	18%	118	

*Levene's test for homogeneity of variances rejected the null hypothesis.

4.2.2 MULTIPLE REGRESSION MODELS

Since data on the position in class group for mathematics were only available for two of the three cohorts, regression analyses were performed on two different data sets: 1) the sample including 2013-2014, 2014-2015, and 2015-2016[a]; and 2) the sample including 2014-2015 and 2015-2016[b]. Table 24 shows the regression coefficients of the different prediction models.

For dataset one, the three regression models consist of at least two predictors, namely the GPA of the PBA and whether or not the student had to take resits in the third year of the PBA. For the GPA of June (N=695) these two predictors accounted for an R^2 of 35.2%, but the incremental value of resits is less than 1%. The model for the GPA at the end of the academic year (N=695) also includes these two predictors and the added explained variance of resits is less than 1% as well (R^2=30.5%). In January's model (N=661) the track during secondary education is a third predictor and gives, in combination with resits, an added R^2 of only 1.5% (R^2=36.8%).

For dataset two, the model of both June (N=239) and at the end of the academic year (N=239) includes the GPA of PBA and position in class group for mathematics. Adding position in class to the model results in an incremental R^2 of 2.8% for the GPA of June (R^2=37.7%) and 2.5% for the GPA at the end of the academic year (R^2=33.8%). For January (N=233) the final model explained 43.2% of the variance in GPA, including GPA of PBA, position in class group for mathematics (added R^2=6.3%), track secondary education (added R^2=1.4%), and study delay during PBA (added R^2=1%).

TABLE 24. STATISTICS REGRESSION MODELS THREE COHORTS

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	SE	β	t	Sig.
GPA January[a]	(Constant)	-62.336	6.267		-9.947	.000
	GPA PBA	1.576	.091	.564	17.324	.000
	Resits	-4.157	1.553	-.087	-2.677	.008
	Track SE	3.622	1.167	.096	3.104	.002
GPA January[b]	(Constant)	-58.069	10.008		-5.803	.000
	GPA PBA	1.517	.145	.533	10.435	.000
	Position class; Disagree	-7.968	2.312	-.202	-3.447	.001
	Position class; Agree	3.311	2.094	.095	1.582	.115
	Track SE	4.861	1.905	.130	2.552	.011
	Study delay	-8.014	3.969	-.102	-2.019	.045
GPA June[a]	(Constant)	-65.681	6.523		-10.070	.000
	GPA PBA	1.643	.095	.559	17.383	.000
	Resits	-4.567	1.597	-.092	-2.860	.004
GPA June[b]	(Constant)	-57.682	9.808		-5.881	.000
	GPA PBA	1.550	.143	.568	10.869	.000
	Position class; Disagree	-4.952	2.308	-.129	-2.145	.033
	Position class; Agree	2.057	2.050	.061	1.003	.317
GPA End[a]	(Constant)	-55.525	6.947		-7.993	.000
	GPA PBA	1.557	.101	.515	15.462	.000
	Resits	-4.850	1.701	-.095	-2.852	.004
GPA End[b]	(Constant)	-47.231	10.068		-4.691	.000
	GPA PBA	1.465	.146	.539	10.003	.000
	Position class; Disagree	-4.932	2.370	-.129	-2.081	.038
	Position class; Agree	1.599	2.105	.048	.760	.448

[a] Data 2013-2014;2014-2015;2015-2016 [b] Data 2014-2015;2015-2016

5 Discussion

5.1 Prediction model: Cohort 2015-2016 (RQ1)

Students' prior achievement in the PBA emerges undeniably as the variable with the highest predictive value. A strong and positive correlation is established between the GPA's in the transfer programme and the GPA of the PBA. This strong correlation results in a simple regression model with a high explained variance: due to the strength of this variable it is difficult to find other significant predictors with a high added value. Other studies include almost always high school GPA or SAT scores (Ackerman et al. 2013; House 2000), which are variables similar to GPA of the PBA.

Of the three different types of independent variables, the academic background variables are the ones with the highest predictive value. These variables contain relevant information for student advisors, but cannot be the basis for remedial programmes since a student's background cannot be adjusted. The diagnostic test aims to inform students about their possible shortcomings and encourage them to participate in intervention initiatives.

The results of the academic background variables are definitely reasonable, since the idea of the 'perfect academic' student is one with good results, no study delay, no resits, and no tolerated credits. In other words, students who had a study path without big hurdles, regarding academic achievement, perform better in the transfer programme. Notice that no pronouncements are made here about their potential social hurdles during the PBA.

Students who kept their results of the PBA in mind when they made the decision to transfer are also the ones with significantly better results in the transfer programme, suggesting that a well-considered study choice results in a higher GPA. This is confirmed by Briggs et al. (2012) since they mention that uninformed decision-making may lead to transition difficulties and withdrawal.

Students who report that they were always good in mathematics during secondary education in comparison with the other students, obtain significantly better results in the transfer programme. This variable is also included in most of the regression models and contains more information than the hours of mathematics a student followed during secondary education. It is therefore not the amount of mathematics that seems to be important but whether or not a student has the perception to be good in mathematics in comparison with fellow students. The amount of mathematics does not capture the differences in the abstraction degree of the mathematical courses or the quality differences between schools or teachers. The perception is probably based on obtained grades so competence is important. The position in the class group is an aspect of the mathematical self-concept and has proven to be a significant predictor for academic achievement (Van Soom and Donche 2014). Regarding the secondary education track, Van Daal et al. (2013) formulated conclusions similar to the findings in this research, namely that first-year students coming from ASO perform better than TSO students. The general characteristics, gender and SES, do not reveal significant differences.

The predictive value of the diagnostic test is unfortunately rather disappointing. By consequence, adaptations to the composition of the test are necessary. For the four CoVaT subtests no correlations are found at all. Therefore, there is reason to believe that these skills are useful engineering attributes, but not crucial for being successful in the transfer programme or that the tests do not differentiate. Mathematics has undeniably an important role in engineering education, but the results of the mathematics test do not correlate significantly with the GPA's of the transfer programme. The fact that students did not have the opportunity to refresh their mathematical knowledge in advance, in combination with the absence of mathematics during their PBA, may explain these low correlations or maybe the test does not differentiate sufficiently (Van den Broeck et al. 2016). Kuh et al. (2008) concluded that student engagement, measured via the National Survey of Student Engagement (NSSE), is predictive for academic achievement of first-year students. Since it is known that the transfer programme has a very heavy workload, it is possible that student engagement plays an important role in the achievement of transfer students.

Regarding the non-cognitive variables, concentration is the only scale that correlates significantly with every GPA of the transfer programme. Selecting main ideas and study aids correlate negatively with achievement. This is unexpected and in contrast with prevailing ideas that students with better learning and study strategies are better performing students (Bernhold et al. 2007; Seabi 2011). Students filled the LASSI in with their learning and study skills at the end of the PBA in mind. When first-year students enter university, they must adapt their learning strategies, used during secondary education, to be successful (Conley 2007). Therefore, it is reasonable that transfer students need to adapt their strategies as well.

The explained variance of the multiple regression models varies between 29.0% and 36.3%. For the GPA at the end of the academic year the explained variance is remarkably lower. Two reasonable explanations are: (1) resits are organised at the end of year and so students had a second chance to pass or (2) the fact that every student goes through a personal development during the transfer programme and all the included variables are measured before the start of the transfer programme.

5.2 CONSISTENCY OVER TIME: COHORT 2013-2014, 2014-2015, AND 2015-2016 (RQ2)

In the composed dataset the same trend as that found in the cohort of 2015-2016 is noticeable, but now all the differences, except one, are significant. Due to the considerably larger sample this result is logical. A comparison of these results with previous research, confirms the findings of this paper. For instance, in their meta-analysis, Richardson et al. (2012) report that female students obtain significant higher GPA's than male students. Another study that examined the effect of study delay in secondary education stated that study delay has a negative effect on achievement of the students in the long-term (Lamote et al. 2014). By extending this mind-set it is feasible that students who leave the PBA without a study delay are the better performing students.

Based on the three cohorts, the data is rather consistent and shows similar trends as data of one cohort. As long as there are no radical programme changes or drastic changes in the profile of the incoming students there is reason to believe that there is consistency over time.

6 CONCLUSIONS AND FUTURE WORK

The aim of this research was to build a prediction model for the GPA of transfer students (RQ1) and to check whether these results are consistent over time (RQ2). First of all, when predicting students' possible future academic achievement in the transfer programme, their obtained GPA in the PBA will play the most important role. Some other academic background variables can also be included, but it is important to keep in mind that their added value is rather low. Although the cognitive part of the diagnostic test has no predictive value and the non-cognitive part no added value on top of the academic background variables, this does not mean that the diagnostic test is useless. To encourage students to participate in interventions is at least as important. In order to increase the predictive value of the diagnostic test adaptations will be made. If the diagnostic test is more predictive, it can be a useful tool for students who want to have an idea about their possible future study success. In the long run we aim for a notable decrease in dropout rate and an increased success rate, since students will be better informed about their chances and should only start the transfer programme if they are sure about their capacities and motivation. Due to consistency over time, generalisability of the model becomes possible and this creates opportunities for a long-term implementation in the institution.In an ongoing research the aim is to investigate the transferability of our findings to the transfer programmes of the five Flemish universities. It would also be interesting to further explore these findings in an international context. A first step is to determine if there are other countries with alternative pathways, similar to transfer programmes, into university. If so, it would be intriguing to compare the different institutions, programmes, and the corresponding students.

CHAPTER 5 - ADVISORY MODELS FOR TRANSFER STUDENTS IN ENGINEERING: THE USE OF A DIAGNOSTIC TEST AND STUDENTS' BACKGROUND

Van den Broeck, L., De Laet, T., Lacante, M., Van Soom, C. & Langie, G. (2019). Advisory models for transfer students in Engineering: The use of a diagnostic test and students' background, *Studies in Higher education* (under review since 25/01/2019).

In an open-entrance institution, data-based informing of prospective students about relevant (academic) background variables is important. Also providing these students with actionable feedback about their skills and abilities is meaningful. Actionable feedback has the aim to influence students' behaviour and help them to improve their skills and abilities. Therefore, two types of advisory models, based on students' pre-entry characteristics, were distinguished. A students' background model, which only included fixed variables (i.e. prior schooling and (family) background). This students' background model is only useful before enrolment. The second model, a diagnostic model, therefore only included malleable variables (i.e. skills and abilities) that were measured in a diagnostic test. Due to the use of malleable variables, the diagnostic model is useful both before and after enrolment. The diagnostic test was developed and administered to (prospective) transfer students at the Faculty of Engineering Technology, KU Leuven (Belgium). The diagnostic test included both cognitive and non-cognitive variables and students received actionable feedback on their test results. The students' background model explained between 34% and 43% of the variance in students' academic achievement, whereas the explained variance of the diagnostic model varied between 10% and 28%. Although the explained variance of the students' background model is higher, both models are useful before enrolment. Once a student is enrolled, the focus has to be on malleable variables, which are only included in the diagnostic model.

1 INTRODUCTION

In Flanders (Belgium), there are no admission requirements to enter higher education, except for medicine, dentistry, and arts. This has the advantage that students can achieve their goals irrespective of their background. Due to this open-entrance system it is however of great importance to stimulate students to make a well-considered educational choice. The educational system of Flanders provides, in addition to the traditional academic Bachelor's programme, alternative ways to enter a Master's programme. Students who obtained a professional Bachelor's degree can enrol into an academic Master's programme provided that they successfully complete a transfer programme. This study focuses on transfer students at the Faculty of Engineering Technology (FET), KU Leuven (Belgium). Chapter 2 revealed that the transfer students at FET experience similar transition problems and have similar academic outcomes after one year of enrolment as traditional first-year students at FET. One of the academic outcomes in Chapter 2 was dropout rate, which was approximately 35%.

Important factors that have an influence on whether or not students drop out, are students' pre-entry characteristics (Tinto 1993), which include prior schooling, skills and abilities, and family background. Data-based informing of prospective students in an open-entrance institution about relevant (academic) background variables is therefore important. But also providing students with actionable feedback about their skills and abilities is meaningful. The aim of actionable feedback is to influence students' behaviour and help them to improve their skills and abilities if necessary. In Chapter 4, only one model was determined, namely the prediction model with the highest predictive value as possible. However, the aim is to properly inform students before enrolment and support them after enrolment. Therefore, it was decided to develop two different types of advisory models for the transfer students at FET: a students' background model, which is only useful before enrolment, and a diagnostic model, which is useful both before and after enrolment. The students' background model only includes fixed variables such as students' (family) background and prior schooling. Prospective students need to be aware which variables influence their possible study success before they decide to enrol in the transfer programme. The diagnostic model, is important both before and after enrolment since it only includes malleable variables such as students' knowledge and attitudes, which are measured in a diagnostic test. The diagnostic test in this research is voluntary, non-binding, and preferably organised before enrolment in the transfer programme. The objectives of the test are (1) to provide students with feedback about their skills and capacities and thus to stimulate them to make a well-considered educational choice, and (2) to encourage students to participate, if necessary, in interventions before or during their transfer programme. This diagnostic test consisted of both cognitive and non-cognitive tests and students received actionable feedback about their test results. Organising a diagnostic test gives students an extra opportunity to position themselves among their peers, with respect to the expectations of the programme. These diagnostic test results are not only interesting before enrolment, but also once students are enrolled. Since students can work on their knowledge and attitudes during the transfer programme as well.

2 LITERATURE OVERVIEW

Section 2.1 provides a concise description of the theoretical framework used in this study, namely Tinto's model for dropout. The other two sections include literature about the use of students' background when predicting academic achievement (Section 2.2) and the use of diagnostic testing (Section 2.3).

2.1 TINTO'S MODEL

Tinto's longitudinal model (1993) provides a framework for understanding student behaviour during the transition to university. Figure 13 shows the interaction between the different variables, such as pre-entry characteristics, goal commitments, institutional experiences, and integration, which eventually leads to the decision whether or not to leave an institution or study programme. Although this model focuses on whether or not a student retains in the programme or drops out. It is also possible to examine the effect of these variables on a quantitative academic outcome such as students' GPA (grade point average).

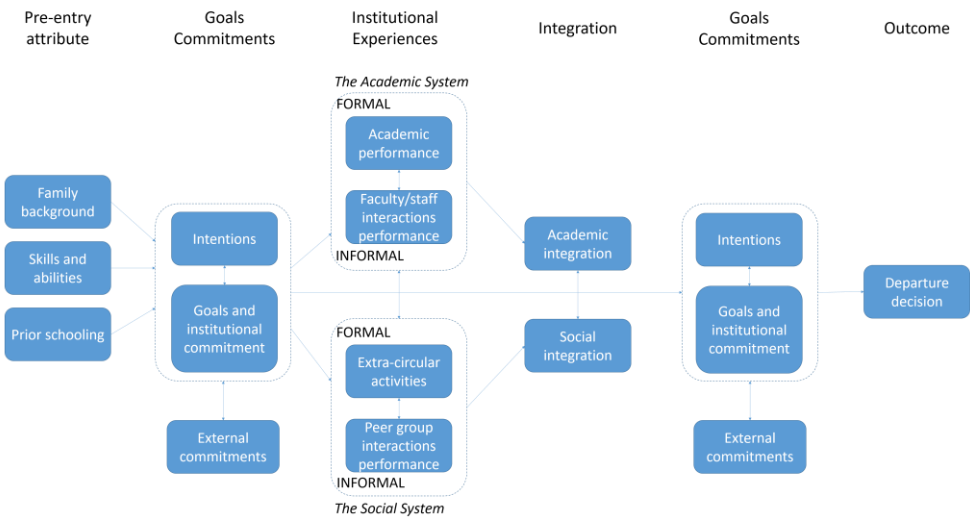


FIGURE 13. TINTO'S TRANSITION MODEL (1993)

This study focuses primarily on students' pre-entry attributes, which Tinto divided into three categories: (1) family background, (2) skills and abilities, and (3) prior schooling. Concretely for this research this means that the students' background model includes prior schooling and family background, whereas the diagnostic model includes students' skills and abilities.

2.2 Students' background

The most predictive cognitive variable, by far, is prior achievement. For this reason, a model for predicting students' academic achievement often includes variables such as High school GPA, High school rank, and ACT or SAT scores (Ackerman et al. 2013, De Winter and Dodou 2011, French et al. 2005, Van Soom and Donche 2014, House 2000, Ting 2011). De Winter and Dodou (2011) focused on high school exam scores and found a strong correlation between high school exam scores in Natural Sciences and Mathematics and GPA (r=.56) at TU Delft (The Netherlands). Non-cognitive variables also contain useful information about for example the students' behaviour, learning strategies, or commitments. When the effect of non-cognitive variables on study success is analysed, these measures are mostly self-reported that are collected through questionnaires. Pinxten et al. (2017) concluded that non-cognitive variables, such as students' learning strategies are related to first-year student success. However, when adding these non-cognitive variables to prior academic achievement, their incremental value was restricted. Ackerman et al. (2013) developed a regression model that explained 40% of the variance in grades of first-year STEM students at Georgia Institute of Technology (US). The model included high school GPA, SAT scores (verbal and maths), the average Advanced Placement exam score (i.e. courses and corresponding exams during college - AP), and five trait complexes: (1) Math/Science self-concept, (2) Mastery and organization,(3) Openness and verbal self-concept, (4) Anxiety in achievement contexts, and (5) Extroversion. House (2000) asked first-year STEM students at Northern Illinois University (US) to complete the Cooperative Institutional Research Programme (CIRP) Annual Freshman Survey focusing on a variety of topics, such as parental education, high school curriculum, financial goals, social goals, academic self-concept, achievement expectancies, and desire for recognition. When academic background variables were added in the first step of the regression model 28% of the variance was explained. Adding academic self-concept and financial goals to the model resulted in an incremental value of only 1% and consequently, with a total explained variance of 29%. In another study (Ting 2011) the first-year engineering students of North Carolina State University (US) were administered to fill in the Non-Cognitive Questionnaire (NCQ). The model includes, besides a cognitive variable, positive self-concept, leadership experiences, and preference of long-term goals (R^2=12%). When predicting GPA, the first step in the linear regression of French et al.

(2005) was significant and included cognitive variables (SAT scores and High school rank) and gender (R^2=18%). When adding non-cognitive variables (i.e. motivation, institutional integration, and orientation class) to the model, the change in R^2 was not significant.

2.3 DIAGNOSTIC TESTING

Variables such as prior academic achievement are static, but students' knowledge, competences, and attitudes are malleable variables. Organising diagnostic tests is one manner to make an estimation of these variables. Based on the selectivity of the institution, a diagnostic test can have different purposes and can be organised on different moments. At many universities, diagnostic tests are organized at the beginning of the academic year (Carr et al. 2013, Johnson and 'O Keeffe 2016, Lee and Robinson, 2005). Using diagnostic tests is helpful to gather information about a cohort of students, identify students at risk, identify mathematical deficiencies, and to find out which remedial support is needed (Hawkes and Savage 2001, Lawson et al. 1995). For open-entrance systems, organising the diagnostic test before enrolment is preferable. In this way, the test can be used as a tool to identify at-risk students in advance and provide them with this important information before enrolment so that they can participate in remedial pre-university courses or reconsider their educational choice and eventually decide to choose another programme (Vanderoost et al. 2014). Organising a diagnostic test, gives prospective students the opportunity to compare their own abilities with those of the other students. If the aim of the diagnostic test is to make an estimation of the students' abilities and determine possible stumbling blocks, it will be important to provide these students with individual and actionable feedback. As stated by Hattie and Timperley (2007) feedback has to answer three questions asked by a lecturer and/or by a student: (1) Feed up: Where am I going? What are the goals?; (2) Feedback: How am I going? What progress is being made toward the goal?; (3) Feed forward: Where to next? What activities need to be undertaken to make better progress? Providing students with effective feedback is one thing, but as Kulhavy (1977) mentioned: "Feedback can be accepted, modified, or rejected.", meaning that at the end, students need to decide if they do something with the feedback, since feedback by itself does not have the power to initiate further action.

3 METHOD

This section includes a description of the sample (Section 3.1), the diagnostic test (Section 3.2), and the students' background variables (Section 3.3). Then the measurement of academic achievement is described (Section 3.4). The end of this section presents the statistical analyses used in this study (Section 3.5).

3.1 SAMPLE

This research focuses on transfer students who are new (i.e. enrolled for the first time) and have a standard study programme (i.e. minimal 50 ECTS). The study includes three cohorts of transfer students: cohort 2015-2016 (N=258), 2016-2017 (N=306), and 2017-2018 (N=335) at FET (KU Leuven).

3.2 DIAGNOSTIC TEST

Throughout the three pilots, the composition of the diagnostic test has been adapted. The following paragraphs include an overview of the pilots (see 3.2.1), the need for developing a mathematics preparation tool (see 3.2.2), and students' participation in the test (see 3.2.3).

3.2.1 PILOTS

The development of the diagnostic test was an iterative process. Tests were deleted or inserted based on literature and data analysis. A more extensive description of the test evolution is included in Appendix A. Table 25 gives an overview of the test composition, whether or not if students could prepare themselves for the mathematics part, and the number of participants.

TABLE 25. PILOT OVERVIEW

	Pilot 2015-2016	Pilot 2016-2017	Pilot 2017-2018
Tests	• Math 19 MC • CoVat • LASSI (10 scales)	• Math 19 MC • CoVat • LASSI (10 scales) • Student engagement	• Math 30 MC • LASSI (5 scales) • Student engagement
Preparation possible	No	Yes, MOOC	Yes, MOOC
Participation	Before enrolment: N=92 During enrolment: N=32	Before enrolment: N=97 During enrolment: N=157	Before enrolment: N=94 During enrolment: N=288

3.2.2 MATHEMATICAL PREPARATION

During focus group discussions transfer students indicated mathematics as a major stumbling block (Van den Broeck et al. 2015). This is because most students followed a track in secondary education with a low or medium level of math. Moreover the professional Bachelor's programme contains no or little math courses since the focus is primarily on more practical subjects. Taking all these factors into consideration, transfer students need an opportunity to improve or brush up their mathematical knowledge. Therefore a math MOOC (Massive Open Online Course) was developed for the pilot of 2016-2017 and 2017-2018. This MOOC allows students to improve their mathematical knowledge in preparation of the diagnostic test (Chapter 7).

3.2.3 PARTICIPATION

During each pilot, the diagnostic test was organised twice on a voluntary basis: (1) before enrolment in the transfer programme and (2) after enrolment in the transfer programme. The most important and crucial test moment is during the last phase of the professional Bachelor's programme, when students are not yet enrolled in the transfer programme. Unfortunately, it is not easy to reach these students since they are not yet in the University system. During the first week of the academic year a second test moment was organised in order to reach all students. Students who participated in the first moment could skip this test moment. Since the test was organised before or between the lectures, time was restricted during the second test moment. Therefore, depending on the available time some tests were not included, but mathematics always was. At the first test moment, before enrolment, the number of participants was similar throughout the pilots. A different phenomenon was observed during the second test moment, since more students participated in each pilot. The increase from the first to the second pilot can be explained by the fact that the math lecturers expressed the urgency of participating. During the third pilot two extra campuses were involved, so this pilot included five campuses instead of three.

3.3 STUDENTS' BACKGROUND

For the development of the students' background model different (family) background (see 3.3.1) and prior schooling variables are gathered. The prior schooling variables include both variables regarding students' secondary education (see 3.3.2) and professional Bachelor's programme (see 3.3.3). Apart from that, also variables regarding students decision are included (see 3.3.4). The paragraphs below give a summary and short description of the collected variables.

3.3.1 (Family) background

- Gender
- Socio economic status (SES): At least one of the parents has a higher education degree (Yes/No)

3.3.2 Prior schooling: Secondary education

- Secondary education track: (1) general secondary education (ASO) aims at a broad general education and prepares pupils for higher education or (2) technical secondary education (TSO) which mainly focuses on general and technical-theoretical subjects
- Level of math: low (<4 hours mathematics/week), medium (4 or 5 hours of mathematics/week), or high (6 or > hours of mathematics/week)
- Position in class group for math: Item *"I was always good in mathematics in comparison with other students during secondary education*." rated on a five-point Likert scale (1='Totally disagree' – 5='Totally agree')
- GPA at the end of secondary education[31]: low (<70%), average (70-80%), high (>80%)
- Math GPA at the end of secondary education[31]: low (<70%), average (70-80%), high (>80%)
- Self-perceived effort secondary education[31]: Item *"How hard did you have to study during secondary education?"* rated on a five-point Likert scale (1='Not hard at all'– 5='Very hard').

3.3.3 Prior schooling: Professional bachelor's programme

- GPA PBA: the students' obtained overall GPA at the end of the professional bachelor's programme
- Study delay during PBA: Did the student finish the professional bachelor's programme in the allotted time (i.e. three years)?
- Resits in the third year of PBA[32]: Did the student participate in resits during the last year of the professional bachelor programme?
- Self-perceived effort PBA: Item *'How hard did you have to study during the professional bachelor programme?'*, rated on a five-point Likert scale (1 = 'Not hard at all' to 5 = 'Very hard').

---

[31] Only collected in 2016-2017 and 2017-2018

[32] When students fail one or more exams during the first or second examination period, they can resit the exam after the second semester, during the third examination period

3.3.4 DECISION

- Moment of decision: Item *"When did you decide to enrol in the transfer programme?"* (1=Before start of PBA; 2=During PBA, and 3=During summer holiday)
- Contribution of results of PBA in decision process: Item *"During the decision-making process for the transfer programme, I have kept my study results of the professional bachelor in mind."* (1='Totally disagree' – 5='Totally agree')

3.4 MEASUREMENT OF ACADEMIC ACHIEVEMENT

Academic achievement was collected through university records (KU Leuven, SAP system). This study uses GPA as a measurement of academic achievement in the transfer programme. Results after the first semester (GPA January), after the second semester (GPA June), and results at the end of the academic year (GPA End) are included.

3.5 STATISTICAL ANALYSIS

This study aims to predict students' academic achievement via two different advisory models: a diagnostic model and a students' background model, of which the statistical methods are explained in the next paragraphs. Some variation in the number of included students is possible and depends on available information or response rates.

3.5.1 DIAGNOSTIC MODEL

As a first step, the predictive value of each independent variable of the diagnostic test (see 3.2.1) was tested separately by calculating the correlation coefficients. Only the variables, which were individually significant ($p< 0.05$), were included in further analysis. Next, multiple linear regression analysis was conducted. The variables were stepwise entered in the model. It was decided to start with the cognitive variables, since literature confirms the large explanatory power of these variables. The non-cognitive variables were added afterwards, starting with the variable that had the strongest correlation with students' academic achievement. Only the variables that led to a significant change in R^2 were retained in the final model. The mathematics test was the only new developed test in this research, therefore the descriptive and item statistics of the mathematics test are presented in Appendix B. Appendix C includes the statistics of the diagnostic model.

3.5.2 STUDENTS' BACKGROUND MODEL

As a first step, the predictive value of each independent variable was tested separately by calculating the correlation coefficient or performing independent sample t-tests and ANOVA analyses. Only the variables, which were individually significant ($p<0.05$), were included in further analysis. Next, multiple linear regression analysis was conducted. The variables were stepwise entered in the model. It was decided to start with GPA PBA since literature emphasises the high predictive value of students' prior achievement. Then the other variables were added. Only the variables that led to a significant change in R^2 were retained in the final model. Appendix D includes the statistics of the students' background model.

4 RESULTS

Section 4.1 includes the diagnostic models. Section 4.2 presents the students' background models. A summary of both the models is given in Section 4.3.

4.1 DIAGNOSTIC MODEL

The paragraphs below discuss the diagnostic models of the three pilots: 2015-2016 (see 4.1.1), 2016-2017 (see 4.1.2), and 2017-2018 (see 4.1.3)[33].

4.1.1 PILOT 2015-2016

Neither the mathematics test, nor the CoVat subtests showed significant correlations with students' academic achievement (N=82). Of the ten LASSI scales, three were significantly correlated with academic achievement (N=51): concentration (GPA Jan r=.37, p=.007; GPA Jun r=.33, p=.017; GPA End r=.32, p=.020), study aids (GPA Jun r=-.29, p=.037), and self-testing (GPA Jan r=.33, p=.019).

The diagnostic model for the GPA of June (N=61) consisted of the concentration and study aids scales, which were also the only two variables that were significantly correlated to students' academic achievement, and explained 28.2% of the variance. The diagnostic model for the January GPA (N=61) and for the end GPA (N=61) consisted of the concentration scale and resulted in an explained variance of 16.7% and 14.9%, respectively.

4.1.2 PILOT 2016-2017

The mathematics test correlated consistently significant with students' academic achievement (N=173; GPA Jan r=.35, p<.001; GPA Jun r=.32, p<.001; GPA End r=.31, p<.001). In addition, for two of the four CoVat subtests a significant correlation was found (N=61): Proverbs (GPA Jun r=.30, p=.020; GPA End r=.30, p=.018) and Folding boxes (GPA Jan r=.34,p=.008; GPA Jun r=.28,p=.028; GPA End r=.28, p=.029). Three LASSI scales were significantly correlated to students' academic achievement:

[33] The more detailed results of the three pilots are included in Appendix F-H at the end of this dissertation

Motivation, Time management, and Concentration. None of the student engagement scales showed a significant correlation.

Although two CoVat subtests were significantly correlated to the students' achievement, it was not possible to provide students with actionable feedback about these variables. The CoVat is thus not included in the diagnostic model[34]. The model for the GPA of January (N=138) consisted of mathematics (R^2=11.7%), concentration (added R^2=4.1%), and motivation (added R^2=2.8%), which resulted in an explained variance of 18.5%. For the GPA of June (N=172) and the GPA at the end (N=172), the mathematics test accounted for an R^2 of 10.2% and 9.4%, respectively.

4.1.3 Pilot 2017-2018

The extended mathematics test correlated consistently significant with students' academic achievement (N=289; GPA Jan r=.40, p<.001; GPA Jun r=.40, p<.001; GPA End r=.34, p<.001). Three LASSI scales were significantly correlated to students' academic achievement: Motivation (N=285; GPA Jan r=.28, p<.001; GPA Jun r=.29, p<.001; GPA End r=.27, p<.001), Time management (N=285; GPA Jan=.21, p<.001; GPA Jun r=.20, p=.001; GPA End r=.21, p<.001), and Concentration (N= 282; GPA Jun r=.13, p=.037; GPA End r=.13, p=.032). One of the student engagement scales, Dedication, correlated significantly with students' GPA (N=59; GPA Jun r=.32, p=.016; GPA End r=.31, p=.015).

The three diagnostic models consisted of mathematics and motivation. The model of January (N=281) and June (N=271) accounted for an R^2 of 22% and 22.3%, respectively. Mathematics alone resulted in an R^2 of approximately 15%, thus the added value of motivation is around 7%. For the model at the end of the academic year the R^2 of mathematics was lower (R^2=11%), whereas the added value of motivation remained around the 7%. The total explained variance of this diagnostic model was 17.6%.

4.2 Students' background model

The paragraphs below discuss the students' background models of the three included cohorts: 2015-2016 (Section 4.2.1), 2016-217 (Section 4.2.2), and 2017-2018 (Section 4.2.3)[35].

---

[34] For more information on why the CoVat is not included, see Appendix A.

[35] The more detailed results of all the cohorts are included in Appendix A-E at the end of this dissertation

4.2.1 COHORT 2015-2016

The students' background models of cohort 2015-2016 retained two (January model and End of year model) or three (June model) significant variables. Students prior achievement (GPA PBA) accounts for the highest explained variance on achievement. The position in class group for math was retained in the model of January (N=124) and resulted in a total R^2 of 36.3%. The model of June (N=124) consisted of three significant variables: GPA PBA, position in class group for math, and student's effort during the PBA (R^2=34.2%). For the GPA at the end of the academic year (N=124), GPA PBA and effort during PBA, explained 29% of the variance.

4.2.2 COHORT 2016-2017

The students' background model of January (N=207) included GPA PBA (R^2=36.4%), students' position in class group for math (added R^2=3.2%), and their math GPA in secondary education (added R^2=3.8%) which resulted in an explained variance of 43.4%. For the GPA of June (N=208) only two variables, GPA PBA (R^2=38.8%) and math GPA in secondary education (added R^2=2.2%), were retained and accounted for 41% of the variance. The students' background model for the end of the academic year (N=248) explained 36.1% of the variance and consisted of GPA PBA (R^2=34.5%) and the secondary education track (added R^2=1.6%).

4.2.3 COHORT 2017-2018

The students' background models of cohort 2017-2018 retained GPA PBA, Position in class group for math, and students' level of math. Dependent on the moment in the academic year, gender and/or track during secondary education also accounted for an added explained variance. The model for the GPA of January (N=238) consisted of these five variables, which resulted in an explained variance of 42.3%. For the GPA of June (N=229) the students' background model included GPA PBA (R^2=26.2%), Position in class group for math (added R^2=6.4%), level of math (added R^2=4%), and secondary education track (added R^2=4.8%) and accounted for an R^2 of 41.5%. The model at the end of the academic year (N=239) explained 32.4% of the variance in students' academic achievement and consisted of GPA PBA (19.9%), Position in class group for math (added R^2=4.8%), level of math (added R^2=5.3%), and gender (added R^2=2%).

4.3 SUMMARY

Table 26 gives a summary of all the advisory models, both diagnostic and students' background models, for the three included academic years. The explained variance of the students' background model is consistently higher than the explained variance of the diagnostic model. For both the students' background model and the diagnostic model the explained variance of the students' GPA at the end of academic year is in each pilot the lowest. Table 26 shows that throughout the three pilots the explained variance of both the models increases or remains stable. Only the models that predict the GPA at the end of the academic year reveal larger inconsistent fluctuations. The diagnostic model consists of one to three variables and includes often mathematics, motivation, or concentration. The number of included variables in the students' background models varies from two to five. In general, students GPA of the professional Bachelor's programme is complemented by other prior schooling variables, mainly regarding students' secondary education.

TABLE 26. SUMMARY MODELS

		GPA January			GPA June			GPA End		
		N	R^2	Variables	N	R^2	Variables	N	R^2	Variables
Diagnostic model	2015-2016	61	16.7%	Concentration	61	28.2%	Concentration, Study aids	61	14.9%	Concentration
	2016-2017	138	18.5%	Math, Motivation, Concentration	172	10.2%	Math	172	9.4%	Math
	2017-2018	281	22%	Math, Motivation	271	22.3%	Math, Motivation	281	17.6%	Math, Motivation
Students' background model	2015-2016	124	36.3%	GPA PBA, Position in class group for math	124	34.2%	GPA PBA, Position in class group for math, Effort PBA	124	29%	GPA PBA, Effort PBA
	2016-2017	207	43.4%	GPA PBA, Position in class group for math, Math GPA	208	41%	GPA PBA, Math GPA	248	36.1%	GPA PBA, Secondary education track
	2017-2018	238	42.3%	GPA PBA, Position in class group for math, Level of math, secondary education track, gender	229	41.5%	GPA PBA, Position in class group for math, Level of math, secondary education track	239	32.4%	GPA PBA, Position in class group for math, Level of math, gender

5 DISCUSSION

In this study two types of advisory models, focusing on students' pre-entry attributes, were developed. These pre-entry attributes have an influence on students' academic achievement and are therefore of great importance. In an open-admission institution, it is worthwhile to use the information of students' pre-entry attributes before enrolment. The students' background model included variables regarding students' (family) background, prior schooling, and decision. Prospective students need to be aware which variables influence their possible study success before they decide to enrol in the transfer programme. The diagnostic model only included malleable variables such as students' knowledge and attitudes.

For both the students' background model and the diagnostic model the explained variance of the students' GPA at the end of academic year is in each pilot the lowest. Since all the significant variables from these models are also included in the models of January and/or June, it is justified to only focus on the models of January and June when further discussing the results. Throughout the pilots, the number of included students in the models increased. This increase is important, since larger sample sizes result in more statistical evidence. In general, the explained variance of the models increased or remained stable.

As of 2016-2017 more prior schooling variables regarding students' secondary education were included in the research. This resulted in added R^2 of approximately 7% compared to the models of 2015-2016. In all the students' background models the GPA of the professional bachelor programme is a very strong predictor and explains the largest proportion of the variance. This is similar to literature, where students' prior academic achievement is by far the most predictive variable (Ackerman et al. 2013, De Winter and Dodou 2011, French et al. 2005, Van Soom and Donche 2014, House 2000, Ting 2011). On average the students' background model explained about 40% of the variance in students' academic achievement, with on average thee variables. By way of comparison, the model of Ackerman et al. (2013) explained 40% of the variance in the students' grades. However, this model included high school GPA, SAT scores, advanced placement exam scores, and a trait complex (a questionnaire with a total of 229 items). Consequently, Ackerman et al. (2013) needed many more variables to explain the same variance in students' grades.

An interesting finding in this study was that one self-reported item regarding students' position in the class group for mathematics during secondary education contained so much predictive value and was included in almost all the students' background models. Also students' level of math and math GPA during secondary education were included in the models. This in combination with the high correlation between the mathematics test and students' academic achievement, showed the importance of mathematics. Pinxten et al. (2017) found that level of math and math/science GPA in secondary school are strongly related to the GPA of first-year STEM students. Since mathematics has a key role in every engineering programme, it is not surprisingly a significant predictor for academic achievement (Veenstra et al. 2008, French et al. 2005, Leuwerke et al. 2004).

During the second and third pilot, when students had the opportunity to refresh their knowledge by participating in the MOOC[36], a significant correlation with academic achievement was found. The correlations in our study are higher than those between the SAT math score and first-year engineering students' grades (r=.26) in the study of Ting (2001). In addition, the internal consistency of the diagnostic test in this research improved and the mean score was significantly higher for the cohort of students that had the opportunity to prepare themselves (Appendix B, Van den Broeck et al. 2018). Between the second and the third pilot, 11 questions were added to the mathematics test, which resulted in an increase in the explained variance of the mathematics test from 10% to 15%.

In this research, participation in the diagnostic test was voluntary, unlike at the Faculty of Engineering Science where students are obligated to participate in the diagnostic test. If they pass the test they receive one credit. Students who do not pass the test, need to follow an extra one credit course during their first semester at the faculty. There is a strong correlation (r=.47) between this diagnostic test and students' academic achievement (Vanderoost et al. 2014, Pinxten et al. 2017), which is somewhat higher than the correlation found in this study. However, it is reasonable that if the diagnostic test is obligatory and if there is some kind of reward when students pass the test, the correlation will be higher, since students will be more motivated to show their real capacities.

During the three pilots, five LASSI scales revealed at least once a significant correlation: Motivation, time management, study aids, self-testing, and concentration. In the diagnostic models of the second and third pilot the significant LASSI scales accounted for an added R^2 of 7%. A large scale STEM research on first-year students revealed significant correlations for all LASSI scales except Study Aids (Pinxten et al. 2017). Pinxten et al. (2017) performed a stepwise regression, which resulted in a model with three scales namely Motivation, Time Management, and Test Strategies that accounted for an explained variance of 9.1%. In their systematic review, Schneider and Preckel (2017) examined which variables are associated with

[36] For more information about the MOOC and its effectiveness see Van den Broeck et al. (2019 under review).

academic achievement. Their ranking included many learning and study strategies such as effort regulation (ES=0.75), motivation (ES=0.64), time management (ES=0.46), concentration (ES=0.37), testing aids (ES=0.34), and test anxiety (ES= -0.43). Although not all the LASSI scales revealed significant correlations, the fact that study strategies are malleable variables makes them attractive to use in a diagnostic test. It is important that students reflect about their own study strategies and adapt them if necessary. Indeed a study of Conley (2007) showed that when students enter university they must adapt their study and learning strategies to be successful in higher education. Although not all the variables in the diagnostic test were significant, students received feedback on all the actionable variables. The underlying idea is that student take benefit if the feedback motivates or stimulates them to work on their shortcomings (Tempelaar et al. 2017).

It is clear that students' pre-entry attributes are valuable for the guidance of prospective transfer students, therefore, data-based informing (i.e. students' background model) and actionable feedback (i.e. diagnostic model) are tools for stimulating a well-considered educational choice. The students' background model explained between the 34% and 43% of the variance in students' academic achievement, whereas the explained variance of the diagnostic model varied between 10% and 28%.

Although the explained variance of the students' background model is higher, both models are useful before enrolment. But, once a student is enrolled, the focus has to be on malleable variables, which are only included in the diagnostic model. It is the responsibility of the institution to provide students with interventions, either before or after enrolment to improve, if necessary, their skills and abilities.

APPENDIX

A. TEST DEVELOPMENT

In 2013–2014 a pre-pilot was organised. This diagnostic test was originally designed for traditional first-year students at FET and consisted of mathematics, academic language skills, and scientific reasoning. Analysis showed moderate correlations with students' academic achievement for mathematics and no correlations for academic language skills and scientific reasoning (Langie and Van Soom 2014). During the academic year of 2014-2015 a diagnostic test, specifically for transfer students, was developed. This test set-up was based on the results of focus group discussions with transfer students, lecturers, and test experts (Van den Broeck et al. 2015). The first pilot of this research (2015-2016) consisted of

- 20 MC math questions developed by the math lecturers: To construct the diagnostic test, the math lecturers selected five categories of subjects (i.e. algebra, calculus, elementary arithmetic, graphics, and geometry & trigonometry) and three levels of difficulty (i.e. easy, average and difficult). Every lecturer developed multiple choice (MC) questions for every category and difficulty level. Next, they answered each other's MC questions and indicated the difficulty level they found appropriate for every question. Only the questions they unanimously designated the same answer as correct, were retained. The difficulty levels of all the questions were discussed and changed, if necessary. Of all the retained MC questions, the aim was to select one easy, two average and one difficult question for each category. This set-up was selected to create a test that properly differentiates.
- Four subtests of the CoVaT- CHC (Magez et al. 2013), namely Logical reasoning (i.e. problems similar to the Einstein problem), Proverbs (i.e. find the most suitable explanations for sayings), Folding boxes (i.e. visualize how an unfolded box (2D) can be folded to a box (3D)), and Point series (i.e. discover the mathematical rule and complete the point series);
- Learning and study strategies inventory (LASSI) (Weinstein 2016) 77 items assigned to 10 scales to measure: Attitude (ATT); Motivation (MOT); Time management (TMT); Anxiety (ANX); Concentration (CON); Information Processing (INP); Selecting Main Ideas (SMI); Study Aids (STA); Self-testing (SFT); and Test Strategies (TST). Students were asked to rate each item on a five-point Likert scale (1='Not at all like me' – 5='Very much like me').

The second pilot (2016-2017) included the same tests as the first pilot and one extra test. Including each test at least two times makes it possible to compare different cohorts. This is important since the samples in this research are rather small. Chapter

2 revealed that transfer students experience problems when adapting to university just like traditional first-year students. However, transfer student feel significantly feel less prepared. To be successful, engagement will be important and they also have to realise that their study routine has to change. Kuh et al. (2017) concluded that student engagement, measured via the National Survey of Student Engagement (NSSE), is predictive of academic achievement for first-year students. Therefore the student engagement scale was included in the second pilot. Also a self-developed scale, consisting of items that focus on the impact on social life of studying in the transfer programme, was added. None of the four CoVat tests revealed a significant relationship with the students' achievement in the first pilot. However, similar to the math test, during the second pilot two of the four tests, namely folding boxes and proverbs, were significantly related to the students' achievement. In literature there is also significant proof of the importance of verbal skills, measured for example via the SAT verbal (Ackerman et al. 2013, Ting 2011, Fonteyne, Duyck, and De Fruyt, 2017), and spatial abilities (Ackerman et al. 2013). Unfortunately it was not possible to provide students with actionable feedback regarding their performance on the CoVat tests. In addition, taking the Covat test was time consuming, not only for the participants but also for the correctors. Although two of the four tests were significantly related to achievement in the second pilot, it was decided to delete the CoVat subtests since the purpose of the CoVat is different than the purpose of the diagnostic test.

For the third pilot (2017-2018), some adaptations were made based on the results of the two first pilots: (1) the CoVat tests were removed, (2) the mathematics test was extended, and (3) fewer LASSI scales were included. Unfortunately, it was not possible to provide students with actionable feedback regarding their performance on the CoVat tests. Two additional rather practical arguments for removing the CoVat are: (1) it takes one hour to complete the four tests, which is rather exhaustive for students who already completed a 2 hour math test and (2) correcting these tests is time consuming. Although two of the four tests were significant in the second pilot, it was decided to remove the CoVat subtests since the purpose of the CoVat is different than the purpose of the diagnostic test. By doing this, there was more time for answering extra math questions. Therefore, a total of 11 new questions were added to the original 19 questions. These extra questions were selected by the math lecturers. When selecting these questions, the level of difficulty was taken into account. In total, three easy, seven average, and one difficult questions were added with the aim of improving the differentiation strength of the test. Minor numeric adaptations were made to some of the original questions. During the first and second pilot all the LASSI scales were included in the diagnostic test. After the second pilot it was decided to downsize the questionnaire to five scales: motivation, concentration, time management, study aids, and self-testing. The reasons why not all the LASSI scales were retained are (1) the low predictive value of the scales and (2) not wanting to overwhelm students with too many questions and corresponding feedback. As mentioned previously, each test is included at least two times, hence students' engagement was included in the third pilot. Although literature (Kuh et al. 2017) showed that student engagement is correlated to students' academic achievement, this study only found one significant correlation, namely between students' GPA and the engagement scale dedication.

B. DIAGNOSTIC TEST: MATHEMATICS

The mathematics test consisted of 19 multiple choice in the pilot of 2015-2016 (N=124). The mean score was 42.15% (SD=15.39%). The internal consistency (Cronbach alpha) of the test was 0.57 (Table 27). The interpretation of the item-total correlations (Rit) according to the thumb rules of Ebel (1972): poor (Rit<0.20), doubtful (0.21< Rit< 0.29), good (0.30< Rit <.039), and very good (Rit >0.40), resulted in 12 poor, 5 doubtful, 1 good, and 1 very good item (Table 28).

In the pilot of 2016-2017 (N=254) the mean score was 49.19% (SD=18.93%), which is significantly higher than the pilot of 2015-2016 (t=3.601, p<.001). The internal consistency was 0.72 (Table 27) and the interpretation of the item-total correlations revealed 4 poor, 4 doubtful, 7 good, and 4 excellent items (Table 28).

In the pilot of 2017-2018 (N=382) the mean score was 42.77% (SD=16.32%). When only looking at the 19 items of the previous pilots the mean score was 46.94% (SD=17.12%), which is lower, but not significantly lower, than the pilot of 2016-2017. The internal consistency was 0.78 (Table 27) and the interpretation of the item-total correlations revealed 6 poor, 8 doubtful, 12 good, and 4 excellent items (Table 28 and Table 29). After analysing the three pilots, three items were poor items three years in a row. An item that remains a poor item, should be deleted from the test.

Table 30 to Table 33 provide an overview of the item difficulty of the items and the proportion correct answers for each question.

TABLE 27. INTERNAL CONSISTENCY MATHEMATICS TEST

Internal consistency	2015-2016	2016-2017	2017-2018
Cronbach alpha	.54	.72	.78

TABLE 28. ITEM-TOTAL CORRELATIONS MATHEMATICS

Corrected Item-Total Correlation			
Item	2015-2016	2016-2017	2017-2018
Q1	0.17	0.33	0.34
Q2	0.17	0.16	0.10
Q3	0.05	0.31	0.31
Q4	0.19	0.34	0.39
Q5	0.18	0.37	0.24
Q6	0.21	0.35	0.31
Q7	0.16	0.27	0.27
Q8	0.24	0.30	0.30
Q9	-0.04	0.07	0.15
Q10	0.25	0.54	0.35
Q11	0.15	0.22	0.17
Q12	0.28	0.28	0.40
Q13	0.36	0.42	0.38
Q14	-0.05	0.10	0.05
Q15	0.40	0.45	0.48
Q16	0.15	0.13	025
Q17	0.17	0.43	0.31
Q18	0.29	0.35	0.30
Q19	0.13	0.27	0.25

TABLE 29. ITEM-TOTAL CORRELATIONS NEW MATHEMATICS ITEMS

Corrected Item-Total Correlation	
New items	2017-2018
Q20	0.32
Q21	0.48
Q22	0.35
Q23	0.29
Q24	0.34
Q25	0.22
Q26	0.27
Q27	0.44
Q28	0.27
Q29	0.13
Q30	0.19

TABLE 30. PROPORTION CORRECT/DISTRACTOR AND ITEM DIFFICULTY 2015-2016

p/d values 2015-2016	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19
a	0.02	0.19	0.11	0.10	0.02	0.06	0.02	0.07	0.19	0.09	0.04	0.06	0.01	0.09	0.05	0.02	0.27	0.08	0.68*
b	0.39*	0.25*	0.16*	0.02	0.52*	0.31	0.45*	0.02	0.13	0.07	0.08	0.09	0.00	0.18	0.02	0.35*	0.06	0.04	0.11
c	0.50	0.06	0.11	0.02	0.06	0.02	0.31	0.06	0.07	0.34*	0.04	0.11	0.10	0.05	0.08	0.11	0.39*	0.69*	0.10
d	0.05	0.02	0.09	0.04	0.08	0.01	0.02	0.69*	0.12*	0.06	0.74*	0.12	0.40*	0.41	0.52*	0.18	0.02	0.05	0.03
e	0.01	0.02	0.15	0.18*	0.17	0.57*	0.15	0.11	0.11	0.04	0.04	0.40*	0.11	0.17*	0.15	0.03	0.04	0.04	0.06
Blank	0.03	0.48	0.37	0.64	0.16	0.03	0.05	0.06	0.37	0.40	0.06	0.22	0.37	0.10	0.19	0.31	0.22	0.10	0.02
Item diff.[1]	*	**(*)	*	**	***	*	**	**	***	*(*)	***	*(*)	**	***	*	**	**(*)	*	*

Note. The correct answer is marked with an *, the other options are distractors. [1]The item difficulty as indicated by the lecturers (*=easy, **= average, ***=difficult).

TABLE 31. PROPORTION CORRECT/DISTRACTOR AND ITEM DIFFICULTY 2016-2017

p/d values 2016-2017	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19
a	0.06	0.18	0.08	0.17	0.04	0.07	0.03	0.04	0.21	0.08	0.04	0.04	0.01	0.08	0.06	0.07	0.25	0.03	0.76*
b	0.49*	0.38*	0.24*	0.04	0.64*	0.21	0.62*	0.00	0.09	0.08	0.04	0.14	0.00	0.21	0.01	0.38*	0.06	0.06	0.11
c	0.39	0.07	0.05	0.04	0.06	0.07	0.17	0.04	0.07	0.50*	0.04	0.11	0.07	0.06	0.11	0.12	0.36*	0.68*	0.06
d	0.04	0.02	0.09	0.06	0.06	0.01	0.01	0.77*	0.14*	0.05	0.79*	0.06	0.63*	0.41	0.58*	0.09	0.03	0.05	0.02
e	0.01	0.02	0.21	0.15*	0.09	0.62*	0.13	0.10	0.14	0.02	0.04	0.50*	0.03	0.16*	0.10	0.07	0.07	0.06	0.04
Blank	0.02	0.33	0.33	0.55	0.11	0.03	0.05	0.05	0.35	0.28	0.06	0.15	0.26	0.08	0.14	0.27	0.24	0.13	0.02
Item diff.[1]	*	**(*)	*	**	***	*	**	**	***	*(*)	***	*(*)	**	***	*	**	**(*)	*	*

Note. The correct answer is marked with an *, the other options are distractors. [1]The item difficulty as indicated by the lecturers (*=easy, **= average, ***=difficult).

TABLE 32. PROPORTION CORRECT/DISTRACTOR AND ITEM DIFFICULTY 2017-2018, Q1-Q15

p/d values 2017-2018	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
a	0.04	0.09	0.12	0.05	0.06	0.02	0.02	0.26	0.11	0.03	0.03	0.05	0.00	0.32	0.04
b	0.48*	0.22	0.01	0.61*	0.15	0.62*	0.01	0.20*	0.04*	0.05	0.05	0.13	0.00	0.08	0.02
c	0.40	0.03	0.02	0.10	0.04	0.19	0.06	0.04	0.09	0.07	0.06	0.07	0.08	0.32*	0.09
d	0.03	0.08	0.04	0.06	0.02	0.02	0.75*	0.03	0.07	0.46*	0.76*	0.11	0.64*	0.13	0.60*
e	0.02	0.09*	0.19*	0.06	0.65*	0.14	0.09	0.03	0.23	0.09	0.02	0.45*	0.05	0.01	0.08
Blank	0.03	0.48	0.62	0.12	0.07	0.01	0.06	0.43	0.46	0.30	0.08	0.20	0.23	0.15	0.17
Item diff.[1]	*	**	**	***	*	**	**	**(*)	**	*	***	*(*)	**	**	*

Note. The correct answer is marked with an *, the other options are distractors. [1]The item difficulty as indicated by the lecturers (*=easy, **= average, ***=difficult).

TABLE 33. PROPORTION CORRECT/DISTRACTOR AND ITEM DIFFICULTY 2017-2018, Q16-Q30

p/d values 2017-2018	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30
a	0.04	0.07	0.82*	0.28	0.80*	0.21	0.44*	0.04	0.01	0.19	0.28	0.15	0.12	0.14	0.08
b	0.03	0.26*	0.11	0.09	0.02	0.11	0.32	0.03	0.05	0.30*	0.06	0.34*	0.21*	0.12	0.30
c	0.03	0.13	0.02	0.32*	0.07	0.00	0.05	0.00	0.02	0.07	0.03	0.04	0.02	0.02	0.02
d	0.68*	0.14	0.01	0.04	0.02	0.35*	0.03	0.17*	0.08	0.27	0.03	0.03	0.13	0.07	0.03
e	0.02	0.06	0.03	0.06	0.00	0.21	0.04	0.66	0.68*	0.03	0.18*	0.04	0.10	0.11*	0.33*
Blank	0.20	0.34	0.02	0.21	0.09	0.12	0.13	0.10	0.16	0.15	0.42	0.40	0.42	0.55	0.24
Item diff.[1]	*(*)	**	*	**(*)	*	**	**	**	**	*	**(*)	*(*)	**	***	**

Note. The correct answer is marked with an *, the other options are distractors. [1]The item difficulty as indicated by the lecturers (*=easy, **= average, ***=difficult).

C. Statistics diagnostic model

TABLE 34. STATISTICS DIAGNOSTIC MODEL 2015-2016

Model		Unstandardized Coefficients B	Unstandardized Coefficients SE	Standardized Coefficients β	t	Sig.
GPA January	(Constant)	1.515	12.487		.121	.904
	LASSI; CON	1.528	.440	.409	3.469	.001
GPA June	(Constant)	28.769	14.425		1.994	.051
	LASSI; CON	1.707	.424	.449	4.029	.000
	LASSI; STA	-1.290	.403	-.356	-3.197	.002
GPA End	(Constant)	5.581	13.286		.420	.676
	LASSI; CON	1.521	.469	.387	3.247	.002

TABLE 35. STATISTICS DIAGNOSTIC MODEL 2016-2017

Model		Unstandardized Coefficients B	Unstandardized Coefficients SE	Standardized Coefficients β	t	Sig.
GPA January	(Constant)	-3.209	11.374		-.282	.778
	Mathematics	32.168	6.842	.372	4.702	.000
	LASSI; CON	.387	.358	.099	1.081	.282
	LASSI; MOT	.884	.413	.198	2.139	.034
GPA June	(Constant)	33.691	3.206		10.510	.000
	Mathematics	28.747	6.517	.320	4.411	.000
GPA End	(Constant)	39.054	3.248		12.022	.000
	Mathematics	27.788	6.604	.306	4.208	.000

TABLE 36. STATISTICS DIAGNOSTIC MODEL 2017-2018

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	SE	β	t	Sig.
GPA January	(Constant)	-4.772	7.049		-.677	.499
	Mathematics	40.815	5.708	.379	7.151	.000
	LASSI; MOT	1.193	.245	.258	4.878	.000
GPA June	(Constant)	-6.566	7.502		-.875	.382
	Mathematics	41.981	5.998	.377	6.999	.000
	LASSI; MOT	1.287	.260	.266	4.942	.000
GPA End	(Constant)	-3.316	8.109		-.409	.683
	Mathematics	38.527	6.566	.319	5.868	.000
	LASSI; MOT	1.329	.281	.257	4.725	.000

D. STATISTICS STUDENTS' BACKGROUND MODEL

TABLE 37. STATISTICS STUDENTS' BACKGROUND MODEL 2015-2016

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	SE	β	t	Sig.
GPA January	(Constant)	-58.437	15.151		-3.857	.000
	GPA PBA	1.539	.221	.512	6.972	.000
	Position class; Disagree	-9.118	3.496	-.226	-2.608	.010
	Position class; Agree	1.787	3.037	.051	.588	.557
GPA June	(Constant)	-47.855	16.250		-2.945	.004
	GPA PBA	1.430	.233	.471	6.144	.000
	Position class; Disagree	-5.772	3.660	-.141	-1.577	.117
	Position class; Agree	3.197	3.225	.090	.991	.324
	Effort; Not hard	-7.320	2.776	-.207	-2.637	.009
	Effort; Hard	-5.164	5.437	-.076	-.950	.344
GPA End	(Constant)	-51.385	17.017		-3.020	.003
	GPA PBA	1.539	.245	.491	6.290	.000
	Effort; Not hard	-7.316	2.918	-.201	-2.508	.013
	Effort; Hard	-4.205	5.737	-.060	-.733	.465

TABLE 38. STATISTICS STUDENTS' BACKGROUND MODEL 2016-2017

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	SE	β	t	Sig.
GPA January	(Constant)	-55.732	9.990		-5.579	.000
	GPA PBA	1.491	.140	.579	10.653	.000
	Math GPA; Low	-2.565	2.072	-.076	-1.238	.217
	Math GPA; High	3.690	2.957	.074	1.248	.213
	Position class; Disagree	-2.515	2.627	-.055	-.957	.340
	Position class; Agree	5.571	2.050	.165	2.717	.007
GPA June	(Constant)	-58.109	10.156		-5.722	.000
	GPA PBA	1.552	.144	.590	10.750	.000
	Math GPA; Low	-3.013	2.055	-.087	-1.466	.144
	Math GPA; High	4.884	3.066	.095	1.593	.113
GPA End	(Constant)	-60.536	9.641		-6.279	.000
	GPA PBA	1.612	.139	.589	11.559	.000
	Track SE	4.763	1.903	.128	2.503	.013

TABLE 39. STATISTICS STUDENTS' BACKGROUND MODEL 2017-2018

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	SE	β	t	Sig.
GPA January	(Constant)	-62.712	10.087		-6.217	.000
	GPA PBA	1.439	.143	.511	10.032	.000
	Level of math; Low	-2.883	2.682	-.058	-1.075	.283
	Level of math; High	7.324	2.094	.194	3.497	.001
	Position class; Agree	4.023	1.992	.111	2.019	.045
	Position class; Disagree	-9.666	3.057	-.169	-3.162	.002
	Gender	6.527	2.969	.116	2.198	.029
	Track SE	5.527	2.166	.143	2.551	.011
GPA June	(Constant)	-62.316	10.820		-5.759	.000
	GPA PBA	1.434	.154	.486	9.330	.000
	Track SE	7.185	2.204	.178	3.260	.001
	Position class; Agree	6.928	2.122	.184	3.266	.001
	Position class; Disagree	-9.778	3.271	-.164	-2.989	.003
	Level of math; Low	-3.589	2.822	-.071	-1.272	.205
	Level of math; High	7.247	2.247	.183	3.225	.001
GPA End	(Constant)	-51.520	12.088		-4.262	.000
	GPA PBA	1.346	.173	.425	7.780	.000
	Position class; Agree	5.811	2.393	.143	2.428	.016
	Position class; Disagree	-11.021	3.695	-.172	-2.982	.003
	Level of math; Low	-2.923	3.205	-.053	-.912	.363
	Level of math; High	8.609	2.450	.203	3.514	.001
	Gender	8.984	3.424	.142	2.624	.009

PART C:

INTERVENTION

Chapter 6 - Effectiveness and efficiency of a student support programme for transfer students in Engineering

Paper will be submitted to *Educational Studies*

When students enter university they can feel unprepared, which has an effect on how they experience the transition to university. Hence, supporting new students before and after enrolment is important. This study focuses on transfer students at the Faculty of Engineering Technology (FET). The FET is a part of KU Leuven (Belgium), which is an open-admission institution. Transfer students are, just like first-year students, new incoming students at university. For these students a student support programme, consisting of eight interventions, was developed. The student support programme aims (1) to attract the right students, (2) decrease the feeling of unpreparedness at the beginning of the academic year, and (3) support students after enrolment. The scope of this study was to estimate the effectiveness and the efficiency of the student support programme. Effectiveness was measured via students' perceived usefulness, determining if the objectives are achieved, and individual effectivity measurements. Efficiency was measured via determining the required development and implementation time and examining the scalability of each intervention. These results were combined into an effectiveness efficiency matrix. The analysis revealed that the most effective interventions are not always the most efficient ones on a large scale and vice versa. Interventions that focus on improving academic skills are ranked by the students as the most effective, followed by the socialisation interventions.

1 INTRODUCTION

When entering university, some of the first-year students feel unprepared (Conley 2007, Lowe and Cook 2003, Carr et al. 2013, Carr et al. 2015). Regardless of students' preparedness, the transition to university always requires adaptation of the student (Holmegaard et al. 2015, Briggs et al. 2012). Each student deals with or experience this transition differently. During the transition period, faculty should organise structured activities to help students to get used to their new environment (Billing 1997). As stated by Tinto (1993), the social and academic integration of a student plays a notable role in students' retention. Hence, supporting new students before and after enrolment is important.

This study focuses on transfer students at the Faculty of Engineering Technology (FET). The FET is a part of KU Leuven (Belgium), which is an open-admission institution. Transfer students are, just like first-year students, new incoming students at university. These students already obtained a professional Bachelor's degree in Technology and can enrol into an academic Master's programme on condition that they successfully complete a transfer programme. Chapter 2 revealed that both students' academic achievement and dropout rates after one year are similar for the transfer students and first-year students at FET. In addition, transfer students experience similar adaptation problems as the first-year students regarding, for instance getting used to the teaching approach and studying at university in general. However, the transfer students feel significantly less prepared than traditional first-year students.

For these transfer students a student support programme was developed. This student support programme, consisting of eight interventions, starts in the last phase of the professional bachelor and ends after the transfer programme. The student support programme aims to (1) attract the right students, (2) decrease the feeling of unpreparedness at the beginning of the academic year, and (3) support students after enrolment. This study presents an analysis of the estimated effectiveness and efficiency of each intervention of the recently developed support programme.

1.1 LITERATURE BACKGROUND

Section 1.1.1 explains why interventions for incoming university students are needed. Section 1.1.2 focuses on the different types of interventions, and the last section (Section 1.1.3) provides a definition and framework for the effectiveness and efficiency of interventions.

1.1.1 WHY STUDENTS NEED SUPPORT

Tinto's longitudinal model (1993) provides a framework for understanding students' behaviour during the transition to university. The interaction between the different variables, such as pre-entry characteristics, goal commitments, institutional experiences, and integration, eventually leads to the decision whether or not to leave an institution or study programme. Yorke and Longden (2004) distinguished four categories of reasons for students leaving their study programmes: (1) flawed decision-making about entering the programme, (2) students' experience of the programme and the institution generally, (3) failure to cope with the demands of the programme, and (4) events that impact on students' lives outside the institution (Yorke and Longden, 2004, p.104). To support students both before and after enrolment, higher education institutions organise interventions for students. These interventions can focus for instance on the improvement of students' skills and abilities (pre-entry attributes), students' institutional experiences, or academic and social integration (Tinto 1993). An improvement of one of these aspects can in turn affect students' academic achievement and retention (Hattie 2015, Schneider and Preckel 2017).

1.1.2 DIFFERENT TYPES OF INTERVENTIONS

Robbins et al. (2009) examined which types of interventions have an effect on students' academic achievement and retention. They distinguished three main types of interventions: (1) academic skill interventions focusing on study skills, learning strategies, note taking, and academic time management; (2) self-management interventions including programmes mainly aimed at improving skills for effective emotional and self-regulation such as stress management, anxiety reduction, and self-acceptance training; and (3) socialization interventions, which are short but intensive orientation programmes for new incoming students. They found that academic skills interventions have the strongest effect on academic achievement, whereas self-management interventions have the strongest effect on retention. Socialization interventions also have a significant effect on retention, but a smaller effect than self-management interventions.

In their systematic review, Schneider and Preckel (2017) examined the effect on academic achievement and found moderate and small effect sizes (ES) for academic skill interventions: academic skills training (ES= 0.48), academic motivation training (ES=0.33), and training in study skills (ES=0.28). A moderate effect was also found for self-management training programmes (ES=0.44). Another study (Hattie 2015) found as well moderate and small effect sizes for academic skills interventions: vocabulary programmes (ES=0.62), writing programmes (ES=0.49), and summer schools (ES=0.23) and a moderate effect for a socialisation intervention: social skills programmes (ES=0.40). Malm et al. (2015) examined the effect on academic achievement and retention of a supplemental instruction programme (i.e. academic skills intervention), which is linked to some difficult courses for new incoming engineering students. The study showed that supplemental instruction has a positive influence on academic achievement and retention.

The previous paragraph focused on interventions that can be assigned to one of the three categories of Robbins et al. (2009). However, in practice, many higher education institutions develop and implement interventions that combine the different categories. For example, the meta-analysis of Sneyers and De Witte (2018) examined the effect of mentoring on retention and graduation. Mentoring can include academic help, but also help with study skills or social needs. Mentoring is considered as an aid to improve students' integration and preparedness. They found that mentoring has a positive, significant but small effect on both retention (ES=0.15) and graduation (ES=0.10) in higher education. During the research of Bacon et al. (2018), various sessions were offered to first-year students such as an orientation week (i.e. socialization intervention), group advising, time management (i.e. academic skill intervention), and de-stressing (i.e. self-management intervention). Bacon et al. (2018) examined students' feedback on the organised support programme. An important conclusion is that students prioritize learning actionable skills such as interventions focusing on study skills for higher education, time management, learning styles, and academic strategies. Students prefer interventions that take place in small group settings and their satisfaction is raised when the content is relevant and timely. Researchers (Lazowski and Hulleman 2016, Wilson 2006, Yeager and Walton 2011) have found that interventions can be powerful and long-lasting when they focus on specific motivational processes at crucial time points during the students' educational process. These interventions are then called target interventions. Malm et al. (2015) also concluded that supplemental instruction improves students' self-confidence, gives student a broader study network, and improves their study and problem-solving skills.

Interventions can be divided into two groups: (1) obligatory and (2) voluntary interventions. Larson (2000) showed that it is important to control for some self-selection factors in case the intervention is on a voluntary basis, since not controlling for these factors can result in overestimation of the effectiveness of an intervention (Larson, 2000). Fredricks and Eccles (2006) controlled for possible covariates when analysing whether extracurricular participation was associated with higher study outcomes. They still found a significant relation between the intervention and target variable but the effect sizes were small and relations were weaker than in previous research. Thus, when participation in interventions is voluntary, self-selection effects have to be taken into consideration.

1.1.3 EFFECTIVENESS AND EFFICIENCY

Efficiency refers to 'doing things right', while effectiveness relates to 'doing the right things' (Drucker 1967). Thus, an intervention is efficient when the observed outcomes are produced at the lowest level of resources. Morrison et al. (2014) defines efficiency as a measure that includes the required time for achieving a level of effectiveness. Whereas, effectivity occurs when the desired objectives are achieved. One of the major conclusions of Morrison et al. (2014) is that educational researches lack efficiency measurements. However, for the examination of the impact of an intervention, both effectiveness and efficiency should be taken into consideration.

Van Yperen, Veerman, and Bijl (2017) developed a theoretical framework for the measurement of the effectiveness of interventions. Their effectiveness scale consists of five levels: (1) Conditional (i.e. descriptive indications), (2) Promising (i.e. theoretical indications), (3) Appropriate (i.e. first empirical indications), (4) Plausible (i.e. good empirical indications), and (5) Operating (i.e. strong empirical indications). Table 40 summarizes the five different levels of effectiveness, their corresponding level of evidence, and the methods that can be used. They state that the effectiveness scale is rather a development model than a hierarchical scale.

TABLE 40. EFFECTIVENESS SCALE

Effectiveness level	Evidence level	Methods
Level 5. Operating	Strong empirical indications	• (Repeated)(Quasi) Experimental designs • Randomized controlled trial
Level 4. Plausible	Good empirical indications	• Standardizations • Benchmarks • Quality research
Level 3. Appropriate	First empirical indications	• Pre and post-test design • Perceived usefulness (only post-test) • Drop-out research
Level 2. Promising	Theoretical indications	• Literature overview • Meta-analyses • Focus group discussions
Level 1. Conditional	Descriptive indications	• Descriptive research • Interviews

When determining the effectiveness of an intervention, performing an experimental design (level 5) does not guarantee that the intervention is effective. It only provides more evidence that if there are differences in the outcomes, these differences are devoted to the intervention. If a study, that used an experimental design, reveals that there are no differences between the experimental group and the control group then there are strong empirical indications that the intervention is not effective.

Van Yperen, Veerman, and Bijl (2017) emphasize the importance of evaluating the developed interventions to guarantee their effectiveness. This is concordant with Billing (1997), who stated that effectiveness of induction needs to be evaluated via surveys and tracking students' progress. Induction is one aspect of student support programmes and includes interventions that are offered when students enter university for the first time.

2 METHOD

Section 2.1 includes a description of the sample of transfer students that were given the opportunity to participate in the student support programme. Section 2.2 provides the development of the student programme as a whole and the objectives of each individual intervention. How effectiveness and efficiency are defined and measured in this study is included in Section 2.3.

2.1 SAMPLE

This research focuses on the transfer students that are enrolled for the first time and have a standard study programme (i.e. a study programme with minimum 50 ECTS). This study includes transfer students of the cohort 2017-2018 of one FET campus[37] (N=40).

2.2 DEVELOPMENT OF THE STUDENT SUPPORT PROGRAMME

The eight interventions of the student support programme, developed in this research, aimed to improve the support before and after enrolment. Since KU Leuven, is an open-entrance institution, properly informing and guiding students to make a well-considered educational choice is of paramount importance. Two interventions, *a Meet & Greet workshop* and *diagnostic test with feedback*, which are both organised before enrolment, target flawed decision-making about entering the programme (Yorke and Longden 2004). Focus group discussions with lecturers and transfer students revealed that basic mathematics and study skills are students' major stumbling blocks in the transfer programme (Van den Broeck et al. 2015). Two

[37] FET campus at Sint-Katelijne-Waver

interventions, *a mathematics MOOC* and *a time management training*, which focused on students' major stumbling blocks, aim to decrease failure to cope with the demands of the programme (Yorke and Longden 2004). In the same focus group discussions, the transfer students mentioned the importance of feedback (Van den Broeck et al. 2015). Hattie and Timperley (2007) stated in their research that feedback is a powerful tool that can influence students' learning and achievement. Three interventions, *an induction activity*, *intermediate exams*, and *individual feedback conversations* (i.e. mentoring) aim to influence students' experience of the programme and the institution in general (Yorke and Longden 2004).

The support programme starts in the last phase of the professional Bachelor's programme and ends at the end of the transfer programme. Before enrolment in the transfer programme, students can participate in three interventions: (1) Meet & Greet workshop, (2) mathematics MOOC (Massive open online course), and (3) a diagnostic test with feedback. After enrolment, students can participate in the remaining five interventions: (1) induction activity, (2) time management training, (3) intermediate exams, (4) individual feedback after intermediate exams, and (5) individual feedback after exams.

Almost all the interventions in the student support programme are voluntary and extra-curricular. Only the induction day and the intermediate exams are obligatory. The grade obtained in the intermediate exam is also taken into account for a part of the final score of the corresponding courses. The next section gives an overview of the specific objectives of each intervention.

2.2.1 Objectives and description of the interventions

The Meet & Greet workshop is organised at the beginning of the second half of the last phase of the professional bachelor programme. The goal is to (1) inform students about the content and success rate of the transfer programme, (2) provide students with a clear idea of what transferring is and thus set their expectations right, and (3) inform students about the interventions and stimulate participation in the interventions. The Meet & Greet workshop consisted of a plenary session in which prospective transfer students received more information about the transfer programme. After the plenary session there was a small reception were participants had the opportunity to ask questions to (ex)transfer students and lecturers of the transfer programme.

Thanks to the *mathematics MOOC*, students have the opportunity (1) to refresh their mathematic knowledge and also (2) to prepare for the diagnostic test and transfer programme. The MOOC covers topics that the math lecturers define as required prior knowledge for starting the transfer programme. Every module contains videos, step-by-step exercises, study material, and self-tests.

The aim of *the diagnostic test* is to provide students with feedback about their skills and capacities and thus to stimulate them to make a well-considered educational choice. The provided feedback also encourages students to participate, if necessary, in interventions before or during the transfer programme. The feedback was provided via a feedback platform, which included: (1) Feed up: if their goal is 'being successful' in the transfer programme, they need to be aware of the importance of mathematics, study behaviour, and engagement. The aim is to create a moment of reflection regarding their results, (2) Feedback: Interpretation of the obtained results and opportunity to position themselves among their peers, and (3) Feed forward: Opportunities to work on their math knowledge and tips or interventions to improve their study strategies. Students' received an individual email with their test result and the link to the feedback platform.

The induction activity is organised at the first day of the transfer programme and focuses on getting to know each other and thus facilitates social integration. During this induction activity students get practical information about studying in the transfer programme and an overview of the student support offered at FET, followed by a campus tour.

The time management training consists of three sessions of 1,5 hour during the first semester of the academic year. This training has the aim (1) to create awareness of the importance of good time management and (2) to help students to manage their time by providing tools to make a schedule. The topics covered in the sessions are: weekly scheduling, creating awareness that scheduling is important, long-term scheduling, dealing with procrastination, and exam scheduling.

The function of *the intermediate exams* is (1) to provide students with intermediate feedback, (2) give them an opportunity to become adapted to the academic approach, and also (3) give the students a wake-up call, if necessary.

The discussion of students' results and giving them advice where necessary, is possible during *individual feedback conversations,* which are organised after the intermediate exams and after the first exam period. The goal of these conversations is to provide students with feedback and stimulate self-reflection.

Applying the same categories as Robbins et al. (2009) to the interventions, results in two interventions that focus on socialisation namely the Meet & Greet workshop and the induction activity, whereas the other interventions are academic skills interventions: the mathematics MOOC, the diagnostic test and feedback, the time management training, intermediate exams, and individual feedback conversations.

2.3 Defining effectiveness and efficiency

The first two sections focus on how the effectiveness (Section 2.3.1) and efficiency (Section 2.3.2) of the interventions are defined and measured in this research. Section 2.3.3 presents how the effectiveness and efficiency of the interventions are combined into an effectiveness efficiency matrix.

2.3.1 Effectiveness

In this study, the effectivity of interventions is examined by analysing if the predetermined objectives are achieved and if the students perceive the intervention as useful. To determine which interventions transfer students perceive as (the most) useful, a ranking questionnaire at the start of the second semester of 2017-2018 was distributed. At that point, students had had the opportunity to participate in all the eight interventions of the student support programme. The ranking questionnaire measures the perceived usefulness (i.e. only post-test design) of the interventions. According to the theoretical framework, an only post-test design results in first empirical evidence for the effectiveness of the intervention (Level 3. Appropriate).

The following paragraph describes the methods that were used to measure the effectiveness of four individual interventions: (1) the Meet & Greet workshop, (2) the mathematics MOOC, (3) the diagnostic test with feedback, and (4) the time management training. These individual effectivity measurements were conducted in this or in a previous research (Chapter 7). The used methods are also linked to the theoretical framework for effectiveness (Van Yperen, Veerman, and Bijl 2017). For the remaining four interventions, namely the induction activity, the intermediate exams, and both the feedback conversations, the ranking questionnaire was the only method for determining the effectiveness.

For the effectivity measurement of the Meet & Greet workshop and the time management training a pre- and post-test design was used. The participants of these interventions were asked to fill in a survey before and after the intervention. By conducting Paired Sample t-tests the results of the pre- and post-test were compared. A pre- and post-test design is a level three method (appropriate). This means that the method provides some first empirical indications about the effectiveness of the intervention. The diagnostic test and the corresponding feedback are evaluated by measuring students' perceived usefulness. To measure the perceived usefulness, students were asked to rate five items on a five-point Likert scale (1='Totally disagree' – 5='Totally agree'). Since the perceived usefulness was measured, the measurement of the effectiveness is appropriate. To measure the effectiveness of the MOOC, differences in diagnostic test results between participants and non-participants are compared. It was also examined if there are differences in students' academic achievement between the participants and non-participants The math diagnostic test is considered to be a post-test. To measure the effectiveness as adequately as possible it was important to control for confounding variables. The used method for determining the impact of the MOOC is considered to be appropriate (level 3).

2.3.2 EFFICIENCY

For defining the efficiency, three different variables are explored: (1) development time, (2) implementation time, and (3) scalability. The development time should be taken into account just once, whereas implementation time is required for each new cohort of students. To quantify the development and implementation time, six categories are distinguished for calculating the estimated required time[38] for each intervention: (1) one day or less, (2) two to six days, (3) one to two weeks, (4) two to four weeks (5) one to two months, and (6) two to four months. The following paragraphs describe the development and implementation phase of each intervention.

For developing *the Meet & Greet workshop*, focus group discussions were organised to map students' misconceptions about the transfer programme. These misconceptions and information about the content and level of the transfer programme were combined into a written manual and presentation. This manual includes all the necessary information, both content and practical, for faculty to organise a Meet & Greet workshop. The implementation is restricted to (1) the training of faculty via the train the trainer principle and the developed manual, (2) finding students and colleagues who want to participate, and (3) doing practical things such as marketing and catering.

When developing *the MOOC*, the first step was to compose a voluntary team of motivated math lecturers. The content of the MOOC was discussed with this team and each lecturer developed a part of the study material. The material was based on an existing online course (i.e. Actimath) and their own course material. The study material was implemented in the Edx platform, with the help of an Edx expert. Training of the faculty is limited to learning how to implement material in the platform. After the development phase the required effort (implementation)

[38] Full time equivalent based time

includes (1) maintenance, for instance correcting errors or developing new course material, and (2) marketing.

The development of *the diagnostic test* required an iterative process for selecting or developing appropriate tests (Chapter 5, Appendix A). Implementing the test each year requires the selection of questions and tests, revision of the test via software (OMR), and sending out feedback to the participants.

For *the induction activity*, the development phase is limited to gathering information that is necessary for new incoming transfer students. The effort for implementing this intervention is restricted to the induction day itself.

The time management training was developed in cooperation with the study advice centre of KU Leuven. After deciding about the content of the training, a manual was developed. This manual contains all the necessary information, scheduling tools, and timing of the sessions. The effort for implementing this intervention each academic year is organising three sessions of 1,5 hour. Training of faculty members can be easily done via the combination of the manual and the train the trainer principle.

Since *intermediate exams* are directly linked to a course, there was no specific development phase in this research for this intervention. However, the lecturers need to develop the questions for the exams, therefore an estimation for developing these questions is included. When implementing the intermediate exams, the lecturer needs to set-up an exam and revise the exam.

The development phase of the *individual feedback conversations* is restricted to setting up a semi-structured approach for the feedback and organising, if necessary, a training for faculty on how to give feedback to students. Implementation of individual feedback consists of (1) sending out individual invitations to the students via e-mail and (2) giving students individual feedback which takes about 10-15 minutes. Individual feedback conversations after the exams are similar to the ones after the intermediate exams. During these conversations a learning analytics dashboard, developed during the ABLE project (Charleer et al. 2017), was used. This dashboard facilitates the conversation between the student and the student advisor. How to give feedback to students and the use of the dashboard is explained during a specific training for the student advisor.

2.3.3 EFFECTIVENESS EFFICIENCY MATRIX

Since both effectiveness and efficiency are taken into account in this research, they were combined in an effectiveness efficiency matrix. For this a 5-point Likert-type scale was used. The effectiveness scale is defined as: Not at all effective (- -), Not effective (-), More or less effective (- +), Effective (+), and Very effective (+ +). The efficiency scale is defined as: Not at all efficient (- -), Not efficient (-), More or less efficient (- +), Efficient (+), and Very efficient (+ +).

3 Results

First the effectiveness of the student support programme and corresponding interventions are discussed (Section 3.1). Then attention is given to the efficiency (Section 3.2). To conclude, these results are combined into an effectiveness efficiency matrix (Section 3.3).

3.1 Effectiveness

26 of the 40 students filled in the ranking questionnaire (response rate= 65%). The questionnaire was distributed during one of the lectures. Two possible explanations for this response rate are: (1) the lectures are not obligatory so it is possible that not all students were present and (2) during and after the first semester some students already dropped out from the transfer programme. Unfortunately it is not possible to quantify this dropout, since students often do not officially withdraw.

Table 41 gives an overview of the percentage of students that participated, did not participate, and the ones that were not aware of the existence of the intervention. Students were also asked to rank the interventions, in which they participated, regarding their effectiveness. The students' top three of most effective interventions was used to determine the ranking of the interventions, which is also presented in Table 41.

TABLE 41. STUDENTS' PARTICIPATION IN AND RANKING OF THE INTERVENTIONS (N=26)

Interventions	Participated? [1]			Ranked by participants in top 3 of most effective[2]
	Yes	No	Not aware of existence	
Intermediate exams	26 (100%)			22 (85%)
Feedback after intermediate exams	26 (100%)			20 (77%)
Feedback after exams	18 (69%)	8 (31%)		12 (67%)
M&G workshop	2 (8%)	6 (24%)	17 (68%)	1 (50%)
MOOC	19 (73%)	6 (23%)	1 (4%)	8 (44%)
Diagnostic test + feedback	15 (58%)	7 (27%)	4 (15%)	6 (40%)
Time management training	15 (58%)	11 (42%)		3 (21%)
Induction activity	22 (85%)	4 (15%)		4 (18%)

Note. [1] These columns give an overview of the number (%) of respondents that (not) participated or were not aware of the existence of the intervention. [2] This column shows how many of the students that participated in the interventions (%) put it in their top 3 of most effective.

Students also indicated why they found their three highest ranked interventions valuable. They could choose from among 11 reasons (see Table 42). Some students did not provide reasons for the three self-indicated interventions. For the Meet & Greet workshop the one student who put it in the top three, did not indicate a reason for the usefulness of the workshop. The following sections focus on the perceived usefulness of each individual intervention and the reasons why students found a specific intervention useful.

TABLE 42. REASONS THAT STUDENTS INDICATED FOR THE PERCEIVED USEFULNESS OF INTERVENTIONS

Reason for usefulness	Meet & Greet	MOOC	Diagnostic test + feedback	Induction activity	Time management training	Intermediate exams	Feedback intermediate exams	Feedback exams
social integration				**2**	1		3	1
info about transfer programme (success rates, level)		1	**3**	**2**	1	3	7	7
preparation for required level/prior knowledge in the transfer programme		**5**	1			9	4	2
stimulating participating in interventions						4	5	1
feedback			2		1	6	**15**	**10**
activate self-reflection		1	2		1	11	9	7
wakeup call					1	13	7	2
become adapted to academic approach		2	1			**16**		
importance of good learning strategies					2	6	4	3
learn to manage time					**3**	2	1	1
understand importance of scheduling					2	3	1	1

Note. The numbers in the cells represents the number of students that indicated that specific reason why they perceived an intervention, mentioned in their top three of most effective, as useful. The bold numbers indicate the most frequent chosen reasons for each intervention.

3.1.1 Meet & Greet workshop

Analysis of the pre- and post-test of the Meet & Greet workshop showed significant higher post-scores on the following self-reported subjects: having a clear idea of the content of the transfer programme, feel well informed, have a good idea of success rates in the transfer programme, know the difficulties of their predecessors, and know how to prepare for the transfer programme. Unfortunately not enough participants filled in the ranking questionnaire.

3.1.2 MOOC

Almost half of the students (44%) who indicated in the ranking questionnaire that they participated, put the MOOC in their top 3 of most useful interventions. The most common reason why it was useful was ‘Preparation for the required level/prior knowledge in the transfer programme’. This is in line with the objectives of the MOOC which is (1) to refresh their mathematic knowledge and (2) to prepare for the diagnostic test and transfer programme. As concluded in Chapter 7, students who participated in the MOOC outperformed the ones who did not participate in the MOOC on the diagnostic test, even after controlling for confounding variables (i.e. students’ concentration, time management, motivation, prior achievement, level of math in secondary education, and secondary education track). However, there was no significant difference in academic achievement between the participants and non-participants.

3.1.3 Diagnostic test and feedback

Almost half of the students (40%) who indicated in the ranking questionnaire that they participated to this intervention, put it in their top 3 of most useful interventions. The most common reason why it was useful was ‘Info about transfer programme’, which is one of the objectives of the diagnostic test. The other objectives, ‘Preparation for the required level’ and ‘Stimulating participation in interventions’ were indicated by respectively one participant and no participants. Students also indicated other reasons, besides the predetermined objectives, why they perceived the intervention as useful (Table 42). The questionnaire that measures the perceived usefulness (Appendix B), was administered at the start of the academic year 2016-2017. Of the professional Bachelor’s students who participated in the diagnostic test before enrolment (N=97) a total of 67 students are enrolled in the transfer programme at FET. The participants reported that the content and variety of the diagnostic test was good (N=48, response rate=72%). Only half of the participants were satisfied with their diagnostic test results and received results that are in line with their expectations. More than a third of the students are satisfied with the received feedback. However, approximately half of the students neither agree nor disagree on this item.

3.1.4 Induction activity

Only 18% of the students who indicated in the ranking questionnaire that they participated to this intervention, put induction activity in their top 3 of most useful interventions. The most common reasons why it was useful were 'social integration' and 'info about transfer programme'. This is in line with the objectives of the induction activity.

3.1.5 Time management training

Only 21% of the students who indicated in the ranking questionnaire that they participated, put the time management training in their top 3 of most useful interventions. The most common reasons why it was useful were 'learn to manage time, the importance of good learning strategies, and understand the importance of scheduling'. These reasons are also the objectives of the time management training. Chapter 7 showed that the pre- and post-test was border insignificant at the 5% level ($p=.053$). There was no significant difference between the academic achievement of the participants and non-participants.

3.1.6 Intermediate exams

85% of the students who indicated in the ranking questionnaire that they participated in the intervention, put intermediate exams in their top 3 of most useful interventions. The most common reasons why it was useful were 'It was good to become adapted to the academic approach', 'activate self-reflection', and 'wakeup call'. The main objectives of the intermediate exams are (1) become adopted to the academic approach and (2) wake-up call, which are the most indicated reasons by the students. Students found the intermediate exams useful for many other reasons as well (Table 42).

3.1.7 Individual feedback after intermediate exams

77% of the students who indicated in the ranking questionnaire that they participated in the intervention, put individual feedback after intermediate exams in their top 3 of most useful interventions. The most common reasons why it was useful were 'feedback' and 'activate self-reflection'. These reasons are the objectives of the individual feedback conversation. Similar to the intermediate exams, students indicated many other reasons for the perceived usefulness of the intervention (Table 42).

3.1.8 Individual feedback after exams

67% of the students who indicated in the ranking questionnaire that they participated in the intervention, put individual feedback after exams in their top 3 of most useful interventions. The most common reasons why it was useful were 'feedback, activate self-reflection, and info about the transfer programme'. The main objectives of the intervention namely (1) feedback and (2) activate self-reflection where thus included. All the reasons, except one, where at least chosen by one student (Table 42).

3.2 EFFICIENCY

Table 43 presents the estimated development and implementation time of each intervention. These estimations are the result of quantifying the descriptions of the development and implementation phase (Section 2.3.2). Table 43 also shows the maximum number of students that is manageable given the implementation time. The combination of implementation time and the number of students enables making statements about the scalability.

TABLE 43. EFFICIENCY DETERMINATION

Interventions	Development	Implementation	Max. N of students
Meet & Greet workshop	2-6 days	1 day or <	30
MOOC	2-4 months	2-6 days	No limit
Diagnostic test and feedback	1-2 months	2-6 days	No limit
Induction activity	2-6 days	1 day or <	60
Time management training	1-2 weeks	1 day or <	30
Intermediate exams	2-6 days	2-6 days	60
Feedback after (intermediate) exams	1 day or <	2-6 days	30

For all the interventions, the development time is higher than or equal to the implementation time, except for the feedback after (intermediate) exams where the implementation time is higher than the development time. Three interventions have a very low implementation time (1 day or <), namely the Meet & Greet workshop, the induction activity, and the time management training.

For the intermediate exams the development time is higher when lecturers need to develop new questions for the exams, whereas if a lecturer re-uses questions or has an existing pool of questions the development time is much lower. The implementation time of the intermediate exams depends on the format. For instance, open ended questions require more grading work than multiple choice questions. Only two interventions, the MOOC and diagnostic test with feedback, have both a high development and high implementation time. However, when looking at scalability, for the MOOC and diagnostic test the number of participants is not a constraint. This is because MOOCs are online, thus the course can be used by an infinite number of participants when and where they want. The diagnostic test is easy scalable, once the test is constructed, since revising the diagnostic is automatic via software and sending out the individual feedback is done via mail merge. The other interventions, with lower development and implementation time are restricted in maximum number of students. This makes the scalability challenging. The development time remains the same, but if the number of students increases, the implementation time increases as well. For example when faculty wants to organise individual feedback conversations with 300 students, the implementation time multiplies by ten. If this intervention is implemented in an institution with a large number of students more faculty staff needs to be engaged, otherwise it is not manageable to organise individual conversations.

3.3 DETERMINING THE EFFECTIVENESS EFFICIENCY MATRIX

In this section, the effectiveness and efficiency of the eight interventions of the student support programme are combined. Effectivity in this research is based on (1) perceived usefulness in the ranking questionnaire, (2) achievement of the objectives, and (3) on individual impact measurements. For efficiency both the necessary time and scalability are taken into account. It is important to point out that the matrix (Table 44) is not static, for example when an intervention improves and becomes more effective. This idea is in line with the theoretical framework for effectiveness of Van Yperen, Veerman, and Bijl (2017) who state that the effectiveness scale is rather a development model than a hierarchical scale in which continuous improvement and evaluation are crucial.

Looking at Table 44 immediately reveals that the most effective interventions for students are individual feedback and intermediate exams, which are not the most efficient interventions when implementing them on a large scale. The induction activity and the MOOC are indicated as the most efficient interventions. However, the effectiveness of the induction activity is rather poor. The MOOC and the diagnostic test are effective and efficient, thanks to the easy scalability, which makes them interesting interventions. The Meet & Greet workshop and time management training seem to be more or less effective and efficient.

TABLE 44. EFFECTIVENESS - EFFICIENCY MATRIX

Efficiency / Effectiveness	- -	-	- +	+	+ +
- -					
-					Induction Activity
- +			Time management training	Meet & Greet workshop	
+				Diagnostic test	MOOC
+ +		Feedback conversations	Intermediate exams		

4 Discussion

This study was a first step to examine the effectiveness and efficiency of a recently developed student support programme. Each intervention of the support programme was first studied individually and then situated on an effectiveness efficiency matrix. The analysis revealed that the most effective interventions are not always the most efficient ones on a large scale and vice versa.

Intermediate exams were ranked as the most effective intervention by the students. The intermediate exams evaluated in this study, were organised and revised on paper. If the number of students is too high or the test too elaborate, correcting these intermediate exams is very time consuming. One way to make it more efficient is the use of multiple choice questions in combination with automatic revision software or online. Day et al. (2018) examined the perceptions of both teachers and students regarding intermediate assessments. Teachers and students agreed that intermediate assessments are an aid for students to study more frequently. However, they also found negative aspects of intermediate assessment. For the teachers the negative aspect was the workload and students mentioned insufficient feedback as a negative aspect. In this research, students received individual feedback after the intermediate exams. These individual feedback conversations were also ranked high by the students. Unfortunately they are time intensive on a large scale and thus less efficient. However, providing students with individual feedback is important (Hattie and Timperley 2007). Billing (1997) stated that higher education teaching staff should also be trained to function as a student advisor. If enough faculty is trained, the workload of organising individual feedback conversation can be shared, which makes it more manageable to implement this intervention on a larger scale. Thus improving the scalability of interventions can be realised by making some adaptations to the intervention or by involving more faculty. Looking at the perceived usefulness of the diagnostic test and the feedback, the students were, in general, satisfied with the content and variety of the diagnostic test. Only a third of the students was satisfied with the received feedback. Unfortunately, it is not known if students accepted the feedback or even read through all the feedback. A study of Broos et al. (2017) examined, among other things, the click-through rate of first-year STEM students on the feedback dashboard for learning and study skills. They found that, on average, students that click through have higher learning and study skills, however, the students that engage more with the feedback are indeed the students with lower scores on the study skill.

The ranking questionnaire shows which interventions the students found the most useful, however, this does not immediately state that they found the lower ranked interventions (i.e. induction day and time management training) not useful. This should be examined more in-depth, since it is not possible to make hard statements about the lower ranked interventions. For the induction day it is important to include an individual effectivity measurement such as for instance a pre- and post-test that focuses on induction and social integration. For the time management training the perceived usefulness should be measured.

When comparing academic achievement between participants and non-participants for evaluating the effectiveness of interventions, self-selection should be taken into account since participation in most of the interventions is voluntary. This makes it more difficult to measure the effectiveness of an intervention. In this study, a part of self-selection is covered, via controlling for confounding variables. If self-selection has to be eliminated completely than there has to be an experimental and a control group. However, this raises some ethical questions. Since students who want to participate in an intervention are perhaps not included in the experimental group or students who do not want to participate in the intervention are included. If the aim of an intervention is to improve students' academic skills, they also have to be willing to participate and improve their academic skills. For instance, Dale (1993) stated that time management is a skill that can be developed at any age, but only if the person wants to improve this skill.

Billing (1997) states that induction should not take place in one day or week since this results in information overload for the students. Students are in need of just-in-time-information. For instance, they want to learn about study methods once they have to start with academic work. The timing of the interventions is thus important (Lazowski and Hulleman 2016, Wilson 2006, Yeager and Walton 2011). Some interventions are only useful when given before enrolment such as the Meet & Greet workshop and the diagnostic test, since the aim of these two interventions is to stimulate students to make a well-considered study choice. Helping students to choose an appropriate study programme should increase retention and study success according to the European Commission (2015). Others are useful before and after enrolment such as the MOOC since it can be seen as a preparation course but also as a remedial course during the transfer programme when students experience math problems. The interventions organised after enrolment are important for supporting the students on appropriate moments in the transfer programme. The time management training starts approximately three to four weeks before the intermediate exams, which corresponds to the moment that students should realise they need to start studying. After notification of the students' results on the (intermediate) exams, individual feedback conversations are organised as soon as possible.

The interventions that focus on improving academic skills are ranked by the students as the most effective. The conclusions of Robbins et al. (2009) are similar, since they found that of the three categories of interventions, the academic skills interventions are the most effective ones. When only taking the extra-curricular intervention category into account the study of Schneider and Preckel (2017) found that the most effective extra-curricular interventions where also the ones focusing on training of academic skills. The individual feedback conversations in this study can be compared to mentoring as examined by Sneyers and De Witte (2018). They found a positive effect of mentoring, which is similar to the findings in this study, since students ranked the interventions as highly effective. Comparing the results of this study to literature is, as stated by the theoretical framework of Van Yperen, Veerman, and Bijl (2017) also a method for examining the effectiveness of interventions. The reasons for usefulness of the interventions are in line with the predetermined objectives. For the majority of the interventions, students indicated additional reasons than the main objectives of the interventions. It is no problem that students indicate other reasons why they perceive the intervention as useful.

Hattie (2009) concluded that effect sizes above 0.4 should gain particular attention in the design of learning environments. However, if the effect sizes are smaller than 0.4 these interventions can still improve instruction considerably, for example when the implementation costs little time and money (Schneider and Preckel 2017). Robbins et al. (2009) stated that higher education institutions must evaluate the cost effectiveness of interventions and should give priority to interventions that have the most potential to increase positive outcomes. In the meta-analysis of Robbins et al. (2009) positive outcomes are related to an improved academic achievement or higher retention rates. In Chapter 8, section 3.1.4, it is examined if the student support programme has an effect on the dropout rate of the transfer programme. However, in this study, an intervention is considered to be effective if the predetermined objectives are achieved and if students' perceive the intervention as useful. The theoretical framework of Van Yperen, Veerman, and Bijl (2017) stated that measuring the perceived usefulness results in first empirical indications for the effectiveness of an intervention. Interventions that are perceived as effective by the students and are efficient regarding their development & implementation time, and scalability, should gain particular attention.

APPENDIX

A. MEET & GREET WORKSHOP

Please indicate for each statements: (1) Totally disagree – (5) Totally agree

TABLE 45. PRE- AND POST-TEST MEET&GREET WORKSHOP (N=14)

			Mean	SD	T
1.	I have a clear idea of the content of the transfer programme	Pre	3.00	.784	-4.770
		Post	4.00	.555	(p<.001)
2.	I know what to expect in the transfer programme	Pre	2.79	.699	-4.505
		Post	3.93	.475	(p=.001)
3.	I feel well informed about the transfer programme	Pre	2.36	.745	-5.264
		Post	3.64	.745	(p<.001)
4.	I worry about my possible study success chances in the transfer programme (reversed item)	Pre	3.14	.770	-0.366
		Post	3.21	.699	(p=.720)
5.	I know what the global success rates are in the transfer programme	Pre	2.93	.917	-6.497
		Post	4.14	.535	(p<.001)
6.	I am aware of the extra job opportunities that come with a master degree	Pre	3.21	1.122	-0.822
		Post	3.43	.646	(p=.426)
7.	I am aware of the difficulties that my predecessors had during the transfer programme	Pre	2.57	.938	-4.500
		Post	3.86	.363	(p=.001)
8.	I know what to do to prepare myself for the transfer programme.	Pre	2.79	.802	-3.242
		Post	3.71	.469	(p=.006)
9.	I have a good idea of the amount mathematics/theoretical subjects in the transfer programme	Pre	3.29	.825	-1.710
		Post	3.71	.825	(p=.111)

B. PERCEIVED USEFULNESS DIAGNOSTIC TEST AND FEEDBACK

TABLE 46. STUDENTS' PERCEPTIONS 2016-2017 (N=48)

Pilot 2016-2017	Totally disagree	Disagree	Neutral	Agree	Totally agree
1. The content of the diagnostic test was good.	2%	4%	33%	56%	4%
2. There was enough variety in the diagnostic test.	2%	6%	29%	56%	6%
3. I am satisfied with my results.	2%	21%	31%	42%	4%
4. My results are in line with my expectations		12%	38%	42%	8%
5. I am satisfied with the received feedback.	6%	12%	46%	23%	12%

CHAPTER 7 – THE EFFECTIVENESS OF A MOOC IN BASIC MATHEMATICS AND TIME MANAGEMENT TRAINING FOR TRANSFER STUDENTS IN ENGINEERING

Van den Broeck, L., De Laet, T., Lacante, M., Van Soom, C. & Langie, G. (2019). The effectiveness of a MOOC in basic mathematics and time management training for transfer students in Engineering Technology, *European Journal of Engineering Education* (under review since 01/02/2019).

When students enter higher education, they can encounter the feeling of unpreparedness. In fact, students who lack the proper prior education are less prepared. Therefore developing and implementing appropriate interventions for incoming students is important. This study examined the effectiveness of two new interventions at the Faculty of Engineering Technology, KU Leuven: (1) a basic mathematics MOOC and (2) a time management training. Transfer students were given the opportunity to participate voluntarily. Some preliminary empirical evidence about the effectiveness of the interventions was found, based on analysis of pre- and post-test scores, a satisfaction survey, and a math diagnostic test. This study found statistical evidence for the effectiveness of the math MOOC. For the time management training the evidence was border insignificant. Students who participated in the time management training, perceived the training as useful.

1 INTRODUCTION

During transition from secondary to higher education, a large proportion of new incoming students experience difficulties that can result in dropout (Marra et al. 2012, Lowe and Coo 2003, Holmegaard et al. 2015, Torenbeek et al. 2011). Tinto's longitudinal model (1993) provides a framework for understanding student behaviour during this transition. The interaction between different variables, such as pre-entry characteristics, goal commitments, institutional experiences, and integration, eventually results in the decision to leave an institution or study programme. Even if students decide to stay, they can still encounter similar problems (Seymour and Hewitt, 1997). Sometimes students lack the right skills and abilities to cope with the new learning environment, others did not follow the proper prior education. In addition, student's expectations not always match with reality (Lowe and Cook 2003), for example the workload is higher or the courses are much more theoretical than expected (Ahmed et al. 2014). All these variables can cause a feeling of unpreparedness and thus a more difficult transition. This problem is not only present in first-year programmes. Hills (1965) was the first to use the term transfer shock, which describes the decrease in GPA experienced by students in the United States who transferred from two-year community colleges to four-year institutions. The feeling of unpreparedness and the so called transfer shock ask for appropriate interventions for all new incoming students.

This research focuses on transfer students at the multi-campus Faculty of Engineering Technology (FET) at KU Leuven (Belgium). In Flanders, a student can choose without restrictions or admission requirements between two types of Bachelor's degrees: a professional (PBA) and an academic (ABA) one. The purpose of a PBA programme, organised at University College, is to prepare students for a professional occupation. An ABA programme, organised at University, is intended to provide students with all the necessary knowledge and skills to start a Master's programme (MA). In order to stimulate a flexible lifelong learning system, students with a PBA degree can enrol into a MA provided that they successfully complete a transfer programme (TR). The transfer programme focuses on acquiring missing academic competences and is organized by the university organising the MA programmes. Just like first-year (FY) students, transfer students also enter university for the first time. In the academic year 2017-2018 a total of 1821 students entered FET for the first time. More than 30% of these new students were transfer students (N_{FY}=1245, N_{TR}=576). Transfer students at FET share many similarities with first-year engineering students and as a result, also face the same challenges during transition to university (Chapter 2). Furthermore, transfer students feel significantly less well-prepared for university compared to traditional first-year students (Chapter 2).

Therefore transfer students need, even more than first-year students, interventions to decrease the transfer shock and increase the feeling of preparedness.

1.1 INTERVENTIONS

Seymour and Hewitt (1997) concluded that students who decided to stay in their programme, can still encounter similar problems as the students who decided to leave the programme. Therefore, it is equally important to properly guide students in their educational choice before enrolment and provide them with the required support once they are enrolled. To support students both before and after enrolment, higher education institutions organise interventions for students. These interventions can focus for instance on the improvement of students' skills and abilities (pre-entry attributes), students' institutional experiences, or academic and social integration (Tinto 1993). An improvement of one of these aspects can in turn affect students' academic achievement and retention (Hattie 2015, Schneider and Preckel 2017). Student characteristics such as performance self-efficacy (ES=1.81), grade goal (ES=1.12), effort regulation (ES=0.75), strategic approach to learning (ES=0.65), and achievement motivation (ES=0.64), have an impact on achievement (Schneider and Preckel 2017). Therefore, it seems worthwhile to develop student-centred interventions that can improve these characteristics. However, when developing interventions, it is important to keep in mind that it is not easy to change a persons' behaviour by organising just one intervention (Michie et al. 2014).

Robbins et al. (2009) examined which types of interventions have an effect on students' academic achievement and retention. They distinguished three main type of interventions: (1) academic skill interventions focusing on study skills, learning strategies, note taking, and academic time management; (2) self-management interventions including programmes mainly aimed at improving skills for effective emotional and self-regulation such as stress management, anxiety reduction, and self-acceptance training; and (3) socialization interventions, which are short but intensive orientation programmes for new incoming students. They found that academic skills interventions have the strongest effect on academic achievement, whereas self-management interventions have the strongest effect on retention. Socialization interventions also have a significant effect on retention, but a smaller effect than self-management interventions. In their systematic review, Schneider and Preckel (2017) examined the effect on academic achievement and found moderate and small effect sizes for academic skill interventions: academic skills training (ES= 0.48), academic motivation training (ES=0.33), and training in study skills (ES=0.28). A moderate effect was also found for self-management training programmes (ES=0.44). Another study (Hattie 2015) also found moderate and small effect sizes for academic skills interventions: vocabulary programmes (ES=0.62), writing programmes (ES=0.49), and summer schools (ES=0.23) and a moderate effect for a socialisation intervention: social skills programmes (ES=0.40). Malm et al. (2015) examined the effect on academic achievement and retention of a supplemental instruction programme (i.e. academic skills intervention), which is linked to some difficult courses for new incoming engineering students. The study showed that supplemental instruction has a positive influence on academic achievement and retention.

Interventions can be divided into two groups: (1) obligatory and (2) voluntary interventions. Larson (2000) showed that it is important to control for some self-selection factors in case the intervention is on voluntary basis, since not controlling for these factors can result in overestimation of the effectiveness of an intervention (Larson, 2000). Fredricks and Eccles (2006) controlled for possible covariates when analysing whether extracurricular participation was associated with higher study outcomes. They still found a significant relation between the intervention and target variable but the effect sizes were small and relations were weaker than in previous research. 'Response to intervention' (ES=1.07) was a highly ranked variable in Hattie's (2015) review, meaning that students who actually participate in interventions achieve higher grades. To conclude, when participation in interventions is voluntary, self-selection effects have to be taken into consideration when measuring the effectiveness of the intervention. When developing and implementing interventions it is important to select the most appropriate method to analyse the effects. The next paragraph describes the theoretical framework used in this study to measure effectiveness.

1.2 Theoretical framework for effectiveness: The effectiveness scale

Van Yperen, Veerman, and Bijl (2017) developed a theoretical framework for the measurement of the effectiveness of interventions. Their effectiveness scale consists of five levels: (1) Conditional (i.e. descriptive indications), (2) Promising (i.e. theoretical indications), (3) Appropriate (i.e. first empirical indications), (4) Plausible (i.e. good empirical indications), and (5) Operating (i.e. strong empirical indications). Table 47 summarizes the five different levels of effectiveness, their corresponding level of evidence, and the methods that can be used. They state that the effectiveness scale is rather a development model than a hierarchical scale. The authors distinguish two strategies to examine the effectiveness of interventions: a top down approach, which includes evidence-based research or a bottom up approach, which includes practice-based research. Regardless which approach is used, evaluating the interventions is necessary to guarantee effectiveness. Continuous improvement of the implemented interventions also has a crucial role in the development model. It is important to point out that not only the design or the used method determines the level of evidence, but also execution of the intervention is crucial. If a randomized controlled trial is poorly executed, the result does not have any credibility.

When determining the effectiveness of an intervention, performing an experimental design (level 5) does not guarantee that the intervention is effective. It only provides more evidence that if there are differences in the outcomes, these differences are devoted to the intervention. If a study, that used an experimental design, reveals that there are no differences between the experimental group and the control group then there are strong empirical indications that the intervention is not effective.

TABLE 47. FRAMEWORK FOR EFFECTIVENESS

Effectiveness level	Evidence level	Methods
Level 5.Operating	Strong empirical indications	• (Repeated)(Quasi) Experimental designs • Randomized controlled trial
Level 4.Plausible	Good empirical indications	• Standardizations • Benchmarks • Quality research
Level 3.Appropriate	First empirical indications	• Pre and post-test design • Perceived usefulness (only post-test) • Drop-out research
Level 2.Promising	Theoretical indications	• Literature overview • Meta-analyses • Focus group discussions
Level 1.Conditional	Descriptive indications	• Descriptive research • Interviews

2 PRESENT STUDY

2.1 THE NEED FOR INTERVENTIONS

During focus group discussions with lecturers and transfer students basic mathematics and study skills were perceived as major stumbling blocks (Van den Broeck et al. 2015). The students' stumbling blocks are related to academic achievement, therefore it is even more important to focus on them. In Hattie's (2015) review, study skills had an ES of 0.60. Since mathematics has a key role in every engineering programme, it is not surprisingly a significant predictor for academic achievement (Veenstra et al. 2008, French et al. 2005, Leuwerke et al. 2004). Pinxten et al. (2017) found that math level (i.e. hours of mathematics/week during secondary education) and math/science GPA in secondary school are strongly related to the GPA of first-year STEM students. Moses et al. (2011) and Hall et al. (2015) concluded that math readiness is predictive for retention. In a study of Ackerman et al. (2013) SAT math and math/science self-concept were significant for predicting STEM students' grades. They also found that time management, which is included in the trait complex mastery and organisation, is significantly related to academic achievement. Schneider and Preckel (2017) included the variable time and study management, defined as the capacity to self-regulate study time and activities with an average ES of 0.41.

We developed two academic skill interventions, based on students' stumbling blocks: a Massive Open Online Course (MOOC) to acquire basic mathematics skills before enrolment and a time management training during the academic year. The MOOC allows students to refresh their mathematical knowledge in preparation of the diagnostic test. This is necessary since results of the mathematics diagnostic test for transfer students are very low. Transfer students are in need of an opportunity to improve or refresh their mathematical knowledge. Most students (>60%) followed a track in secondary education with a low (< 4 hours of mathematics/week) or medium (4 or 5 hours of mathematics/week) level of math. Moreover the PBA programme contains no or little math courses. The main goal of the time management training was to make students aware of the importance of time management and help them to improve their time management skills. We considered this as important since the lowest mean score on the LASSI test was on the time management scale. The next two paragraphs provide more information on the interventions.

2.1.1 Basic math MOOC

In a world with continuously improving technology, online learning environments receive more and more attention. One of these fairly new online learning environments is a MOOC (Massive Open Online Course). The number of MOOCs is rapidly increasing. Over the past five years they gained popularity and at the end of 2017 there were more than 9000 MOOCs with a total of 78 million learners.

The basic math MOOC was developed within KU Leuven by three math lecturers of the FET, one IT-expert, and two educational scientists. The course consists of four modules: (1) Elementary arithmetics A, (2) Elementary arithmetics B, (3) Trigonometry, Geometry, Equations, Inequalities, & Linear systems, and (4) Derivatives & Integrals. The MOOC covers topics that the math lecturers define as required prior knowledge for starting the transfer programme. Every module contains videos, step-by-step exercises, study material, and self-tests. The estimated effort for completion of the MOOC is between 8 and 12 hours. MOOC participation was non-compulsory and non-binding.

2.1.2 TIME MANAGEMENT TRAINING

Interactive time management training (TMT) was developed together with practitioners of the Study Advice Centre of KU Leuven. Three trainings were organised during the first semester (i.e. 13 weeks) of the transfer programme. Participation was voluntary, but if students decided to participate they were advised to follow the three trainings, since it was offered as a package deal. Each training lasted 1,5 hour and had specific topics (Table 48).

TABLE 48. TIMING AND TOPICS TIME MANAGEMENT TRAINING

TMT training	Timing in the academic year (AY)	Topics
Training 1	Week 4	• Weekly scheduling • Create awareness that scheduling is important
Training 2	Week 6	• Long-term scheduling • Dealing with procrastination
Training 3	Week 11	• Exam scheduling

2.2 RESEARCH QUESTIONS

The goal of this study is to answer for each intervention the following research question (RQ):

RQ. Is there a measurable effect of the intervention

(a) on the target variables (i.e. time management skills, mathematics test)?

(b) on students' academic achievement?

We divided the study into two parts: Time management training (Section 3) and Basic math MOOC (Section 4).

3 STUDY A: TIME MANAGEMENT TRAINING

3.1 SAMPLE

This study includes transfer students of the cohort 2017-2018 of one FET campus. The focus is on the transfer students that are enrolled for the first time and have a standard study programme (i.e. a study programme with minimum 50 ECTS). Of these students (N=40), 11 participated voluntarily in the time management training (participation rate=27.5%).

3.2 DATA

We distinguish three categories of data: profile variables, target variables, and academic achievement.

3.2.1 PROFILE VARIABLES

Since participation in the time management training was voluntary, it was important to compare the profile of the participants to the profile of the non-participants. In order to do this, following variables were collected:

- Track secondary education: a general track (ASO) aims at a broad theoretical education and prepares pupils for higher education. A technical track (TSO) mainly focuses on general and technical-theoretical subjects combined with practical lessons and prepares pupils for a future professional career or for higher (technical) education.
- Level of mathematics during secondary education: Low (<4 hours/week), Medium (4-5 hours/week), and High (≥6 hours/week).
- GPA PBA: weighted average GPA at the end of the professional bachelor's programme.
- Learning And Study Strategies Inventory (LASSI; Weinstein 1987–2002–2016): The scales Motivation (N items=8); Time management (N items=8); and Concentration (N items=8). Students were asked to rate each item on a five-point Likert scale (1='Not at all like me' to 5='Very much like me').

3.2.2 TARGET VARIABLE

Differences on self-reported time management skills via a pre- and post-test: Students were given the same seven items before and after time management training. Participants were asked to rate each item on a five-point Likert scale (1='Totally disagree' to 5='Totally agree')(See Appendix A). There was a difference in internal consistency of the pre-(Cronbach alpha=.60) and post-test (Cronbach alpha=.79). The post-test included one additional item gauging students' self-perceived usefulness 'I found it useful or valuable to participate in this training'.

3.2.3 ACADEMIC ACHIEVEMENT

Academic achievement was collected through university records. GPA TR is a weighted average of students' exam results in the transfer programme. This study includes GPA TR after the first semester (GPA TR January)[39].

3.3 STATISTICAL ANALYSIS

Profile variables of participants and non-participants to the intervention were compared (Chi Square tests and Independent Sample t-tests). Effectiveness of the intervention was measured through a pre- and post-test design and by conducting Paired Sample t-tests. Finally, an Independent Sample t-test was performed to determine if there was a difference in GPA TR between the participants and non-participants. Cohens' d was used to calculate ES. Cohen (1988) distinguished three categories: small effect, d = [0.20;0.49]; moderate effect, d = [0.50;0.79]; and large effect, d = [0.80;+∞[.

3.4 PARTICIPANTS' PROFILE

There were no significant differences in the secondary education track ($\chi(1)=1.477$, $p=.224$) or the level of math ($\chi(2)=4.091$, $p=.129$) between participants and non-participants at the time management training (Table 49).

TABLE 49. CROSSTABLE PARTICIPATION TMT TRAINING*SECONDARY EDUCATION VARIABLES

Participation TMT training	Secondary education track			Level of math in secondary education			
	TSO	ASO	Total	Low	Medium	High	Total
No	17	12	29	4	14	10	28
Yes	8	2	10	4	2	3	9
Missing data			1				3
Total	25	14	**40**	8	16	13	**40**

[39] GPA TR June and GPA TR End was not available at the time of analysis

Also, there were no significant differences in prior achievement, motivation, concentration, and time management skills between participants and non-participants (Table 50).

TABLE 50. PROFILE VARIABLES VS. PARTICIPATION TMT TRAINING

Profile variables	Participation TMT training	N	Mean	SD	T-value
GPA PBA	No	28	66.9%	6.01%	2.007(p=.053)
	Yes	7	72.3%	7.75%	
Motivation	No	28	28.0	3.68	1.532(p=.134)
	Yes	9	30.1	3.55	
Time management	No	27	25.6	4.49	1.417(p=.165)
	Yes	9	23.3	3.12	
Concentration	No	28	28.7	4.46	0.917(p=.365)
	Yes	9	27.1	4.88	

To conclude no significant differences are found between the profile of the participants and the non-participants.

3.5 EFFECT MEASUREMENT

Table 51 presents mean pre-and post-test scores of individual items of the time management test. In general, there is an increase in post-test scores. However, only for one of the seven items ('I know the characteristics of a good schedule.'), this difference was significant (p=.041). The corresponding ES is large (ES=1.58).

TABLE 51. SCORES ON INDIVIDUAL ITEMS OF TIME MANAGEMENT PRE-AND POST-TEST (COMPLETE PAIRS N=6)

Pre- and post-test TMT		Mean	SD	T-value
I know how to make a week schedule.	Pre	3.17	.408	.542(p=.611)
	Post	3.33	.816	
I know one or more tools for scheduling.	Pre	2.33	1.37	.655(p=.542)
	Post	2.83	1.33	
I am confident that I am able to plan the exam period.	Pre	2.83	.753	1.536(p=.185)
	Post	3.67	.816	
I know the characteristics of a good schedule.	Pre	2.00	.632	2.739*(p=.041)
	Post	3.00	.632	

Pre- and post-test TMT		Mean	SD	T-value
I know how to make a long term schedule.	Pre	2.00	.000	1.464(p=.203)
	Post	2.50	.837	
I know how I can effectively deal with procrastination.	Pre	2.83	1.47	1.274(p=.259)
	Post	3.67	.816	
I am confident that I can cope with study related stress in an appropriate manner.	Pre	3.17	.753	-.791(p=.465)
	Post	2.83	.408	

*Significant at the .05-level.

Looking at the mean sum score of the pre-and post-test, a paired Sample t-test did not show a significant difference (Table 52). On the extra post-test item 'I found it useful or valuable to participate in this training', all students answered positively (agree or totally agree).

TABLE 52. SUM SCORE ON THE TIME MANAGEMENT PRE- AND POST-TEST (COMPLETE PAIRS N=6)

Pre- and post-test		Mean	SD	T-value
Sum score	Pre	18.3	1.37	2.528(p=.053)
	Post	21.8	3.12	

Table 53 shows differences in mean GPA TR January of students who participated in the time management training and the ones who did not. Although participants had a higher mean GPA TR, there was a high standard deviation and an Independent Sample t-test showed that the difference was not significant.

TABLE 53. PARTICIPATION TMT TRAINING AND CORRESPONDING MEAN GPA'S

GPA TR	Participation TMT training	N	Mean GPA	SD	T-value
GPA TR January	No	28	38.6%	21.6%	0.828
	Yes	11	45.0%	21.6%	(p=.413)

4 STUDY B: BASIC MATH MOOC

4.1 SAMPLE

This study includes aspirant transfer students who participated voluntarily in the diagnostic test before enrolling in the transfer programme (N=92). The diagnostic test was organised on three FET campuses. Of these students, 57% indicated on the diagnostic test that they followed the MOOC before participating in the diagnostic test (N=52). In total, 73% of all the participants (N=92) effectively enrolled in the transfer programme in 2016-2017 (N=67).

4.2 DATA

We distinguish three categories of data: profile variables, target variables, and academic achievement.

4.2.1 PROFILE VARIABLES

Since participation in the MOOC was voluntary, it was important to compare the profile of the participants to the profile of the non-participants. In order to do this, the following variables were collected:

- Track secondary education: general track (ASO) or technical track (TSO) (3.2.1)
- Level of math in secondary education: Low, medium, or high (3.2.1)
- GPA PBA (3.2.1)
- Learning And Study Strategies Inventory (LASSI): The scales Motivation, Time management, and Concentration (3.2.1).
- Four subtests of the Dutch Cognitive Ability Test (CoVaT-CHC; Magez, Tierens, Bos, Van Huynegem, & Decaluwé, 2013): Logical reasoning (problems similar to Einstein problem), Proverbs (find the most suitable explanations for sayings), Folding boxes (visualise how an unfolded box (2D) can be folded to a 3D box) and Point series (discover mathematical rule and complete point series).

4.2.2 TARGET VARIABLES

- Math MOOC satisfaction survey: Students were asked to answer four perception questions about the math MOOC. The questions were rather general since the goal was to gather some first thoughts about students' perceived usefulness of the MOOC (Appendix B).
- Result on math diagnostic test: Mathematics test (MATH) consisted of 19 multiple-choice questions focusing on basic mathematical skills.

4.2.3 ACADEMIC ACHIEVEMENT

This study includes GPA TR after the first semester (GPA TR January), second semester (GPA TR June), and at the end of the academic year (GPA TR End)(3.2.3).

4.3 STATISTICAL ANALYSIS

The profile variables of MOOC participants and non-participants were compared (Chi Square tests and Independent Sample t-tests). Effectiveness of the intervention was measured via a satisfaction survey and by comparing the differences in diagnostic test results of students who followed the MOOC and the ones who did not. Controlling for possible covariates (students' concentration, time management, motivation, prior academic achievement, level of math in secondary education, and secondary education track) by executing an ANCOVA, resulted in a more in-depth analysis of the effectiveness of the intervention. Finally, an Independent Sample t-test was performed to determine if there was a difference in the GPA TR between participants and non-participants. Cohens' d was used to calculate ES.

4.4 PARTICIPANTS' PROFILE

There were no significant differences in secondary education track ($\chi(1)=2.601$, $p=.107$) or level of math in secondary education ($\chi(2)=0.171$, $p=.918$) (Table 54).

TABLE 54. CROSSTABLE PARTICIPATION MOOC*SECONDARY EDUCATION VARIABLES

Participation MOOC	Secondary education track			Level of math in secondary education			
	TSO	ASO	Total	Low	Medium	High	Total
No	29	9	38	5	17	18	40
Yes	30	20	50	8	22	22	52
Missing data			4				
Total	59	29	**92**	13	39	40	**92**

Table 55 shows that performing an Independent Sample t-test did not result in a significant difference in prior achievement between students who followed the MOOC and the ones who did not. A similar conclusion can be drawn regarding the differences in mean results on the four CoVat subtests. Independent Sample t-tests did not show any significant differences between the MOOC participants and non-participants. Students who participated in the MOOC have higher scores on the three included LASSI scales. The MOOC participants score significantly higher on Time management ($p=.014$) and Concentration ($p=.003$).

TABLE 55. PROFILE VARIABLES VS. PARTICIPATION MOOC

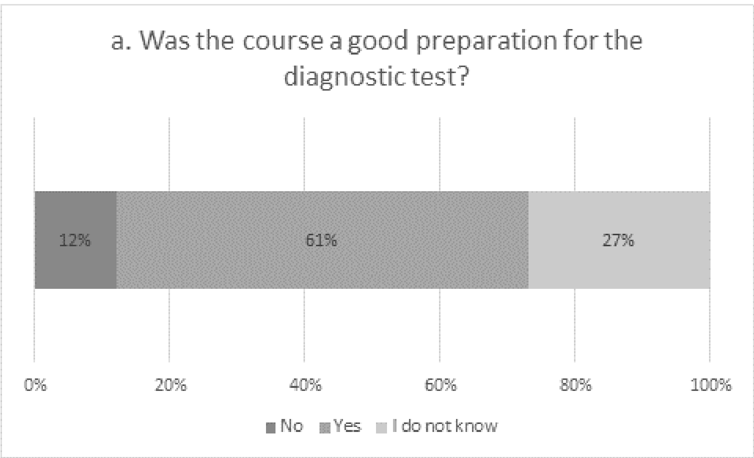
Profile variables	Participation MOOC	N	Mean	SD	T-value
GPA PBA	No	37	68.4%	6.73%	0.947(p=.346)
	Yes	50	69.8%	6.73%	
Point Series	No	34	62.3%	8.57%	0.053(p=.958)
	Yes	51	62.4%	8.81%	
Logical Reasoning	No	34	44.6%	14.1%	1.313(p=.193)
	Yes	51	40.7%	13.2%	
Proverbs	No	35	60.9%	11.4%	0.301(p=.764)
	Yes	52	60.1%	12.5%	
Folding Boxes	No	35	86.1%	11.6%	1.440(p=.153)
	Yes	52	82.0%	13.6%	
Motivation	No	36	26.3	4.18	1.864(p=.066)
	Yes	46	28.1	4.51	
Time management	No	36	21.4	4.28	2.509*(p=.014)
	Yes	46	24.1	5.26	
Concentration	No	37	24.3	5.00	3.119**(p=.003)
	Yes	46	27.5	4.48	

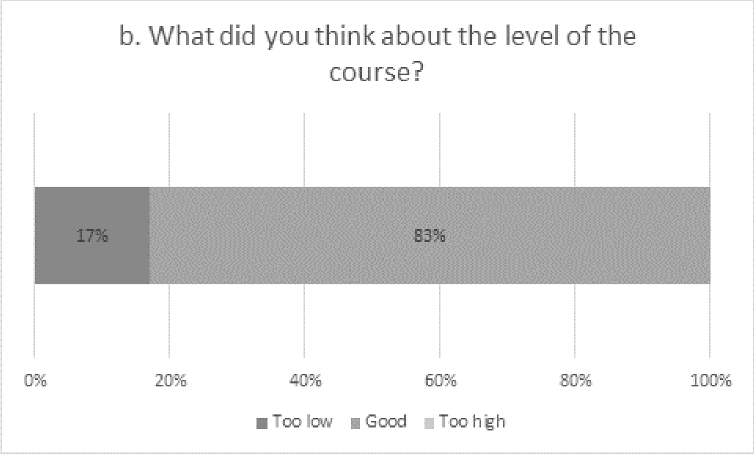
*Significant at the .05-level. **Significant at the .01-level.

To conclude, comparing the profile of MOOC participants and non-participants revealed significant differences in two learning and study strategies, namely time management and concentration, but no significant differences in the other eight profile variables.

4.5 Effect measurement

After students followed the MOOC and participated in the diagnostic test, they were asked to fill in a perception survey about the MOOC (N=52) (Figure 14). 61% of the respondents considered the MOOC as a good preparation for the diagnostic test. 83% reported that the difficulty level of the MOOC was good. 24% perceived the content too condensed and would have preferred a more elaborate course. Regarding the confidence in their own math knowledge, 36% agreed that they had more confidence after following the MOOC, whereas 43% of the students answered neutral to this question.





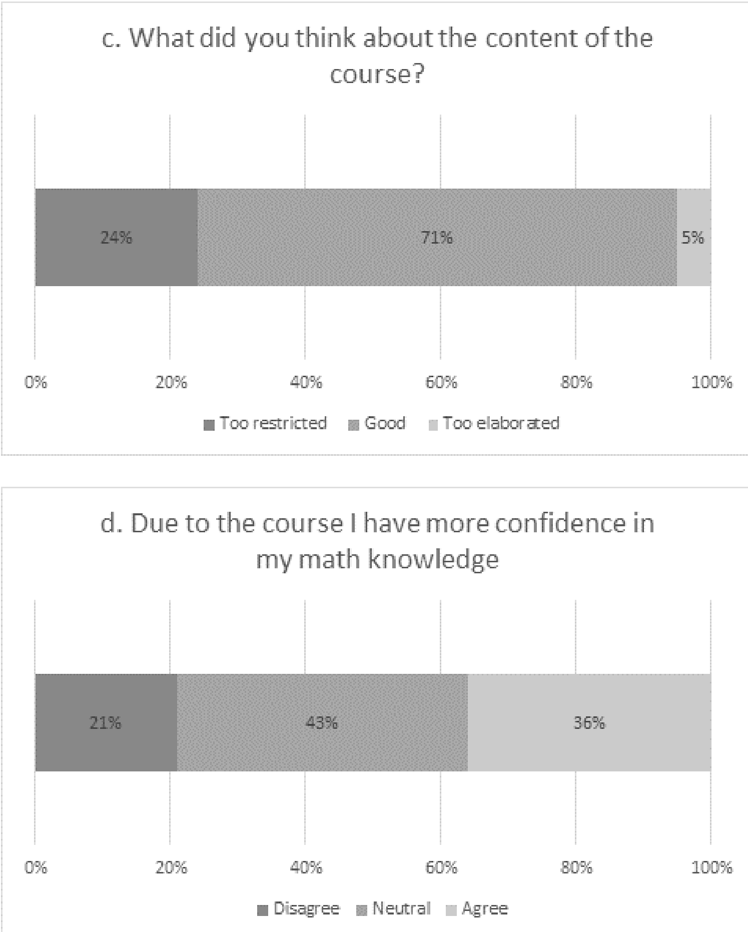


FIGURE 14. MOOC PERCEPTION SURVEY

Table 56 shows mean results on the math diagnostic test of students who followed the MOOC and the ones who did not. An Independent Sample t-test revealed that MOOC participants obtain significantly higher diagnostic test results (p=.002). A moderate ES was found (ES=0.67).

TABLE 56. MOOC PARTICIPATION AND CORRESPONDING MEAN SCORES ON MATH DIAGNOSTIC TEST

Math diagnostic test		N	Mean	SD	T-value
Participation	No	40	38.37%	22.95%	3.186**(p=.002)
MOOC	Yes	52	52.96%	20.81%	

**Significant at the .01-level

After controlling for possible confounding variables (i.e. students' concentration, time management, motivation, prior achievement, level of math in secondary education, and secondary education track), the effect of MOOC participation on the math diagnostic test results remained significant (F=8.548, p=.005). Level of math in secondary education and GPA PBA are also significant for the diagnostic test result (Table 57).

TABLE 57. ANCOVA

	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1.737[a]	8	.217	6.158	.000
Intercept	5.162E-5	1	5.162E-5	.001	.970
MOOC participation	.301	1	.301	8.548	.005**
Secondary education	.077	1	.077	2.191	.144
Level of math secondary education	.451	2	.226	6.400	.003**
GPA PBA	.198	1	.198	5.623	.021*
CON	.000	1	.000	.009	.924
TMT	.007	1	.007	.186	.668
MOT	.009	1	.009	.251	.618
Error	2.363	67	.035		
Total	20.688	76			
Corrected Total	4.100	75			

Dependent variable: Math diagnostic test. R Squared=.424 (Adjusted R Squared=.355).
*Significant at the .05-level.**Significant at the .01-level.

Table 58 reveals differences in diagnostic test results between the different levels of math in secondary education. Within each level the MOOC participants achieve higher results than the non-participants, but only for the medium level this difference was significant (t=3.301, p=.002).

TABLE 58. LEVEL OF MATH IN SECONDARY EDUCATION*MOOC PARTICIPATION AND CORRESPONDING MEAN SCORES ON MATH DIAGNOSTIC TEST

Math diagnostic test		Participation MOOC	N	Mean	SD	T-value
Level of math in secondary education	Low	No	5	18%	13%	1.5031(p=.161)
		Yes	8	37%	26%	
	Medium	No	17	29%	17%	3.301**(p=.002)
		Yes	22	49%	20%	
	High	No	18	53%	22%	1.534(p=.133)
		Yes	22	62%	15%	

*Significant at the .05-level.**Significant at the .01-level

The estimated mean scores (adjusted for the covariates) on the math diagnostic test (Table 59) are for both the MOOC participants and non-participants slightly lower in comparison to the original means (Table 56).

TABLE 59. ESTIMATED MEANS MATH DIAGNOSTIC TEST

MOOC participation	N	Mean	SD	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
No	32	37.3%[a]	23.2%	29.3%	45.4%
Yes	44	51.1%[a]	21.9%	44.5%	57.7%

Dependent variable: Math diagnostic test. Covariates are evaluated at following values: GPA PBA= 69.60, CON= 26.42, TMT= 23.29, MOT= 27.33.

Independent Sample t-tests showed no significant differences in mean GPA TR's of the students who participated in the MOOC and the ones who did not (Table 60).

TABLE 60. MOOC PARTICIPATION AND CORRESPONDING MEAN GPA'S

GPA TR	Participation MOOC	N	Mean	SD	T-value
GPA TR January	No	24	46.31%	22.80%	0.044(p=.965)
	Yes	37	46.08%	16.70%	
GPA TR June	No	24	45.19%	22.74%	0.482(p=.632)
	Yes	36	47.70%	17.52%	
GPA TR End	No	24	49.86%	22.90%	0.401(p=.690)
	Yes	37	51.97%	18.17%	

5 DISCUSSION

In this study we aimed to measure the effectiveness of two interventions: a basic math MOOC and a time management training. Since interventions are voluntary it is important to compare the profile of participants and non-participants. For both interventions, educational background and prior achievement of the participants and non-participants was similar. However, when study skills were compared, MOOC participants had significant higher scores on Time management and Concentration compared to non-participants. It is reasonable to suspect that higher Time management and Concentration skills are important for starting, persevering and/or completing the MOOC. Xiong et al. (2015) confirmed that engagement is a strong predictor of MOOC retention. De Barba et al. (2016) suggested that also motivation levels are related to MOOC performance. However, this is not confirmed by our study, since self-reported motivation of MOOC participants was not different from non-participants. The fact that MOOC participants have higher scores on time management and concentration must be taken into account when the effectiveness of the MOOC is studied.

There was no significant evidence of a positive effect of the time management training, except for the item 'I know the characteristics of a good schedule'. It is also interesting that for one item, 'I am confident that I can cope with study related stress in an appropriate manner', a decrease between the pre- and post-test emerged. Students completed the post-test two weeks before the start of the exam period, so it is reasonable that they experience more study related stress and are more unsure if they can cope with this stress. During the training we focused on making a good exam schedule, but a good schedule does not take away all the study related stress. In addition, it was also the students' first exam period. A previous study stated that after the first semester, the transfer students are more adapted to university (Chapter 2). Therefore, it is possible that students are more confident that they can cope with study related stress in the second semester. The difference between the sum scores of the pre- and post-test was almost border significant at the 5% level ($p=.053$). This gives reason to believe that the time management intervention has potential to be effective. In addition, all participants found the training useful or valuable. Although there are some indications for the effectiveness of the time management training, it is also important to reflect about possible explanations for finding this non-significant results. The main problem is the small sample size. This can be explained by the timing of the time management training. Since the training is organised in the first semester of the academic year, it is possible that students realise only after the first exam period that they need this intervention. During the exam period good time management becomes even more important, and when students' results are not as high as they desired, this might lead to a need to improve their time management skills. It would be interesting to study the effect of a time management intervention in the second semester. Regarding the measurement of the effectiveness two other possible problems can be pinpointed: (1) In this study there were some differences in internal consistency of the pre- and post-test, although the items were the same. Misinterpretation of items during the pre-test could clarify the non-significant results. (2) Since the time management test is based on self-reported time management skill, it is possible that students overestimated their own abilities in the pre-test, resulting in inflated pre-test scores. When they participated in the intervention, it is possible that knowledge of good time management resulted in a more realistic judgement of their own time management skills.

One possibility to deal with the small sample size would be to organise the intervention in an experimental design and assign students arbitrary to the treatment or control group. However, we believe that this would raise ethical questions, since students who want to improve their time management skills, need to be able to enrol in the training. Forcing students to participate, is also not considered as a good idea, since Dale (1993) stated that time management is a skill that can be developed at any age, but only if the person wants to improve this skill. In addition, studies (Indreicaa et al. 2011, Burrus et al. 2017) that used a (quasi) experimental design for time management interventions, did not always found significant evidence for the effectiveness of the intervention. Indreicaa et al. (2011) designed and implemented an obligatory time management intervention, when they observed that a majority (73%) of the first-year students started studying less than one week before the exam period. Since good time management is important for each student in higher education, they hypothesized that efficient time management would lead to higher grades. The study included 130 students, who had low learning performances after the first two exam periods but above average cognitive abilities. The students were randomly assigned to treatment or control group. A counsellor developed an individual but flexible schedule for all the activities of the students. In the pre-test there were no significant differences between the treatment and control group regarding management of their time. The students of the treatment group reported significant higher study times in the post-test. The treatment group also achieved higher grades, which confirmed the hypothesis. Burrus et al. 2017 investigated the effectiveness of a time management intervention for high school students based on a quasi-experimental design. Half of the students participated in a 5-week intervention, which included an assessment of time management, feedback and action plans, and homework assignments. The control group received an unrelated intervention. Students were not randomly assigned, since the control group was a focal-local group. This means that students are divided into groups from the same school and same year with similar characteristics on the target variables.

Afterwards, time management behaviours for the treatment group were rated higher by academic advisors who were blind for the condition, but not significantly higher. However, this difference was significant when analysis was limited to students with initial low time management skills.

Hattie (2009) concluded that ES above 0.4 should gain particular attention when designing learning environments. However, if ES are smaller than 0.4 these interventions can still improve instruction considerably, for example when implementation costs little time and money (Schneider and Preckel 2017). The time management training require little time and money, since there are only three group training sessions of 1,5 hour for groups of 30 students, so we believe it is worthwhile to further explore how we can improve its efficiency.

Transfer students appreciated the course content and level of the math MOOC. Hone and El Said (2016) found evidence for the importance of good course content since their post-MOOC survey showed that perceived MOOC Course Content was a significant predictor for retention. A quarter of the participants however found the course too concise and they requested more modules. As a consequence, math lecturers already developed two additional modules. Organizing interventions online, such as the MOOC, has the advantage that students can participate when and where-ever they want. According to Hattie (2015) using online and digital tools is positively related to academic achievement with an ES of 0.32. Chingos et al. (2017) studied the effectiveness of an online math summer course. The included students were randomly assigned to either treatment (N=352) or control group (N=345). Students were invited to participate, received free access to the math course, and were encouraged via emails from program facilitators to engage in the course. However, the treatment was voluntary and the students of the treatment group were not obligated to follow the online course. In total, 36% of the invited students logged in at least once. Students who did not register had several reasons: they were already satisfied with their pre-test results, or they did not want to work on their math knowledge in summer, or they did not believe that an online tool could help them improve their skills. At the end of the summer, both treatment and control group were invited to retake the placement test and if their score was high enough, they could enrol into a higher level of math. A total of 23% of the treatment group retook the test compared to 10% of the control group. The treatment group scored significantly higher after controlling for some variables. The authors also mention that it is reasonable that retaking the same test affects the results. They did not found evidence that students of the treatment group achieve higher grades in the subsequent math course. In another study (Forrest et al. 2017), at-risk students (N=125) were encouraged to use a math tutorial during the first two weeks of the semester to increase their chances of passing the course. A total of 49% of the at-risk students completed the tutorial and results showed that the math tutorial increased their odds of passing the course.

In this study, the effectiveness of the math MOOC is measured quantitatively based on results of the math diagnostic test. When the results on this test of MOOC participants are compared with results of non-participants without controlling for other variables, a significant positive, moderate effect of MOOC participation was found. After controlling for confounding variables, MOOC participation remained significant. The perceived usefulness and moderate ES, even after controlling for other variables, give us reason to believe that participation to the math MOOC has a real impact on students' preparedness for the diagnostic test. Chapter 5 also revealed that the diagnostic test results were significantly related to students' academic achievement when students had the opportunity to refresh their math knowledge.

It becomes clear that prior education remains important, since participation to the MOOC is not sufficient to bring students who followed a study programme with a low level of math to the same mathematics knowledge and skills level as students that followed a programme with a high level of math. When comparing the participants and non-participants within the same levels of mathematics background, the MOOC participants obtain higher results on the diagnostic test, but only for MOOC participants with a medium level of math these results were significantly higher. Schneider and Preckel (2017) also concluded that online learning is about as effective as learning in the classroom (with a difference of ES=0.05). The advantage of online learning is that aspirant transfer students can enrol and learn when they want and on their own-pace. The math MOOC was a time consuming intervention in the development phase, but once it is implemented it does not require much work and it can be used for many years.

For both interventions, there was no significant relationship with academic achievement of the transfer students during and at the end of the academic year. However, this does not mean that we do not have to organise these interventions, on the contrary we need to further develop the interventions and collect larger samples. In the future it is important to stimulate at-risk students (for example students who followed a study programme with low and medium level of math) to participate in interventions. For the time management training it is also important to point out that there is a difference between knowing what good time management is and actually doing it. Unfortunately, this is much more difficult to measure. A first starting point can be to add more items to the pre- and post-test and also ask if students do make a schedule instead of just asking if they know how to make a good schedule.

This study used a bottom-up approach (Van Yperen, Veerman, and Bijl 2017), resulting in practice-based measurements for the effectiveness. For the time management training a pre- and post-test design was used, this method provides some first empirical indications for the effectiveness of the intervention (Level 3. Appropriate). For the math MOOC a satisfaction survey, which measures the perceived usefulness, was used. The math diagnostic test is considered to be a post-test. Since there was no pre-test, we controlled for other variables to measure the effectiveness as adequately as possible. An only post-test design is also a method that can be used to find some first empirical indications of the effectiveness of the intervention (Appropriate). Although there are five levels of effectiveness in the framework of Van Yperen, Veerman, and Bijl (2017) we do not believe that reaching level 5 has to be the holy grail. As mentioned above there are some ethical problems when only a part of the students get the opportunity to participate in an intervention. Therefore, it is more interesting to optimize the intervention on level 3 or level 4 (e.g. standardization). For the time management training this means focusing more on a pre- and post-test design of high quality. It could be worthwhile to optimize and validate the existing pre- and post-test. Also organising the training for example during the second semester could be interesting. For the math MOOC, adding a pre-test will result in a more accurate measurement of the effectiveness. However, to avoid retest effects as mentioned by Chingos et al. (2017), it could be a good idea to use similar questions instead of identical questions.

6 Conclusion

To conclude, in both interventions, we found some preliminary empirical evidence about the effectiveness of the interventions based on analysis of pre- and post-test scores, a satisfaction survey, and a math diagnostic test. For now, there is statistical evidence that proves the effectiveness of the cognitive intervention, namely the basic math MOOC. For the time management training the evidence was border insignificant. Nevertheless, we keep organizing the time management training, since students who participated found the training useful. This study did not reveal significantly higher academic achievement for students who participated in the interventions. It will be important to stimulate a larger group of students to participate and enrol this initiative on all the FET campuses. The goal is to optimize both the training itself as the measurement of the effectiveness.

APPENDIX

A. PRE- AND POST-TEST TIME MANAGEMENT TRAINING

Q1. I know how to make a week schedule.

Q2. I know one or more tools for scheduling.

Q3. I am confident that I am able to plan the exam period.

Q4. I know the characteristics of a good schedule.

Q5. I know how to make a long term schedule.

Q6. I know how I can effectively deal with procrastination.

Q7. I am confident that I can cope with study related stress in an appropriate manner.

B. MOOC PERCEPTION SURVEY

Q1. Was the course a good preparation for the diagnostic test?

- Yes
- No
- I do not know

Q2. What did you think about the content of the course?

- Too restricted
- Good
- Too elaborated

Q3. What did you think about the level of the course?

- Too low
- Good
- Too high

Q4. Thanks to the course I have more confidence in my math knowledge.

- Disagree
- Neutral
- Agree

CHAPTER 8 – DISCUSSION

In this final chapter an answer is given to each of the four research questions:

1. To which extent can a diagnostic test aid us in predicting students' academic achievement?
2. Can we create a diagnostic test which has a higher predictive value compared to an analysis of (academic) background variables of the students?
3. Can we measure the effectiveness of the interventions that are developed in this research?
4. Is it possible to reduce drop out or assure that reorientation can happen at an earlier stage?

In Section 1, exploration, the profile of the transfer student is critically analysed. The prediction of students' academic achievement is the topic of Section 2. The first two research questions focus on prediction and will consequently be discussed in this section. In Section 3, the developed interventions are discussed and the two last research questions are answered. At the end of each section, some suggestions for future work are provided. Finally, attention is paid to the limitations of this research (Section 4), the link of this dissertation with the actual educational context (Section 5), and a general conclusion is formulated (Section 6).

1 EXPLORATION

1.1 REFLECTIONS

Transfer students are an unstudied group as well in Flanders as in the rest of the world. As a consequence little information can be found in literature. This dissertation started by consequence with an explorative study (Part A) in order to gain more insight in the target group. To determine the potential need for support before and after enrolment it was useful to (1) gain insight in students' experiences, (2) examine how students perceive the transition to university, and (3) define students' stumbling blocks.

The reflections about this exploration are classified in five sections: the importance of contextual differences (Section 1.1.1), students' experiences (Section 1.1.2), the transition to university (Section 1.1.3), students' stumbling blocks (Section 1.1.4), and the effect of the perceived fit on students' outcome variables (Section 1.1.5).

1.1.1 THE IMPORTANCE OF CONTEXTUAL DIFFERENCES

In the following paragraphs, five countries that provide alternative pathways to university are discussed. It is important to point out that this is certainly not a complete overview of all the countries that provide alternative pathways. The purpose of this overview is also not to provide the reader with a detailed image of all the educational systems, but to create awareness for the differences between the educational contexts. For each of the countries, three different aspects are discussed: (1) the different types of Bachelor's programmes, (2) admission requirements, and (3) how alternative pathways are shaped.

In the Netherlands[40], students can choose between two types of Bachelors' programmes: HBO (university of applied sciences) and WO (academic university education). HBO Bachelor's programmes take four years (240 ECTS) and have a professional orientation, whereas WO Bachelor's programmes have an academic orientation and take three years (180 ECTS). Admission to a study programme is based on students' secondary education degree. If they do not possess the required degree, they have to address deficiencies to meet, for example the pre-university level of mathematics. Students with a HBO degree do not gain immediately access to a Master's degree. However, some study programmes provide a transfer programme in which the students can address possible deficiencies. When students have addressed their deficiencies they can enrol in a Master's programme.

In Finland[41,42], students can choose between two types of Bachelors' programmes: Bachelor's at university (180-210 ECTS) and Bachelor's at university of applied sciences (UAS)(180-270 ECTS). Admission to university is based on students' upper secondary education certificate and entrance examinations. Students at UAS often have to complete a three-year work experience before they can apply to a UAS Master's degree. These students with a Bachelor's degree from UAS may also apply to a Master's degree at University, but often they are required to take additional courses.

In Denmark[43,44], students can choose between a professional Bachelor's programme and a Bachelor's programme. both programmes take three to four years (180-240 ECTS) and have a similar level. However, the professional Bachelor's programme has a stronger focus on professional practice. Admission is based on the Danish upper

---

[40] https://www.tudelft.nl/onderwijs/voorlichting-en-ervaren/wat-is-het-verschil-tussen-hbo-en-wo/
[41] http://www.fulbright.fi/en/guide/higher-education
[42] https://norric.org/nordbalt/finland
[43] https://norric.org/nordbalt/denmark
[44] http://studyindenmark.dk/study-options/admission-requirements

leaving certificate. Depending on the choice of study programme, students have to pass certain subjects on a certain level or achieved a certain grade. Both programmes give access to Master's programmes.

In the US, students can enrol in a two-year programme (community college) or a four-year programme (college/university). Admission to a four-year college or university can be very rigorous. Entry requirements for a two-year community college however are less strict and most of the community colleges have an open-door policy (i.e. restricted admission requirements). The scarce literature about transfer students focuses on students that transfer from a two-year programme to a four-year programme (Lanaan 2001, Jackson and Lanaan 2015, Lopez and Jones 2016, Meyers et al. 2015). During the two-year programme at the community college students take courses and then validate almost all the obtained credits when transferring to a four-year programme (Lopez and Jones 2016).

This is very different from the transfer at FET, since transfer of credits from the professional bachelor to the transfer programme is non-existing at the moment. Introducing regulations for the transfer of credits, obtained in a professional Bachelor's programme to the transfer programme, is not considered appropriate due to the different goals of the programmes. The courses in the professional bachelor are more practical, whereas the courses in the transfer programme have the intention to prepare students for the academic approach of the Master's programme (Chapter 1). A possible solution is that last year professional bachelor students, considering to transfer, are stimulated to take on top of their professional Bachelor's programme (extracurricular) a course from the transfer programme. This might be a solution, because this enables students to become aware of the level and goal of a transfer programme, before they enrol. During the conducted focus group discussions and interviews, this unawareness of for example the level of the transfer programme was confirmed, since students stated that the transfer programme was more difficult than expected.

In this dissertation, the transfer students at FET were compared to Irish transfer students at DIT (Dublin Institute of Technology). In Ireland, students can enrol in a level 8 (four years) or level 7 (three years) programme. Students gain access to higher education based on the Irish leaving certificate. There are two distinct routes to achieving an Honours degree (Level 8) in engineering in DIT. Students who have achieved a H4 (60%) or higher in Higher Level Mathematics in the Irish Leaving Certificate in secondary school are eligible to enter directly into a four-year Honours degree in engineering. Students who do not have this level of mathematics but have a pass in Ordinary Level Mathematics may enter onto a three-year Ordinary degree (Level 7) in engineering. Based on their results at the end of level 7, students at DIT can transfer to level 8. The transfer students at DIT enrol in the third year of level 8, whereas at FET transfer students follow a specific transfer programme. Although the educational context in both countries is fundamentally different, it was possible to compare these two groups of students (Chapter 3).

To conclude, students can be called transfer students, but how the transfer and the study programmes in general are shaped, can be very different. Contextual differences have an impact on the intake of students (i.e. profile) and can thus affect the perceived fit to university and the academic outcome variables (i.e. dropout rates, academic achievement), which makes it more challenging to conduct comparative international studies.

1.1.2 Students' experiences

Due to the major contextual differences and differences in the transfer programmes as a whole, it was decided to commence by gaining insight in the experiences of the transfer students at FET. In order to achieve this, a mixed method approach was used. Qualitative focus group discussions and dropout interviews were conducted as well as a quantitative perception research via questionnaires. Thanks to this methodology it was possible to pinpoint students' stumbling blocks and moreover, to really capture their transition experiences and perceived fit between the professional Bachelor's programme and the transfer programme. Although qualitative research is rather time intensive, it is necessary for gaining insight in the experiences of the transfer students. This first exploration revealed that the transfer students at FET experience transition problems. Since for most transfer students the transfer programme is their first experience at university, there was reason to believe that they experience similar transition problems as traditional first-year students. This resulted in a comparative study between the traditional first-year students and transfer students at FET (Chapter 2). After secondary education, students in Flanders can enrol in almost all higher education study programmes (i.e. no admission requirements). Thus, in this comparison there were no contextual differences. Nevertheless, there were some differences between the profile of the transfer and first-year students (i.e. difference regarding followed track of secondary education and perceived fit).

1.1.3 Transition to university

The transition to university always requires adaptation of the student (Holmegaard et al. 2015, Briggs et al. 2012). Each student deals with or experience this transition differently. Tinto's model (1993) provides a framework for understanding student behaviour during the transition to university. The interaction between the different variables, such as pre-entry characteristics, goal commitments, institutional experiences, and integration, eventually leads to the decision whether or not to leave an institution or study programme. To capture students' experiences about the transfer to university, a perceived fit questionnaire was used (Van Torenbeek et al. 2011). The perceived fit was measured in a comparative study with first-year students at FET (Chapter 2) and in the comparison with DIT students (Chapter 3).

The DIT students perceived the highest fit. The transfer students at FET perceived the lowest fit, which was significantly lower than the fit of the DIT students and the first-year FET students. The admission requirements are probably the major explanation for the significantly higher score on the perceived fit for the DIT students. Two additional reasons for the higher perceived fit of the DIT students are: (1) during the three years of level 7, students have a mathematics course every semester, whereas the transfer students have had no or almost no mathematics during the professional bachelor and (2) there is much overlap between the faculty of level 7 and level 8. In general, the DIT students feel significantly better prepared, do not have the feeling that they lack content knowledge, and found the teaching approach in level 8 similar to the approach in level 7.

First-year students feel significantly better prepared for university, but experience similar adaptation problems as transfer students. Regarding students' preparedness it is not odd that transfer students perceive a lower fit because of three reasons. First of all, the professional Bachelor's programme does not aim at preparing students for university but for the labour market. Secondary education on the contrary and especially general secondary education prepares students for higher education. Although the transfer students already studied in higher education, this does not imply that they are better prepared for university. In contrary, during the professional bachelor the focus is on practical aspects (Onderwijs Vlaanderen, Chapter 1), whereas in the transfer programme and other study programmes at FET the emphasis is more on the combination of theory and practice. Another important explanation for this difference in perceived fit is the difference in prior secondary education. About three quarters of the transfer students at FET followed a technical track (TSO) during secondary education, which is a good preparation for a professional Bachelor's programme or even the labour market, though not always for an academic study programme (Chapter 1). Three quarters of the first-year students followed a general track (ASO) during secondary education. This is considered to be a more appropriate prior education for university. Chapter 4 and 5 stated that ASO students obtain significantly higher grades in the transfer programme than TSO students. This difference in prior education is not considered as a problem, but students need to be aware of these differences and if necessary follow extra interventions. Another explanation for the difference in the perceived fit is the different pace in the two programmes. Focus group discussions revealed that the pace of the courses specific for transfer students, is much higher than the pace of the courses for both first-year and transfer students.

In this dissertation evidence was found that the transfer students at FET need the same or even more support than traditional first-year students since they feel significantly less prepared for university. To smoothen the transition and increase the preparedness it is therefore beneficial to implement interventions for all new incoming students and not only for the traditional first-year students (Chapter 6 and 7).

1.1.4 Students' stumbling blocks

Before defining which support the transfer students at FET need, it was necessary to determine their stumbling blocks. Thanks to focus group discussions with transfer students and lecturers of the transfer programme it was possible to define students' major stumbling blocks, namely study strategies and mathematical knowledge. According to the lecturers, study strategies were the most important stumbling block. If students do not have effective study strategies, it will be more difficult to improve, for instance their mathematical knowledge.

The first-year students and transfer students at FET were compared in terms of their learning and study strategies. Students' learning and study strategies were measured via the validated LASSI (Weinstein 1987–2002–2016). The LASSI contains 10 scales: Attitude, Motivation, Time management, Anxiety, Concentration, Information Processing, Selecting Main Ideas, Study Aids, Self-testing, and Test Strategies. Transfer students scored significantly higher on six of the ten LASSI scales, but as stated in chapter 2, this could be an overestimation due to their success experience of the professional bachelor. It is important to keep in mind that both first-year and transfer students filled in the questionnaire with their most recent prior education in mind. Conley (2007) stated that when students enter university they must adapt their study and learning strategies to be successful in higher education. This statement is confirmed by a research of Coertjens et al. (2017), which concluded that students' learning strategies change during the transition to higher education. The transfer students reported on their learning and study strategies in the last phase of the professional Bachelor's programme, whereas the first-year students did this at the beginning of the academic year when they were already enrolled. This timing difference could also have influenced the results. In addition, the professional bachelor students already adapted their study strategies during the transition from secondary education to the professional Bachelor's programme. After three years in the professional Bachelor's programme they should possess effective strategies to be successful in the PBA, whereas for the traditional first-year students, it is their first experience at higher education and also the first time they need to adapt their current study strategies.

When determining students' stumbling blocks it was striking that according to the transfer students their stumbling blocks are primarily related to the study load and the mathematical or theoretical approach of the courses and thus to the programme. In contrast, the lecturers mainly indicated that student related factors such as students' attitudes, study strategies, and (mathematical) knowledge gaps were the major stumbling blocks. The students' stumbling blocks were of paramount importance throughout the research. The content of the diagnostic test, developed and discussed in this dissertation (Chapter 4 and 5), was primarily based on students' major stumbling blocks. In addition, two interventions (i.e. mathematics MOOC and time management training) were developed to tackle these stumbling blocks. These interventions are also useful for first-year students. As a result, traditional first-year students who have a low or medium math background are encouraged to follow the mathematics MOOC. The LASSI showed that the first-year students at FET have similar time management skills as transfer students. Therefore, it was decided that as from the academic year 2017-2018 both transfer and first-year students were able to participate in the time management training.

1.1.5 OUTCOME VARIABLES

The question emerged if a difference in perceived fit results in a difference in academic outcome variables (i.e. academic achievement and dropout rates). The comparative studies showed that transfer students at FET perceive a significantly lower fit to university than both first-year and DIT students. However, analyses revealed that the outcome variables of transfer students and first-year students at FET are similar after one year of enrolment. Both DIT and FET transfer students experience a dip in grades, but at the end of the study programme their grades recover and they obtain similar grades. The dropout rates are however not similar. At DIT the dropout rate is virtually non-existing, whereas at FET the dropout rate in the transfer programme is approximately 35% after one year of enrolment. This difference can be devoted to a different perceived fit but is also related to the contextual differences (i.e. admission requirements and different content in the study programme). Including admission requirements for transfer students at FET can be an aid for increasing students' study success and decrease the dropout rate. However, it is important that these admission requirements take into account the potential of a student and not only their knowledge before entrance. It would also be beneficial if the transfer students at FET have more (extra)curricular mathematics, since this would increase their preparedness.

To conclude, after the transition to university, students obtain similar grades, thus the differences in perceived fit at the beginning of the academic year have no influence on students' grades at the end. The differences in dropout rates are primarily related to differences in students' preparedness and the presence of admission requirements, which in their turn affect how students perceive the transition to university.

1.2 SUGGESTIONS FOR FUTURE WORK

Suggestions for future work are rather restricted since the aim of the exploration was primarily to gain insight in the transfer students at FET. The exploration phase was the starting point of this research. However, it would be worthwhile to gain more insight in the transfer students that do not have a standard study programme and thus focus more on the distance learners and students who have a study programme of less than 50 ECTS. Two other suggestions for future work are described below.

In the future it would be worthwhile to compare the transfer students at FET (1) with Flemish transfer students of other study programmes than engineering and (2) if possible with transfer engineering students of international open-entrance institutions. Our hypothesis is that transfer students of non-engineering programmes encounter, in general, the same transition problems as transfer students at FET. However, there is reason to believe that mathematics will not be defined as a major stumbling block, whereas students' study strategies will remain a major stumbling block.

2 PREDICTION

2.1 REFLECTIONS

Due to the high dropout rate after one and even two years of enrolment and because these students already possess a valuable degree in Technology, it was important to determine which variables are predictive for the academic achievement of transfer students at FET. In addition, since literature on transfer students is scarce, this research aims to provide other researchers with interesting insights.

The reflections are divided into three sections. Section 2.1.1 discusses the transition from a theoretical model to two advisory models (i.e. student background and diagnostic model). Section 2.1.2 focuses on the diagnostic test and Section 2.1.3 determines the practical use of the research findings.

2.1.1 FROM A THEORETICAL MODEL TO ADVISORY MODELS

Both Chapter 4 and 5 focus on the prediction of academic achievement. However, the used approach is somewhat different. In Chapter 4 the goal was more theoretical: developing the model with the highest predictive value. The goal of Chapter 5 was to develop models that improve the guidance of students in their educational choice before enrolment as well as provide them with the required support once they are enrolled. Therefore, two types of advisory models that use pre-entry attributes, were developed: a student background and a diagnostic model. The students' background model includes only fixed variables such as prior schooling and (family) background, whereas the diagnostic model only includes malleable variables such as skills and abilities, which were tested via the diagnostic test.

The list of possible predictor variables used in educational research is very extensive, including for instance numerous personality traits, academic background variables, students' goals, and commitments. Adding more variables to a model always results in an increase in the explained variance, however it is important to include only variables that result in a significant change. Ackerman et al. (2013) used for example different trait complexes, of which each complex consisted of various parameters. For the development of these trait complexes students needed to complete a survey with 229 items. The trait complexes in combination with students' high school GPA, SAT scores, and AP scores explained 40% of the variance in students' grades. This model has a rather high explained variance, but the number of variables is also high and requires a lot of effort to gather the data. The models in this dissertation needed to be sustainable, which means that the preparatory work does not require for example that students have to fill in numerous questionnaires. Not only does it take time from the student to fill in all the questionnaires, it also requires time from researchers or faculty to process the completed questionnaires and give feedback. Similar to findings of other studies, the academic background variables are, without a doubt, the variables that account for the highest explained variance. Students' prior achievement, GPA in the professional Bachelor's programme, was the strongest predictor and therefore included in each model of Chapter 4 and in the students' background models in Chapter 5. In Chapter 4, when data of three cohorts (2013-2014, 2014-2015, and 2015-2016) were pooled, the added explained variance of the other two retained variables (i.e. resits and/or secondary education track), on top of the variance explained by GPA PBA, was only 1%. When combing the data of 2014-2015 and 2015-2016, the variable *position in the class group for mathematics during secondary education* resulted in an added R^2 that varied between 3% to 6%. As a result, it was decided to gather more detailed information about students' effort and achievement in secondary education (i.e. GPA at the end of secondary education, math GPA, and self-perceived effort).

In an open-admission institution, it is worthwhile to use the information of students' pre-entry attributes before enrolment. The students' background model enables to inform students about their possible study success based on their background. The diagnostic model informs students about which malleable variables can influence their study success and gives them the opportunity to position themselves towards the other prospective students. Both models are useful before enrolment but once a student is enrolled, the focus has to be on malleable variables, which are only included in the diagnostic model. Hattie (2015) concluded that about 50% of the variance in achievement was a function of students' characteristics. This includes, off course, fixed variables, but also malleable variables such as students' attitudes. Which variables are fixed and which are malleable depends on which mind-set a person has. According to Dweck (2006) a person can have a fixed or growth mind-set. A person who has a fixed mind-set believes that qualities such as intelligence and talents are fixed traits. On the other hand, a person with a growth mind-set believes that their basic abilities can develop further through hard work and dedication.

Looking at the results of both studies, the prediction models in Chapter 4 consisted of similar variables as the students' background model in Chapter 5. The models in Chapter 4 retained two to four variables, the student background models in Chapter 5 retained two to five variables. In addition, the explained variances were also rather similar. The model that predicts the GPA at the end of the academic year has the lowest predictive value. This phenomenon is consistent over time. Two reasonable explanations are: (1) resits are organised at the end of the year and so students had a second chance to pass or (2) the fact that every student goes through a personal development during the transfer programme and all the included variables are measured before the start of the transfer programme. Therefore we advise faculty to use the variables that appear in the models of January and June for informing students. The similarities between the models in Chapter 4 and the students' background models in Chapter 5 justify the decision to continue with the two advisory models.

2.1.2 DIAGNOSTIC TEST

The first version of the diagnostic test was included and examined in Chapter 4, but none of the diagnostic test variables was retained in the theoretical prediction models. In Chapter 5, the results of the three pilots were combined into the diagnostic models. The following five sections discuss different aspects of the diagnostic test: (1) the evolution of the content, (2) the moment of organisation, (3) the voluntary nature, (4) the predictive value, and (5) the test validity.

2.1.2.1 CONTENT

The main focus of the diagnostic test is to properly guide students and to give them actionable feedback about important malleable variables. The content of the diagnostic test was primarily based on students' major stumbling blocks: (1) basic mathematics and (2) study strategies. These were identified during focus group discussions with students and lecturers.

A previous study (Langie and Van Soom 2014) revealed moderate correlations between a mathematics diagnostic test, originally designed for first-year students at FET, and the academic achievement of the transfer students. During focus group discussions, the math lecturers of the transfer programme stated that there were other requirements regarding the expected prior knowledge of transfer students in comparison to traditional first-year students. Therefore it was decided to develop a mathematics test specific for transfer students together with math lecturers of the transfer programme. To measure students' learning and study strategies, educational experts suggested to use the validated LASSI (Weinstein 2016).

Besides tests that focus on students' stumbling blocks, it was also decided, together with educational experts, to add four cognitive tests (i.e. CoVat-CHC: Logical Reasoning, Folding Boxes, Proverbs, and Point Series) to the diagnostic test, since these cognitive skills are also important for prospective engineering students (Ackerman et al. 2013, Ting 2011, Fonteyne, Duyck, and De Fruyt 2017). However, after the second pilot, it was decided to no longer include the CoVat based on the following three reasons: (1) instead of creating the highest predictive value as possible, the main focus of the diagnostic test was to properly guide students and give them actionable feedback. Unfortunately, it was not possible to give students actionable feedback regarding their CoVat results, (2) correcting the CoVat-tests was time intensive and thus not sustainable, and (3) there was a need to add more mathematics questions to increase the differentiating power of the math test. Therefore, it was decided to give priority to the mathematics test. As from the second pilot, a student engagement questionnaire was added to the diagnostic test.

In the third pilot, the mathematics test consisted of 11 extra mathematics items. It was also decided to reduce the LASSI from 10 to 5 scales. There were three reasons for doing this: (1) the predictive value of the individual LASSI scales was restricted, (2) not wanting to overwhelm students with too many tests, and (3) not wanting to overwhelm students with too much feedback, since they also received actionable feedback about the four student engagement scales. Another possibility was to remove the student engagement scales, however at that time, it was not yet possible to examine the predictive value of the engagement questionnaire. In addition, at the start of this research it was decided to include each test at least two times.

For the future, after analysing the data of the three pilots, it is suggested that the diagnostic test consists of a mathematics test (30 multiple choice question) and the LASSI. The student engagement scales should no longer be included since (1) the predictive value is as good as non-existing, (2) the feedback is less actionable than the feedback of the LASSI, and (3) the engagement scales are strongly correlated to the LASSI scales. When the student engagement scales are removed, the ten LASSI scales can be included, although not all the scales correlate significantly with students' academic achievement, the actionable feedback is valuable. One LASSI scale that requires extra attention is Study aids. This scale revealed negative correlations with students achievement, meaning that students who indicate that they have good study aids, obtain lower grades in the transfer programme. One reasonable explanation for this negative correlation is that students overestimate their study aids, due to their success experiences.

During the pilots the test length varied between 2.5 and 3 hours. This timeframe seems sufficient, since if the test takes longer, students will most likely be less concentrated. Implementing more tests is only justified if the added value is significant and actionable feedback is sufficient. However, before adding more tests, attention should be given to the current test set, more specifically in further optimizing the mathematics test. This can be done by performing more in-depth item analyses and thus focus on the construct validity of the mathematics test.

To conclude, the content of the diagnostic test, developed in this research, focused primarily on the stumbling blocks of the transfer students. The test has to include both cognitive and non-cognitive tests, since students need to realise that these are both important for study success at university. However, it is important not to overwhelm students with too many tests and too much actionable feedback.

2.1.2.2 Moment of organisation

During this dissertation the diagnostic test was organised at the beginning of the last semester of the students professional Bachelor's programme. It was not always easy to find a suitable moment for the organisation of the test since students were working on their Bachelor's thesis and were therefore not often on campus. The organisation of the test has to be sustainable. Therefore it was decided, before the fourth pilot, to organise the diagnostic test at the same time as the one for the traditional first-year students, which is in the beginning of July. In the future, it remains important to reach more students and encourage participation before enrolment. The correlation of the results of the test given before enrolment with students' academic achievement was higher than the correlation of the one organised during the first weeks of the transfer programme. For instance the correlation between the mathematics test and students' academic achievement was

.47 for the test before enrolment and .39 for the test at the start of the academic year 2017-2018. Looking at the motivation scale this difference was even bigger: a correlation of .54 before enrolment and .26 for the test at the beginning of the transfer programme. Two reasonable explanations for this difference are: (1) students who participated before enrolment, participated on their own initiative, whereas students that participated after enrolment also felt more obligated to participate and (2) students who participated before enrolment responded in a true and accurate manner, whereas after enrolment, students are perhaps more tempted to give socially desirable answers.

To conclude, the diagnostic test should be organised before enrolment, together with the diagnostic test for traditional first-year students. When the test is organised before enrolment it can stimulate students to make a well-considered educational choice. Organising the test simultaneously with the diagnostic test of the first-year students has the additional advantage that practical arrangements have to be made only once instead of twice.

2.1.2.3 Voluntary or obligatory?

Throughout this research, participation in the test was voluntary and the result non-binding. Cole and Osterlind (2008) stated that a low-stakes test with limited consequences lowers both students' effort levels and achievement. During this research there were no consequences when students did fail the test. However, in the future it is desired to have some limited consequences, which should result in higher effort level than when there were no consequences. Nevertheless, the diagnostic test has to remain non-binding, so each student should be able to enrol in the study programme. At the Faculty of Engineering Science, participation in the diagnostic test is obligatory and if students pass the test they get an exemption for one credit. At TU Delft, admission in a study programme depends on the students' secondary education degree and the chosen study programme. However, each student is able to enrol, but it is possible that students have to address deficiencies (e.g. mathematics) before enrolment. A preferable situation would be a combination of both, namely an obligated diagnostic test (cf. Faculty of Engineering Science) and if students do not pass, they have to address their deficiencies (cf. TU Delft).

To conclude, the test has to be non-binding. However, if the test has limited consequences, students who fail the test would be required to follow for instance an extensive summer course to address their deficiencies. If it is decided to implement consequences the test has to be obligatory.

2.1.2.4 *PREDICTIVE VALUE*

Regarding the predictive value of the test, it is peculiar that in the first pilot none of the cognitive tests (i.e. mathematics and four CoVat subtests) were predictive for academic achievement, whereas in the second pilot three of the five cognitive tests were significant (i.e. mathematics, proverbs, and folding boxes). For the mathematics test there is a reasonable explanation. In the second pilot, participants obtained a significantly higher mean score on the mathematics test, but this difference can be assigned to the emergence of the MOOC (Chapter 5 and 7). Students had the opportunity to refresh their mathematical knowledge, therefore they are tested on their potential instead of on their memory. Regarding the CoVat tests, pinpointing a reason for these differences is much more difficult. There were no significant differences between the test results of the two cohorts. Therefore the question emerged if there were differences between the CoVat participants. The participants of 2015-2016 and 2016-2017 were compared with each other regarding GPA PBA, GPA TR, attitude, motivation, time management, concentration, level of math in secondary education, and secondary education track. The only significant difference was found for the concentration scale. The participants of 2016-2017 reported a significant lower level of concentration than the ones of 2015-2016. Due to this minor difference, it is not possible to conclude that there is a difference in correlations due to differences between the participants.

Regarding students' learning and study strategies, significant correlations between concentration and academic achievement were found in each pilot. During the second and third pilot, when there were more participants, motivation and time management were also significantly correlated to students' academic achievement. These three scales resulted in the most consistent correlations. This is in agreement with the study of Pinxten et al. (2017), which focused on first-year STEM students, where the highest correlations were found for motivation, time management, and concentration. The student engagement questionnaire, which was included in the second and third pilot, only revealed one significant correlation between the scale dedication and students' academic achievement.

When the significant variables were combined into a model, one to three variables were retained in the diagnostic models. The diagnostic model explained between 10.4% and 28.2% of the variance in the GPA's of the transfer students.

2.1.2.5 *VALIDATION OF THE DIAGNOSTIC TEST*

The title of this dissertation states that one of the goals of this research was to develop a validated diagnostic test. Test validity examines to which extent a test measures what it attempts to measure (Carmines and Zeller 1979). In this section, four types of test validity are discussed: (1) content validity, (2) face validity, (3) predictive validity, and (4) construct validity.

“Content validity is based on the extent to which a measurement reflects the specific intended domain of content” (Carmines and Zeller 1991, p.20). Empirical evidence for content validity is based on theoretical arguments of different stakeholders. The starting point of this research were focus group discussions with different stakeholders (lecturers and experts), meaning that content validity was taken into account.

“Face validity is concerned with how a measure appears. Unlike content validity, face validity does not require established theories“ (Fink 1995). The tests in the diagnostic test focus on students’ stumbling blocks, therefore the face validity of the diagnostic test is appropriate. However, ideally the test should be representative for studying in the transfer programme in Engineering Technology, which is not the case if only a mathematics test and the LASSI are included.

“Predictive validity, on the other hand, concerns a future criterion which is correlated with the relevant measure” (Carmines and Zeller 1979). For the predictive validity of a test, empirical evidence is based on a correlation between the test score and the criterion. In this research it was examined if students’ test scores are significantly correlated to academic achievement in the transfer programme.

“Construct validation focuses on the extent to which a measure performs in accordance with theoretical expectations” (Carmines and Zeller 1979). Empirical evidence for construct validity is based on item and/or factor analyses. In the LASSI, a validated questionnaire, construct validity is guaranteed, meaning that each scale measures the corresponding theoretical construct. For the mathematics test, developed in this research, some item analyses were performed but this should be examined more in detail.

Besides validity, the reliability of a test is also important. Reliability examines if the results are consistent. In this research, the focus was on the internal consistency of the mathematics test, which was measured via calculating the Cronbach’s alpha. On item level, the item-total correlations were calculated, which give in combination with the proportion answers correct a good idea of the quality and difficulty of an item.

This research primarily focused on the predictive validity of the test. Since the diagnostic test results correlated significantly with the students’ academic achievement in the transfer programme, empirical evidence for the predictive validity was found.

2.1.3 PRACTICAL USE OF THE RESEARCH FINDINGS

This section focuses on the practical use of the research findings. It was decided to discuss this for three important moments in students' educational pathway: (1) after secondary education, (2) after the professional Bachelor's programme, and (3) after enrolment in transfer programme.

2.1.3.1 AFTER SECONDARY EDUCATION

An open-entrance institution has the advantage that students can achieve their goals irrespective of their background. However, since students are free to choose a study programme, this might result in a wrong educational choice. Supporting students when making this important educational decision requires intensive cooperation between secondary education, universities, and university colleges. Secondary education does make serious efforts to guide students in their study choice. In addition, higher education institutions offer extra insights and information during SID-ins (Study information days), open campus days, and info moments. During these initiatives prospective students can for example gain insights in the success rates and listen to the experiences of other students. Online tools such as Onderwijskiezer[45] and LUCI[46] provide additional information about higher education and particular study programmes.

It is interesting that the variables regarding students' secondary education still contain valuable information for their study success in the transfer programme. The readySTEMgo project (Pinxten et al. 2017) revealed that students' performance during secondary education, level of math, followed study programme, and the advice of the teacher board at secondary school contain valuable information about the possible study success at university. The questionnaire[47], used for developing the student background model, showed that 38% of the students followed a study programme in secondary education with a high level of math (6 or more hours of mathematics/week). Of this group of students, 38% reported that their end result in secondary education in general and for mathematics was 70% or higher. These students actually have a good starters profile of a traditional first-year student at FET, since Pinxten et al. (2017) found evidence that first-year students with a high level of math obtained significantly more credits. In addition, a final GPA in secondary education of 70% or higher also resulted in obtaining more credits.

The prediction models of this research are useful for prospective first-year students, since students with potential and motivation need to know that they can be

---

[45] https://www.onderwijskiezer.be/v2/index.php
[46] https://www.kuleuven.be/luci/
[47] Organised in the academic year 2016-2017 (N=406)

successful in the academic Bachelor's programme. Therefore, it is of great importance to inform prospective students about the differences between the professional Bachelor's programme and the academic Bachelor's programme. Students that are already considering to follow the transfer programme before even starting in higher education and who followed a study programme with a high level of math and obtained GPA's of 70% or more, should be advised to start immediately with the academic Bachelor's programme. Unless for instance they want to enrol in a professional Bachelor's programme because the programme is more practical. However, those students need to be aware that the transition from the professional Bachelor's programme to the transfer programme is perhaps more difficult than the transition from secondary education to university (Chapter 2). Transfer students feel significantly less prepared for university than the first-year students. This research also found that one third of the students would have started with the academic Bachelor's programme if they could choose again. As a result, it is even more important to guide each student to the appropriate study programme as soon as possible.

2.1.3.2 After professional Bachelor's programme

When it is only to inform students, all the variables of the diagnostic and students' background model can be used. However, if the predictive variables of the diagnostic model are used for an entrance exam that takes place before official enrolment, self-reported questions cannot be used, since students will give socially desirable answers. Therefore only the mathematics test can be used as an entrance exam. If participation in the test is obligatory and students are aware of the requirements they can refresh their mathematical knowledge. As mentioned in 2.1.2.3 students' performance on the diagnostic test should result in some consequences. Students who fail the test should be required to address their deficiencies, for example by doing an intensive summer course.

Students' prior achievement (GPA PBA) is such a strong predictor and their chances to be successful in the transfer programme increase significantly when their grade in the PBA was 70% or higher. In addition, the comparative study with DIT (Chapter 3) showed that the dropout during the transfer from level 7 to level 8 students was almost non-existing. One of the main explanations for this limited dropout rate was the use of admissions requirements. Therefore, it would be beneficial to implement a direct entrance mark for the transfer programme at FET, similar to the entry to level 8 at DIT.

When combining GPA PBA and the mathematics test, the total explained variance of these two variables varied between 31% (GPA June 2017-2018) and 49% (GPA June 2016-2017). Important to point out is that for 2017-2018 the correlation between prior achievement and students' academic achievement in the transfer programme was not as strong as in the previous years. The added value of the mathematics test varies between 3 and 6%. Pinxten et al. (2017) found similar results for predicting the grades of first-year engineering students: an increase of 6% when the mathematics diagnostic test was added to the model.

2.1.3.3 After enrolment in the transfer programme

After students are enrolled in the transfer programme, all the malleable variables of the diagnostic model remain useful. Students can improve their skills and abilities both before and after enrolment. If it is decided to implement an entrance exam, the LASSI should be administered at the start of the academic year to all the new incoming students. Students receive actionable feedback, based on their results, and are provided with the opportunity to participate in interventions.

2.2 Research questions answered

In this section the first two research questions of the dissertation are answered.

RQ1. *To which extent can a diagnostic test aid us in predicting students' academic achievement?*

In this research, the three academic achievements of the transfer programme were included: GPA January, GPA June, and GPA at the end of the academic year. As already mentioned above, the explained variance of the models that predict students' GPA at the end of the academic year are consistently lower and therefore not included. The explained variance of the diagnostic models, constructed with one to three variables, varied between 10.2% and 28.2%. Of the six developed models (three pilots consisting of two GPA's), mathematics was retained four times. The scales motivation and concentration were retained in three models. This means that both the mathematics test and the non-cognitive learning strategies were able to explain some of the variance in students' academic achievement. It is important to point out that, since the PBA contains no or little mathematics, organising a diagnostic test is only meaningful when students can refresh their math knowledge before the test (Chapter 7). Providing students with an opportunity to prepare themselves is even more important when the test is used as an entrance exam. In this research, there was no predetermined target regarding the variance that the diagnostic test should explain. Although not all the scales are predictive and the predictive value is not consistent for all variables throughout the pilots, students receive actionable feedback about all their results and are provided with interventions both before and after enrolment.

When the test is used to inform students and provide them with actionable feedback, both the mathematics test and study strategies inventory can be included. However, when the test is used as an entrance exam, self-reported measures can no longer be used since students will give social preferable answers. As a result, an entrance exam can only test knowledge and not students' attitudes. Consequently, students' study strategies should be measured at the beginning of the academic year, since they were identified as major stumbling block by the lecturers. Students are provided with actionable feedback and the opportunity to participate in interventions.

To conclude, the results on the developed diagnostic test enables predicting students' academic achievement to a certain extent.

RQ2. *Can we create a diagnostic test which has a higher predictive value compared to an analysis of (academic) background variables of the students?*

The analyses revealed that students' prior achievement (GPA PBA) is a very strong predictor, which is in line with the existing literature. Creating a diagnostic test with a higher predictive value than an analysis of students' (academic) background variables was thus challenging. Since it was decided to develop two models that focused on pre-entry attributes (i.e. students' background and diagnostic model), it was out of the question to focus on creating a diagnostic test with a higher predictive value than an analysis of background variables. Using pre-entry attributes to inform students before enrolment was of great importance due to the open-entrance system in Flanders. Before students decide to enrol in the transfer programme it is important to provide them with the information of both the student background model and the diagnostic model. Once they are enrolled the focus must be on malleable variables and not on their background, since they can work on their skills and abilities if they participate in interventions. These models are not only useful when informing students, but also for faculty to support students and even to formulate possible admission requirements. The student background model and diagnostic model complement each other when guiding and supporting (prospective) students.

The explained variance of the diagnostic model, with one to three variables, varied between 10.2% and 28.2%. Kobrin et al. (2000) examined in his study the validity of the SAT test (mathematics, writing, and critical reading). He found a moderate correlation ($r=.35$, $R^2=12\%$) when only presenting the correlation of the enrolled students. Correcting for the restriction of range (i.e. analysing only admitted students restricts the amount of variation in test scores) resulted in a strong correlation ($r=.53$, $R^2=28\%$). In this research, no correction techniques were used.

However, the explained variance of the SAT is similar to the R^2 of the diagnostic model. The students' background model, with two to five variables, resulted in an R^2 between 34.2% and 43.4%. It is interesting to note that this research used fewer variables than Ackerman et al. (2013) but resulted in a similar or even higher explained variance.

Both the students' background and diagnostic model have advantages and disadvantages. The advantage of the students' background model is its high predictive value. However, the disadvantage is that students cannot change these variables, so it is only useful before enrolment. Whereas the advantage of the diagnostic model is the use of malleable variables, meaning that students can improve their skills and abilities, which can positively influence their academic achievement. The model is thus useful both before and after enrolment. The disadvantage of the diagnostic model is that the predictive value is lower in comparison to the predictive value of the students' background model and when they are combined into one model, the incremental value of the malleable variables is limited.

2.3 Suggestions for future work

Although four pilots were carried out during this research, further optimisation of the test composition is preferable. For the mathematics test it is worthwhile to focus more on construct validity. If the mathematics test is used as an entrance exam and thus obligatory for all students, extra attention should be given to the reliability and validity of the test (classical test theory). If the sample of students is large enough it can be considered to use item-response theory (Embretson and Reise 2000), which focuses on the item level of the test. To ensure that the organisation of the diagnostic test is sustainable and manageable, it is worthwhile to change the pencil-paper test in an online test, which would result in an even more efficient intervention. In the future, it should be considered to make the test obligatory. As a result, the test has to be organised at all the Flemish universities that offer transfer programmes in Engineering Technology.

The perception questionnaire showed that more than a third of the students were satisfied with the received feedback. However, half of the students neither disagreed or agreed on this item. Therefore, it can be examined more in-depth, which feedback students are lacking and what they actually do with the feedback they received. For instance, do students with a lower result on the mathematics test participate in the MOOC or do students with low time management skills participate in the time management training. This can be examined if the number of participants in the interventions is large enough. It would also be beneficial if students with, for example, a low result on time management are explicitly invited to participate in the time management training. This can be done when the student support programme is implemented on all the campuses.

3 INTERVENTION

3.1 REFLECTIONS

The student support programme aims (1) to attract the right students, (2) decrease the feeling of unpreparedness at the beginning of the academic year, and (3) support students after enrolment. The reflections on the intervention part are categorised into four sections: Section 3.1.1 focuses on reflections about the effectiveness and efficiency of the developed interventions. Section 3.1.2 discusses the content of the ideal student support programme. The last two sections provide insight in the extra work for faculty when implementing interventions (Section 3.1.3) and examine the evolution of the dropout rate in the transfer programme (Section 3.1.4).

3.1.1 EFFECTIVENESS AND EFFICIENCY OF THE STUDENT SUPPORT PROGRAMME

The interventions of the student support programme focused on three of the four categories of reasons for leaving a study programme as distinguished by Yorke and Longden (2004). It was not possible to focus on the fourth category since this included events that impact on students' lives outside the institution. The Meet & Greet workshop and the diagnostic test with feedback, which are both organised before enrolment, targeted flawed decision-making about entering the programme. The induction activity, intermediate exams, and individual feedback conversations aimed to influence students' experience of the programme and the institution in general. The math MOOC and the time management training, which focused on the students' major stumbling blocks, aimed to decrease failure to cope with the demands of the programme. The aim was to examine the effectiveness and efficiency of these developed interventions. In order to do this, it was of great importance to define effectiveness and efficiency.

Efficiency refers to 'doing things right', while effectiveness relates to 'doing the right things' (Drucker, 1967). Thus, an intervention is efficient when the observed outcomes are produced at the lowest level of resources. Effectivity occurs when the desired objectives are achieved. In this research, effectiveness was mainly estimated via (1) measuring the perceived usefulness, (2) determining if the objectives are achieved, and (3) conducting individual effectivity measurements such as a pre- and post-test. Efficiency was assessed via an estimation of the time required to develop and implement the intervention, and the scalability of the intervention. In literature, efficiency is often not included (Morrison et al. 2014). However, this is highly important in the long term. Measuring the effectiveness and efficiency of interventions is challenging. In this research, it was even more difficult to measure the effectiveness since participation in almost all the interventions was voluntary. There were two reasons for the voluntary nature of the interventions. Firstly there were ethical considerations, since each student who wants to participate has to have the opportunity to participate. Secondly, forcing students to participate will not result in finding more evidence for the effectiveness of an intervention (Dale 1993). Therefore, self-selection had to be taken into account in this research. It was decided to control for confounding variables such as motivation. Another option that was considered, was to compare the participants and non-participants with the transfer students of other campuses. But due to the small number of participants in the interventions it was decided not to do this.

The analysis in Chapter 6 revealed that the most effective interventions are not always the most efficient ones on a large scale and vice versa. For instance, individual feedback conversations and intermediate exams were ranked by the students as the most effective interventions, which are not the most efficient interventions when implementing them on a large scale. Schneider and Preckel (2017) found that the nature, quality, and frequency of feedback from the teacher is positively related to students' academic achievement (ES=.47). The MOOC and the diagnostic test were the two interventions that are both effective and efficient. Both interventions have a high development time, which is not considered as a problem, since it is reasonable that developing an effective intervention takes time. However, an effective intervention has preferably a low implementation time and is also rather easily scalable. As stated by Schneider and Preckel (2017) intervention with an effect size smaller than 0.4 can still improve instruction, for example when implementation of the intervention costs little time and money.

In Chapter 7 the effectiveness of the mathematics MOOC and time management training was examined more in-depth. The three reasons why it was decided to focus on these interventions are: (1) mathematics and study strategies were defined as students' stumbling blocks, (2) during this research most of the attention was given to the development and implementation of these two interventions; the time management training was organised three times and the MOOC was available since the second pilot (academic year 2016-2017), and (3) it was interesting to examine a cognitive and non-cognitive intervention, since different methods for measuring the effectiveness are used. Some empirical evidence about the effectiveness of the interventions was discovered, based on analysis of (1) pre- and post-test scores for the time management training and (2) a satisfaction survey and math diagnostic test for the MOOC. In this research there was more statistical evidence for the effectiveness of the math MOOC, compared to the effectiveness of the time management training. However, it is much more difficult to measure the effectiveness of interventions that focus on non-cognitive characteristics. The aim of these interventions is to create a change in behaviour. Experts made it clear that a change in behaviour can be observed, but not measured via performance measurement (such as for example the math diagnostic test). Other effectivity studies that focus on behaviour, also use self-reported pre and post-tests (Armstrong and Rimes 2016, Greenberg et al. 2016, Danitz et al. 2016). Conform with other studies, it was decided to use a self-reported pre- and post-test design for measuring the effectiveness of the time management training.

3.1.2 IDEAL STUDENT SUPPORT PROGRAMME

Although the statistical evidence for the effectiveness of the student support programme is restricted, students' perceived the interventions as useful and the predetermined objectives were achieved. Robbins et al. (2009) also concluded in their research that the first-year programmes only have a limited impact on students' academic achievement, but that it does not mean that there is no increase in students' satisfaction. In this section, each intervention is discussed separately and advice, about whether or not the intervention should be included in the support programme in the future, is formulated.

The main advantage of the *Meet & Greet workshop* was the presence of current and ex-transfer students, who shared their experiences with prospective students. In the future, it remains important to search for students who are willing to share their experiences. However, this should not be too difficult, since if students found the workshop useful themselves, they are probably more willing to help. It was also noticed during the research that if students feel supported, they are also willing to do something in return. In the long term it should be considered to integrate the workshop into one of the existing info days on the campuses. Preferably the workshop is organised in the evening, since prospective transfer students work during the day or are working on their professional Bachelor's thesis.

Empirical evidence for the effectiveness of the *mathematics MOOC* was found during this research, thus the MOOC should definitely be included in the student support programme. Due to the general character of this intervention, the MOOC is also used by (incoming) first-year students at FET and even other faculties use the MOOC or make publicity for the MOOC. Between January and August 2018, a total of 1500 participants enrolled in the MOOC. The 8th of October 2018, a new MOOC run has started. After one month there are already 250 participants enrolled. Since the intervention is organised online, distance learners can also benefit from the MOOC.

The organisation of an *induction day* is very important for students' social integration. However, more attention should be given to the development of induction activities. It would be worthwhile to organise an induction week before the official start of the academic year instead of an induction day so that the information is less overwhelming. Induction activities can also be combined with a summer course, similar to the summer boot camp for incoming engineering students at the University of Nevada (Vollstedt 2018).

Students who participated in the *time management training* perceived the training as useful. Since the absence of effective study strategies was defined as one of the major stumbling blocks, it is important to organise this training. Students have to feel the need for participating (1) based on the results of the diagnostic test, (2) based on their own judgement, or (3) when a lecturer or student advisor advises them to participate. The time management training has a low implementation time, which makes it an efficient intervention.

Intermediate exams are very valuable for the students (Day et al. 2018), since they provide an opportunity to become adapted to the academic approach. As mentioned by Day et al. (2018) an intermediate exam is preferably a low-stakes exam. This is similar to the intermediate exams organised in this research, where the exam accounted for 10% of the students' total grade. Keeping the stakes low gives students the opportunity to catch up, if necessary, during the exam period. If the exam consists of multiple choice questions, the time required to revise the exam is low. This makes the intermediate exam a more efficient intervention. For the intermediate exams it was also important that students receive feedback in a foreseeable time. In this research students received feedback one or two weeks after the exam.

Individual feedback conversations were considered to be very effective. During these conversations, students were (1) encouraged to study more (if necessary) or use a different approach, (2) offered support if they were facing problems, or (3) confirmed that they were doing great. However, as mentioned in Chapter 6, these conversations are rather inefficient when organised on a large scale. Since individual feedback conversations are of paramount importance, it was decided to calculate the workload more in detail. At FET, the students are divided into class groups. These class groups are necessary for the organisation of lab and exercise sessions. In the further calculation it is assumed that a class group consists of 35 students. During this research, maximum four feedback conversations (after the intermediate exams, and after each of the three exam periods) of 15 minutes each were organised for each student. This results in one hour per student and thus 35 hours in total. Assuming that there are 210 working days per year and that faculty works eight hours per day results in only 2% of the total workload. It is also important to point out that not all the students need individual feedback on each of the four different moments.

To conclude, all the developed interventions should remain in the support programme, since each of them has different and important objectives. However, continuously improvement of the developed interventions is of great importance (Van Yperen, Veerman, and Bijl 2017). According to the current research the ideal student support programme consists of (1) interventions both before and after enrolment, (2) interventions that focus on academic and social integration, (3) both cognitive and non-cognitive interventions, (3) both individual and group interventions, and (4) both online and face-to-face interventions. Table 61 provides an overview of the different interventions and determines for each of the interventions the appropriate option in all the five categories, mentioned above.

Table 61 shows that in this research the focus was primarily on academic integration, thus in the future more attention should be given to interventions that improve social integration. This should not necessarily be the task of faculty, since former transfer students can be involved when organising induction activities. Almost all the interventions were face-to-face interventions, thus developing extra online interventions seems worthwhile. Online interventions have the advantages that there is no limit on the number of participants, distance learners can participate, and students can participate when they want. For instance, during this research the time management training was organised on a Monday morning, for some students this was inconvenient, if it is also offered online they can participate when they want. Regarding the moment of organisation (before or during enrolment) the balance seems appropriate. The same applies for the balance between group and individual interventions.

TABLE 61. OVERVIEW STUDENT SUPPORT PROGRAMME

Intervention	*Before/ after enrolment*	*Academic/ social integration*	*Cognitive/ Non-cognitive*	*Individual/ group*	*Online/ Face-to-face*
Meet & Greet workshop	Before	Academic	Non-cognitive	Group (but individual questions)	Face-to-face
MOOC	Before/after	Academic	Cognitive	Group	Online
Diagnostic test	Before	Academic	Cognitive/ non-cognitive	Group (but individual feedback)	Face-to-face (feedback online)
Induction day	After	Social	Non-cognitive	Group	Face-to-face
Time management training	After	Academic	Non-cognitive	Group (but individual aspects)	Face-to-face
Intermediate exams	After	Academic	Cognitive	Individual	Face-to-face
Feedback conversations	After	Academic	Non-cognitive	Individual	Face-to-face

3.1.3 WHAT ABOUT THE 'EXTRA WORK' FOR FACULTY?

Developing and implementing a student support programme results inevitably in extra work for the faculty. However, it is important to put this in perspective. If interventions before enrolment stimulate a well-considered educational choice and if students already have the opportunity to master the required prior knowledge, students are better prepared. As a result, it is expected that faculty can mainly focus on the course content instead of paying attention to study strategies or the required prior knowledge. Off course, the extra work has to be limited. Robbins et al. (2009) made the same consideration in their meta-analysis:

"Like any educational and employment tool, any intervention program should be designed and evaluated with its cost effectiveness (utility) and practicality carefully considered (Burke & Day, 1986; Guzzo, Jette, & Katzell, 1985). That is, if the cost of an intervention program exceeds its benefit, then the intervention program is reconsidered in terms of design and target participant: (a) The intervention program may be redesigned in a more cost effective manner at the expense of some loss in effect size, or (b) educational administrators can be more careful in identifying college students who are more likely to get increased benefit from the intervention program." (Robbins et al. 2009, p. 1179)

Since the workload for faculty has to be manageable, it is not realistic to only have individual interventions. For the students, who have a quite full schedule with lectures and exercise sessions, it is important that what they learn during the interventions can be easily integrated into their own study life. A possibility is to add individual support during group interventions. For example, during the time management training, there is time to help students individually with the construction of a study schedule. Another example is the feedback email of the diagnostic test, which is individual and guides students to the feedback they need. The MOOC is the largest group intervention of all, but one of the major advantages of the MOOC is the online forum where not only faculty can answer students' questions but also peers.

3.1.4 EFFECT ON DROPOUT RATES

The question emerged if all these interventions resulted in a decrease in dropout rates. To examine this, the dropout rates of the academic years with no interventions (2013-2014 and 2014-2015) and the years with interventions (2015-2016, 2016-2017, and 2017-2018) were compared[48]. Before comparing the dropout rates, it is

[48] The complete student support programme was only organised on one campus at FET, so only the dropout rates of this campus are presented.

important to point out that as of the academic year 2015-2016, KU Leuven introduced a new regulation regarding the cumulative study efficiency (CSE) of new students. After one complete year of enrolment starting students with a CSE <30% are not eligible to continue in their study programme. This new regulation complicated comparison of dropout rates in this dissertation. Figure 15 presents both the dropout rates and time-to-completion rates, but it is not possible to distinguish clear trends. There is no distinct decrease in dropout rates throughout the years. One remarkable change is that the dropout during the second and after the second year in the transfer programme is substantially lower during the years when interventions were organised (χ^2=13.28, $p<.001$). Unfortunately it is very difficult to relate this directly to this research, due to the KU Leuven CSE regulation. A study of Sneyers and De Witte (2018) revealed that both academic probation (i.e. similar to CSE regulation) and mentoring (i.e. similar to student support programme) are effective.

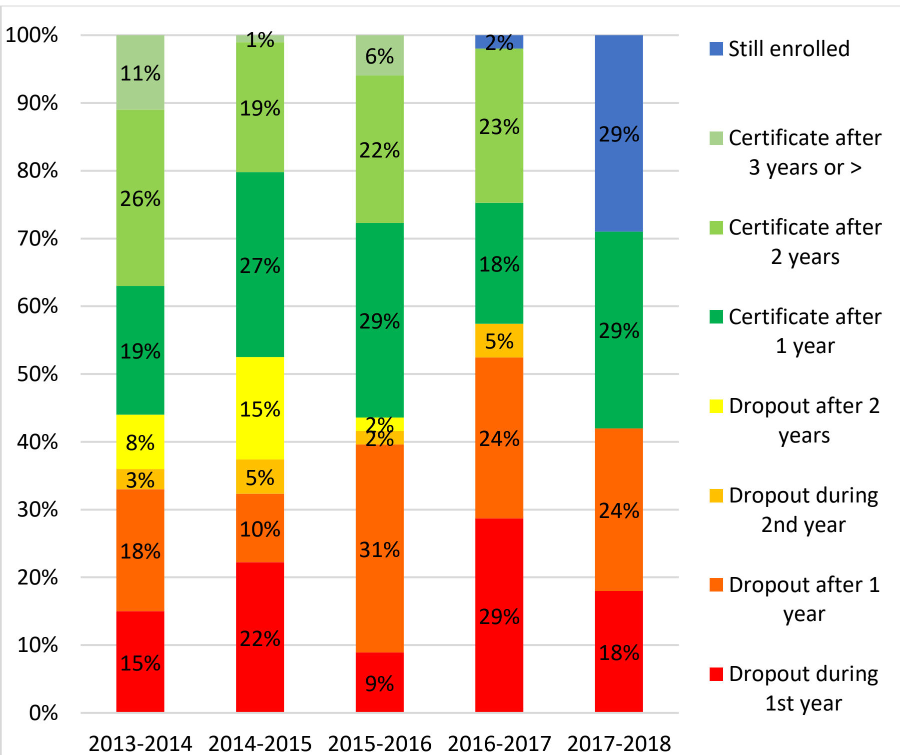


FIGURE 15. COMPARISON OF DROPOUT RATES AND TIME-TO-DEGREE RATES BETWEEN THE ACADEMIC YEARS WITH (2015-2016 (N=65);2016-2017 (N=66);2017-2018 (N=49)) AND WITHOUT INTERVENTIONS (2013-2014 (N=73); 2014-2015 (N=73))

It is also worthwhile to examine if reorientation takes place at an earlier stage (i.e. during the first year of enrolment). However, to see this possible change, students need to officially withdraw from the study programme during the academic year and it is well-known that not all the students that dropout during the year do this.

Another possibility is to look at the inflow in the transfer programme. Since one of the aims of the student support programme is to attract the right students, it is striking that the number of new transfer students decreases throughout the years. It is possible that more students make a well-considered study choice and decide not to enrol in the transfer programme. To find out if the right students are attracted, the student inflow was analysed. Part B, prediction, revealed that students who achieved a GPA in the professional bachelor of 70% or more, are more likely to achieve higher grades in the transfer programme. On the campus with the support programme there is an increase in incoming transfer students who graduate with honours or higher in the PBA, except for the academic year 2017-2018 (see Table 62). This increase is border insignificant (χ=3.5691, p=.058) It is not possible to relate this increase only to this research since in 2014-2015, when the student support programme was not yet implemented, there was already a major increase.

TABLE 62. INFLOW PROFILE OF THE FET CAMPUS WITH COMPLETE STUDENT SUPPORT PROGRAMME

Inflow	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018
With honours or >	34%	50%	58%	59%	46%
No honours	66%	50%	42%	41%	54%
Included students	50	46	45	39	35

Note. Based on available data of students that followed a PBA associated with KU Leuven.

Besides an increase in students who graduated with honours, there is also an increase in students who followed a general track during secondary education, from 27% to 35%. Staying cautious when relating these changes to the research is important, since it is also possible that the inflow of the professional Bachelor's programme has changed throughout the years. Looking at the total percentage of students that graduate with honours or higher in the professional bachelor, there is a small increase (39% to 42%). There is also an increase in graduated professional bachelor students who followed a general track (29% to 33%). For now it is not possible to state that these changes are entirely due to this research. Further analysing this data will be necessary.

3.2 RESEARCH QUESTIONS ANSWERED

RQ3. *Can we measure the effectiveness of the interventions that are developed in this research?*

It is difficult to measure in a scientifically correct way the actual effectiveness and at the same time guarantee that the ethics are correct. Even when an experimental design is used, which was not used in this research, it is still challenging to measure only the effectiveness of an intervention. Effectiveness in this research was measured, in general, via a perceived usefulness ranking questionnaire and by determining if the objectives were achieved. In general, students perceived the interventions as useful, especially the ones in which they received individual feedback. However, due to the use of the ranking questionnaire, it is not possible to say if students found the lower ranked interventions not useful. During this research, measuring the effectiveness of a cognitive intervention (i.e. MOOC) via a performance measurement was more convenient than the measurement of the effectiveness of a non-cognitive intervention (i.e. time management training) for which a self-reported pre-and post-test design was used. Besides effectiveness, efficiency also has an important role. For instance, a very effective intervention that comes at a really high cost and effort is perhaps not a long-lasting intervention. Unfortunately, the measurement of the efficiency of an intervention is often not included in literature. In this current work, efficiency was assessed via an estimation of the time required to develop and implement the intervention, and the scalability. An efficient intervention has preferably a low implementation time and is easy scalable such as the diagnostic test and the mathematics MOOC. A high(er) development time is not considered as a problem, since it is reasonable that developing an effective intervention takes time. To conclude, in this research it was possible to make a first estimation of the effectiveness and efficiency of the interventions.

RQ4. *Is it possible to reduce drop out or assure that reorientation can happen at an earlier stage?*

Unfortunately, there was no distinct decrease in the dropout rate and it was also not possible to assure that reorientation happened at an earlier stage (i.e. during the first year). However, the dropout rate during the second and after the second year in the transfer programme is substantially lower since the moment the interventions were organised. Due to the CSE regulation, which was introduced in the same academic year as the interventions, it was not possible to associate this lower dropout rate in the second and after the second year exclusively with the organised interventions.

Since one of the aims of this research was to improve the guidance of students before enrolment, it was also decided to examine the inflow in the transfer programme. First of all, since the start of this research the number of enrolled students on the pilot campus decreased and secondly there are some indications that the quality of the inflow (i.e. larger proportion that graduated with honours in PBA) has improved. Thus, it is possible that more students make a well-considered choice thanks to the interventions before enrolment (i.e. Meet & Greet workshop, MOOC, and diagnostic test) and decide to not enrol in the transfer programme. However, as stated in Chapter 5, once a student is enrolled it is important to support them. The organisation of intermediate exams and individual feedback conversation can also trigger an early dropout. In Chapter 3, which included the comparison between the transfer students at FET and the level 7 to level 8 students at DIT, there was a major difference in the dropout rates, since at DIT, the dropout rates were as good as non-existent. The most important explanation for this almost non-existing dropout is the use of admission requirements at DIT. This gives reason to believe that the implementation of an entrance exam with limited consequences could decrease the dropout rate.

3.3 SUGGESTIONS FOR FUTURE WORK

Future work must firstly focus on finding more statistical evidence of the effectiveness of the developed interventions. In order to do this, one needs larger pilots and thus more participants in the interventions. With larger pilots it can then be examined if the theoretical scalability is aligned with reality. It is also important to determine, via qualitative research, why students found for instance, an induction day less effective and which adaptations can be made to make it more effective. Combining all these elements allows to fine tune the effectiveness efficiency matrix. The methods, used to measure the effectiveness of the interventions, can be improved in different manners. For instance, the development of a validated pre- and post-test for the Meet & Greet workshop and time management training. For the MOOC, it would be worthwhile to develop a pre-test that captures students' prior knowledge. Regarding the intermediate exams and the individual feedback conversations, it can be examined what students do after the feedback and if it is possible to notice behavioural changes. Examining more in-depth if students are satisfied with the nature, quality and frequency of the individual feedback conversations is important too.

Although the student support programme that was developed in this research already includes quite a number of interventions, it should be further examined if there are other needs. During focus group discussions it was mentioned that some students for instance did not have chemistry during secondary education. Therefore, developing a basic science and engineering MOOC seems needed.

Regarding the mathematics MOOC, much research can be done regarding the learning analytics of this course. For instance, it is possible to gain insight in the profile of the MOOC follower and examine if students watch all the videos or make all the self-tests. It can be examined if students go linearly through the MOOC or only go through one or two modules. Another possibility is to determine if the MOOC profile of the high achievers on the diagnostic test is different in comparison to low achievers. Xiong et al. (2015) found that motivation is predictive for course engagement and that engagement predicts MOOC retention. Future work can examine if the more motivated students are more engaged in the MOOC and are more likely to retain and complete the MOOC.

Although MOOCs have a high development time, the advantage that there is no restriction on the number of participants is tremendous. With this in mind, it would be worthwhile to develop more MOOC's. These MOOC's can focus on cognitive or non-cognitive aspects. As already mentioned, a MOOC that focuses on the required basic science and engineering knowledge before enrolment should be beneficial. Furthermore, a MOOC that focuses on students learning and study strategies is interesting for students who want to work on their strategies at their own pace. The sessions on-campus can be for other students or supplementary to the MOOC. Another advantage of developing more MOOC's is that distance learners can also benefit from this.

For the interventions that aim to result in behavioural changes, students' behaviour can be measured via technology instead of involving an observer. The measurement via technology can be compared to students' self-reported answers on the pre and post-test. It would be interesting to measure for instance students' concentration via eye-tracking. Some studies already used eye-tracking to examine students' visual attention when solving a multiple-choice science problem (van Meeuwen et al. 2014, Tsai et al. 2012). In 2017, IMEC (Interuniversitair Micro-Elektronica Centrum) launched their Smart education programme, in which they amongst other things want to develop a mobile learning environment that uses sensors to measure students' concentration and stress level[49].

---

[49]https://www.imec-int.com/nl/imec-magazine/imec-magazine-januari-2018/Technologie-kan-een-revolutie-in-het-onderwijs-betekenen-met-imecs-Smart-Education-programma-hebben-we-het-ecosysteem-gecreeerd-om-deze-innovatie-te-versnellen

With the focus on the transition and the perceived fit of the students (Chapter 2 and 3), future research should repeat the conducted focus group discussions and dropout interviews with students who participated in the student support programme. By doing this, it can be examined if there are notable changes after implementation of the student support programme or if students still experience the same difficulties as their predecessors. When conducting dropout interviews it can be determined if students dropped out (1) because they had to, due to the CSE regulation or (2) because they realized after intermediate exams and individual feedback conversations that it is better to dropout, or (3) for another reason. This is one way to examine if academic probation or mentoring are the main reason for dropping out early.

As stated in Chapter 1, the interventions in this research were student-centred. Hattie (2015) concluded that about 50% of the variance in achievement was a function of students' characteristics. Another 20% of the variance was related to the teacher. Therefore future work can examine the effectiveness of teacher-centred interventions. During this dissertation one teacher-centred intervention was developed and implemented once, namely a workshop for teachers that focused on how a teacher can integrate study strategies during the exercise sessions. Although this workshop was positively evaluated by the teachers, it is not included in this research. Schneider and Preckel stated that for instance stimulating meaningful learning (i.e. teachers preparation, relating content to the students) and social interaction (i.e. teachers encouragement of questions/discussion) were significantly related to students' academic achievement.

4 LIMITATIONS

The limitations of this dissertation are categorized into four categories: limitations regarding the sample (Section 4.1), the used methodology (Section 4.2), the available data (Section 4.3), and other limiting factors (Section 4.4).

4.1 SAMPLE

- Small sample sizes, especially when examining the effectiveness of the interventions, is one of the major limitations in this dissertation, since small sample sizes decrease the statistical power (i.e. the power to detect an effect). In addition, when participation is voluntary, there can be bias in the results due to non-response.
- When determining the prediction models (academic, students' background and diagnostic models) there was always a variability in number of included students

due to missing data. Especially when participation in the diagnostic test was not really high (first pilot), this resulted in models with smaller samples.

4.2 Methodology

- Regarding the optimization of the diagnostic test the possibilities are restricted due to timing. When students take the test before enrolment, these results can only be linked to their academic achievement in the transfer programme one year later. The available time between analysing the data and the organisation of the next pilot was really restricted (i.e. sometimes only one or two weeks). Therefore, for the second pilot is was decided to organise a retest and add an extra test based on literature. For the third pilot it was possible to use the information gathered in the first pilot.
- The use of self-developed questionnaires (e.g. pre- and post-test for measuring the effectiveness of the Meet & Greet workshop and time management training) is considered to be a limitation of this study. Analysing the results in detail made it clear that not all the questions are appropriate. In the future, validated questionnaires should be used or developed. Although the pre- and post-tests, used in this dissertation, are far from perfect, they definitely give a first idea of the effectiveness of an intervention.
- Assumptions statistical analyses: regarding independent sample t-tests and paired t-tests normality was checked via Shapiro-Wilk test, for the independent sample t-tests equality of variances was tested via Levene's test. The normality assumption was always met, whereas the equality of variances was not always met. If equality of variances was not assumed, this is marked in the tables with an *. None of the regression analyses showed multicollinearity (VIF was always <3). The normality of residuals and homoscedasticity was checked via PP plots and scatterplots. The normality of the residuals was not always perfect for the models of GPA End and sometimes GPA June, but for GPA January this was assumption was met.
- Since participation for almost all the interventions was voluntary, self-selection has taken into account via controlling for some variables such as GPA PBA and level of math during secondary education.
- It was not manageable to organise all these intervention on all the campuses of FET. Some of the interventions were organised on the three pilot campuses, but only on one campus the whole student support programme was implemented. If interventions were organised on all the campuses, the sample sizes were larger.
- It was decided to develop a complete student support programme for the transfer students during this research. As a result, there was less time remaining

for measuring the effectiveness of the interventions. For two interventions, the effectiveness was analysed more in-depth.

- Efficiency is estimated based on both development and implementation time, and the scalability of the intervention. This is only an estimation and for instance does not take into account the different statutes and corresponding salaries of the faculty that were involved in the development and implementation of the interventions.

4.3 DATA

- There are only data available as from the academic year 2013-2014, so it is not yet possible to do historical analysis.
- There is no information about students' background in the professional Bachelor's programme for students who followed a programme at a university college that is not a member of the Association KU Leuven.
- Although four pilots were carried out, only data of the first three can be included, since the students of the fourth pilot only started in 2018-2019.
- It is not possible to track students that drop out during the academic year if they do not officially withdraw.

4.4 OTHER FACTORS

- In American institutions, students and faculty are offered a compensation for being a tutor or study advisor. No such thing has been done during this research. The two main reasons for not offering compensations were: (1) there was no budget to do so and (2) students or faculty should realise that participation or being involved can be useful for themselves and a learning experience for the future. Therefore the goodwill of colleagues (for example for the development of the MOOC and time management training) and students (for example for filling in questionnaires and participation in focus group discussions and interventions) was very important.

5 LINK WITH ACTUAL EDUCATIONAL SITUATION

Before heading to the general conclusion, we will place this dissertation in the context of the actual education situation in Flanders. Many of the topics, covered in this dissertation, are incorporated in the current educational policy plan of the KU Leuven: (1) Orientation of prospective students via pre-academic initiatives, (2) non-binding diagnostic tests, (3) more attention for transfer students, and (4) the use of MOOC's.

The Flemish government provides subsidies for improving students' educational choices. For example, the Columbus test focuses on making a well-considered educational choice after secondary education. This dissertation focuses on the educational choice after a professional Bachelor's programme, but the approach is similar. According to Onderwijs Vlaanderen[50], transfer programmes are very popular amongst students. Consequently, this dissertation can function as an inspiration source for other programmes and institutions as well. Especially, when more and more students are entering higher education. The success rates and completion rates of Flemish students in higher education are a concern. The effects of the flexibilisation are currently examined at UGent. KU Leuven and UGent stated that they aim to increase success rates by using more activating methods during lecturers, lab-, and exercise sessions.

The use of diagnostic testing has become a hot topic in Flanders in recent years. In the academic year 2018-2019 the diagnostic test at Engineering Science became obligatory. As from academic year 2019-2020 this will also be obligatory for prospective students in Engineering Technology and Bio Engineering. Although these tests are obligatory, they provide students with a non-binding advice.

To conclude, it is clear that this dissertation focuses on important topics and concerns of the current educational situation in Flanders.

6 GENERAL CONCLUSION

This exploratory research about an unstudied group of students resulted in important findings for students, faculty, and student advisors. An important conclusion is that although transfer students already followed a higher education programme, there are many more similarities (e.g. transition problems and academic outcomes) with traditional first-year students than one might suspect. Just as the transition from secondary education to university can be difficult for the first-year students, the transfer from a professional Bachelor's programme to the transfer programme is at least as difficult. Although the transfer students are already more mature, this does not guarantee that they have for instance better developed study strategies to be successful at university. The comparative study with the Irish level 7 to level 8 students, showed that the educational context is of paramount importance. Due to the open-entrance system in Flanders, using information regarding students' pre-entry attributes before enrolment is worthwhile. Students' background and the results of the diagnostic test contain valuable information.

[50] https://onderwijs.vlaanderen.be/nl/hoger-onderwijs-in-cijfers

Regarding student' background, students' prior achievement (i.e. GPA PBA) is a very strong predictor and if a student graduates with 70% or higher in the professional Bachelor's programme their chances to be successful in the transfer programme increases significantly. The diagnostic test, which included both cognitive and non-cognitive variables, gives students information about malleable variables that influence their possible study success.

An important goal of this dissertation was to improve the guidance of students in their educational choice before enrolment as well as provide them with the required support once they are enrolled. The diagnostic test is a tool that aims to stimulate students to make a well-considered educational choice and to participate in interventions. For the development of these interventions, both the effectiveness and efficiency are taken in to account and considered as equally important. However, it is difficult to measure the effectiveness of interventions, especially when ethics are taken into account. In general, the transfer students were satisfied with the support offered in the student support programme, both before and after enrolment.

Although the predetermined challenge in this study was to decrease dropout rates, analyses showed no evidence regarding a significant change in dropout. The dropout rate during the second and after the second year in the transfer programme is substantially lower since the interventions were organised. Due to the CSE regulation it is not possible to attribute this lower dropout rate in the second and after the second year exclusively to the organised interventions. However, this study did find some first empirical evidence regarding an improved inflow in the transfer programme, which is considered as a first step towards a lower dropout.

REFERENCES

Ackerman, P. L., Kanfer, R., and Beier, M. E. 2013. "Trait complex, cognitive ability, and domain knowledge predictors of baccalaureate success, STEM persistence, and gender differences." *Journal of Educational Psychology*, 105 (3): 911–927. doi:10.1037/a0032338.

Ahmed, N., Kloot, B., and Collier-Reed, B. I. 2014. "Why students leave engineering and built environment programmes when they are academically eligible to continue." *European Journal of Engineering Education*, 40 (2): 128–144. doi:10.1080/03043797.2014.928670.

Araque, F., Roldán, C., and Salguero, A. 2009. "Factors influencing university dropout rates." *Computers & Education*, 53 (3): 563–574. doi:10.1016/j.compedu.2009.03.013.

Armstrong, L. and Rimes, K.A. 2016. "Mindfulness-Based Cognitive Therapy for Neuroticism (Stress Vulnerability): A Pilot Randomized Study". *Behaviour Therapy,* 47(3):287-98. doi: 10.1016/j.beth.2015.12.005

Astin, A. W. 1993. *Assessment for excellence: The philosophy and practice of assessment and evaluation in higher education*. Phoenix: The Oryx Press.

Bacon, H.K.K., Birdwell, J.A., Brown, O., Tevaarwerk, E., Freeman, R.W., Roldan, W., Gentry, K., and Pokryfky, A.R. 2018. "Academic Advising and Student Affairs Working Together to Improve First year Experience of Engineering Students". Paper presented at the 125st annual ASEE conference, Utah, United States of America, June 24-28.

Bailli, C., and Fitzgerald, G. 2000. "Motivation and attrition in engineering students." *European Journal of Engineering Education,* 25 (2): 145-155.

Berger, J.B., and Malaney, G.D. 2003. "Assessing the Transition of Transfer Students from Community Colleges to a University", *NASPA Journal*, 40(4):1-23, DOI: 10.2202/1949-6605.1277.

Bernold, L. E., Spurlin, J. E., and Anson, C. M. 2007. "Understanding Our Students : A Longitudinal-Study of Success and Failure in Engineering With Complications for Increased Retention." *Journal of Engineering Education*, 96 (3): 263-274.

Billing, D. 1997. "Induction of New Students to Higher Education", *Innovations in Education and Training International*, 34(2): 125-134, DOI:10.1080/1355800970340208.

Briggs, A.R.J., Clark, J., and Hall, I. 2012. "Building Bridges: Understanding Student Transition to University." *Quality in Higher Education,* 18(1):3–21.doi:10.1080/13538322.2011.614468.

Broos, T., Peeters, L., Verbert, K., Van Soom, C., Langie, G., and De Laet T. 2017. "Dashboard for Actionable Feedback on Learning Skills: Scalability and Usefulness." In: Zaphiris P., Ioannou A. (eds) *Learning and Collaboration Technologies. Technology in Education*. LCT 2017. Lecture Notes in Computer Science, vol 10296. Springer, Cham. https://doi.org/10.1007/978-3-319-58515-4_18.

Burrus, J., Jackson, T., Holtzman, S., and Roberts, R.D. 2017. "Teaching High School Students to Manage Time: The Development of an Intervention". *Improving Schools,* 20(2):101-112.

Burtner, J. 2005. "The Use of Discriminant Analysis to Investigate the Influence of Non-Cognitive Factors on Engineering School Persistence." *Journal of Engineering Education,* 94 (3): 335-338.

Carmines, E.G., and Zeller, R.A. 1979. *Reliability and validity assessment*. Newbury Park: Sage.

Carr, M., Ni Fhloinn, E., and Bowe, B. 2013. "Core skills assessment to improve mathematical competency" *European Journal of Engineering Education*, 38(6): 608-619, DOI:10.1080/03043797.2012.755500.

Carr, M., Bigotte, E., Fidalgo, C., Santos, V., Branco, J.R., Murphy. E., and Ni Fhloinn, E. 2015. "Mathematics diagnostic test in engineering: An international comparison between Ireland and Portugal" *European Journal of Engineering Education,* 40(5):546-556, DOI:10.1080/03043797.2014.967182.

Carr, M., Sheridan, D., Llorens, M., O'Shaughnessy, S., Mc Carrick, A., Sorby, S., and Bowe, B. 2015. "What role does Mathematical preparedness play for engineering students who transfer from an Ordinary degree into an Honours degree?" Paper presented at Research in Engineering Education Symposium (REES), Dublin, Ireland, July 13-15.

Charleer, S., Vande Moere, A., Klerkx, J., Verbert, K., and De Laet, T. 2018. "Learning Analytics Dashboards to Support Adviser-Student Dialogue". *IEEE Transactions on Learning Technologies*, 11(3):389-399, doi: 10.1109/ TLT.2017.2720670.

Chingos, M.M., Griffiths, R.J., and Mulhern, C. 2017. "Can Low-Cost Online Summer Math Programs Improve Student Preparation for College-Level Math? Evidence From Randomized Experiments at Three Universities", *Journal of Research on Educational Effectiveness*, 10(4):794-816.

Cejda, B.D. 1994. “Reducing transfer shock through faculty collaboration: A case study.” *Community College Journal of Research and Practice,* 18:189-199.

Cohen, J. 1988. *Statistical power analysis for the behavioral sciences*. 2nd ed. Hillsdale, NJ: Lawrence Earlbaum Associates.

Cohn, E., Cohn, S., Balch, D.C, and Bradley, J. 2004. “Determinants of undergraduate GPAs: SAT scores, high-school GPA and high-school rank.” *Economics of Education Review*, 23(6):577–586.doi:10.1016/j.econ edurev.2004.01.001.

Cole, J. S., and Osterlind, S.J. 2008. “Investigating differences between low- and high-stakes test performance on a general education exam”. *The Journal of General Education*, 57:119–130.

Conley, D.T. 2007. “Redefining College Readiness.” Eugene, OR: Educational Policy Improvement Center.

Dale, M. 1993. *Developing Management Skills: Techniques For improving Learning and Performance*. London: Kogan Page Limited.

Danitz, S., Suvak, M., and Orsillo, S. 2016. “The Mindful Way Through the Semester: Evaluating the Impact of Integrating an Acceptance-Based Behavioral Program Into a First-Year Experience Course for Undergraduates”. *Behavior Therapy*. 47.487-499.

Day, I.N.Z., van Blankenstein, F.M., Westenberg, M., and Admiraal., W. 2018. “A review of the characteristics of intermediate assessment and their relationship with student grades”, *Assessment & Evaluation in Higher Education*, 43(6):908-929, DOI: 10.1080/02602938.2017.1417974.

De Barba, P.G., Kennedy, G.E., and Ainley, M.D. 2016. “The Role of Students ’ Motivation and Participation in Predicting Performance in a MOOC.” *Journal of computer assisted learning*, 32:218–31.

De Winter, J.C.F., and Dodou, D. 2011. “Predicting Academic Performance in Engineering Using High School Exam Scores.” *International Journal of Engineering Education*, 27(6): 1343–1351.

Drucker P.F. 1967. *The Effective Executive*. Heinemann: London.

Dweck, C.S. 2006. *Mindset: The new psychology of success*. Random House LLC.

European Commission/EACEA/Eurydice, 2015. *The European Higher Education Area in 2015: Bologna Process Implementation Report.* Luxembourg: Publications Office of the European Union.

ECITB. 2018. “Engineering today: The supply and demand for engineers in the UK” Herts: UK.

Engineering UK. 2018. “Engineering UK 2018: The state of engineering Synopsis” London: UK.

Embretson, S.E., and Reise, S.P. 2000. *Item response theory for psychologists*. Mahwah, NJ: Lawrence Erlbaum.

Faculty of Engineering Technology. 2014. Zelfevaluatierapport Bachelor of Science in de industriële wetenschappen [Self Evaluation Report Bachelor of Science in Industrial Sciences]. Leuven: KU Leuven.

Faulkner, F., Hannigan, A., and Gill, O. 2010. “Trends in the Mathematical Competency of University Entrants in Ireland by Leaving Certificate Mathematics Grade.” *Teaching Mathematics and its Applications*, 29(2):76–93. doi:10.1093/teamat/hrq002.

Fink, A., ed. 1995. *The survey Handbook*, v.1.Thousand Oaks, CA: Sage.

Fonteyne, L., Duyck, W., and De Fruyt, F. 2017. “Program-specific prediction of academic achievement on the basis of cognitive and non-cognitive factors.” *Learning and individual differences*, 56:34-48.

Forrest, R.L., Stokes, D.W., Burridge, A.B., and Voight, C.D. 2017. “Math Remediation Intervention for Student Success in the Algebra-Based Introductory Physics Course”, *Physical review physics education research*, 13:1–8.

Fotheringham, J., and Alder, E. 2012. “Getting the message: supporting students’ transition from Higher National to degree level study and the role of mobile technologies,” *Electronic Journal of e-Learning*, 10(3):264-274.

Fredricks, J.A. and Eccles, J.S. 2006. “Is extracurricular participation associated with beneficial outcomes? Concurrent and longitudinal relations”. *Developmental Psychology*, 42(4):698-713.

French, B. F., Immekus, J. C., and Oakes, W. C. 2005. “An Examination of Indicators of Engineering Students’ Success and Persistence.” *Journal of Engineering Education*, 94 (4): 419–425. doi:10.1002/j.2168-9830 .2005.tb00869.x.

Georg, W. 2009. “Individual and institutional factors in the tendency to drop out of higher education: a multilevel analysis using data from the Konstanz Student Survey.” *Studies in Higher Education*, 34 (6): 647–661. doi:10.1080/03075070802592730.

Godfrey, E., Aubrey, T., and King, R. 2010. “Who leaves and who stays? Retention and attrition in engineering education”, *Engineering Education*, 5(2):26-40, DOI:10.11120/ened.2010.05020026.

Greenbank, P. 2007. "From foundation to honours degree: the student experience”, *Education+Training*, 49(2):91-102, DOI:10.1108/00400910710739450.

Greenberg, D., Kosinski, M., Stillwell, D., Monteiro, L.B., Levitin, D.J., and Rentfrow, P. 2016. “The Song Is You: Preferences for Musical Attribute Dimensions Reflect Personality*”. Social Psychological and Personality Science*.7.10.1177/194855061664 1473.

Hall, C.W., Kauffmann, P.J., Wuensch, K.L., Swart, W.E., Deurquidi, K.A., Griffin, O.H., and Duncan, C.S. 2015. “Aptitude and Personality Traits in Retention of Engineering Students”. *Journal of Engineering Education*, 104(2):167–88.

Hattie, J.A.C. 2009. *Visible learning: A synthesis of 800 meta-analyses relating to achievement*. Oxon, England: Routledge.

Hattie, J. 2015. “The Applicability of Visible Learning to Higher Education”. *Scholarship of Teaching and Learning in Psychology,* 1(1):79-91.

Hattie, J. and Timperley, H. 2007. “The power of feedback”. *Review of Educational Research*, 77(1):81-112. DOI: 10.3102/003465430298487.

Hawkes, T. and Savage, M.D. 2001. “Measuring the Mathematics Problem”. Engineering Council, UK.

Hieb, J.L., Lyle, K.B., Ralston, P.A.S., and Chariker, J. 2015. “Predicting Performance in a First Engineering Calculus Course: Implications for Interventions”. *International Journal of Mathematical Education in Science and Technology*, 46(1):40–55.

Hills, J.R. 1965. “Transfer shock: The academic performance of junior college transfer.” *Journal of Experimental Education*, 33:201-215.

Holmegaard, H.T., Madsen, L.M., and Ulriksen, L. 2014. “A Journey of Negotiation and Belonging: Understanding Students ’ Transitions to Science and Engineering in Higher education”. *Cultural studies of Science Education*, 9: 755–86. ttps://doi.org/10.1007/s11422-013-9542-3.

Hone, K.S. and El Said, G.R. 2016. “Computers & Education Exploring the Factors Affecting MOOC Retention: A Survey Study”. *Computers & Education*, 98:157–68.

House, J. D. 2000. “Academic background and self-beliefs as predictors of student grade performance in science, engineering and mathematics.” *International Journal of Instructional Media,* 27 (2): 207-220.

Howieson, C. 2012. Students’ experience of the transition from HN to degree study 2011-12. University of Edinburgh: Centre for Educational Sociology.

Indreica, E.S., Cazan, A.M., and Truţa, C. 2011. “Effects of Learning Styles and Time Management on Academic Achievement”. *Social and Behavioral Sciences,* 30:1096–1102.

Jackson, D.L., Laanan, F.S. 2015. “Desiring to Fit: Fostering the Success of Community College Transfer Students in STEM”, *Community College Journal of Research and Practice*, 39(2):132-149, DOI: 10.1080/10668 926.2012.762565

Jansen, E.P.W.A. and Van Der Meer, J. 2012. “Ready for university? A cross-national study of students’ perceived preparedness for university”, *Australian Educational Researcher*, 39:1–16.

Johnson, P., and O’Keeffe, L. 2016. “The Effect of a Pre-University Mathematics Bridging Course on Adult Learners ’Self-Efficacy and Retention Rates in STEM Subjects”. *Irish Educational Studies*, DOI:10.1080/03323315 .2016.1192481.

Jones, S. 2017. “Expectation vs experience: might transition gaps predict undergraduate students’ outcome gaps?”, *Journal of Further and Higher Education*, DOI:10.1080/0309877X.2017.1323195.

Kobrin, J., Patterson, B.F., Shaw, E.J., Mattern, K., Barbuti, S.M. 2008. “Validity of the SAT ® for Predicting First-Year College Grade Point Average”. Coll. Board. 5.

Kuh, G.D., Cruce, T.M., Rick, S., Kinzie, J., and Gonyea, R.M. 2017. “Unmasking the Effects of Student Engagement on First-Year College Grades and Persistence*” The Journal of Higher Education* 79(5): 540–63.

Lamote, C., Pinxten, M., Van Den Noortgate, W., and Van Damme, J. 2014. “Is the Cure Worse than the Disease? A Longitudinal Study on the Effect of Grade Retention in Secondary Education on Achievement and Academic Self-Concept.” *Educational Studies,* 40(5):496–514.doi:10.1080/03055698.2014.936828.

Lanaan, F.S. 2001. “Transfer Student Adjustment. Transfer Students: Trends and Issues.” *New Directions for Community Colleges*, 114:5-13.

Langie, G., Valkeneers, G., De Samblanx, G., Mees, E., De Nil, I., Boukhlal, S., Moons, G.J., van Tilburg, C., and Gastmans, M. 2012. “Study track dependent values and exam results for master students in Engineering Technology” Paper presented at the 40th annual SEFI conference, Thessaloniki, Greece, 23-26 September.

Langie, G. and Van Soom, C. 2014. “Diagnostic test for students bridging to Engineering Technology.” Paper presented at 42nd annual SEFI meeting, Birmingham, September 15–19.

Larson, R. W. 2000. “Toward a psychology of positive youth development”. *American Psychologist*, 55:170 –183.

Lawson, D.A., Tabor, J.H., and Whitehead, A. 1995. “The implications of the spread of entry qualification of engineering undergraduates”. In Mustoe, L.R. and Hibberd, S. (eds) *Mathematical Education of Engineers*. Clarendon Press, Oxford, UK.

Lazowski R.A., and Hulleman C.S. 2016. “Motivation interventions in education: a meta-analytic review”. *Review Educational Research.* 86:602–40.

Lee, S. and Robinson, C.L. 2005. “Diagnostic testing in mathematics: paired questions”. *Teaching mathematics and its applications,* 24(4):154-166.

Leuwerke, W.C., Robbins, S., Sawyer, R., and Hovland, M. 2004. “Predicting Engineering Major Status From Mathematics Achievement and Interest Congruence”. *Journal of Career Assessment,* 12(2):135–49.

Llorens, M., Nevin, E. and Mageean, E. 2014. “Online Resource Platform for Mathematics Education.” Paper presented at 44th Annual Frontiers in Education (FIE) Conference, Madrid, Spain, October 22-25.

Lopez, C., Jones, S.J. 2016. “Examination of Factors that Predict Academic Adjustment and Success of Community College Transfer Students in STEM at 4-Year Institutions”, *Community College Journal of Research and Practice*, DOI: 10.1080/10668926.2016.1168328

Lowe, H. and Cook, A. 2003. “Mind the Gap: Are students prepared for higher education?” *Journal of Further and Higher Education*, 27(1):53-76, DOI:10.1080/03098770305629.

Magez, W., Tierens, M., Bos, A., Van Huynegem, J., and Decaluwé, V. 2013. CoVaT-CHC Uitbreiding.

Malm, J., Bryngfors, L., and Mörner, L.-L. 2014. “The potential of Supplemental Instruction in engineering education: helping new students to adjust to and succeed in University studies.” *European Journal of Engineering Education*, 40 (4): 347–365. doi:10.1080/03043797.2014.967179.

Marra, R. M., Rodgers, K. A., Shen, D., and Bogue, B. 2012. “Leaving Engineering : A Multi-Year Single Institution Study” *Journal of Engineering Education*, 101(1): 6-27. https://doi.org/10.1002/j.2168-9830.2012.tb00039.x

Mc Quay, P.L. 2000. “College Transfer: Community College to University, United States Community College System” Paper presented at the meeting of the Inter-American Bank Countries, Cambridge, UK, September 4-8.

Michie, S., Atkins, L., and West, R. 2014. The Behaviour Change Wheel: A Guide to Designing Interventions. London: Silverback Publishing.

Myers, B., Starobin, S.S., Chen, Y., Baul, T., Kollasch, A. 2015. “Predicting Community College Student’s Intention to Transfer and Major in STEM: Does Student Engagement Matter?”, *Community College Journal of Research and Practice*, 39(4): 344-354, DOI: 10.1080/10668926.2014.981896

Moses, L., Hall, C., Wuensch, K., De Urquidi, K., Kauffmann, P., Swart, W., and Dixon, G. 2011. “Are math readiness and personality predictive of first-year retention in engineering?” *The Journal of Psychology*, 145 (3): 229–45. doi:10.1080/00223980.2011.557749.

Morrison, J.Q., Rahschulte, R.L., McKinley, L., and Maxwell, A.M. 2014. “Examining intervention effectiveness and efficiency outcomes in single-case design studies”. *Problems of psychology in the 21st century,* 8(2): 161-171.

National Academy of Engineering. 2004. “The Engineer of 2020: Visions of Engineering in the New Century”. Washington, DC: The National Academies Press.doi:10.17226/10999.

Noyens, D., van Daal, T., Coertjens, L., Donche, V., and Van Petegem, P. submitted. “Assessing students’ perceived fit between secondary and higher education: a validation study.” *Journal of Psychoeducational assessment.*

O’Shaughnessy, S., Mc Carrick, A.M., Farrell, F., Beagon, U., and Pérez, L.C. 2015. “Is this “transfer shock”? Examining the perceptions of engineering students who articulate within the Irish higher education context” Paper presented at Research in Engineering Education Symposium (REES), Dublin, Ireland, July 13-15.

Pinxten, M., Langie, G., De Laet, T., and Van Soom, C. 2015. “Targeting increasing drop-out rates in the STEM field: The European readySTEMgo Project.” Paper presented at the 43nd annual SEFI meeting, Orléans, June 30 – July 2.

Pinxten, M., Van Soom, C., Peeters, C., De Laet, T., Hockicko, P., Pacher, P., and Langie, G. 2016. “Learning and study strategies of incoming science and engineering students: A comparative study between three institutions in Belgium, Slovakia, and Hungary”. Paper presented at the 44th annual SEFI meeting, Tampere, September 12-15.

Pinxten, M., Van Soom, C., Peeters, C., De Laet, T., and Langie, G. 2017. “At-risk at the gate: prediction of study success of first-year science and engineering students in an open-admission university in Flanders - any incremental validity of study strategies?” *European Journal of Psychology of Education*, 1-22. doi.org/10.1007/s10212-017-0361-x.

Prendergast, M. and O' Meara, N. 2016. "Assigning mathematics instruction time in secondary schools: what are the influential factors?" *International Journal of Mathematical Education in Science and technology*, 47(8):1137-1155. https://doi.org/10.1080/0020739X.2016.1192231.

Richardson, M., Abraham, C.., and Bond, R. 2012. "Psychological Correlates of University Students' Academic Performance: A Systematic Review and Meta-Analysis." *Psychological Bulletin* 138(2):353-87. doi:10.1037 /a0026838.

Robbins, S.B., Oh, I., Huy, L., and Button, C. 2009. "Intervention Effects on College Performance and Retention as Mediated by Motivational, Emotional, and Social Control Factors: Integrated Meta-Analytic Path Analyses". *Journal of Applied Psychology*, 94(5): 1163-1184.

Schneider, M., and Preckel, F. 2017. "Variables Associated With Achievement in Higher Education: A Systematic Review of Meta-Analyses." *Psychological Bulletin*, Advance online publication. http://dx.doi.org/10.1037 /bul0000098.

Seabi, J. 2004. "Relating Learning Strategies , Self-Esteem , Intellectual Functioning with Academic Achievement among First-Year Engineering Students" *South African Journal of Psychology,* 41(2):239–49.

Seymour, E., and Hewitt, N. 1997. *Talking about leaving: Why undergraduates leave the sciences*. Boulder, Colorado: Westview Press.

Sneyers, E. and De Witte, K. 2018. "Interventions in higher education and their effect on student success: a meta-analysis", *Educational Review*, 70(2):208-228, DOI:10.1080/00131911.2017.1300874.

Tempelaar, D., Rienties, B., and Nguyen, Q. 2017. "Towards Actionable Learning Analytics Using Dispositions". *IEEE Transactions on Learning Technologies*. 10:6-16. 10.1109/TLT.2017.2662679.

Ting, S.R. 2001. "Predicting Academic Success of First-Year Engineering Students from Standardized Test Scores and Psychosocial Variables." *International Journal of Engineering Education,* 17 (1): 75-80.

Tinto, V. (1993). Leaving College: Rethinking the Causes and Cures of Student Attrition, 2nd(ed.), Chicago: University of Chicago Press.

Torenbeek, M., Jansen, E.P.W.A., and Hofman, W.H.A. 2011. "Predicting first-year achievement by pedagogy and skill development in the first weeks at university." *Teaching in Higher Education*, 16(6): 655–668. doi:10.1080 /13562517.2011.560378.

Torenbeek, M., Jansen, E.P.W.A., and Hofman, W.H.A. 2011. "The Relationship between First-year Achievement and the Pedagogical-didactical Fit between Secondary School and University". *Educational Studies,* 37(5):557–68.

doi:10.1080/03055698.2010.539780.

Tsai, M.J., Hou, H.T., & Lai, M.L., Liu, W.Y., Yang, F.Y. 2012.” Visual attention for solving multiple-choice science problem: An eye-tracking analysis”. *Computers & Education*. 58. 375-385. 10.1016/j.compedu.2011.07.012.

Tynjälä, P., Salminen, R.T., Sutela, T., Nuutinen, A., and Pitkänen, S. 2005. “Factors related to study success in engineering education.” *European Journal of Engineering Education*, 30(2):221–231. doi:10.1080/0304379050 0087225.

Ulriksen, L., Madsen, L.M., and Holmegaard, H.T. 2010. “What do we know about explanations for drop out/opt out among young people from STM higher education programmes?” *Studies in Science Education*, 46 (2): 209–244. doi:10.1080/0305 7267.2010.504549.

UNESCO. 2010. “Engineering issues challenges and opportunities for development”. Paris, France. ISBN 978-92-3-104156-3

Van Daal, T., Coertjens, L., Delveaux, E., Donche, V., and Van Petegem, P. 2013. *Klaar voor hoger onderwijs of arbeidsmarkt? Longitudinaal onderzoek bij laatstejaarsleerlingen secundair onderwijs*. Antwerpen, Apeldoorn: Garant.

Van den Broeck, L., De Laet, T., Lacante, M., Van Soom, C., and Langie, G.. 2015. “Creating an optimized diagnostic test for students bridging to Engineering Technology.” Paper presented at 43nd annual SEFI meeting, Orléans, June 30 – July 2.

Van den Broeck, L., De Laet, T., Lacante, M., Van Soom, C., and Langie, G. 2018. “Study success of transfer students in Engineering Technology: The effect of a MOOC and a math diagnostic test”. Paper presented at the 125st annual ASEE conference, Utah, United States of America, 24-28 June.

Vanderoost, J., Callens, R., Vandewalle, J.P.L., and De Laet, T. 2014. “Engineering positioning test in Flanders: a powerful predictor for study success?” Paper presented at the 42nd annual SEFI conference, Birmingham, UK, September 15-19.

Van Meeuwen, L., Jarodzka, H., Brand-Gruwel, S., Kirschner, P., de Bock, J.J.P.R., Van Merrienboer, J..J.G. 2014. “Identification of effective visual problem solving strategies in a complex visual domain”. *Learning and Instruction*. 32:10–21. 10.1016/j.learninstruc.2014.01.004.

Van Soom, C. and Donche, V. 2014. “Profiling first-year students in STEM programs based on autonomous motivation and academic self-concept and relationship with academic achievement.” *PLoS ONE,* 9(11):e112489. Doi:10.1371/journal.Pone.0112 489.

Van Yperen, T., Veerman, J.W., and Bijl B. 2017. *Zicht op effectiviteit*. Rotterdam: Lemniscaat B.V.

Veenstra, C.P., Dey, E.L., and Herrin, G.D. 2008. “Is Modeling of Freshman Engineering Success Different from Modeling of Non-Engineering Success?” *Journal of Engineering Education*, 97 (4): 467–479. doi:10.1002/j.2168-9830.2008.tb00993.x.

Veenstra, C.P., Dey, E.L. and Herrin, G.D. 2009. “A model for Freshman Engineering Retention.” *Advances in Engineering Education* 1(3):1-33.

Vollsted, A.M. 2018. “Engineering Boot Camp: An Intense, Transformative Program for Incoming Freshmen”. Paper presented at the 125st annual ASEE conference, Utah, United States of America, 24-28 June.

Weinstein, C..E. 1987-2002-2016. *LASSI: Learning and Study Strategies Inventory.*© Clearwater, Florida: H&H. Dutch version: Lacante, M., W. Lens, and V. Briers.1999

Weinstein, C.E., and Palmer, D.R. 2002. *LASSI: User’s manual Learning and Study Strategies Inventory.*© Clearwater, Florida: H&H

Wilson, T.D. 2006. The power of social psychological interventions. *Science,* 313:1251–52

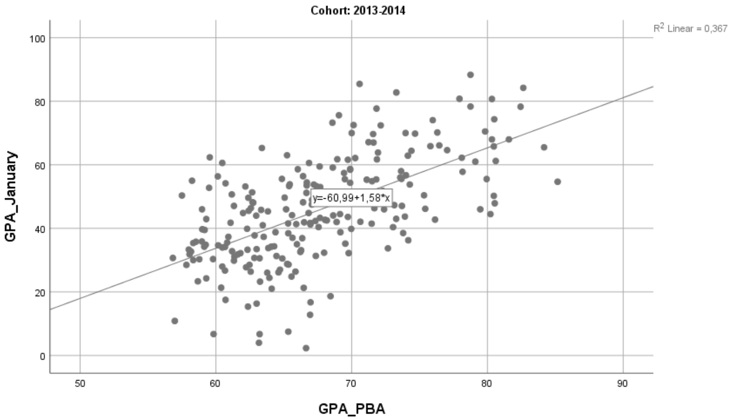
Xiong, Y., Li, H., Kornhaber, M.L., Suen, H.K., Pursel, B. and Goins, D.D. 2015. “Examining the relations among student motivation, engagement, and retention in a MOOC: A structural equation modeling approach”. *Global Education Review*, 2(3):23-33.

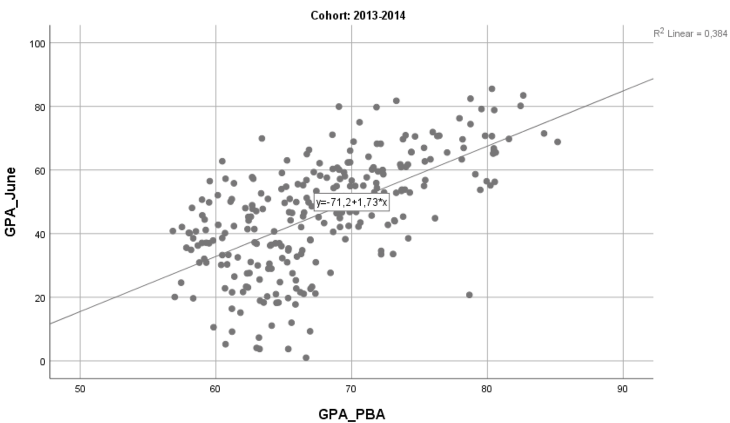
Yeager, D.S., Walton, G.M. 2011. “Social-psychological interventions in education: They’re not magic.” *Review of Educational Research,* 81:267–301. https://doi.org/10.3102/0034654311405999

Yorke, M. and Longden, B. 2004. *Retention and student success in higher education*. Maidenhead, UK: Open University Press.

APPENDIX

A. COHORT 2013-2014





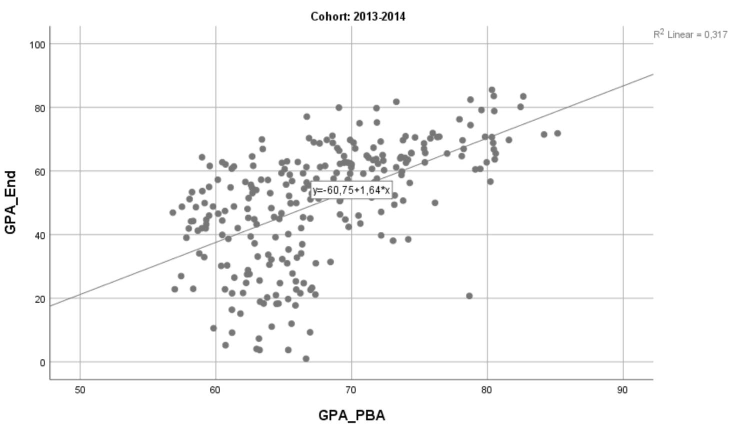


FIGURE 16. GPA PBA VS. GPA TR (A) JANUARY, (B) JUNE, (C) END; COHORT 2013-2014 (N=224)

TABLE 63. DICHOTOMOUS VARIABLES AND CORRESPONDING MEAN GPA'S (SD=STANDARD DEVIATION, N=NUMBER OF STUDENTS, T=T-VALUE); COHORT 2013-2014

		GPA January				GPA June				GPA End			
		Mean	SD	N	T	Mean	SD	N	T	Mean	SD	N	T
Gender	M	46%	17%	236	n.s.	45%	18%	279	n.s.	49%	19	279	n.s.
	F	49%	19%	34		51%	19%	39		55%	19	39	
Track SE	ASO	50%	17%	76	2.006	49%	19%	96	n.s.	53%	19	96	n.s.
	TSO	45%	17%	189	(p=.046)	45%	17%	215		49%	18	215	
Study delay	Yes	38%	12%	19	2.026	37%	15%	21	2.525	42%	18	21	2.124
	No	46%	17%	225	(p=.044)	47%	18%	258	(p=.012)	51%	18	258	(p=.035)
ECTS tolerated	Yes	37%	15%	51	4.001	35%	15%	61	5.827	39%	17	61	5.811
	No	48%	17%	193	(p<.001)	49%	17%	218	(p<.001)	53%	18	218	(p<.001)
Resits	Yes	40%	16%	21	n.s.	38%	16%	27	2.728	42%	18	27	2.438
	No	47%	16%	192		47%	18%	210	(p=.007)	51%	18	210	(p=.016)

B. COHORT 2014-2015

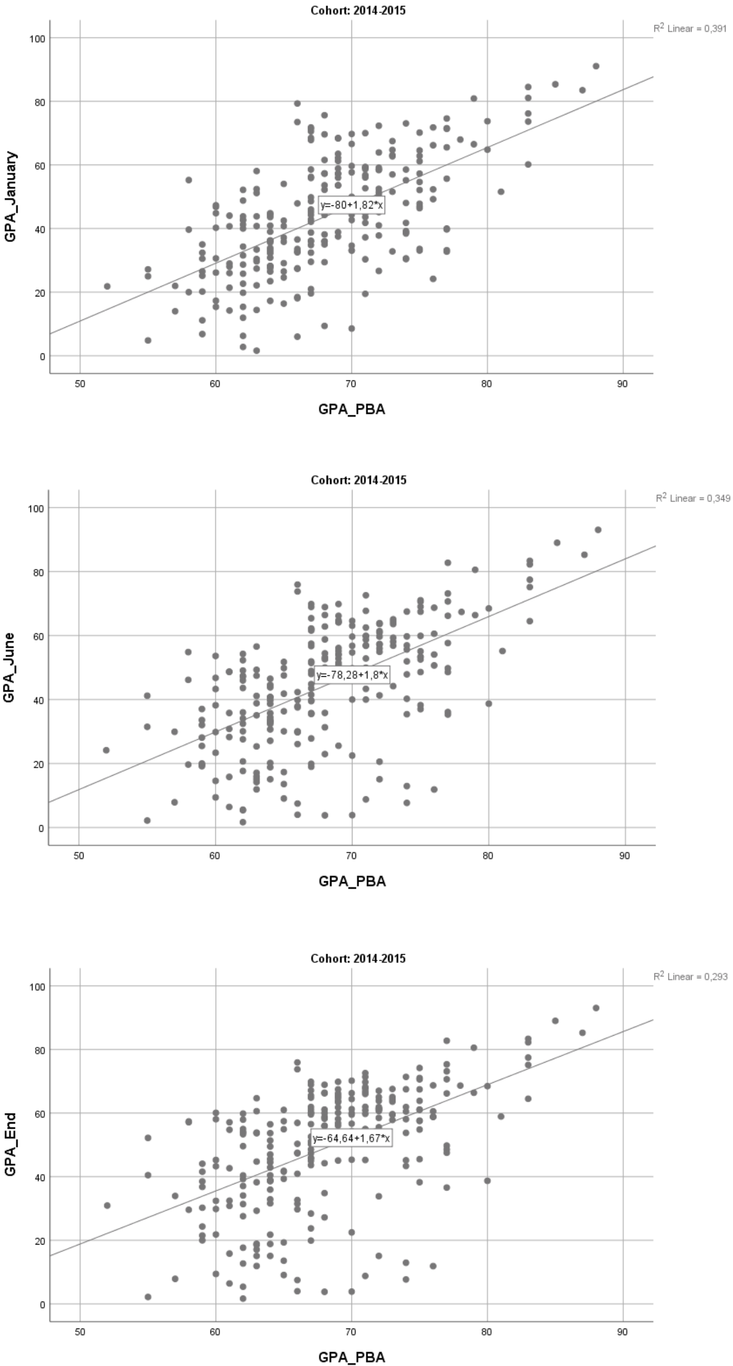


FIGURE 17. GPA PBA VS. GPA TR (A) JANUARY, (B) JUNE, (C) END; COHORT 2014-2015 (N=247)

TABLE 64. DICHOTOMOUS VARIABLES AND CORRESPONDING MEAN GPA'S (SD=STANDARD DEVIATION, N=NUMBER OF STUDENTS, T=T-VALUE); COHORT 2014-2015

		GPA January				GPA June				GPA End			
		Mean	SD	N	T	Mean	SD	N	T	Mean	SD	N	T
Gender	M	42%	19%	247	n.s.	43%	20%	247	n.s.	47%	20%	247	n.s.
	F	46%	16%	28		46%	15%	28		52%	16%	28	
Track SE	ASO	47%	18%	78	2.050	46%	19%	78	n.s.	51%	20%	78	n.s.
	TSO	42%	18%	193	(p=.041)	43%	19%	193		47%	19%	193	
Study delay	Yes	35%	19%	18	2.214	35%	16%	18	2.225	39%	15%	18	2.282
	No	45%	18%	230	(p=.028)	45%	19%	230	(p=.027)	50%	19%	230	(p=.023)
ECTS tolerated	Yes	37%	16%	55	3.147	38%	17%	55	2.915	44%	18%	55	2.362
	No	46%	18%	193	(p=.002)	46%	19%	193	(p=.004)	51%	19%	193	(p=.019)
Resits	Yes	33%	15%	39	4.790*	33%	15%	39	4.267	37%	16%	39	4.257
	No	46%	18%	209	(p<.001)	47%	19%	209	(p<.001)	51%	19%	209	(p<.001)

TABLE 65. CATEGORICAL VARIABLES AND CORRESPONDING MEAN GPA'S (SD=STANDARD DEVIATION, N=NUMBER OF STUDENTS, F=F-VALUE); COHORT 2014-2015

		GPA January				GPA June				GPA End			
		Mean	SD	N	F	Mean	SD	N	F	Mean	SD	N	F
Position in class	Disagree	41%	11%	31	10.764 (p<.001)	47%	11%	31	9.262 (p<.001)	52%	12%	31	9.481 (p<.001)
	Neither disagree/agree	47%	17%	38		49%	15%	38		54%	13%	38	
	Agree	57%	17%	45		59%	15%	45		63%	12%	45	

C. COHORT 2015-2016

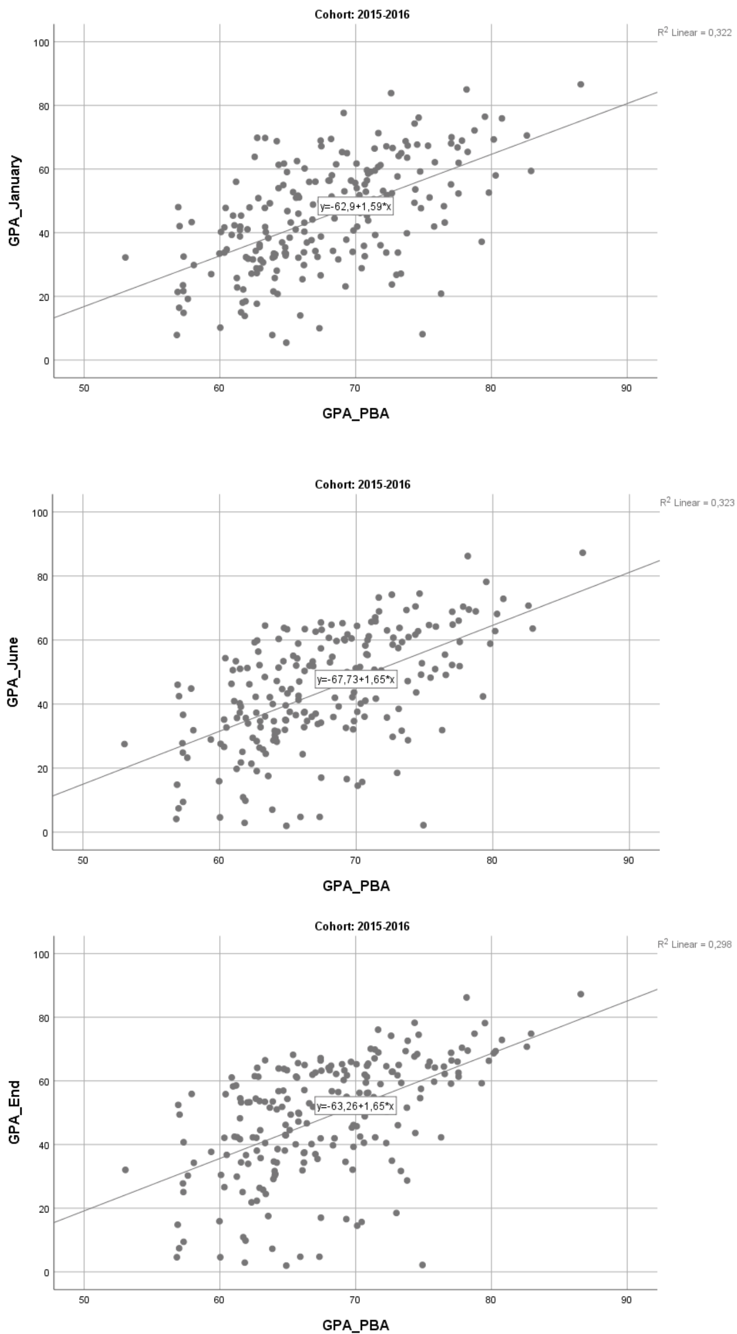


FIGURE 18. GPA PBA VS. GPA TR (A) JANUARY, (B) JUNE, (C) END; COHORT 2015-2016 (N=210)

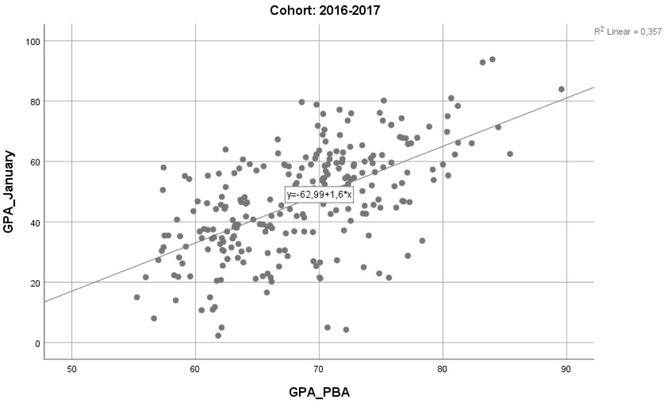
TABLE 66. DICHOTOMOUS VARIABLES AND CORRESPONDING MEAN GPA'S (SD=STANDARD DEVIATION, N=NUMBER OF STUDENTS, T=T-VALUE); COHORT 2015-2016

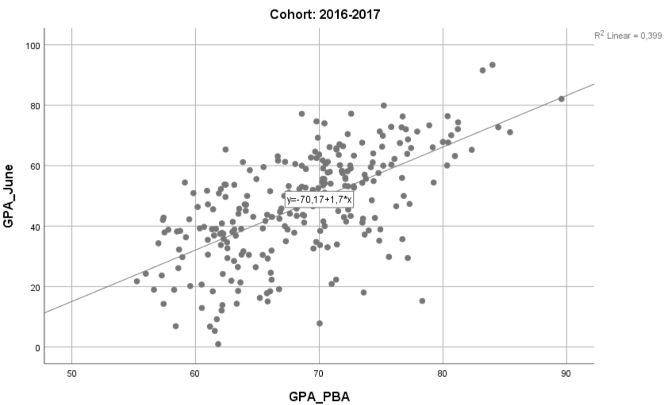
		GPA January				GPA June				GPA End			
		Mean	SD	N	T	Mean	SD	N	T	Mean	SD	N	T
Gender	M	44%	18%	217	n.s.	43%	18%	217	n.s.	47%	19%	217	n.s.
	F	48%	16%	36		47%	18%	36		52%	19%	36	
SES	Yes	45%	17%	113	n.s.	46%	17%	113	n.s.	50%	18%	113	n.s.
	No	42%	17%	45		42%	20%	45		46%	20%	45	
Track SE	ASO	50%	17%	83	3.386	49%	18%	83	2.959	52%	18%	83	2.530
	TSO	42%	17%	162	(p=.001)	42%	18%	162	(p=.003)	46%	19%	162	(p=.012)
Study delay	Yes	37%	20%	19	2.023	38%	20%	19	n.s.	43%	20%	19	n.s.
	No	46%	17%	189	(p=.044)	45%	17%	189		49%	18%	189	
ECTS tolerated	Yes	39%	17%	60	3.259	37%	18%	60	3.904	41%	19%	60	3.811
	No	48%	17%	151	(p=.001)	47%	17%	151	(p<.001)	51%	17%	151	(p<.001)
Resits	Yes	33%	15%	46	5.674	33%	16%	46	5.253	37%	18%	46	5.006
	No	48%	16%	165	(p<.001)	48%	17%	165	(p<.001)	52%	17%	165	(p<.001)

TABLE 67. CATEGORICAL VARIABLES AND CORRESPONDING MEAN GPA'S (SD=STANDARD DEVIATION, N=NUMBER OF STUDENTS, F=F-VALUE); COHORT 2015-2016

		GPA January				GPA June				GPA End			
		Mean	SD	N	F	Mean	SD	N	F	Mean	SD	N	F
Position in class	Disagree	37%	14%	42	4.705 (p=.010)	38%	17%	42	3.912 (p=.022)	42%	19%	42	3.805 (p=.024)
	Neither disagree/agree	46%	17%	44		47%	17%	44		51%	17%	44	
	Agree	47%	18%	73		47%	18%	73		51%	19%	73	
Contribution results	Disagree	39%	16%	33	5.682 (p=.004)	40%	18%	33	6.283 (p=.002)	44%	19%	33	7.115 (p=.001)
	Neither disagree/agree	38%	17%	34		38%	18%	34		41%	19%	34	
	Agree	48%	17%	91		49%	17%	91		53%	17%	91	
Effort	Not hard	42%	19%	82	n.s.	42%	19%	82	3.566 (p=.031)	46%	20%	82	3.403 (p=.036)
	Average	47%	16%	67		49%	16%	67		53%	17%	67	
	Hard	38%	12%	10		36%	15%	10		40%	18%	10	
Level of math	Low	41%	18%	31	n.s.	41%	18%	31	n.s.	45%	18%	31	n.s.
	Medium	46%	16%	55		47%	18%	55		50%	18%	55	
	High	44%	18%	73		44%	18%	73		49%	20%	73	
Decision	Before start PBA	45%	17%	25	n.s.	47%	17%	25	n.s.	51%	17%	25	n.s.
	During PBA	44%	17%	109		45%	17%	109		49%	18%	109	
	During summer	42%	19%	20		39%	20%	20		43%	21%	20	

D. Cohort 2016-2017





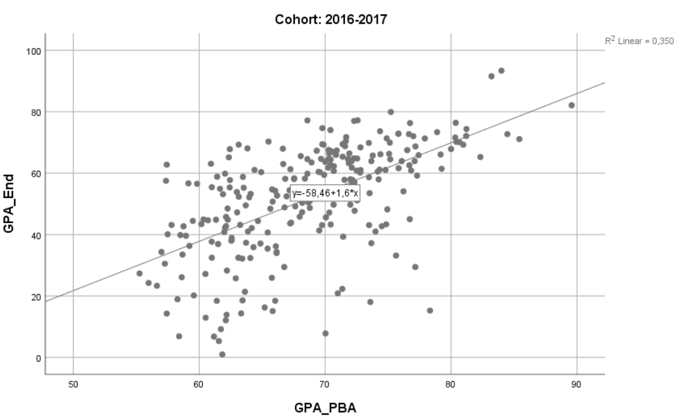


FIGURE 19. GPA PBA VS. GPA TR (A) JANUARY, (B) JUNE, (C) END; COHORT 2016-2017 (N=252)

TABLE 68. DICHOTOMOUS VARIABLES AND CORRESPONDING MEAN GPA'S (SD=STANDARD DEVIATION, N=NUMBER OF STUDENTS, T=T-VALUE); COHORT 2016-2017

		GPA January				GPA June				GPA End			
		Mean	SD	N	T	Mean	SD	N	T	Mean	SD	N	T
Gender	M	45%	18%	265	3.135*	45%	18%	265	2.026	50%	18%	263	n.s.
	F	53%	12%	33	(p=.003)	52%	16%	34	(p=.044)	56%	15%	33	
SES	Yes	47%	17%	199	n.s.	47%	17%	199	n.s.	52%	14%	197	n.s.
	No	46%	19%	70		46%	19%	70		50%	19%	69	
Track SE	ASO	49%	18%	100	n.s.	49%	18%	100	2.220	54%	18%	100	2.349
	TSO	45%	18%	193		44%	18%	194	(p=.027)	49%	18%	190	(p=.019)
Study delay	Yes	35%	18%	26	3.708	36%	18%	26	3.444	40%	19%	26	3.592
	No	48%	17%	227	(p<.001)	48%	17%	227	(p=.001)	53%	17%	225	(p<.001)
ECTS tolerated	Yes	38%	15%	56	4.502	37%	16%	56	4.830	41%	17%	56	5.087
	No	49%	17%	197	(p<.001)	50%	17%	197	(p<.001)	54%	17%	195	(p<.001)
Resits	Yes	39%	18%	89	4.730	40%	17%	90	3.888	46%	17%	89	3.008
	No	49%	17%	209	(p<.001)	49%	18%	209	(p<.001)	52%	18%	205	(p=.003)

TABLE 69. CATEGORICAL SECONDARY EDUCATION VARIABLES AND CORRESPONDING MEAN GPA'S (SD=STANDARD DEVIATION, N=NUMBER OF STUDENTS, F=F-VALUE); COHORT 2016-2017

		GPA January				GPA June				GPA End			
		Mean	SD	N	F	Mean	SD	N	F	Mean	SD	N	F
Position in class	Disagree	42%	14%	42	5.075 (p=.007)	44%	14%	42	n.s.	51%	15%	41	n.s.
	Neither disagree/agree	45%	18%	97		46%	18%	97		50%	18%	95	
	Agree	51%	17%	112		50%	18%	112		54%	17%	108	
Level of math	Low	43%	16%	51	n.s.	43%	17%	21	n.s.	48%	17%	49	n.s.
	Medium	45%	18%	114		45%	18%	114		49%	19%	112	
	High	48%	18%	114		48%	18%	114		53%	17%	113	
End result SE	Low	42%	16%	115	12.034	42%	17%	115	10.879	47%	18%	115	10.031
	Average	51%	15%	119	(p<.001)	50%	15%	119	(p<.001)	55%	15%	119	(p<.001)
	High	59%	22%	17		59%	23%	17		63%	23%	17	
Math result SE	Low	43%	16%	132	11.371	44%	17%	132	8.191	49%	17%	132	6.784
	Average	50%	15%	77	(p<.001)	49%	16%	77	(p<.001)	54%	16%	77	(p=.001)
	High	58%	19%	33		57%	20%	33		61%	19%	33	
Effort SE	Not hard	46%	15%	119	n.s.	46%	17%	119	n.s.	50%	17%	117	n.s.
	Average	50%	18%	98		50%	17%	98		54%	16%	96	
	Hard	44%	18%	34		46%	19%	34		50%	19%	34	

TABLE 70. CATEGORICAL PROFESSIONAL BACHELOR'S VARIABLES AND CORRESPONDING MEAN GPA'S (SD=STANDARD DEVIATION, N=NUMBER OF STUDENTS, F=F-VALUE); COHORT 2016-2017

		GPA January				GPA June				GPA End			
		Mean	SD	N	F	Mean	SD	N	F	Mean	SD	N	F
Contribution results	Disagree	42%	18%	56	6.243 (p=.002)	42%	19%	56	5.166 (p=.006)	47%	19%	56	4.338 (p=.014)
	Neither disagree/agree	45%	15%	59		46%	15%	59		51%	16%	59	
	Agree	50%	17%	135		50%	18%	135		55%	17%	130	
Effort PBA	Not hard	45%	18%	150		45%	18%	150		50%	18%	148	
	Average	49%	16%	105	n.s.	49%	16%	105	n.s.	54%	16%	103	n.s
	Hard	42%	19%	22		42%	22%	22		45%	22%	22	
Decision	Before start PBA	51%	18%	52		51%	15%	52	4.014 (p=.019)	56%	14%	52	4.810 (p=.009)
	During PBA	47%	16%	144	n.s.	48%	17%	144		52%	17%	141	
	During summer	43%	17%	55		42%	19%	55		46%	19%	54	

E. COHORT 2017-2018

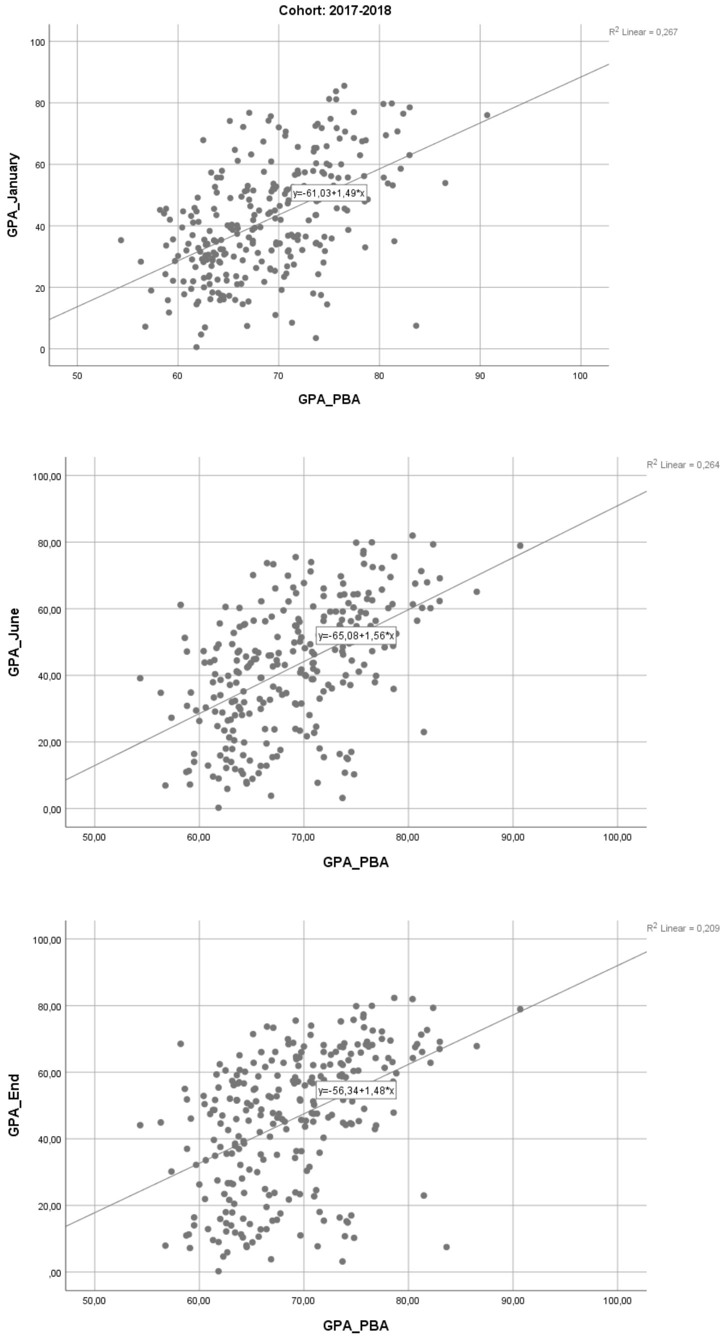


FIGURE 20. GPA PBA VS. GPA TR (A) JANUARY, (B) JUNE, (C) END; COHORT 2017-2018 (N=269

TABLE 71. DICHOTOMOUS VARIABLES AND CORRESPONDING MEAN GPA'S (SD=STANDARD DEVIATION, N=NUMBER OF STUDENTS, T=T-VALUE); COHORT 2017-2018

		GPA January				GPA June				GPA End			
		Mean	SD	N	T	Mean	SD	N	T	Mean	SD	N	T
Gender	M	41%	18%	289	3.129	42%	19%	279	3.302*	45%	21%	290	4.142*
	F	51%	15%	35	(p=.002)	50%	13%	35	(p=.002)	55%	12%	35	(p<.001)
SES	Yes	42%	17%	181	n.s.	43%	18%	173	n.s.	47%	19%	181	n.s.
	No	43%	18%	89		44%	20%	87		48%	21%	89	
Track SE	ASO	47%	19%	111	3.938*	48%	19%	108	3.749*	51%	19%	111	3.417
	TSO	39%	17%	205	(p<.001)	39%	18%	198	(p<.001)	43%	20%	206	(p=.001)
Study delay	Yes	35%	19%	25	n.s.	36%	18%	24	n.s.	40%	21%	25	n.s.
	No	42%	17%	247		42%	19%	239		46%	20%	247	
ECTS tolerated	Yes	35%	13%	49	3.601*	35%	16%	46	2.537	40%	17%	49	2.169
	No	43%	18%	223	(p=.001)	43%	19%	217	(p=.012)	47%	20%	223	(p=.031)
Resits	Yes	33%	15%	42	3.290	35%	16%	38	2.255	39%	19%	42	2.294
	No	43%	18%	230	(p=.001)	43%	19%	225	(p=.025)	46%	20%	230	(p=.023)

TABLE 72. CATEGORICAL SECONDARY EDUCATION VARIABLES AND CORRESPONDING MEAN GPA'S (SD=STANDARD DEVIATION, N=NUMBER OF STUDENTS, F=F-VALUE); COHORT 2017-2018

		GPA January				GPA June				GPA End			
		Mean	SD	N	F	Mean	SD	N	F	Mean	SD	N	F
Position in class	Disagree	32%	14%	40	8.817	31%	18%	39	13.027	34%	21%	40	11.054
	Neither disagree/agree	42%	17%	112	(p<.001)	43%	18%	108	(p<.001)	46%	20%	112	(p<.001)
	Agree	45%	18%	134		48%	18%	129		51%	18%	134	
Level of math	Low	33%	15%	46	11.522	35%	15%	45	8.549	40%	18%	46	5.980
	Medium	41%	18%	133	(p<.001)	43%	19%	128	(p<.001)	46%	21%	133	(p=.003)
	High	48%	17%	106		49%	18%	102		52%	19%	106	
End result SE	Low	41%	16%	138		42%	18%	132		45%	20%	138	
	Average	43%	20%	117	n.s.	44%	20%	113	n.s.	47%	21%	117	n.s.
	High	49%	14%	18		52%	16%	18		56%	17%	18	
Math result SE	Low	41%	18%	146		41%	19%	141	3.642	44%	21%	146	4.426
	Average	45%	17%	94	n.s.	48%	16%	91	(p=.028)	51%	17%	94	(p=.013)
	High	44%	20%	29		46%	19%	28		50%	20%	29	
Effort SE	Not hard	40%	17%	144		41%	18%	139	3.518	44%	20%	144	
	Average	44%	18%	116	n.s.	46%	18%	112	(p=.031)	50%	19%	116	n.s.
	Hard	47%	20%	26		48%	22%	25		50%	22%	26	

TABLE 73. CATEGORICAL PROFESSIONAL BACHELOR'S VARIABLES AND CORRESPONDING MEAN GPA'S (SD=STANDARD DEVIATION, N=NUMBER OF STUDENTS, F=F-VALUE); COHORT 2017-2018

		GPA January				GPA June				GPA End			
		Mean	SD	N	F	Mean	SD	N	F	Mean	SD	N	F
Contribution results	Disagree	39%	17%	71	3.368 (p=.036)	41%	19%	67	4.313 (p=.014)	44%	20%	71	4.468 (p=.012)
	Neither disagree/agree	40%	18%	67		40%	20%	65		43%	22%	67	
	Agree	45%	18%	148		47%	17%	144		50%	19%	148	
Effort PBA	Not hard	42%	17%	101	n.s.	43%	18%	99	n.s.	47%	19%	101	n.s.
	Average	42%	18%	159		44%	19%	152		47%	20%	159	
	Hard	42%	19%	26		43%	21%	25		46%	21%	26	
Decision	Before start PBA	48%	18%	46	3.574 (p=.029)	48%	18%	46	n.s.	53%	19%	46	3.790 (p=.024)
	During PBA	42%	17%	167		44%	18%	161		47%	20%	167	
	During summer	38%	19%	61		40%	19%	57		42%	21%	61	

F. DIAGNOSTIC TEST 2015-2016

TABLE 74. CORRELATION BETWEEN THE GPA'S AND THE COGNITIVE VARIABLES; COHORT 2015-2016 (N=82)

	GPA January	GPA June	GPA End	Math	Point series	Logical reasoning	Proverbs	Folding boxes
GPA January	1							
GPA June	.913**	1						
GPA End	.866**	.978**	1					
Math	.049	.101	.119	1				
Point series	-.089	-.062	-.062	.139	1			
Logical reasoning	-.029	-.105	-.119	.130	-.055	1		
Proverbs	.091	.193	.209	.250*	.168	.156	1	
Folding boxes	.051	.053	.062	.011	.131	.077	-.070	1

**.Significant at the 0.01 level (2-tailed). *.Significant at the 0.05 level (2-tailed).

TABLE 75. CORRELATIONS BETWEEN THE GPA'S AND THE LASSI SCALES: ATTITUDE(ATT); MOTIVATION(MOT); TIME MANAGEMENT(TMT); ANXIETY(ANX); CONCENTRATION(CON); INFORMATION PROCESSING(INP); SELECTING MAIN IDEAS(SMI); STUDY AIDS(STA); SELF-TESTING(SFT); AND TEST STRATEGIES (TST); COHORT 2015-2016 (N=51)

	GPA January	GPA June	GPA End	ATT	MOT	TMT	ANX	CON	INP	SMI	STA	SFT	TST
GPA January	1												
GPA June	.910**	1											
GPA End	.862**	.977**	1										
ATT	.245	.209	.185	1									
MOT	.140	.099	.123	.516**	1								
TMT	.236	.177	.200	.563**	.600**	1							
ANX	.022	-.009	.001	.401**	.137	.082	1						
CON	**.374****	**.334***	**.324***	.566**	.539**	.623**	.211	1					
INP	.150	.016	.038	.247	.226	.282*	.264	.225	1				
SMI	-.100	-.200	-.199	.116	-.038	.083	.099	.057	.302*	1			
STA	-.118	**-.293***	-.268	.044	.285*	.278*	.106	.022	.332*	.298*	1		
SFT	**.328***	.227	.211	.492**	.555**	.604**	.141	.521**	.501**	.277*	.421**	1	
TST	.185	.178	.199	.540**	.382**	.452**	.410**	.545**	.461**	.278*	-.135	.453**	1

**.Significant at the 0.01 level (2-tailed). *.Significant at the 0.05 level (2-tailed).

G. DIAGNOSTIC TEST 2016-2017

TABLE 76. CORRELATION BETWEEN THE GPA'S AND THE COGNITIVE VARIABLES; COHORT 2016-2017, TESTMOMENT BEFORE ENROLMENT (N=60)

	GPA January	GPA June	GPA End	Math	Point series	Logical reasoning	Proverbs	Folding boxes
GPA January	1							
GPA June	.851**	1						
GPA End	.755**	.960**	1					
Math	.340**	.273*	.243	1				
Point series	.069	.065	.055	.200	1			
Logical reasoning	.076	.019	.027	.054	.340**	1		
Proverbs	.160	.300*	.301*	.324**	.314**	.323**	1	
Folding boxes	.337**	.284*	.280*	.133	.361**	.219*	.188	1

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

TABLE 77. CORRELATIONS BETWEEN THE GPA'S AND THE LASSI SCALES; COHORT 2016-2017, TESTMOMENT BEFORE ENROLMENT (N=57)

	GPA January	GPA June	GPA End	ATT_1	MOT_1	TMT_1	ANX_1	CON_1	INP_1	SMI_1	STA_1	SFT_1	TST_1
GPA January	1												
GPA June	.851**	1											
GPA End	.755**	.960**	1										
ATT_1	.027	.027	.006	1									
MOT_1	.204	.162	.066	.340**	1								
TMT_1	.224	.251	.141	.360**	.681**	1							
ANX_1	.090	.016	.070	.127	-.197	.035	1						
CON_1	.355**	.217	.191	.302**	.455**	.606**	.297**	1					
INP_1	.057	.171	.187	.285**	.215*	.001	-.048	-.008	1				
SMI_1	.053	.018	.021	.223*	.121	.254*	.457**	.482**	.301**	1			
STA_1	.064	.126	.157	.206	.293**	.166	-.319**	-.015	.506**	-.058	1		
SFT_1	.172	.213	.248	.379**	.489**	.375**	-.118	.343**	.553**	.288**	.532**	1	
TST_1	-.020	-.080	-.059	.278**	.156	.340**	.422**	.424**	.158	.562**	-.189	.162	1

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

TABLE 78. CORRELATIONS BETWEEN THE GPA'S, MATH TEST, AND THE LASSI SCALES; COHORT 2016-2017, BOTH TESTMOMENTS (MATH N=173, LASSI N=147)

	GPA January	GPA June	GPA End	Math_ALL	MOT_ALL	TMT_ALL	CON_ALL	STA_ALL
GPA January	1							
GPA June	.907**	1						
GPA End	.845**	.967**	1					
Math_ALL	.348**	.320**	.306**	1				
MOT_ALL	.166*	.128	.102	-.139	1			
TMT_ALL	.173*	.158	.135	-.047	.627**	1		
CON_ALL	.218**	.140	.111	.019	.510**	.616**	1	
STA_ALL	-.124	-.051	-.051	-.019	.229**	.049	-.058	1

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

TABLE 79. CORRELATIONS BETWEEN THE GPA'S AND THE STUDENT ENGAGEMENT SCALES: VITALITY (VI), DEDICATION (DE), ABSORPTION (AB), AND CHANGES IN SOCIAL LIFE (SOC); COHORT 2016-2017, BOTH TESTMOMENTS (N=171)

	GPA January	GPA June	GPA End	VI	DE	AB	SOC
GPA January	1		.				
GPA June	.851**	1					
GPA End	755**	.960**	1				
VI	.143	.052	.022	1			
DE	-.008	.028	.046	.391**	1		.
AB	.141	.129	.119	.406**	.554**	1	
SOC	.138	.109	.118	.326**	396**	.356**	1

**. Correlation is significant at the 0.01 level (2-tailed).

H. DIAGNOSTIC TEST 2017-2018

TABLE 80. CORRELATIONS BETWEEN THE GPA'S AND MATH TEST: BEFORE ENROLMENT (MATH_1, N=60) AND AFTER ENROLMENT (MATH_2, N=235); COHORT 2017-2018

	GPA January	GPA June	GPA End	Math_2	Math_1
GPA January	1	.925**	.891**	.385**	.468**
GPA June	.925**	1	.981**	.395**	.430**
GPA End	.891**	.981**	1	.323**	.420**
Math_2	.385**	.395**	.323**	1	.602
Math_1	.468**	.430**	.420**	.602	1

**. Correlation is significant at the 0.01 level (2-tailed).

TABLE 81. CORRELATIONS BETWEEN THE GPA'S, LASSI, AND THE STUDENT ENGAGEMENT SCALES, TESTMOMENT BEFORE ENROLMENT; COHORT 2017-2018 (N=60)

	GPA January	GPA June	GPA End	MOT_1	TMT_1	CON_1	STA_1	SFT_1	VI_1	DE_1	AB_1	SOC_1
GPA January	1											
GPA June	.925**	1										
GPA End	.891**	.981**	1									
MOT_1	.492**	.539**	.534**	1								
TMT_1	.310*	.383**	.394**	.546**	1							
CON_1	.252	.369**	.396**	.552**	.588**	1						
STA_1	-.183	-.092	-.135	.182	.236*	-.071	1					
SFT_1	.160	.134	.126	.431**	.338**	.329**	.402**	1				
VI_1	.136	.135	.147	.543**	.459**	.663**	.075	.473**	1			
DE_1	.227	.315*	.314*	.499**	.379**	.596**	-.010	.385**	.563**	1		
AB_1	.090	.147	.149	.439**	.530**	.554**	.020	.447**	.692**	.590**	1	
SOC_1	-.024	-.010	.042	.321**	.402**	.337**	.204	.265*	.472**	.380**	.443**	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

TABLE 82. CORRELATIONS BETWEEN THE GPA'S AND LASSI SCALES, TESTMOMENT AFTER ENROLMENT; COHORT 2017-2018 (N=264)

	GPA January	GPA June	GPA End	MOT_2	TMT_2	CON_2	ANX_2	TST_2
GPA January	1							
GPA June	.925**	1						
GPA End	.891**	.981**	1					
MOT_2	.259**	.255**	.243**	1				
TMT_2	.242**	.225**	.233**	.632**	1			
CON_2	.147*	.155*	.150*	.405**	.550**	1		
ANX_2	-.043	-.019	-.028	-.167**	-.032	.234**	1	
TST_2	.111	.094	.122*	.185**	.270**	.445**	.378**	1

TABLE 83. CORRELATIONS BETWEEN THE GPA'S, MATH TEST, AND THE LASSI SCALES; COHORT 2017-2018, BOTH TESTMOMENTS (MATH N=289, LASSI N=285)

	GPA January	GPA June	GPA End	MOT_ALL	TMT_ALL	CON_ALL	Math_ALL
GPA January	1						
GPA June	.925**	1					
GPA End	.891**	.981**	1				
MOT_ALL	.275**	.285**	.272**	1			
TMT_ALL	.214**	.201**	.214**	.594**	1		
CON_ALL	.107	.126*	.128*	.418**	.559**	1	
Math_ALL	.399**	.395**	.336**	.031	-.040	.011	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).