The Role of Psychological Capital in First-year Computer Science Students' Retention from a Threshold Concepts Perspective

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This thesis is submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy.

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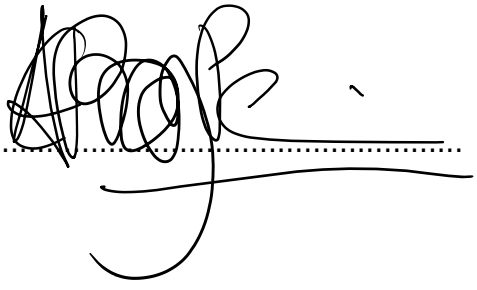
This thesis results entirely from my own work and has not been offered previously for any other degree or diploma.

This thesis consists of 44986 words and does thereby not exceed the permitted maximum of 45 000 words.

Signature ..... 

Abstract

Globally, student retention is a concern in computer science (CS) study programmes. Using a qualitative longitudinal case study, this research explores how psychological capital (PsyCap) and its factors: self-efficacy, optimism, hope and resilience influence first-year computer science students' experiences and retention from a threshold concepts (TC) perspective.

The longitudinal case study contained three rounds of semi-structured interviews that were conducted with a group of 16 first-year computer science students from a Dutch university of applied sciences. The aim was to gain insights into their PsyCap and experiences in relation to student retention. In each interview round a different graphic elicitation method was applied, both as an interview stimulus and as an additional data source. Meyer and Land's TC (2006c) provided an overarching framework to enable comparisons between the participants' PsyCap and their experiences.

The findings report on what I refer to as *troublesome experiences* of participants, which are a combination of troublesome knowledge (Perkins, 1999), skills and emotions, that relate mainly to students' academic integration. In navigating liminality across TC, the identified participant groups: *leavers*, *persisters* and *stayers* reached different levels of success in crossing thresholds, leading to differences in their transformation towards becoming a CS student and potentially a (future) computer scientist. Findings reveal that the affective elements of the *troublesome experiences* influenced the participants' psychological capital and vice versa. The interplay between individual factors, self-efficacy, hope and resilience appeared

important in the participants' retention, with hope being the main driver. The findings led to the development of an explanatory model for transition to higher education from a TC perspective.

This research showed that many personal and academic variables influence participants' *troublesome experiences* and these experiences influence their efforts to navigate liminality. Fostering the development of self-efficacy, hope and resilience in students could improve their transformation into successful computer science students.

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Acknowledgements

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List of Abbreviations

ASD	autistic spectrum related disabilities
CS	computer science
ECTS	European Credit Transfer System
HAVO	hoger algemeen vormend onderwijs (general secondary education)
HBO	hoger beroepsonderwijs (higher professional education at a university of applied sciences)
HE	higher education
IT	information technology
MBO	middelbaar beroepsonderwijs (senior secondary vocational education and training)
PCQ	psychological capital questionnaire
PsyCap	psychological capital
RU	research university (institutions for higher academic education and research)
STEM	science, technology, engineering and mathematics
TA	thematic analysis

TC	threshold concept(s)
UAS	university of applied sciences (institution for higher professional education)
VMBO	voorbereidend middelbaar beroepsonderwijs (preparatory secondary vocational education)
VWO	voorbereidend wetenschappelijk onderwijs (university preparatory education)
WO	wetenschappelijk onderwijs (academic education and research at a research university)

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Chapter 1: Introduction

1.1 Aim and context of the research

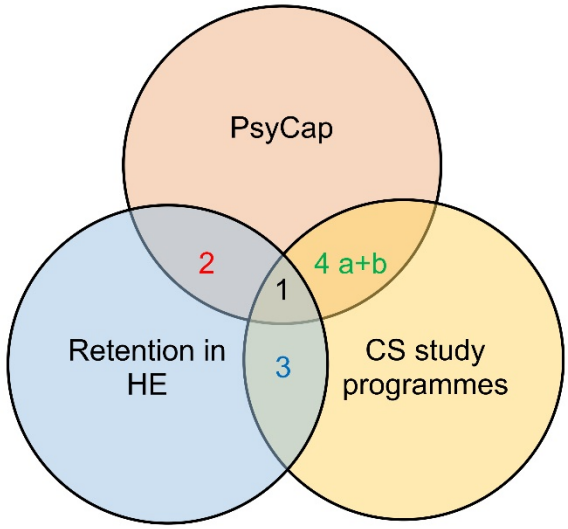
The aim of my research is to gain insight into the role of psychological capital (PsyCap) on the retention of first-year computer science (CS) students by looking at their experiences throughout their first academic year. The findings of this research are related to threshold concepts (TC) to enable PsyCap and the different participant experiences to be connected.

Chapter 1 provides the aim and context of my research by positioning it within related research domains to identify the knowledge gap (1.2) and describes my personal connection to the research (1.3). To familiarise readers with the context of the research, background information on the Dutch education system and student retention in Dutch higher education (HE) is provided (1.4). This is followed by the presentation of the research questions for my research (1.5), a note on choices in terminology and language (1.6) and the structure of the thesis (1.7).

1.2 Positioning of the research

This section explains how my research relates to other research domains and identifies the knowledge gap addressed in my thesis. With its focus on the role of PsyCap in first-year CS students' retention, my research is positioned in the centre of three different research domains: PsyCap, retention research in HE and CS programme related research.

These three related research domains, shown in figure 1.1 each have a large body of research behind them, with different angles and approaches considered.



	Qualitative or Quantitative	**Comments**
1	Qualitative (this research)	Focus area for this research
2	Quantitative	Mainly applying psychological capital questionnaire
3	Mainly quantitative	Often focused on programming curriculum or specific student groups
4	a) - b) Mainly quantitative	a) No studies on PsyCap in CS identified b) Research on individual PsyCap factors in a CS programme context

Figure 1.1 Identifying the knowledge gap between related and overlapping research domains

PsyCap, with its origins in the positive psychology movement, was originally applied to measure and influence employee attitudes, behaviours and performance (You; 2016, Luthans et al., 2007) and consists of four factors: self-efficacy, optimism, hope and resilience. Over recent years PsyCap has gained more recognition in different research domains such as education (Siu et al., 2014; Newman et al., 2014).

Student retention in HE is a well-researched area, with a range of subjects, perspectives and approaches (Tinto, 2006). Both quantitative and qualitative research approaches are applied, as well as mixed method research. Research into computer science programmes is mainly of a quantitative nature and often focuses on the content of the curriculum or on specific student groups, such as women or under-represented minority groups (Papastergiou, 2009; Köppe and Bartilla, 2014; Payton et al., 2016). The affective side of CS students' experiences can be considered an under-researched area of the CS education research domain.

Research on the interface between PsyCap and retention in HE (figure 1.1-2), mostly applies the (quantitative) psychological capital questionnaire (PCQ) (Siu et al., 2014; Luthans et al., 2007). Most studies into retention within CS programmes (figure 1.2-3) also have a quantitative approach (Giannakos et al., 2017). It appears that there are no studies published that combine PsyCap with CS programmes (figure 1.2-4a), although there are studies that look at one of the factors of PsyCap (figure 1.2-4b), predominantly self-efficacy, in relation to CS programmes or students (Bhardwaj, 2017). Again these are mainly quantitative studies.

This overview of current research in related and overlapping domains (figure 1.1) identifies a gap in knowledge on PsyCap in a CS programme in relation to student retention in a qualitative way, the focus for my research. I have added the TC perspective to enable PsyCap and participant experiences' findings to be related in one overarching way.

1.3 Personal connection to the research

My interest in the psychological and emotional factors that influence the retention of first-year CS students was sparked through my role as academic tutor in a CS programme in a Dutch university of applied sciences (UAS). Through my work, I experienced high numbers of first-year students leaving and through the academic tutoring of my students I became intrigued as to why some succeeded and others failed when they had all met the entry qualifications for admission to the CS programme and they were all motivated at the start of the academic year.

The individual meetings I had with CS students, discussing their experiences and how this affected them led me to look closer at the affective side of student retention in CS programmes, especially at the influence of self-efficacy and resilience. The concept of PsyCap offered me the opportunity to explore these factors, along with hope and optimism in CS student retention. I hope my research contributes to understanding more about the emotional side of student retention and will eventually lead to more students passing their CS degree.

1.4 Introduction to higher education in the Netherlands

Dutch secondary and HE differ from that of many other European countries. This section offers an overview of the Dutch education system, discusses the different entry qualifications to access Dutch HE, and gives a characterisation of Dutch HE at UAS. Further, it discusses student retention in Dutch HE, in general, and in CS study programmes, in particular.

1.4.1 Access to higher education in the Netherlands

From the 1970s onwards, HE world-wide experienced a rapid growth. In the Netherlands this has led to an increase in the number of first-year students in HE from around 80 000 in 1995 to 260 000 in 2018 (Gans, 2010; Inspectie van het Onderwijs, 2019), with one-third of the first-year students applying for research universities (RU) and two-thirds for higher professional education at UAS (Gans, 2010, Inspectie van het Onderwijs, 2019). This means that the number of students with a variety of social, cultural and educational backgrounds able to access HE has increased. Earning a degree is linked to cognitive, societal, and economic benefits for individuals, their families and society at large (de Koning et al., 2014; Meens, 2018) and the Dutch education system aims to make all levels of education available for all students, through selection based on talent (Rinnooy Kan, 2015). Placement in one of the three forms of secondary education (figure 1.2), is based on test scores of a standardised test taken in the final year of primary school, around the age of twelve, making the Netherlands one of the countries with an early selection (OECD, 2013).

As the Dutch education system (figure 1.2) shows, students transfer to either VMBO (preparatory secondary vocational education), HAVO (general secondary education) or VWO (university preparatory education), following the aforementioned test results.

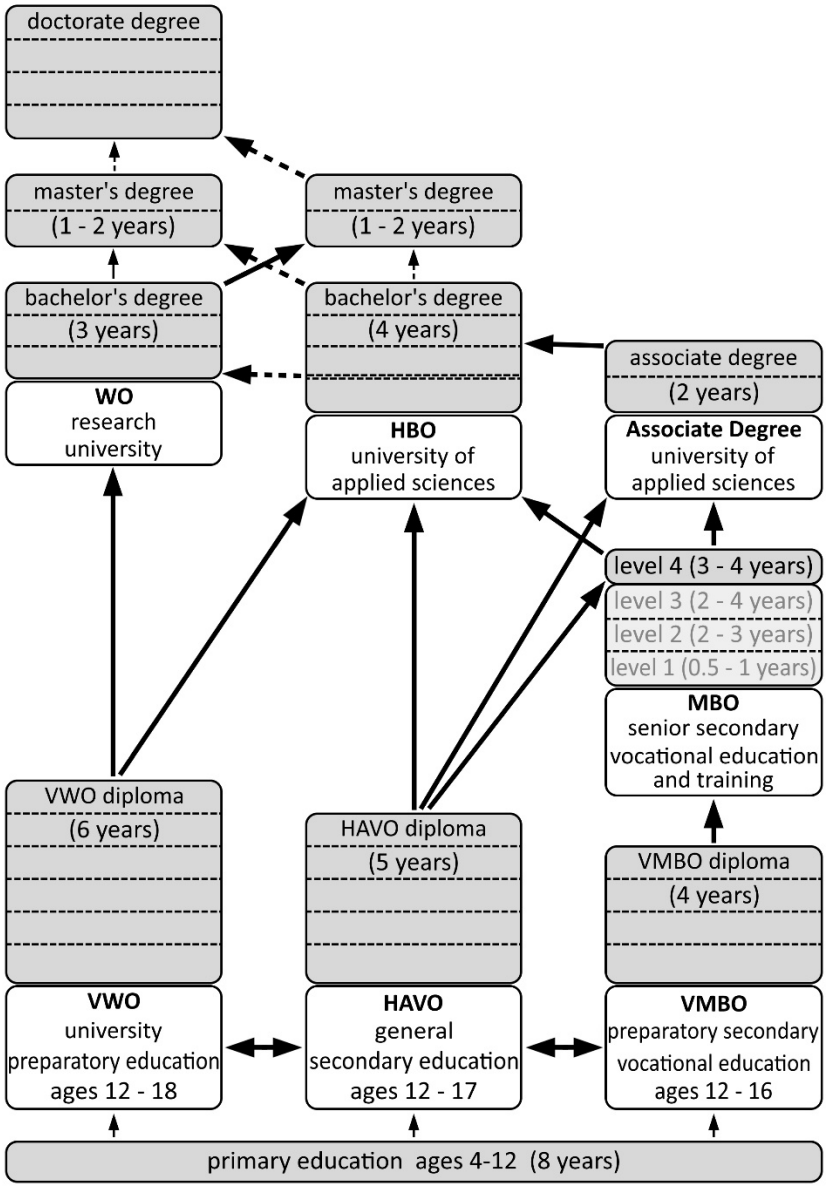


Figure 1.2 The Dutch education system. Adapted from Nuffic: https://www.nuffic.nl/en/subjects/education-in-the-netherlands/ (2019)

Each of the forms of secondary education have their own characteristics. In figure 1.2 the arrows in between VMBO, HAVO and VWO indicate that students can move between levels, depending on their general results. Dutch education is compulsory up until the age of 18 or earlier if an MBO (senior secondary vocational education and training) level 2, HAVO or VWO diploma is obtained. After receiving their secondary diploma students can transfer to

the final two years of the higher level, so from VMBO to HAVO or HAVO to VWO, to obtain a diploma.

After finishing secondary education there are intended routes to further education, but also other options. VMBO students mostly continue their education at an MBO institution. MBO has four levels, but only passing level four gives students access to UAS or an associate degree programme. The intended route for HAVO students is to transfer to UAS, but they are also allowed to go to an MBO or associate degree programme. VWO students are prepared for study at an RU, but they are also allowed to transfer to a UAS.

The Dutch HE system is a binary system with the traditional RU (wetenschappelijk onderwijs or WO) and the UAS (hoger beroepsonderwijs or HBO) which can be described as higher professional education. UAS offer a wide variety of programmes, such as engineering, nursing, teaching or business studies, but the programmes are always aimed at a specific profession or work domain. This is similar to the binary HE systems of countries such as Belgium, Germany and Finland. Once a Dutch student has successfully obtained an entry qualification to a UAS, RU or both, they can enter almost any study programme they want without further selection or entry exam, with some exceptions such as medicine or art school programmes. If a VMBO or HAVO student passes the first year at a UAS, they are allowed to transfer to an RU. The dotted arrow in figure 1.2 shows that there might be additional requirements before transfer is granted.

The possibility to transfer to a UAS through VMBO and MBO, or from HAVO to a UAS and sometimes even on to an RU (figure 1.2) has proven to be a popular route towards social mobility for students from a low socio-economic background, those with a migrant background, and first generation students (Herweijer and Turkenburg, 2016, Cohen-Schotanus et al., 2019).

Since 2002, following the Bologna Process in which European countries agreed to unify standards and quality of HE qualifications (European Union, 2018), a bachelor degree from a UAS is equal to that obtained from an RU. The different routes to HE make a degree in HE available to a large number of students and thereby creates diverse student populations (Cohen-Schotanus et al., 2019), especially at UAS. The selected participants for my research reflect the diversity in entry qualifications of the researched CS programme.

1.4.2 A characterisation of higher education in the Netherlands

Bachelor programmes at a UAS are four-year programmes that include one or more mandatory internships at programme related companies or institutions to prepare students for their chosen profession. In the researched CS programme, students are placed in groups of around 25-30 and with that group they follow a fixed timetable, but this may vary slightly between different UAS or disciplines. Each group has, what can best be described as, an academic tutor, whose role includes a specific task to monitor each individual student's progress and speaks to them at least four times per academic year or more, if the tutor or student finds it necessary. During their meetings they

talk about academic and personal issues and, if necessary, the academic tutor refers the student peer mentors or study counselling support.

Most UAS academic years consist of four periods, rather than trimesters or semesters. In the first year all Dutch HE programmes have a minimum number of credits students need to obtain. Each course is appointed a number of credits based on the estimated study time they need to complete the course. One credit in the European Credit Transfer System (ECTS) represents 28 hours of study effort. Dutch HE students usually need to acquire somewhere between 45 and 50 ECTS out of the maximum of 60 per academic year to be allowed to continue to year 2. In the researched programme the required minimum in year 1 is 48 ECTS.

If a student fails to reach the required minimum number of ECTS for their programme they are not allowed to continue, unless they have mitigating circumstances backed by the student counsellor. This binding study recommendation only applies to the first year. Together with students that voluntarily drop out of a programme, those that are not allowed to continue add to the total drop-out numbers for a study programme.

The researched CS programme has, as can be expected of a UAS study programme, a practice-oriented curriculum, with a large focus in year 1 on learning how to programme. Besides the programming oriented courses there are also general professional or study related courses, such as project management, study skills and remedial courses Dutch and English for

students that did not pass these mandatory exams for all students at the beginning of the year.

1.4.3 Student retention in higher education in the Netherlands

First-year drop-out in HE is higher than in other years (Cohen-Schotanus et al., 2019; Delnoij et al., 2020; Van Rooij et al., 2017), thereby making it an interesting period for research. When combining the numbers of students leaving and students switching to a different programme, UAS have a higher average non-continuation rate in year 1 than RU, respectively 36% and 23% (Inspectie van het Onderwijs, 2019, Vereniging van Samenwerkende Nederlandse Universiteiten, 2017). These percentages vary not only between different UAS and RU institutions throughout the Netherlands, but also between different disciplines. The differences between first-year students at UAS compared to those at RU can be partially explained by the fact the UAS student population is much more diverse in terms of socio-economic background and entry qualifications (Cohen-Schotanus et al., 2019).

Over the past decade numerous national and institutional policies and interventions have tried to improve student retention in Dutch HE. At first the student success policies had a distinctive quantitative character with a focus on completion rates, but more recently there has been a shift in acknowledging that student success also has a qualitative aspect. This qualitative aspect focuses more on the characteristics of a successful study programme, by looking at the quality of the curriculum and exams through constructive alignment as described by (Biggs and Tang, 2011), whereby learning is seen as constructive because it is building on previous knowledge

and experiences and alignment in the way the exams in a programme align with the programme's learning objectives (Cohen-Schotanus et al., 2019).

Internationally, programmes in science, technology, engineering and mathematics (STEM) domains, such as CS, generally have a higher drop-out rate than non-STEM study programmes (Gordon, 2016; Giannakos et al., 2017; OECD, 2008) and this is also the case in STEM study programmes in the Netherlands, making it an area of interest for retention research. Student retention in HE, especially in CS programmes, is further discussed in the literature review in Chapter 2.

1.5 Research questions

The identification of the gap between related research domains in section 1.2, together with the context of differences in entry qualifications and student retention in Dutch UAS leads to the following research questions to guide my research:

RQ1 How does psychological capital influence first-year computer science students' retention?

RQ2 What experiences influence first-year computer science students' psychological capital and retention?

RQ3 How do threshold concepts relate to the psychological capital and experiences of first-year computer science students?

These questions enable the exploration of how PsyCap influences first-year CS students' experiences and retention from a TC perspective, whereby the TC vocabulary is applied as an overarching connector of the different findings rather than strictly theoretical. This will be further explained in chapter 3.

1.6 A note on terminology and language

In this thesis, I have made some choices regarding certain descriptions. First, throughout the world different words are used to describe study programmes in the CS domain. Most have a similar meaning and are used in the same context, such as the term *information technology* (IT) in the Netherlands or the reference to a specialised area within CS, such as software engineering or computer engineering. Globally, the term *computer science* is most commonly used as a collective name to describe IT, software engineering, CS, computer engineering and other studies relating to computer programming and the analysis of digital data. Throughout this thesis I will use the *computer science (CS)* to describe the study programme studied in this research, with the exception of direct quotes.

Second, throughout the thesis *participant* is used when it refers to one of the students that took part in the interviews. *Student* is used when there is no direct connection to the participants and refers to students in general.

Third, although the official Dutch abbreviation for higher professional education is HBO and for academic education is WO (figure 1.2) in this thesis, I use the aforementioned abbreviations UAS and RU, because these appear to be more relatable in international discussions. For consistency, the

abbreviations for the different forms of Dutch secondary education VMBO, HAVO and VWO are also written in capital letters.

1.7 Structure of the thesis

Following this first introductory chapter, chapter 2 provides a literature review relating to PsyCap, transition to HE and student retention in CS. Chapter 3 explores the theoretical framework used in this research, namely, TC. In chapter 4 the methodology for the research is introduced, together with the methods used to collect and analyse the data. Chapter 5 presents the findings of my research by discussing the participants' PsyCap and how their experiences influenced this. Chapter 6 connects and explains the findings from a TC perspective and presents a model for transition to HE from that TC perspective, combining the different elements of the research. This is followed by the discussion of the key findings in chapter 7 and the conclusions in chapter 8.

Chapter 2: Literature review

2.1 Introduction

The purpose of my research is to explore the role of PsyCap on the retention of first-year CS students using TC. The literature review presented here was narrowed down to three main topics that relate to the aim and research questions of this research and to related research domains presented in section 1.2: PsyCap (2.2) and PsyCap factors (2.3), transition to HE (2.4) and student retention in CS programmes (2.5). Note that TC are further discussed in the theoretical framework presented in chapter 3.

2.2 Psychological capital

PsyCap is what Luthans et al. (2007: 4) define as *"a higher order positive construct comprised of the four-facet constructs of self-efficacy/confidence, optimism, hope, and resiliency"*. This section explores the origins, critiques and the positioning of PsyCap in relation to other forms of capital. This is followed by an exploration of each of the PsyCap factors of: self-efficacy (2.5.1), optimism (2.5.2), hope (2.5.3) and resilience (2.5.4).

The origins of psychological capital

Luthans and Youssef (2004) based their construction of PsyCap on Seligman's (2002) book *Authentic Happiness*, in which he laid the foundations for positive psychology by challenging the psychological domain to move away from a focus on the negative in favour of the positive, on strengths, rather than weaknesses, and on what goes well instead of what goes wrong. He posed the question whether psychological capital exists, and if so, what it

would be and how it could be developed. Seligman suggested that *"when we are engaged (absorbed in flow), perhaps we are investing, building psychological capital for our future"* (Seligman, 2002: 116). Luthans and Youssef (2004: 152) combined these insights with what they called *"positive organizational behavior"* (POB). These POBs apply *"positively oriented human resource strengths and psychological capacities that can be measured, developed and managed for performance improvement in today's workplace"* (Luthans and Youssef, 2004: 152). Of the identified POB's, four factors meet the criteria of being positive, measurable, developable and performance related: self-efficacy, optimism, hope and resilience (Luthans et al., 2007, Luthans, 2002, Luthans and Youssef, 2004). Together this led to the following definition:

> PsyCap is an individual's positive psychological state of development and is characterized by: (1) having confidence (self-efficacy) to take on and put in the necessary effort to succeed at challenging tasks; (2) making a positive attribution (optimism) about succeeding now and in the future; (3) persevering toward goals and, when necessary, redirecting paths to goals (hope) in order to succeed; and (4) when beset by problems and adversity, sustaining and bouncing back and even beyond (resiliency) to attain success (Luthans et al., 2007: 3)

Although PsyCap originally stems from organisational psychology, it has been applied in other research domains in recent years such as HE research (Luthans et al., 2012; Siu et al., 2014). This can be attributed to the familiarity of the above mentioned four factors in different domains and the claim that

these ‘state-like’ factors are open to development (Luthans et al., 2007)(authors’ emphasis). On a scale ranging from state to trait, with moods and emotions at the ‘state’ end of the scale and stable traits such as intelligence at the ‘trait’ end of the scale, PsyCap occupies the midrange because there is malleability in the four factors (Dawkins et al., 2013). This midrange position also means that the factors are, to a certain extent, part of the students’ disposition. Dawkins et al. (2013: 351) indicate that it could be expected that state-like side of the PsyCap factors would *“moderate or mediate the relationship between ‘trait-like’ hope, optimism, self-efficacy and resilience and outcomes such as performance”.* Dawkins et al. (2013) suggest that longitudinal research, such as this research, may provide insights into the ‘state-like’ nature of PsyCap. This tension between ‘trait-like’ and ‘state-like’ contributed to selecting PsyCap as a focus in this research to explore the fluctuations in PsyCap during the year and the influence PsyCap might have on students’ experiences.

Critique on psychological capital

One of the critiques from Dawkins et al. (2013) focuses on the fact that the PsyCap questionnaire (PCQ) (Luthans et al., 2007) is the standard measure for PsyCap and that the scores for the individual factors are combined into a final composite score. This leaves no room for identifying variety in outcomes or dynamics between factors. Dawkins et al. (2013: 363) suggest that analysing the individual factors together with the composite score would offer what they call “*PsyCap profiling”*, where different PsyCap profiles could give insights into how they relate to certain outcomes. The qualitative nature of my

research, which does not include the PCQ, supports Dawkins' PsyCap profiling approach, whereby the individual PsyCap factors and their interaction, together with a form of *PsyCap profiling* for the different participants, play a part in gaining insights into the retention of the participants.

Positioning of psychological capital

According to Luthans et al. (2004: 46) PsyCap is positioned *"beyond human and social capital and basically consists of 'who you are' rather than what or who you know"*. In this early publication about PsyCap one of the factors listed is "confidence". This is replaced in later publications by "self-efficacy" and in a later publication Luthans et al. (2006: 388) emphasised that it is not only about 'who you are', but more importantly about 'who you are becoming' (see figure 2.1 below).

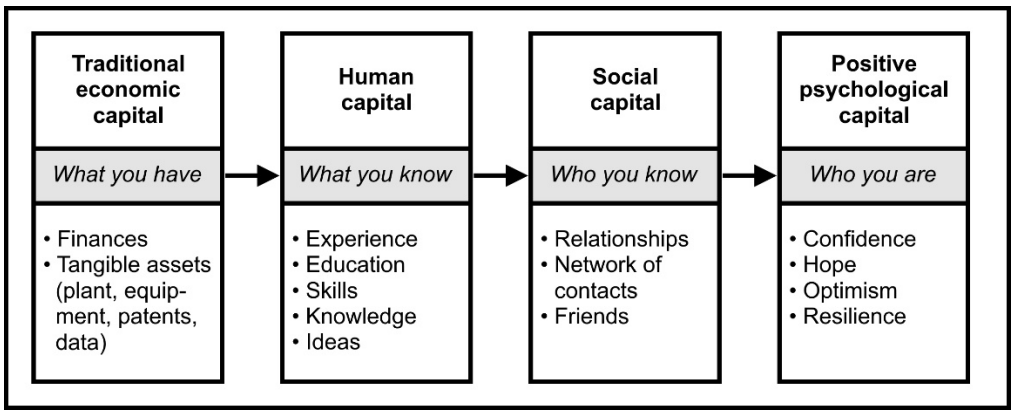


Figure 2.1 Relation between different forms of capital (Luthans et al., 2004: 44)

Human capital is usually seen as a person's knowledge, skills, abilities or competencies obtained through education, experience and specific identifiable skills. It consists of explicit knowledge, but also of tacit knowledge

that the individual gains through being a part of a particular organisation or environment, represented in figure 2.1 as “what you know” (Luthans et al., 2004: 44). Social capital is defined by Luthans et al. (2004:149) as a multifaceted construct made up of *“interpersonal, inter-group and inter-organizational relationships, networks and connections”* and it operates in three dimensions: networks, norms and behaviour and trust. Although they do not mention Bourdieu in relation to their definition of social capital. Bourdieu and Waquant define it as:

> the sum of the resources, actual or virtual, that accrue to an individual or a group by virtue of possessing a durable network of more or less institutionalized relationships of mutual acquaintance and recognition (Bourdieu and Wacquant, 1992: 119).

When compared, it becomes apparent that these two definitions are similar. In figure 2.1 social capital is described as “who you know”. It would have been interesting to see how Luthans et al. (2004) would position PsyCap in relation to another form of capital with a more affective orientation such as emotional capital, which is defined by Cottingham (2016: 452) as *“a tripartite concept composed of emotion-based knowledge, management skills, and capacities to feel that links self-processes and resources to group membership and social location”*.

Emotional capital originates in Bourdieu’s theory of social practice and is a *“form of cultural capital that includes the emotion specific, trans-situational resources that individuals activate and embody in distinct fields”* (Cottingham,

2016: 351). It is more a description of a set of assets a person can utilise, rather than a facility to process emotional issues (Cousin, 2006). It is not made up of a fixed group of factors like PsyCap, but it does include the way a person is emotionally capable of handling situations and experiences. Rattray (2018: 6) states that students with low emotional capital *"lack the ability to identify alternatives, are unable or unwilling to persist in the face of challenge and frequently give up before the learning task is achieved or concept mastered"*. It appears that emotional capital and PsyCap are to some extent related.

2.3 Psychological capital factors

Self-efficacy, optimism, hope and resilience are the identified POB's that make up PsyCap, and have all been researched in their own right in relation to HE retention. Consequently, the process of applying PsyCap, with its organisation and employee achievement origins, into a CS programme is less alien. Dawkins et al. (2013: 350) argue that the PsyCap factors may have a synergistic effect, where the effect of the whole is greater than that of each factor individually, and where the individual factors *"may be better understood as markers of an overarching core construct"*. Avey et al. (2011) claim that this is the case with PsyCap because the four factors have similar coping mechanisms in common.

In the next four sub-sections self-efficacy, optimism, hope and resilience are explored to identify their relevance in relation to this research. The order of presentation is the same as the definition by Luthans et al. (2007) presented

earlier, despite the different order in which the factors appear in other publications by the same and other authors researching PsyCap. Because I do not believe the order of the factors to influence the exploration of the individual factors and PsyCap as a whole in my research, therefor I kept Luthans' order.

2.3.1 Self-efficacy

Self-efficacy was introduced by Bandura (1986) as part of his social cognitive theory and can be described as a person's belief about their ability to learn and perform tasks on a designated level to achieve a desired outcome (Bandura, 1997). It is often confused with self-confidence, but self-confidence only focuses on the strength of the belief an individual has in their ability, whereas self-efficacy also involves a specific goal and the strength of an individual's belief that they can achieve this (Hutchison et al., 2006). A high level of self-efficacy improves further development of skills and motivates students to *"participate more readily, work harder, persist longer when they encounter difficulties, and achieve at a higher level"* (Schunk and Zimmerman, 1997: 36). Bandura (1997) identified four sources of self-efficacy: (1) mastery experience, the most powerful source of self-efficacy according to Bandura (1997), where successfully mastering a task, and overcoming obstacles to do so, contributes positively to building self-efficacy in that area. (2) Vicarious experiences, where seeing a similar person to themselves succeed, influences someone's belief that they can do it too. (3) Verbal persuasion, where positive support from parents, teachers or friends contributes to the belief that an individual can do a certain task. (4) Emotional and physiological

states, where the state an individual is in, influences their self-efficacy (Bandura, 1994;1997). My research explores the dynamics between PsyCap factors and how self-efficacy influences participants' PsyCap and possibly their retention.

In an early publication by Luthans (2002) in the developmental stage of PsyCap, he initially introduces *confidence* as a POB. He mentions self-efficacy and its close connection to confidence, but keeps referring to the POB as confidence or as confidence/self-efficacy. In later publications this changes to *self-efficacy/confidence* (Luthans and Youssef, 2004) and later to *self-efficacy* (Luthans et al., 2007). Although there is no explanation for this, Luthans et al. (2007: 16) state that *"self-efficacy has the most established theoretical foundation and empirical research base".*

Rand (2018) states that the distinction between self-efficacy and hope is less clear than between hope and optimism. The two main differences between self-efficacy and hope are that self-efficacy is *"a domain or situation specific expectancy"* (Rand, 2018: 54) and hope generalises across situations and goals. Second, the difference between self-efficacy and hope can best be described as "*the difference between what one <u>can</u> do versus what one <u>will</u> do"* (Rand, 2018: 54), where 'can' relates to self-efficacy and "will" to hope. Hope is the intention to strive for goals as opposed to self-efficacy being about an individual's belief only (Rand, 2018).

The characterisation of three of the four factors of PsyCap: self-efficacy, optimism and hope by Rand (2018) in table 2.1 not only summarises their

characteristics, it also enables a comparison of their differences and similarities. It shows that self-efficacy, optimism and hope are all goal-oriented, future oriented and cognitive, but that there are differences in whether it is self-focused, related to perceived ability or perceived intention.

Characteristic	Self-efficacy	Optimism	Hope
Goal-directed	Yes	Yes	Yes
Future-oriented	Yes	Yes	Yes
Generalised	Maybe	Yes	Yes
Cognitive	Yes	Yes	Yes
Self-focused	Yes	No	Yes
Perceived ability	Yes	No	Yes
Perceived intention	No	No	Yes

Table 2.1 Characteristics of self-efficacy, optimism and hope theories (adapted from Rand, 2018: 44)

Over the past three decades, extensive research in HE on self-efficacy has proven that it is an important factor in achieving academic success (Duchatelet and Donche, 2019; Zajacova et al., 2005; Honicke and Broadbent, 2016). My research does not measure the participants' self-efficacy, but tries to gain insight into their self-efficacy beliefs and the positive or negative development of them and how this influences their experiences and retention.

A related specification of self-efficacy can be identified in the CS domain: computer programming self-efficacy. It focuses on an individual's beliefs in relation to learning how to programme. This should not be confused with computer self-efficacy, that looks at an individual's beliefs in relation to performing and managing general computer related tasks (Compeau and Higgins, 1995; Jan, 2015) and has a wider application than just the CS domain.

Computer programming self-efficacy

Computer programming self-efficacy is a domain specific differentiation of self-efficacy, focused on how students judge their ability to learn or execute computer programming tasks. Ramalingam and Wiedenbeck (1998) developed their quantitative Computer Programming Self-Efficacy Scale, aimed at the C++ programming language, because they identified at that time already that programming courses had low retention rates and that CS courses were perceived as difficult by novice programmers. Similar research by Jegede (2009), aimed at Java programming, showed outcomes aligning with Ramalingam and Wiedenbeck (1998) in that previous programming experience has a large influence on computer programming self-efficacy. This resonates with Bandura (1986) in that self-efficacy beliefs develop gradually when skills and experience increase. My research focuses on self-efficacy as part of PsyCap and not specifically on computer programming self-efficacy, although because of the CS domain the research is situated in, it will mean that the participants' beliefs in their ability in computer programming will play a part in the findings.

2.3.2 Optimism

In optimism theory, developed by Scheier and Carver (1985: 219), optimists are regarded as people that *"expect things to go their way, and generally believe that good rather than bad things will happen to them"*. Scheier and Carver (1985) see the outcome expectancy as the main driver of goal-directed behaviours, rather than pathways and agency related thoughts and action in

hope. As can be seen in table 2.1, there is an overlap in characteristics between hope and optimism in *"coping, goal attainment, and indicators of well-being"* (Rand, 2018: 47). Snyder et al. (2018: 31) also acknowledge a connection between measures of hope and optimism, but claim that *"hope has produced unique variance beyond optimism in the prediction of several variables"*. A further distinction is that optimism is not self-focused (table 2.1) making it a wider concept than hope and less specific about the role of the individual in the expectation of good outcomes (Rand, 2018). This makes optimism slightly more 'trait-like' in nature than hope. Another distinction is that Scheier and Carver (1985) do not explicitly mention the role of positive and negative emotions in optimism, whereas these are considered to be very influential within hope theory (Snyder et al., 2018).

2.3.3 Hope

Over the past three decades hope has become a well-researched topic, often in relation to education, student success and academic outcomes (Gallagher and Lopez, 2018; Marques et al., 2017). Linking hope and education is a logical step, because both are goal-oriented in nature. Hope is defined as *"a positive motivational state that is based on an interactively derived sense of successful (a) agency (goal-directed energy) and (b) pathways (planning to meet goals)*" (Snyder et al., 1991b: 287). Almost all hope research is connected to Hope Theory, developed by Snyder (1994).

As table 2.1 shows, compared to self-efficacy and optimism, hope scores a 'yes' on all listed characteristics. This means that hope potentially influences

the participants' experiences in this research in different ways and at different levels. According to a review of critique on hope measurement by Schmid Callina et al. (2018), several authors have criticised Snyder's measurement of hope. Carver and Scheier (2002) state that measuring hope, rather than measuring agency, it measures prior success in attaining goals. Aspinall and Leaf (2002) found that Snyder's treatment of hope lacked a focus on future orientation. Aspinall and Leaf (2002: 281) claim that this focus would *"not only bring hope research to be in line with most people's conceptions of hope"*, but also that it would *"make a great deal of theory and research on expectations and future-oriented thinking more directly relevant to research and intervention efforts based on the hope model"* (Aspinwall and Leaf, 2002: 281). My research tries to gain insights not only into the participants' past experiences of reaching goals, but also how they plan to attain them in the (near) future. The qualitative data in this research offers the opportunity to look beyond these issues raised as a critique on the Hope Scale developed by Snyder et al. (1991a).

2.3.4 Resilience

Resilience can be seen as the positive adaptation to past experiences and can be defined as *"the ability to recover rapidly from difficult situations as well as the capacity to endure ongoing hardship in every conceivable way"* (Walker et al., 2006: 251). Other than resilience, self-efficacy, hope and optimism *"represent specific manifestations of an overall positive expectation about the future"* (Rand, 2018: 52). The reactive nature of resilience in contrast to more proactive self-efficacy, shares the pathways element with hope, but it does not

contain the same agency element (Luthans, 2002). Resilience, in light of positive psychology, shows a change in direction by promoting *"strengths-based psychosocial processes"*, rather than emphasizing *"deficits in functioning"* (Allan et al., 2014: 10). According to Holdsworth et al. (2018: 1837) *"resilience at university is central to a successful participatory learning experience, and therefore, to the collective human and social capital of an individual"*. The role of resilience in student retention has been well-researched in recent years (Walker et al., 2006; Allan et al., 2014; Cotton et al., 2017; Holdsworth et al., 2018) and it shows that students that drop-out have not necessarily experienced more difficulty or stress than those who continue. The difference lies with their *"perceived difficulties and obstacles within university life"* (Gilardi and Guglielmetti, 2011: 38) and the students' ability to bounce back from difficult situations. Cotton et al. (2017) identified protective and risk factors in their resilience framework, both within and outside university, that may influence students' resilience, such as support from family, support from tutors and attendance. These factors have the potential to influence participants in this research and have therefore been explored within the interviews. The predominantly quantitative way in which PsyCap is used in research does not give an insight into the dynamics among the four PsyCap factors. My qualitative longitudinal approach enables an exploration of which dynamics lead to an increase or decline in PsyCap.

2.4 Transition to higher education

Transition to HE has been identified by numerous researchers as a pivotal phase in first-year students' success (Trautwein and Bosse, 2017; McGhie,

2017). Coertjens et al. (2017a: 359) adapted Nicholson and West's (1995) definition of work-related transition into a definition of transition to HE, stating that *"educational transitions are any major changes in students' role requirements or study contexts"*. As they explain, this definition:

> ...binds the concept of change on the one hand, more specifically in case of the transition for secondary to higher education, a confrontation with change and on the other hand students' coping with this change (Coertjens et al., 2017a: 359).

Cole (2017) summarises three common themes that influence a student's transition to HE: student expectations of their first-year experiences, academic and social integration and first-year stagnation, where some students experience little to no growth regarding motivation or deep approaches to learning. This trichotomy forms the basis of looking at transition to HE both in this literature review and throughout the thesis. The wide variety of participants in the researched CS programme have different entry qualifications, differences in programming experience, and some have switched from other HE programmes, which makes the transition to HE an interesting topic for my research. The longitudinal design makes it possible to explore issues with the transition to HE and their effects over the course of the academic year.

Unrealistic expectations, adjusting to HE, diversity in the student population, insufficient preparation on the programme contents (Cohen-Schotanus et al., 2019), and also choosing the wrong study programme (Meens, 2018) are

considered factors that influence the higher drop-out in Dutch HE in year 1 compared to that of years 2, 3 and 4. If transition to HE is not successful, it does not always lead to students leaving HE altogether, but to switching from one study programme to another. The percentage of so called ‘switchers’ is relatively stable in Dutch HE at around 18% (Vereniging Hogescholen, 2016).

To understand *“the numerous changes experienced by students during their transitions into and through higher education”* Cheng et al. (2015: 1) reviewed six different models relating to transition to HE. Most of these models identify transition phases that consists of an optimistic first phase, a second phase where reality sets in and a phase of adjusting to the new environment. Some of the models only look at the transition during the first weeks whilst others consider the whole of the first year as the transition to HE (Cheng et al., 2015). One of the presented models, the Psychological Model of Student Retention (Bean and Eaton, 2001), is different from the other models because it focuses on underlying psychological processes and skills that influence the transition to HE, and is probably closest related to my research. The models presented by Cheng et al. (2015) all seem to present the situation of the student that continues in their chosen study programme. My aim is to develop a model that includes the students that leave throughout the year or do not continue to year 2. It will share some elements with the models reviewed by Cheng et al. (2015), especially with the psychologically oriented model of Bean and Eaton (2001), but will also include TC elements and a connection to PsyCap.

Following the themes identified by Cole (2017) in relation to transition to HE, the next sections explore students' expectations, social and academic integration, and first-year stagnation as topics that will be addressed in the interviews and related to how these topics might influence participants' PsyCap and retention.

2.4.1 Students' expectations

Könings et al. (2008: 536) identified that *"expectations affect students' motivation, engagement, and investment of effort in learning",* thereby making students' expectations a major contributor to a successful transition to HE and retention. McGhie (2017) states that students that transitioned successfully had more realistic study related expectations and took responsibility for their own learning from the start. Students making a successful transition also used motivation from family and friends as self-motivation and made choices such as going to class, asking questions and making use of available facilities. This relates to what Briggs et al. (2012) call the development of a learner identity, and students can be described as successfully handling the changes that studying in HE requires. Lowe and Cook (2003) found that the study habits students formed in secondary school persist to the end of the first semester of university life, leading to their conclusion that some students are not bridging the gap between school and university quickly and effectively. My research explores the participants' expectations in interview 1 and asks them to reflect on this in interview 3 to see how realistic their expectations were. Study habits are discussed in all three interviews to assess why, when and how these changed and whether this varies among participants.

Dutch UAS students have three major entry qualifications: MBO, HAVO and VWO, with very different characteristics (see 1.4.1, figure 1.2). The entry qualification influences the way in which students were prepared for further education, or the way they felt they were prepared by their secondary school. In turn, this influences the extent to which they have a gap to bridge between secondary education and HE and their ability to adjust to the changes in the HE environment and what is expected of them (Cohen-Schotanus et al., 2019). The way in which students prepared themselves in their own time for the transition to HE varies. Together with their expectations, it appears that preparation for HE influences students' retention in their first year in HE.

CS programmes see large differences in new students' programming experience (Gordon, 2016). Some students have already done some programming in secondary school or as a hobby, while others have never programmed before entering HE. Programming experience influences the students' expectations, both in the transition to HE in general and to a CS programme specifically (Gordon, 2016; Hagan and Markham, 2000).

One of the participants' selection criteria is their programming experience, to enable the influence of programming experience on PsyCap and retention to be explored.

2.4.2 Social and academic integration

The second theme in transition to HE, identified by Cole (2017), is social and academic integration. This aligns with findings by Briggs et al. (2012) in international studies of student transition to HE that emphasise the interplay

between the social and academic circumstances of students and the institutional systems that should support them. Tinto's pioneering work (1987) on first-year student success and progression relates to his Student Integration Model (1993) in which the students' persistence and retention is influenced by both social and academic integration. Tinto (1987) suggests that universities should meet both academic and social needs for successful student adjustment to HE. Tinto's model *"assumes that institutional experiences impact on persistence directly as well as indirectly via social and academic integration"* (Severiens and Schmidt, 2008: 60). In my research the effort it takes for successful social and academic adjustment varies per participant. Having student populations with a range of educational, social and cultural backgrounds creates additional difficulty when institutional systems want to support to students to improve their social and academic adjustment. Drawing on secondary international research, Briggs et al. (2012) argue that national policies to extend access to university have changed the nature and needs of incoming cohorts of students and advocate that support is needed on both sides of the transition bridge to enable students to adjust to HE and develop learner identity and autonomy.

Adjusting to university life in the Netherlands is different to that in most other countries, because Dutch UAS do not have campuses with student accommodation. 86% of UAS students live at home (CBS, 2018), within less than an hour travel time from their institution (Studentenmonitor, 2017). This percentage is lower for RU students, because the RU are often further from their home. The UAS students that do not live at home, usually have

independent living accommodation. Due to this situation the social integration in the researched CS programme happens therefore on weekdays during breaks, unscheduled project time and the occasional organised event, such as a game event or hackathon. My research explores how these looser social ties to the CS programme influence participants' experiences of social integration. Because of the differences in orientation between social integration and academic integration, these topics will be discussed in separate sections in chapter 5.

Social and academic integration add to students' sense of belonging in their chosen study programme. Giannakos et al. (2017: 2370) found that in CS education *"high levels of social support contribute to students' overall sense of belonging in their program, and, ultimately, their likelihood of persistence".* This is similar to findings by Taheri et al. (2018) who also identified sense of belonging as an important factor in CS students' academic persistence. Establishing a sense of belonging is one of the things that has to develop together with all other aspects connected to transition to HE and it will be interesting to explore this in the interviews.

Academic integration is a challenge for all students in HE, but as the vast majority of participants in my research have no explicit CS background, there is the additional challenge of not only coming into contact with new knowledge about CS, but having to apply that knowledge in developing a new skill: learning how to programme (Guloy et al., 2017, Ulriksen et al., 2017). The expected challenges in academic integration in my research appear to relate to learning how to programme. Research shows that there is a relation

between academic integration and the ECTS obtained (Van Rooij et al., 2017) In my research I assume that there is also a link between academic integration, obtained ECTS and retention in CS programmes. This is further explored in section 2.5 where student retention in CS is examined more closely.

2.4.3 First-year stagnation

The third common theme identified by Cole (2017: 549) is what he called *"first-year stagnation"*. By this he means that for some students there is little or no growth in their motivation or approaches to deep learning. It appears that first-year stagnation is closely related to academic integration. The more general aspects of academic integration and the specific issues that cause first-year stagnation appear to be connected, especially in research that only looks at the first year, such as mine. Therefore they are discussed together in chapter 5.

Schneider and Preckel (2017) identified motivation and learning strategies together with intelligence and personality as important student related predictors of achievement in their meta analyses on achievement related variables in HE. Locke and Latham (2004: 388) state that *"the concept of motivation refers to internal factors that impel action and to external factors that can act as inducements to action".* Students' motivation is generally high at the start of their first year in HE (Brahm et al., 2017), considerably higher than their motivation at the end of their secondary education (Kyndt et al., 2015), but their intrinsic motivation shows a decline during the first year (Busse, 2013). Lack of motivation has been identified as a major reason for

drop-out in multiple research studies, both in general (Meens, 2018) and CS programme related research (Kori et al., 2015).

Students enter HE with individual differences in the extent to which secondary schools, as well as the individuals, spent time and effort in developing study skills and learning strategies. This means that first-year students experience differences in the way they are and feel prepared for HE (Vervoort and Elffers, 2018, Herweijer and Turkenburg, 2016). Entry qualification is one of the participant selection criteria in this research to explore its influence on PsyCap and retention in a CS programme.

To summarise, transition to HE is an important phase in a students' life. Current models on transition to HE appear not to address the experiences of students that either leave during their first year or that do not continue after year 1. This is something I will address in my research by developing a new model that integrates all elements and participant groups of this research. The three themes for transition to HE, identified by Cole (2017): student expectations, social and academic integration and first-year stagnation provide the focus for the interviews. To better suit the different perspective of social and academic integration and the similarities between academic integration and first-year stagnation, they will be represented in chapter 5 as: participants' expectations, social integration, academic integration and first-year stagnation.

2.5 Student retention in computer science programmes

Student retention in HE, especially focused on the first year of study, has grown into a vast body of research over the past decades (van der Zanden et al., 2018, Van Rooij et al., 2017). Therefore, this section focuses on research on retention in CS programmes looking at different positive and negative influences and perspectives and general HE retention research that can be related to my own.

In CS programmes world-wide, as in other STEM programmes, the drop-out rate is higher than in non-STEM study programmes (Gordon, 2016; OECD, 2008; Giannakos et al., 2017; Kori et al., 2016). Data from the annual Dutch National Student Survey (de Nationale Studenten Enquête), shows that the average drop-out rate in first-year UAS CS programmes is 42%, with 31% being the lowest and 54% being the highest drop-out rate in 2017 (Studiekeuze123, 2018). According to Ulriksen et al. (2017) the focus in understanding student drop-out in STEM programmes has moved from regarding students' entry qualifications as the major reason for drop-out, towards looking more at students' first-year experiences and the relation between the students and the institution. Cohen-Schotanus et al. (2019) see a shift in general in Dutch HE from the focus solely on quantitative student success to a focus on quantitative and qualitative student success, that also looks at improving the students' experiences.

When reviewing literature specifically aimed at student retention in CS programmes, some issues emerge. Giannakos et al. (2017) underline the important role of the first year in CS programmes. Research in the United

States of America by Barker et al. (2009) and in Estonia by Kori et al. (2015) supports this. Even though their research took place in different parts of the world, there are similarities in the positive and negative influences they found. Both identify the positive impact of programming experience and prior studies and the importance of institutional characteristics, such as a meaningful curriculum, student-faculty interaction and pedagogy, together with more affective ones such as student-student interaction, motivation and expectations. They also identify risk factors, such as performance and low grades, in relation to persistence. Although at first glance these findings do not differ much from those in non-CS retention studies, the difference can be found in what they mean in the CS context. For example, on a curriculum and pedagogy level there are many options for CS programmes, such as the choice of programming language(s), an abstract or applied approach, and the role and importance of mathematics; but also fundamental choices that have to be made on whether to be a ‘wide’ programme that covers a range of topics superficially or a ‘deep’ programme that focuses on a particular aspect of the extensive CS domain, and how to handle incorporating the rapid developments within a CS programme.

Kori et al. (2015) found in their quantitative study on CS retention that, although there were not many differences in CS students’ perceptions and expectations at the beginning of the year, this changed after the first semester when differences between students that would eventually drop-out and those who stayed became apparent. This was specifically related to the students’ interest in CS, how well the curriculum met their expectations, and how they

evaluated their probability of finishing the programme and working in the IT domain. Interestingly, there were no differences in students' perceptions regarding the difficulty of the programme. Aligning with these findings, Giannakos et al. (2017) also stated the reasons students gave for dropping out appear to be very broad and diverse, such as poor teaching and quality of the studies; workload and time required. They also found that the lack of assistance from lecturers; not feeling qualified to do an undergraduate CS programme; and negative stereotyping of the IT profession could lead to students dropping out.

Gordon (2016) identifies that one of complicating features in CS is the curriculum being a mix of academic theory and vocational knowledge. Students not only obtain theoretical knowledge about programming and the CS domain, but also have to acquire the skill of producing code or software solutions. Additionally, there is a wide variety in the nature of students' preparation for the course. Having programming experience is not a pre-requisite for the majority of CS programmes (Gordon, 2016). In the Dutch UAS context there is the added complication that there is not only a variety in programming experience among students, but also in the way they are prepared for the transition to HE as described in chapter 1.

For CS, Gordon (2016: 5) states that *"some students embarking on courses do not appreciate what a course involves"* and that there is a gap between the students' expectations and the reality in content and requirements of a CS related degree. Misunderstandings and misrepresentations of CS programmes by teachers and career advisors, but also from family and peers

contribute the external framing where the student develops false expectations of contents, sequencing, pacing etc. This can lead them to make an erroneous study choice (Meens, 2018). A mismatch between expectations and the curriculum complicates the development of a *"disciplinary identity"* (Ulriksen et al. 2017: 423). Taheri et al. (2018) found that developing a disciplinary identity in CS directly influences academic persistence in CS.

The literature reviewed in this section informed some of the choices of my research. In STEM retention research and in Dutch student success research there is a noticeable shift towards involving student experiences in their focus on retention. This aligns with the focus on participants' experiences in the research questions of this research. Further, the reviewed CS retention research delivered a wide variety of possible positive and negative influences on retention, linking it to expectations, social and academic integration and first-year stagnation. To explore the extent of the influence of programming experience and prior studies on CS retention they were used as participant selection criteria. Findings by Kori et al. (2015) showing that perceptions in CS students changed over the year influenced the longitudinal approach of my research.

2.6 Summary and conclusion

Chapter 2 explored three main literature topics related to my research: 1) PsyCap, and the four factors it is composed of: self-efficacy, optimism, hope and resilience, 2) transition to HE, which included students' expectations, social and academic integration and first-year stagnation and 3) student

retention in CS programmes. This literature review provides the lens for exploring and explaining the research data, together with the theoretical framework for this research, TC, presented in chapter 3.

Chapter 3: Theoretical Framework

3.1 Introduction

This chapter explores the notion of TC, as introduced by Meyer and Land (2003) and how it can act as a lens in my research to connect the participants' PsyCap and experiences to answer the research questions. Similar to Land's (2011) suggestion of using TC as a tool for analysis, using TC as an overarching connector in my research not only makes it possible to relate PsyCap and the different participant experiences, but also enables the findings to be placed in a wider perspective of student retention in CS.

First, TC and its relevance to this research is discussed and this is followed by providing insight into how TC has been applied within the CS domain (3.2). Then, the concept of troublesome knowledge (Perkins, 1999) is reviewed and the notion of *troublesome experiences* is introduced (3.3), followed by a section on the affective dimension of liminality (3.4), relating student experiences and the emotions these involve with retention.

3.2 Threshold concepts

Meyer and Land developed the notion of TC to explore student learning by focusing on the notion *"that there might be concepts in any discipline that have a particularly transformative effect on student learning"* (Meyer and Land, 2006c: xv). In their original paper they define TC as follows:

> A threshold concept can be considered as akin to a portal, opening up a new and previously inaccessible way of thinking about something. It

> represents a transformed way of understanding, or interpreting, or viewing something without which the learner cannot progress. (Meyer and Land, 2003: 412)

Meyer and Land identified seven characteristics of TC: transformative, irreversible, integrative, troublesome, bounded, reconstitutive and discursive. *Transformative* means that once a student understands something, it has an effect on their learning and behaviour and creates a significant change in how they perceive a subject, or part of a subject. *Irreversible* means the change in perspective by understanding the TC is not easily forgotten. *Integrative* means that through a TC an interrelatedness that was hidden before, is exposed. *Troublesome* relates to a concept being alien, tacit, counterintuitive, subversive, or conceptually difficult (Perkins, 1999) and *bounded* in a way that every concept has boundaries that are connected to new conceptual areas. *Reconstitutive* relates to the way in which individuals reposition themselves in relation to the subject, and *discursive* involves the use and understanding of specific language relating to the subject (Meyer and Land, 2003; Meyer and Land, 2006a; Meyer et al., 2010). Each of these characteristics plays a part in whether or not students' progress in their study of choice, although not all characteristics are always apparent in a TC.

Where at first TC was focused on the cognitive side of learning, over the years the focus has shifted and it *"has become more sensitive to differences between individual learners and in the different pedagogies within disciplines"* (Meyer and Land, 2006c: 22). Peter Felten described the research into TC as *"the common endeavour [that] is more concerned 'to provoke and suggest,*

not to prove and conclude'' (cited in Meyer et al., 2016: xii). The application of TC in over 250 subject areas in over 45 countries (Flanagan, 2019) gives an indication how the *"new analytic discourse and vocabulary can be applied to new contexts of practice* [… in a way that also] *addresses mainstream pedagogical and curricular issues within higher education"* (Meyer et al., 2016: xii). This makes TC suited to act as a lens in my research as it enables the different participant experiences to be discussed and positioned in a consistent way.

However, critiques by Rowbottom (2007) and Barradell (2013) focus on the 'vagueness' of what a TC is. If a TC does not need to display all TC characteristics as Meyer and Land (2006a) state, how many are needed to count as a TC? In their original idea, Meyer and Land (2003: 10) stated that what TC exactly entailed was still evolving, however they wanted *"to open up discussion of threshold concepts as an important but problematic factor in the design of effective learning environments within disciplines"*. Rowbottom (2007: 263) further states a TC is an *"extrinsic property"* that can be different from one person to the next. Furthermore, Cousin (2008: 263) also claims *"it will be hard to unravel processes of intellectual maturation from those of disciplinary enculturation".*

All these criticisms do not influence my research negatively, because in this research identifying TC within the CS domain is not a goal in itself. The notion of TC is applied to enable the interpretation of my findings in this research. The TC or their characteristics are not only related to the development of CS skills, but also to the development of a first-year student, with the possibility of

this personal development influencing their CS development. Schwartzman (2010: 28) describes that by *"lacking an operative paradigm, TC is valued as an agent of connection and communication* [… and by doing so] *TC provides a common vocabulary for discourse"*. This is also how TC is applied in my research.

3.2.1 Threshold concepts and computer science

As identified by Flanagan (2019), research on TC comes in a wide variety of disciplinary educational settings, including the CS domain. Every CS curriculum is based on certain core concepts from the CS domain and although there is overlap between CS curricula around the world and between universities, there are also differences based on different pedagogical and CS related views (Zander et al., 2008). A TC is not the same as a core concept. It is a *"conceptual 'building block' that progresses understanding of the subject* […and although it has to be understood] *it does not necessarily lead to a qualitatively different view of the subject matter"* (Meyer and Land, 2006a: 6).

Research on TC in the CS curriculum is mostly focused on programming courses and the identification of TC (Reeping et al., 2017; Sanders and McCartney, 2016; Sorva, 2010). Zander et al. (2008) applied semi-structured interviews in their research to gain insight into student experiences with TC in the CS domain. Their focus was on students' experiences with the content of the CS curriculum and not the general student experience as a CS student, as is the focus of this research.

In their research, Flanagan and Smith state that the programming language itself is troublesome and identify three computer programming learner identities for students with no prior programming experience: the *"bemused",* the *"confused"* and the "*transformed*" student (2008: 92). For the *bemused* student, the programming language itself is the threshold and they are *operationally challenged*, because they cannot program at all. For the *confused* and *transformed* student, the threshold is not the programming language itself, but they experience *local thresholds* in the grasping of one or more specific aspect of programming, for example interfaces. The *confused* student fails to get past this threshold, can therefore not grasp complex interactions and ends up *conceptually challenged*, because they cannot programme effectively. The *transformed* student is able to overcome the *local threshold* and able to understand complex interactions, after which transformation follows. The *transformed* student is *locally challenged*, because they can programme effectively, but will encounter some difficulties (Flanagan and Smith, 2008: 92). These ideas on the *bemused*, *confused* and the *transformed* student can be applied to the data for my research.

3.3 From troublesome knowledge to troublesome experiences

Meyer and Land (2006a) describe how their data revealed that some study programme related concepts appeared to be troublesome to students. They identified these troubles as important thresholds for students to conquer and use the notion of troublesome knowledge, introduced by Perkins (1999) to further explore the nature of this concept.

Perkins (1999) defined troublesome knowledge as that which appears counterintuitive, alien or incoherent and identifies four types of knowledge that might be troublesome: ritual knowledge, inert knowledge, conceptually difficult knowledge, alien knowledge. Meyer and Land (2006a) added a fifth possible source of troublesome knowledge: tacit knowledge. According to Perkins (1999: 8) ritual knowledge has a *"routine and meaningless character* [… and] *it feels like part of a social of individual ritual"*. Ritual knowledge, such as names, dates, routines in arithmetic or producing some forms of diagrams, enable students to (re)produce something without understanding the concept in depth (Meyer and Land, 2006a). Inert knowledge *"sits in the mind's attic, unpacked only when specifically called for"* (Perkins, 1999: 8), for example, answers to certain quiz questions. Conceptually difficult knowledge can be found in all kinds of disciplines but is particularly evident in mathematics and science. It relates to concepts that are often complex and difficult to understand, for example Newton's Laws (Meyer and Land, 2006a). Perkins (1999: 9) characterises alien knowledge as that which *"comes from a perspective that conflicts with our own. Sometimes the learner does not even recognise the knowledge as foreign"*. This often corresponds with personal and societal issues, such as historical perspective or cultural or religious value systems. Perkins (1999) suggests that there might be other sources of troublesome knowledge and invited others to add other categories. Meyer and Land (2006a) added tacit knowledge to Perkins' list of possibilities for troublesome knowledge. *"Tacit knowledge is knowledge that is not explicated"* (Collins, 2010: 1). It is the knowledge that you do not know you know, but it

informs actions. Tacit knowledge is difficult to transfer to others through speech or writing.

Shinners-Kennedy (2016) found that the notion of troublesome is often used in literature as an euphemism or synonym for conceptually difficult knowledge and also points out that ritual, inert and tacit knowledge all relate to knowledge that the learner already possesses, so it is not newly acquired knowledge that causes the troublesomeness, but the unsuccessful way of retrieving the existing knowledge (Shinners-Kennedy, 2016). Meyer and Land (2006a: 14) identify troublesome language as a further source of troublesomeness. By this they mean the *"specific discourse to represent (and simultaneously privilege) particular ways of seeing and thinking"*. The language used in a specific domain or community could lead to finding *"familiar concepts strange and subsequently conceptually difficult"* (Meyer and Land, 2006a: 14). This could certainly be of influence in the CS domain where there is a specific discourse related to programming. The ability to understand and later use the domain specific terminology of the programming language and the surrounding language, plays a large part in successfully mastering CS.

Felten (2016: 4) states that students' reflections on troublesome knowledge show they *"used at least some emotional language to explain their encounter with troublesome knowledge"*. He therefore argues not merely to look at the troublesome knowledge students encounter, but also at the troublesome emotions or *troublesome affect* of that knowledge. The emotional language students use to reflect on the troublesome knowledge gives an insight into

how they are feeling about being stuck. Using words, such as frustrated, stressed, upset, determined, says more about them than about the subject causing it. In my research this beforementioned troublesome affect will play a part in the interviews about the CS students' experiences.

Research on TC in the CS education domain, by Sanders et al. (2012), highlights that learning computing involves learning new concepts, but also involves learning a new skill at the same time. In their interviews with students to identify TC in computing, students reported *"not having difficulties when they listened to a lecture or read the text, but when they had to do something"* (Sanders et al., 2012: 27). This led Sanders et al. (2012) to not only look for TC in their research, but also for threshold skills. Similar to a TC, a threshold skill can be transformative, integrative and troublesome. Unlike TC threshold skills are semi-irreversible, meaning the skill *"can be regained with practice, without having to start from scratch"* (Sanders et al., 2012: 28) and that the skill is associated with practice.

Building on these findings of Sanders et al. (2012), I would like to take a further step in my research by integrating troublesome knowledge, troublesome affect and threshold skills and introduce *troublesome experiences*. I define *troublesome experiences* as cognitive, affective and/or skills experiences that obstruct students from further development. This definition not only captures the troublesome knowledge and the affect it has on students, but also includes skills. In professional oriented programmes like CS, students do not only have to acquire a knowledge base, but also need to work at the skills component of the domain, in this case learning how to

programme. Acquiring a skill can be troublesome, sometimes in combination with troublesome knowledge when a student lacks certain knowledge to fulfil the skilled task and in combination with troublesome affect it can lead to certain emotional barricades to overcome.

My research will explore the participants' *troublesome experiences* rather than separately look at troublesome knowledge, threshold skills and troublesome affect, because these different types of troublesomeness often appear to be interrelated.

3.4 The affective dimension of liminality

Liminality is an aspect of TC (Meyer and Land, 2006b) and has its origins in the Latin word *limen*, meaning boundary or threshold. Inspired by work by Van Gennep (1960) and Turner (1969), Meyer and Land (2005) consider TC in some disciplines comparable to a rite of passage. Turner adopted the term liminality *"to characterise the transitional state of space or time within which rituals are conducted"* (Meyer and Land, 2005: 375). Liminality, often also referred to as the liminal space (Reeping et al., 2017, Land et al., 2014a), is the state or *"space of discomfort and transformation while grasping a concept"* (Reeping et al., 2017: 4).

Meyer and Land (2006b) state that liminality has a transformative function. First, in the way it plays a part in the students becoming aware that they are or starting to become, in this case, a computer scientist. Second, that this subsequently leads to the *"a new status and identity within the community"* (Meyer and Land, 2006b: 23). And third, the transformation can take place

over a longer period of time. Students navigate the liminal space in different ways and at different speeds, based on individual differences such as prior experience, motivation, personality or study strategy. This is visualised in figure 3.1, where the crosses represent the individual students and the arrows the different ways students navigate through or get stuck in the liminal space. Learning within liminality is characterized by *"oscillating between and confusing the new and old understandings, emotional response and the feeling of being "stuck""*(Meyer and Land, 2005 cited in Sanders and McCartney, 2016: 92).

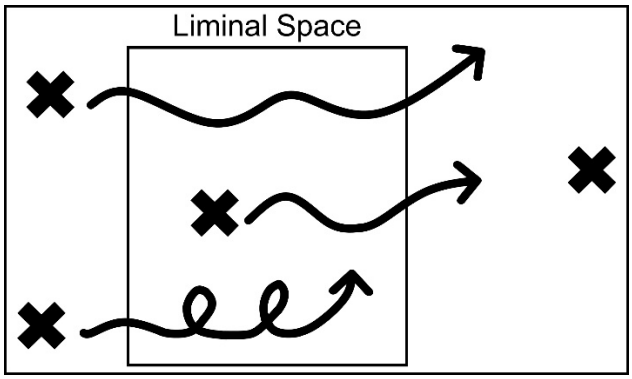


Figure 3.1 Liminal space (Reeping et al., 2017: 44)

When students have trouble navigating liminality they often appear to adopt a form of *"compensatory mimicry"* (Meyer and Land, 2006b: 24), as a way to compensate or mask partial mastery of a concept (Thomas et al., 2015) or as a *"serious attempt to come to terms with conceptual difficulty, or to try on certain conceptual novelties for size"* (Meyer and Land, 2005: 383).

Although Meyer and Land call liminality a *"transformational state*" (2005: 380), indicating its importance in students' development, they also admit that it remains *"to some extent the 'black box' of threshold research"* (Meyer et al.,

2016: xvii). Both Land et al. (2014a) and Rattray (2016) refer to a visualisation by Vivian (2012) whereby liminality is represented as a 'liminal tunnel'. According to Rattray (2016: 72) the tunnel *"emphasises the idea of an intimidating or unseen place that must be entered and passed through if transformation is to occur"*. The tunnel is part of the *"conceptual domain, which is internal to the individual learners and tutors"* (Land et al., 2014b: 6). In relation to seeing liminality as a conceptual space, Land et al. (2014b: 8) present four possible outcomes for students based on unpublished work by Vivian (2012): "*meaningless response"*, when students do not know what to do or how to use the new knowledge; "*partial understanding"*, when students understand parts of the new knowledge. This occurs in varying degrees in different students; "*wrong"*, when students appear to have an understanding by using language or concepts associated with the new knowledge, but have a misunderstanding of the knowledge and a "*correct and coherent understanding"*, when the student grasps the new knowledge completely. What happens in the liminal tunnel is a *"changing of function or a changing of state"* (Land et al., 2014b: 1) that often involve a kind of moving back and forwards between states of not understanding, partial understanding or understanding wrongly before emerging from the liminal tunnel with a correct and coherent understanding. Whether the student is willing and able to use the new knowledge or skill *"will depend on their understanding of the learned concepts and their feelings about the learning process"* (Land et al., 2014a: 204). Research by Eckerdal et al. (2007: 130) on CS students' experiences with liminality shows that they *"admit and accept that learning computing concepts takes time".* They also note that for new HE students this could be

their first experience of the time intensive character of learning, especially in a complex domain such as CS.

Troublesome knowledge and TC have a cognitive and affective component (Meyer and Land, 2006a) and the acquisition of TC can be considered a highly emotive experience for students (Felten, 2016, Rattray, 2016). This affective component that plays a role in the mastery of TC has gained research interest over the years (Land et al., 2014a, Rattray, 2016, Cousin, 2006). In her research Cousin (2006) emphasises the importance of affective factors in the mastery of TC arguing that emotional capital and affective learner positions influence students ability to navigate liminality. She identifies four affective learner positions (Cousin, 2006: 140): *"the spectator/voyeur"*, *"the defended learner"*, *"the victim-identified learner"* and *"the self-reflexive learner"* and states that these typical representations should be used as:

> heuristic devices, in this case to prompt thinking about student states of liminality, their connection to pedagogic strategy and to questions of emotional capital for the mastery of the threshold concept (Cousin, 2006: 145).

Building on Cousin's (2006) work connecting the affective factors and emotional capital in relation to liminality, Land et al. (2014a), Land et al. (2014b) and Rattray (2016) link the affective side of navigating liminality with PsyCap. Rattray's work (2016: 68) focused on *"the extent to which psychological characteristics of the learner contribute to coping with liminality"* and how this might explain why some students persist and some withdraw.

This served as an important source of inspiration for my research, both for pointing towards the factors of PsyCap and for using TC in looking for insight into why so many students leave CS programmes. The limited research specifically on liminality within the CS domain acknowledges that students navigate liminality differently and that within the CS domain, students have to deal with a broad range of activities, such as design, implementation, testing and maintenance, that both require knowledge and skill (McCartney et al., 2009; Thomas et al., 2015). Most research relating to liminality in CS programmes focuses on the cognitive and not the affective dimension of liminality. My research adds a longitudinal view on CS students' experiences with liminality, especially on their psychological and affective experiences.

3.5 Applying threshold concepts vocabulary in this research

In this research the TC vocabulary is applied as an overarching connector which was to gain insight regarding their retention and enable connections with the participants' experiences of TC. The most commonly used TC related vocabulary is thresholds, troublesome knowledge/*troublesome experiences*, liminality and transformation.

In this research the concept thresholds is used more loosely than in most TC oriented research. It not only refers to the portal described by Meyer and Land (2003), but sometimes also as the obstacle that stands in the way of the participants' development and their perception of development. This makes overcoming a specific *troublesome experience* an obstacle for one, but a threshold for another student. The difference between obstacle and threshold

is the transformed state after crossing a threshold. For example, passing an exam was experienced as a *troublesome experience* by most participants, but where in some participants' experiences passing the exam led to some kind of transformation, it did not in some other cases. Throughout this thesis I used 'threshold', because in the participants' experiences it is often unclear, but plausible that some kind of transformation occurred.

The newly introduced concept of *troublesome experiences* is an adaptation of TC troublesome knowledge. *Troublesome experiences* can be applied to a wider range of troublesomeness that influences the participants' experiences, from troublesome knowledge to skills, but also personal issues that hinder the participants' development and possibly their retention. Troublesome experiences are connected to liminality and to hurdles and thresholds.

Liminality and transformation are used in the same way as in the TC literature. Liminality in the way that it relates to the no man's land a student tries to navigate in order to cross a threshold as defined by Meyer and Land (2003). Transformation in relation to the changed state of the student after their encounters with troublesome experiences, liminality and thresholds. In this research this transformation can be connected to becoming an HE student and becoming a future computer scientist.

3.6 Summary and conclusions

The concept of TC can be used as a linking pin between CS students' experiences during their first year and the role PsyCap plays in student retention, by providing the connecting vocabulary through which it can be

explored and explained. The findings of my research will especially be related to thresholds, *troublesome experiences*, liminality and transformation, but will not ignore other TC characteristics. Chapter 4 will explain how the research was conducted and analysed methodologically.

Chapter 4: Methodology and methods

4.1 Introduction

This chapter explains the methodological approach taken and methods used both in the collection and analysis of the data. This is done by stating the ontological and epistemological stance (4.2) and describing the methodological approach of my research (4.3). This is followed by an explanation of the methods used by looking at the research design, with a special focus on the graphic elicitation exercise used (4.4), the profile of participants (4.5), data collection (4.6), data analysis (4.7), but also a discussion of the ethical issues of the research (4.8) and credibility of the findings (4.9).

4.2 Ontology and epistemology

The ontological position of this research can be placed within the interpretivist paradigm. It aligns with Creswell's (2009: 8) explanation that *"interpretive methodology is directed at understanding a phenomenon from an individual's perspective, investigating interaction among individuals as well as the historical and cultural contexts which people inhabit".* By letting the participants reflect on their past and current experiences, interactions and approaches, I hope to gain an understanding of how this might help or hinder PsyCap or their potential withdrawal from the CS programme.

This research has a social constructivist epistemological position and aligns with Berryman's (2019: 273) claim that *"interpretivists believe truths is revealed through social interactions, language, shared consciousness and*

other social interactions". The qualitative case study methodology adopted in this research also connects to social constructivism in the way it supports a *"transactional method of inquiry, where the researcher has a personal interaction with the case"* (Hyett et al., 2014: 2). This means that the case takes shape because of a relationship between researcher and participant, and maybe even the reader in constructing meaning from the experiences (Hyett et al., 2014; Stake, 1995). Additionally, in TC literature there are connections described with social constructivism between active, social and creative constructivist approaches to learning in relation to troublesome knowledge (Perkins, 1999) and by linking navigating the liminal space to Vygotksky's zone of proximal development to explain or overcome barriers experienced by students (Cousin, 2008).

4.3 Qualitative longitudinal case study

The aim of this research is to explore CS students' experiences during their first year at a UAS. The purpose is to get a better understanding of why and when CS students leave the CS programme and how their decision and actions relate to PsyCap. A qualitative longitudinal case study provides the scaffolding to explore this topic.

4.3.1 Qualitative longitudinal approach

A qualitative approach was chosen because, according to Denscombe (2010), it is best suited to capture rich experiences, such as those of the participants. Data were collected through a series of three individual semi-structured

interviews with the participants and additional graphic elicitation exercises (see section 4.4.1.).

The three interview rounds were spread over the course of the participants' first academic year. The shared characteristic of the participants is that they are all members of cohort 2018-2019 of the CS programme in the same Dutch UAS. This allowed the research to be characterised as longitudinal (Bryman, 2012). Seidman (2013) describes this three-interviews-series approach and explains that the foundations of this method were laid earlier by Schuman (1982). Seidman (2013: 21) defines the nature of the three different interviews as follows:

> the first interview establishes the context of the participants' experience. The second allows participants to reconstruct the details of their experience within the context in which it occurs. And the third encourages the participants to reflect on the meaning their experience holds for them.

This aligns with the orientation of the interviews in this research where the first interview looked at the students' experiences up until the point in time the interview took place. Interview 1 included experiences in secondary education, choice and motivation for the CS programme, expectations, preparations, transition to HE and first experiences. Interview 2 explored the participants' experiences once the initial enthusiasm had worn off and the reality of learning how to programme and first exam results appeared; and how these experiences influenced the participants' decisions. Interview 3

partly continued exploring issues from interview 2, but also asked the student to reflect on the whole year. Whereas Seidman proposes to spread interviews over a period of a couple of weeks, in this research interviews were spread over a period of seven months. The rationale for this is that the interviews followed the experiences as they happened.

4.3.2 Case study

Over the years there has been much debate about the application of case studies in social research. One of those debates relates to whether or not a case study is part of the methodology or of the methods of a research project. According to Creswell (2013: 97), the case study qualifies as a qualitative approach because it:

> explores a real-life, contemporary bounded system (a case) or multiple bounded systems (cases) over time, through detailed, in-depth data collection involving multiple sources of information (e.g., observations, interviews, audiovisual material, and documents and reports), and reports a case description and case themes.

This aligns with my research because the CS programme is a real-life bounded system, and in depth data were collected through interviews to explore the role of PsyCap on CS students' retention. The researched CS programme itself is not the object of study, but provides the backdrop to explore student retention and PsyCap, making this case study part of the methodological approach of the research, rather than the method of collecting data.

The application of case studies has also been criticised. Flyvbjerg (2006) notes that they only yield practical knowledge instead of theoretical knowledge, which is often seen as more valuable. Additionally, he states that a single case cannot be generalised and therefore, cannot contribute to scientific development. When trying to improve student retention, I would argue the practical knowledge can offer a large contribution to the scientific development together with theoretical knowledge that is collected otherwise. The credibility of my research findings is discussed in section 4.4.6

4.3.3 Insider research

My research took place in the university and CS programme where I am employed and can therefore be classified as *"insider research"* (Trowler, 2016). The biggest advantage this provided was access to participants and naturalistic data (Trowler, 2016). Knowledge of the domain and the CS programme helped me to ask informed questions in the interviews and possibly helped participants to feel more at ease with someone who is familiar with their study programme. Since most insider research at universities are case studies (Trowler, 2016), the criticism on credibility pointed out in section 4.3.2 also applies here. This will be further discussed in section 4.9. The advantage of having insider knowledge of the programme and of having experience with working with first-year CS students can also act as a disadvantage when this leads to subjectivity in interpreting participants' views and experiences. Looking at the participants' experiences in relation to PsyCap and from a TC perspective, rather than stand-alone experiences, helps to mitigate possible subjectivity.

The outsider-insider continuum as described by Mercer (2007) and Hellawell (2006) helps to balance the advantages and disadvantages of insider research. An important aspect of this new thinking about outsider-insider positioning, pointed out by Milligan (2016: 239), is *"the notion that in conducting research we are neither entirely one identity nor another; neither fully inside nor outside"*. This means that although the participants and I share the same CS programme, my role as researcher gives me a different perspective on their experiences than my regular role as lecturer and academic tutor, but with some additional insights into the situation.

4.4 Research design

This section outlines the research design, selection of participants, data collection and data analysis, ethical issues and credibility of the findings. The methods applied in this research were chosen to find answers to the following research questions:

> *RQ1 How does psychological capital influence first-year computer science students' retention?*
>
> *RQ2 What experiences influence first-year computer science students' psychological capital and retention?*
>
> *RQ3 How do threshold concepts relate to the psychological capital and experiences of first-year computer science students?*

The research design for this qualitative longitudinal case study consists of three rounds of individual interviews with a group of participants during their

first academic year. All interviews tried to identify how the students' experiences influenced their psychological capital or the other way around: how PsyCap influenced their experiences and if there were differences between students.

Figure 4.1 shows when the interviews took place.

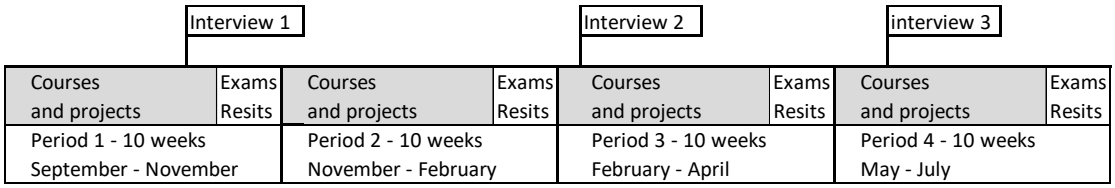


Figure 4.1 Overview of academic year in relation to the interviews

As figure 4.1 shows the academic year in the researched CS programme is divided into four periods of ten weeks. Each period has seven weeks of courses and projects and three weeks of exams, resits and time for preparation or catching up. Resits take place at the end of the following quarter, so the resits for period 1 are at the end of period 2 etc. Students are entitled to one exam and one resit for each course per academic year.

Central to interview 1, conducted in October and November 2018, were the expectations and preparations of the student prior to the start of their academic year and their experiences with the transition to HE and especially to the CS programme. The interview also explored how participants had made their choice for the CS programme and how this affected their expectations and preparations. Further, the participants were asked about their definitions and views of PsyCap and its four factors: self-efficacy, optimism, hope and resilience.

The focus of interview 2, conducted in January and February 2019, were the participants' experiences during their first semester. Participants reflected on their experiences and difficulties, that included two exam rounds and one resit round, and how these had influenced them and their development, personally and as a CS student.

The focus of interview 3, conducted in May and June 2019, also explored the participants' experiences, strategies and expectations at that point in time, but they were also asked to reflect on their first year. In all three interviews, participants were asked to perform graphic elicitation exercises, both as interview stimuli and additional data.

4.4.1 Graphic elicitation

To collect rich interview data, I explored ways of using interview stimuli. Although not all CS students fit the stereotypical image of being non-communicative, based on my experience I anticipated that asking them to talk through a graphic elicitation exercise might help participants in getting their feelings and experiences across and deflect their focus from the awareness of being interviewed. For each graphic elicitation exercise, participants were asked to talk through a research related exercise. This approach was inspired by the *thinking aloud* protocol that is a regular method used by CS professionals and students. *Thinking aloud* is the most frequently used method in usability testing of software applications, originating in the human-computer interaction domain (Nielsen, 1992; Nielsen et al., 2002).

From a review of literature it became apparent that there are numerous applications of what Crilly et al. (2006: 342) named "*elicitation stimuli"*, with similar aims and claims to success, but according to Rodriguez and Kerrigan (2016: 1053) *"definitions remain inconsistent across scholars and fields"*. Summarising the different methods in this field shows that graphic elicitation and visual elicitation can be considered the overarching terms that cover all techniques that make use of maps, photographs, word or picture cards or similar materials. Visual elicitation is often used in relation to the use of photographs, although photo elicitation is also used in this respect (Crilly et al., 2006). Diagrammatic elicitation involves the use of a diagram and participatory diagramming involves the participant in creating a diagram ((Crilly et al., 2006; Rodriguez and Kerrigan, 2016; Umoquit et al., 2011), where the sort of diagram is chosen in line with what the research needs as long as *"some level of abstraction exists, often with some level of parameters and direction"* (Rodriguez and Kerrigan, 2016: 1053). Akama et al. (2007) describe the use of playful triggers and using artefacts to start or deepen an interview by using real objects such as buttons or bits of wood.

Publications on interviewing autistic participants that may have difficulty expressing themselves, similar to some of the participants in this research, lead to activity oriented questions, similar to their application by Winstone et al. (2014) and Colucci (2007), which in essence can be considered forms of graphic elicitation. Winstone et al. (2014: 201) conclude that applying activity-oriented interviews with autistic children *"resulted in a greater amount of dialogue from participants than standard interviews"*. Colucci (2007: 1424)

states that the actual content of the activities is not the main focus, but that they *"provide a different way of eliciting answers and promoting discussion"*. This is also how I approached the exercises at first, but during the interview process itself I realised the added value of the data the exercises provided. Aligning with Rodriguez and Kerrigan (2016) and Umoquit et al. (2013) this research uses elicitation techniques *"both through and as diagrams"* (Umoquit et al., 2013: 7). This helps to *"gather data and to improve the quality of that data by using the visual displays to clarify and reveal meanings, relationships, structures and understandings"* (Rodriguez and Kerrigan, 2016: 1053). I have not found any publications that apply graphic elicitation in a series of interviews, so I decided to use different graphic elicitation exercises in each interview round, aligning with Colucci (2007: 1424) who states that activity oriented questions *"can assume several forms, adapting them to the specific sample and area of investigation"*.

The graphic elicitation exercises used in my research were: a prepared mind map of first-year CS students' expectations used in interviews 1 and 3 (appendices 1, 2 and 3); a scale exercise to let the participants rate their self-efficacy, optimism, hope, resilience and PsyCap used in interviews 2 and 3 (appendices 4, 5 and 6) and an exercise where participants were asked to draw a graph for the increase or decrease of each of the PsyCap factors throughout the year (appendix 7 and figure 5.7 to 5.12). Data collection with graphic elicitation is discussed further in section 4.6.

4.5 Participants

To conduct the interviews for this research, a diverse but representative group of participants of first-year CS participants was required. In September 2018, all 2018-2019 first-year CS students were invited to participate voluntarily in a small online questionnaire by their academic tutor. The first-year group I was directly involved with as an academic tutor or lecturer was not included. This left ten groups, resulting in 273 students of the total of 303 students in the cohort that were invited to fill out the questionnaire. The questionnaire contained some general questions about their entry qualifications, programming experience, gender and four statements with a five point scale drawn from the 24 item PSQ (Luthans et al., 2007), one on each of the PsyCap factors of self-efficacy, optimism, hope and resilience. There was also information provided about the research and the opportunity to leave their student number if they were interested in participating in the research. The aim of the PsyCap statements and the questionnaire in itself was to give the students a small taster of the research subject and to attract them as participants and for me to assess any differences in students' views on the statements.

The aim was to select 12-15 participants. This group size was considered acceptable for saturation of data in a PhD study (Mason, 2010) while it was still within the practical achievable time limits of the research and accounted for limited participant attrition without jeopardising the research. In total 105 students filled out the questionnaire and 28 of those students indicated an interest in participating.

Participant selection was based on three selection criteria: entry qualification, previous HE experience and programming experience. Gender was also taken into account in selecting a representative group of participants, although the number of male and female students is not evenly distributed in this, and many other, CS programmes. The first selection criterion was entry qualification because, as explained in Chapter 1, there are different entry qualifications for HE in the Netherlands, with different drop-out risks (Vereniging Hogescholen, 2016; Inspectie van het Onderwijs, 2016; Wartenbergh and Broek, 2008). Second, the selection was based on prior experience in HE. Around 18% of Dutch HE students switch programmes after year 1 (Vereniging Hogescholen, 2016). This is a national average although it varies a lot across different domains. The definition of study-switch used in different publications also varies (Onderwijs in Cijfers, 2015; Vereniging Hogescholen, 2016), making it hard to track numbers. In my research it is of interest to see if having previous experience in HE influenced the students' PsyCap, preparation, transition to the new study programme, and/or study approach. The third selection criterion was the participants' prior programming experience. Having some programming experience, even in other computer languages than the ones that are taught, can help the students understand a new programming language more easily or add to their motivation and academic achievement (Hagan and Markham, 2000; Kori et al., 2016).

First, fifteen participants were selected. One participant, that volunteered in January 2019, was added when a number of participants had already left the

programme. The selected participants form a realistic representation of the whole cohort population of the researched CS programme. This is done purely for the realism of the representation of the cohort and does not lead to claims of generalisability within the cohort or in a wider context.

The small size of the group of participants, makes it difficult to have the same distribution as the whole cohort. One participant more or less in a category has a large impact on the representation percentage. Ideally, I would have liked to include one more participant with an MBO background, because then they would have represented 25% of the participant group, but only three students with this entry qualification indicated an interest to take part.

Cohort 2018-2019	N= 303	%		Participants	N= 16	%		
Entry qualification				**Entry qualification**			1st HE	>1 HE
MBO	79	26.1		MBO	3	18.8	2	1
HAVO	174	57.4		HAVO	9	56.2	5	4
VWO	23	7.6		VWO	2	12.5	1	1
Other	27	8.9		Other	2	12.5	2	0
HE experience				**HE experience**				
First	251*	82.9*		First	10	62.5		
Previous	52*	17.1*		Previous	6	37.5		
Gender				**Gender**				
Male	276	91		Male	14	87.5		
Female	27	9		Female	2	12.5		

*Table 4.1 Overview total cohort 2018-2019 vs participants * based on Onderwijs in Cijfers (2015)*

Table 4.1 shows a difference in the percentages in HE experience in the full cohort compared to my sample. This can be explained by the fact that the participants were first selected on their entry qualification. Selection on HE experience aimed to have both participants with and without HE experience within each entry qualification.

The category ‘other’ is not mentioned in Chapter 1, but these students have either a foreign diploma equivalent to the entry requirement or were allowed to enrol because they had successfully completed the 21+ entry exam for students over the age of 21 that have no MBO, HAVO or VWO diploma. However, no students from this category with previous experience in HE wanted to take part. The current sample of participants offered the opportunity to take into account the effect of having previous experience in HE on retention into account. The third selection criterion, programming experience, was not included in table 4.1, because there is no data of the whole cohort to compare.

Tables 4.2 to 4.5 show an overview of the participants based on their entry qualification. To get an impression of the sort of programming language, the programming experience is divided into three different forms of programming experience. HTML represents web oriented programming languages, such as HTML, CSS, PHP and Javascript and they are not closely related to the type of programming required in the researched CS programme. C# represents major programming languages, such as C#, Java and C++ that are different than what is taught at the start of the researched CS programme, but are relatable programming languages. Python is the programming language taught in the first semester of the researched CS programme. The tables also indicate in which interviews the participants took part.

Pseudonym (gender)	First HE	Programming experience	Programming languages			Interview		
			HTML	C#	Python			
Charlie (m)	yes	reasonable	yes	yes		1	2	
David (m)	no	none				1	2	
Henry (m)	yes	none				1		

Table 4.2 Participants with an MBO entry qualification

Charlie, did his MBO education in the IT domain of application development, so he had some programming experience with web oriented programming languages. David came from a human technology programme and Henry from a business administration programme and both had no programming experience. All the MBO participants (table 4.2) left the programme, with Charlie and David taking part in the second interview even though they had already left the programme by then.

Pseudonym (gender)	First HE	Programming experience	Programming languages			Interview		
			HTML	C#	Python			
Noa (m)	no	none				1	2	3
Bryan (m)	no	minimal	basics		basics	1	2	3
John (m)	no	limited	yes			1	2	3
Emma (f)	no	none				1	2	3
Simon (m)	yes	minimal	basics			1		
Andrew (m)	yes	minimal	basics			1		
William (m)	yes	minimal	basics				2	3
Osman (m)	yes	none				1	2	3
Paul (m)	yes	limited	yes			1	2	3

Table 4.3 Participants with a HAVO entry qualification

Table 4.3 shows the nine participants with a HAVO entry qualification. This is the largest group of participants, but HAVO students also form the largest group of students that apply for UAS programmes in general. Some of the HAVO schools offer extracurricular IT classes, but if they do, the subjects and levels covered show a large variety. Some of these participants started programming as a hobby when they were younger. One of the participants,

William, volunteered in January 2019 to take part, after he had heard about the research from his fellow student Bryan. He had filled out the original questionnaire at the beginning of the year, but at that time he felt too overwhelmed by the whole HE experience to take part. Now he felt more settled and was motivated to take part.

Table 4.4 lists the two participants with a VWO qualification. Both have some programming experience that started out of personal interest.

Pseudonym (gender)	**First HE**	**Programming experience**	**Programming languages**			**Interview**		
			HTML	C#	Python			
Richard (m)	no	good	yes	yes	basics	1	2	3
Fred (m)	yes	limited	basics	yes		1	2	3

Table 4.4 Participants with a VWO entry qualification

The participants in table 4.5 did not have an MBO-level 4, HAVO or VWO qualification.

Pseudonym (gender)	**First HE**	**Programming experience**	**Programming languages**			**Interview**		
			HTML	C#	Python			
Liam (m)	yes	reasonable	yes	yes		1	2	3
Miranda (f)	no	reasonable	basics	yes	basics	1	2	3

Table 4.5 Participants with a 21+ entry exam pass

Miranda had a level 2 MBO qualification and Liam had no qualifications and had worked for a number of years before deciding he wanted to return to education. These participants took the 21+ entry exam and both have some programming experience that they gained out of personal interest.

All participants were offered the opportunity to come up with their own pseudonym, provided it was a first name that is commonly accepted and was not the name of any other student in their cohort. All participants left the

choice of pseudonym to me. When asked, only one of the participants wanted their pseudonym to reflect their cultural or ethnic background. I chose to use first names that are used both in the Netherlands and the United Kingdom, to make reading and discussing the research in English easier for all concerned.

4.6 Data collection

The data collected in this research consists of three rounds of semi-structured interviews that were all recorded and transcribed verbatim and three different graphic elicitation exercises. All interviews were held in Dutch to make sure the students could comfortably describe and discuss their experiences. All interviews were conducted at the location of the researched CS programme in a one-on-one setting in an empty office or classroom, with the door closed. Because the research focuses on experiences during the first academic year, the timing was imperative, and involved approaching the students in September and timing of the interviews in October, February and May. This meant that a more pragmatic and iterative approach was taken throughout the data collection, alternating between preparation for an interview, reading relevant literature and reflecting and analysing on the interviews in different ways.

Interview 1

Interview 1 took place in October 2018, near the end of the first period (figure 4.1) and started with the participant being asked to talk about their decisions and journey to the CS programme. This included how they experienced their secondary education, how they chose CS as a study programme, and any

programming experience. These were low risk questions to make the participants feel comfortable with the setting and answering questions. It gave me the opportunity to assess if this was a participant that was an easy or more difficult interviewee, based on how the conversation flowed. The interview then moved to how participants had prepared themselves for the transition to HE or to CS in particular, or how they felt their secondary school had prepared them. The interview continued with exploring the expectations participants might have had and they were presented with the first graphic elicitation exercise: the mind map. As explained in 4.4.1 the prepared mind map contained themes and expectations collected from the previous cohort of CS students. The collected expectations were grouped into four themes in the mind map: learning how to program, study in general, the student and general issues. There were blank boxes for the participants to add expectations that were not yet included. Appendix 1 shows a translated version of the mind map and appendices 2 and 3 shows two participants' examples.

The participants were asked to talk about expectations they recognised they had themselves, opposing expectations to items on the mind map, or to add expectations that were not yet included. Having the mind map helped participants to put their own expectations into words. This was followed by questions on their experiences so far and how this relates to their expectations and how they approached their study. At the end of the interview I explained what self-efficacy, optimism, hope and resilience meant. We then spoke about the individual factors of PsyCap, their importance for a student and whether they felt it was a fixed trait or not. At the end of the interview the

participants were given the opportunity to return to any of the topics discussed or add topics they would like to discuss at this point.

Interview 2

The second interview took place in February 2019, at the start of the second semester. The students had experienced two different exam weeks and one resit week (figure 4.1) when the interview took place. At the start of the interview the participants were asked if they had spoken to someone about the first interview, and if so, what they had discussed, thus, linking interview 1 with interview 2. The focus of the second interview was the participants' experiences, good and bad, how they approached the first exams and if and how they had changed their study approach. After discussing this the participants were presented with the second graphic elicitation exercise: the scale exercise. The exercise shows five lines, with a 0 at the start of the line and a 10 at the end, but no markings in between. Each line represents one of the PsyCap factors and PsyCap as a whole. An empty scale exercise and two participants' examples are shown in appendices 4, 5 and 6. The students were asked to mark their 'self-efficacy' for interview 1, in retrospect, and at the time of interview 2. It was explained that the exact position on the scale was not as relevant as whether it went up, down or stayed the same and perhaps most important was the participants' explanation of their positioning on the scale. This was repeated for optimism, hope, resilience and PsyCap as a whole. Again, at the end of the interview the participants were given the opportunity to return to any of the topics discussed or add topics they wanted to discuss at this point.

Interview 3

The third interview took place in May 2019, after the third exam week and second resit week (figure 4.1). This interview focused further on the students' experiences, study approach and possible changes. It was also the opportunity to reflect on the academic year. The mind map exercise and scale exercise from interviews 1 and 2 were reintroduced. The participants were shown their mind map and were asked to reflect on the expectations they had at the beginning in relation to how they experienced it in reality, and position their current view on the PsyCap factors on the scale. They were also asked what advice they would have for future students and also for the study programme itself, to improve student retention. Participants were presented with the third graphic elicitation exercise: the graph (appendix 7 and figures 5.7 to 5.12). Participants were asked to draw a graph for each of the PsyCap factors and explain the fluctuations throughout the year for each factor, talking through the exercise whilst doing it. The analysis of the graphic elicitation exercises is discussed in section 4.7.3.

4.7 Data analysis

This research generated two main sources of data: interview data and data collected through three different graphic elicitation exercises. This section explains how both sets of data were analysed.

4.7.1 Thematic analysis of the interviews

Thematic analysis (TA) formed the basis of the analysis of the verbatim transcribed interview data. Braun and Clarke (2006) state that TA's biggest asset is its flexibility in the widest sense of the word, including flexibility in data collection methods and approaches to meaning generation. They also describe how *"TA can be used to identify patterns within and across data in relation to participants' lived experience, views and perspectives and behaviour and practices"* (Clarke and Braun, 2017: 297). This fits with the approach and aims in this research. The advantage of the flexibility of TA has led to a wide range of its applications in qualitative research, but also to the critique that TA is applied as an *"omni-method, suited to any and all qualitative research questions and designs"* (Clarke and Braun, 2017: 297). Also this *"flexibility can lead to inconsistency and a lack of coherence"* (Holloway and Todres, 2003: 346).

The trustworthiness of TA can be enhanced by being clear about how the data were approached and how codes and themes led to the analysis of the data, thereby enhancing credibility, transferability, dependability and confirmability (Nowell et al., 2017). Roberts et al. (2019) also tried to enhance the trustworthiness of their TA by describing step by step how they applied a combination of theory driven-deductive codes with data driven-inductive codes, based on work by Fereday and Muir-Cochrane (2006).

This method was also applied in my research whilst following the phases described by Braun and Clarke (2006).

Atlas TI was used to assist with coding and analysing the data.

Phase	Description
1. Familiarizing yourself with your data	Transcribing data, reading and re-reading the data, noting down initial ideas
2. Generating initial codes	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code.
3. Searching for themes	Collating codes into potential themes, gathering all data relevant to each potential theme.
4. Reviewing themes	Checking if the themes work in relation to the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic 'map' of the analysis.
5. Defining and naming themes	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme.
6. Producing the report	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating the analysis back to the research question and literature, producing a scholarly report of the analysis.

Table 4.6 Phases of thematic analysis. Adapted from Braun and Clarke (2006: 87)

Although the interviews were held in Dutch, all coding was done in English making it easier to discuss the findings. The phases of TA as described by Braun and Clarke (2006) were used to guide the analysis (table 4.6).

Phase 1 consisted of the activities as described in table 4.6. In Phase 2 a preliminary codebook was created, before the coding started. The codes were based on the interview questions, literature, the research questions and from codes picked up through transcribing and (re)reading the transcripts. For all codes an individual definition was created, to revisit when there was any doubt if a code fitted a quotation. Apart from some initial trial coding after the first interview round, all coding was done after all data were collected. After the initial coding, additional inductive codes were added to the codebook, similar to Roberts et al.'s (2019) approach. I concur with their view that

development of a codebook *"enables a discussion and possibility of replication within qualitative methods"* (Roberts et al., 2019: 2), creating greater reliability in the findings.

In phase 3 the coding was fine-tuned by reviewing the data again, creating new codes, sometimes combining existing ones and creating code families. Initial themes were created, leading to nine possible themes. In phase 4 the number of themes was decreased by looking further into combining codes and checking the themes, not only to the extracts and entire data set as proposed by Braun and Clarke (2006), but also to the three participant groups emerging from the research that will be further explained in section 5.2. This continued in phases 5 and 6, leading to four distinctive themes that will inform the answers to the research questions. Initially moving through phases 3 to 6 proceeded as chronologically as presented here, but after moving through all phases once, the different phases were revisited in an iterative way, together with revisiting related literature, to further fine-tune codes, themes and ultimately, the findings.

4.7.2 Themes emerging from literature and interview data

Similar to the codes, the chosen themes have a strong relationship to the research questions, the literature discussed in chapter 2 and the theoretical framework of chapter 3. This is because of the iterative nature of the data collection and data analysis, whereby there was an interplay among research questions, interview questions and literature in the data collection and interview data, codes, themes and literature in the TA, leading to the themes.

Initially, nine themes were identified in the complete interview data:

Initial themes		**Final themes**
Expectations		PsyCap
Preparation/transition to HE		Transition to HE
Emotions		Transformation
Role of others		Troublesome experiences
Threshold concepts		
Troublesome experiences		
Transformation/identity		
Student experiences		
PsyCap		

Table 4.7 Initial and final themes emerging from the data

Iterations, whereby the codes that related to a theme and literature were revisited, led to merging and sometimes renaming themes. The final four themes all encompass a number of codes in the complete interview data set. There are no hard borders between themes, so there is sometimes a small overlap in codes that are used in more than one theme.

Psychological capital

PsyCap is a prominent focus in this research. This theme includes all codes relating to PsyCap and the PsyCap factors, both in quotations, where participants were specifically asked about PsyCap or the factors, especially during the graphic elicitation exercises in interviews 2 and 3, and when participants mentioned them spontaneously. The participants' quotations with a specific PsyCap factor code were compared with the statements in the PCQ (Luthans et al., 2007) of the corresponding PsyCap factor to make sure the factors were used similarly in both the quantitative and qualitative approach of PsyCap.

The psychological capital theme was found in all three interview rounds.

Transition to HE

This theme combines the initial themes of expectations, preparation/transition to HE, emotions, role of others and student experiences. It includes codes relating to expectations and preparations either by the student or their secondary school; relating to curriculum and structure; the role of others, such as parents, partners, fellow students and friends outside the programme; learning how to programme; being taught in English; and items coded as negative or positive emotions. Most of the input for this theme came from interview 1 and the mind map exercise, but also from interview 3 where the participants reflected on the mind map exercise in relation to their lived experience.

Transition to HE is a large theme, but this multifaceted phase is very important in determining a student's chances of staying in the programme (Trautwein and Bosse, 2017). Identifying and understanding student experiences, especially in the transition to HE, is an important step towards identification of mechanisms of student success (Kahu and Nelson, 2017). The theme transition to HE was broken down into three sub-themes to explore specific areas within transition to HE. These sub-themes adopted from Cole (2017) were: expectations, social integration and academic integration, and first-year stagnation. The input for this theme was found in all three interview rounds, with experiences relating to the transition to HE more prominently featured in interviews 1 and 2 and the reflection on the experience of transition in interview 3.

Transformation

This theme relates to the transformative nature of a TC. Transformation, in my research, relates to the transformation into an HE student and the transformation into a (future) computer scientist by engaging with, and overcoming *troublesome experiences*. This theme included codes relating to study and learning approaches, changes in study approach, student development, and identity. Students' study behaviour and perceptions of what actions to take, as well as how these change and develop over time could offer important insights into students' retention (Wilson, 2018). This theme was mainly found in interview 3, with early indications in interview 2.

Troublesome experiences

Troublesome experiences, an adaptation of Perkins' (1999) concept of troublesome knowledge that Meyer and Land (2006a) included in TC is defined by me in Chapter 3 as a cognitive, affective and/or skills experience that obstructs students from further development. The *troublesome experiences* code in the interview data highlights pivotal points in the participants' experiences that go beyond either troublesome knowledge, threshold skills or troublesome affect because they relate to a combination of these three concepts. This theme mainly consists of the code: *troublesome experiences*, and acted as a kind of meta-code when a selected and coded part of the interview could be considered *troublesome experiences* for the participant. This makes this theme different from the previous three themes, because it operates more on a meta-level. The theme, *troublesome*

experiences, was found in interviews 1,2 and 3, because these experiences occurred throughout the year for the participants.

4.7.3 Analysis of graphic elicitation exercises

The graphic elicitation exercises were analysed in two ways. First, the participants' explanations and comments made during the interview whilst doing the graphic elicitation exercises are part of the interview transcripts and are therefore analysed as part of the interviews through TA. The sections of the interviews relating to the individual exercises are coded as one large section named mind map, scale or graph, so these complete sections can easily be retrieved in the data. Second, the results of the exercises were analysed separately and related to the participant groups of *leavers*, *persisters* and *stayers.* The participant groups will be further explained in section 5.2.

The results of the mind map exercise were collected in a spreadsheet, mapping the participants and their expectations to gain insight into what were common and uncommon expectations and whether there are differences across the three participant groups. These findings are incorporated in the findings relating to participants' expectations (section 5.6.1).

For the scale exercise the responses of all participants were collected on an individual scale exercise sheet for interviews 1, 2 and 3. This visualises how the participants rated the individual PsyCap factors at the time of the three interviews. Then separate visualisations were created for each of the three participant groups, visualising their views on the PsyCap factors. These

visualisations are incorporated in the comparison of PsyCap factors in section 5.3.

The outcomes of the graph exercise were compared with the scale exercise for each participant to see if the answers in the two exercises matched. Then, the graphs for the three participant groups are compared to find similarities and differences. The analysis of the graph exercise was then compared with the interview data that was already analysed earlier to explain the similarities and differences found, based on the interview data, especially when analysis of the graph and scale exercise of a participant showed inconsistencies. This approach can be compared to that applied by Winstone et al. (2014) who used their activity-oriented questions mainly as an interview stimulus to obtain richer dialogue, and used the drawing their participants created as additional evidence of the conclusions drawn from the interview data.

4.8 Ethical Issues

Prior to the start in September 2018, this research project received ethical approval in July 2018 through the standard procedure the Doctoral Programme Educational Research at Lancaster University has in place. Key ethical considerations in the approval were my role as both an academic tutor and lecturer in the researched programme, and as a researcher, in the interviews with student participants.

To make it clear for the participants, my role as researcher in this project was emphasised in the participant information sheet and my tutor group were not invited to participate. Although I might teach participants in the future, this was

explained and given the subjects discussed in the interviews this was deemed a low risk. Further, the students were asked for their personal email address and mobile phone number with the explanation that this would only be used in case the participant left the programme and I wanted to contact them for a final interview. The added relevance in taking part in one more interview after they have left the programme was explained to the participants. Participants that left, were sent an email to their personal and university email address and a reminder two weeks later. If there was still no response I telephoned them once. All participants provided their email address and mobile phone number on the signed consent forms.

The participants received an information sheet on the research project with their emailed invitation for the first interview. The opportunity to ask questions was mentioned in the email. Before the start of the first interview I explained again what the research and participation implied and pointed out their right to withdraw at that point or within two weeks after the interview took place. The participants were asked if they had any questions and, if they had no further questions, they were asked to read and sign the consent form. At the start of interviews 2 and 3 the participants were asked again if they had any questions and were reminded of their right to withdraw. None of the participants withdrew their data at any point.

Institutional anonymity cannot be guaranteed, because in section 4.3.3 this research was identified as insider research and as Trowler (2016: 43) indicates, it is best to assume that the researched institution can be identified, should someone wish to do so. The nature of this research is such that the

focus lies on the participants' experiences rather than the institution. Personal anonymity of the participants can be established through the use of pseudonyms in this thesis and subsequent publications and presentations. These pseudonyms are first names that are not present in the participants' cohort.

4.9 Credibility of the research findings

The lack of solid evidence on validity and reliability in qualitative research in comparison to quantitative research is often criticised (Noble and Smith, 2015). Because of the difference between qualitative and quantitative research methods, I propose to use alternative criteria for establishing rigour in qualitative research developed by Lincoln and Guba (1985) that looks at truth value, consistency, applicability and neutrality.

The truth value of my research is formed by the accurate presentation of the participants' perspectives (Noble and Smith, 2015), by including direct quotes from the interviews and results from the graphic elicitation exercises. The consistency is further guarded by clearly describing the steps taken in the analysis. This is aided by the development of the codebook to make sure that there is consistency in connecting codes to specific quotation content. (Roberts et al., 2019: 2) state that the development of a codebook *"enables a discussion and possibility of replication within qualitative methods".* Applicability involves considering if the findings can be applied wider. The findings of my research can be applied to retention research in general and in a CS or STEM setting. Further, the qualitative angle adds a new perspective

to existing, quantitative, PsyCap findings. The neutrality, or confirmability, of qualitative research can be achieved when truth value, consistency and applicability have been addressed (Noble and Smith, 2015). Throughout my research, I have been aware of its interpretivist nature. By applying the iterative approach, whereby codes, themes, interpretations and literature were revisited multiple times; creating a codebook to standardise the codes used; applying graphic elicitation exercises as additional data sources; and letting the participants reflect on experiences discussed in the earlier interviews, I tried to improve the credibility of my findings and ultimately the credibility of my original contributions.

4.10 Summary and conclusions

This chapter presented the methodology for this research and the methods used. It covered the reasoning behind choosing a qualitative longitudinal case study approach and explained the research design, participants, data collection and analysis, but also the ethical issues and the creditability of the research findings. Together with the literature review and the theoretical framework presented in chapters 2 and 3, this chapter formed the basis for the next two chapters in this thesis: namely the presentation of the findings in chapter 5 and exploring these findings from a TC perspective in chapter 6.

Chapter 5: Findings – psychological capital and participants' experiences

5.1 Introduction

This chapter presents the findings of my research, related to the participant groups that emerged. The findings are presented in two main parts. The first part, presented in sections 5.2 to 5.4, relates to my first research question:

> *RQ1 How does psychological capital influence first-year computer science students' retention?*

It focuses on the differences in PsyCap related perceptions across the different participant groups by discussing data from the graphic elicitation exercises, supported by interview data.

First, the three different participant groups that emerged from the research: *leavers*, *persisters* and *stayers* are presented (5.2) and their progression pathways compared to the selection criteria for participation (5.3). The PsyCap factors for the different participant groups, based on the interview data and the scale exercise undertaken during interviews 2 and 3, are compared (5.4). These factors provide the basis for this section in which the interview data and the graph exercise explore findings on how these factors developed for the individual participants and the participant groups.

The second part of chapter 5 is presented in sections 5.5 to 5.8, and relates to my second research question:

> *RQ2 What experiences influence first-year computer science students' psychological capital and retention?*

It explores the participants' experiences throughout the first year that influenced and were influenced by PsyCap. The experiences are related to the participant groups for similarities and differences.

After the introduction for the second part of chapter five (5.5), participants' expectations relating to their transition to HE, are outlined (5.6), followed by the presentation of transformation (5.7) and *troublesome experiences* (5.8), to gain a deeper understanding of the underlying dynamics that influenced the participants' PsyCap and retention.

The participant comments taken from the interviews that are used to illustrate the findings, include emphases added by me. All comments state the participants' pseudonym, their participant group and a number to indicate from which interview round the comment is taken.

The next chapter, chapter 6, will connect the findings of chapter 5 to TC (Meyer and Land, 2006c).

5.2 Participant groups emerging from the research

At the end of the academic year it became apparent that the participants fall into three categories*. Leavers* who dropped out of the CS programme during

the academic year, *persisters* who stayed the whole academic year but did not achieve the necessary 48 ECTS required to continue, and *stayers* who passed with 48 ECTS and continued their studies.

5.2.1 Leavers

Leavers were the largest participant group (table 5.1).

Pseudonym + (gender)	**Entry qual.**	**First HE**	**Programming experience**	**Interviews**			**Left in**
Henry (m)	MBO non-IT	yes	none	1			October 2018
Simon (m)	HAVO	yes	minimal	1			January 2019
Andrew (m)	HAVO	yes	minimal	1			January 2019
Charlie (m)	MBO IT	yes	reasonable	1	2		December 2018*
David (m)	MBO non-IT	no	none	1	2		January 2019*
Osman (m)	HAVO	yes	none	1	2		March 2019
Liam (m)	21+	yes	reasonable	1	2	3	May 2019*

Table 5.1 Overview participant group leavers (participated after leaving)*

For six of the seven *leavers,* it was their first experience in HE. The first participant left in October 2018, before the first exam round, and the last one left at the beginning of the fourth period, in early May 2019. By the end of the year, all participants with an MBO qualification had left, together with three former HAVO students and one student that was accepted based on a 21+ entry exam. Amongst the *leavers* three students had no programming experience at all when they started, three had some basic programming experience and one was a reasonably experienced programmer. All the *leavers* left before interview 3 took place. Two participants, Charlie and David, took part in interview 2 after they had already left the programme. Liam left close to interview 3 and he agreed to still take part in interview 3, making him the only leaver represented in interview 3.

5.2.2 Persisters

Five participants can be classified as *persisters* (table 5.2). The *persisters* followed the complete year 1 programme, but were not allowed to continue because had less than 48 ECTS.

Pseudonym + (gender)	**Access to HE via**	**First HE**	**Programming experience**	**Interview**		
Bryan (m)	HAVO	no	minimal	1	2	3
Emma (f)	HAVO	no	none	1	2	3
Fred (m)	VWO	yes	limited	1	2	3
Miranda (f)	21+	yes	reasonable	1	2	3
William (m)	HAVO	yes	minimal		2	3

Table 5.2 Overview participant group persisters

Some of the *persisters* knew near the end of the year that it would be (near) impossible to reach 48 ECTS, but stayed on because they still wanted to gain knowledge and skills. For others, it really came down to the final exams or resits whether or not they would gain sufficient ECTS. Three *persisters* have a HAVO and one a VWO background (table 5.2). One *persister* was accepted based on a 21+ entry exam. Programming experience varied amongst the *persisters*. One participant had no programming experience, three had some basic experience and one was a reasonably experienced programmer. For three *persisters,* this was their first HE experience. The two female participants are also in this group. All *persisters* participated in all interview rounds, with the exception of William, who joined in January 2019.

5.2.3 Stayers

Four participants can be classified as *stayers* (table 5.3). They planned to continue their programme in year 2.

Pseudonym + (gender)	Access to HE via	First HE	Programming experience	Interview		
Paul (m)	HAVO	yes	minimal	1	2	3
Richard (m)	VWO	no	good	1	2	3
Noa (m)	HAVO	no	none	1	2	3
John (m)	HAVO	no	limited	1	2	3

Table 5.3 Overview participant group stayers

S*tayer* John, had less than 48 ECTS due to personal issues, but in his case the student counsellor advised the programme that he should be allowed to continue, because of his mitigating circumstances. None of these four participants have obtained the full 60 ECTS available in year 1. In the whole cohort 2018-2019 out of the 303 students that started, only 43 students acquired all 60 ECTS. All four *stayers* continued on the programme, although John chose to retake year 1. Three of these participants have a HAVO and one a VWO qualification (table 5.3). One had no programming experience, two had some basic experience and one was a reasonably experienced programmer. For three of the four *stayers,* it was not their first HE experience. All four *stayers* participated in all the interview rounds.

5.2.4 Comparing leavers, persisters and stayers

When comparing the *leavers*, *persisters* and *stayers* to the selection criteria used: entry qualification, previous experience in HE and programming experience, some noticeable differences in the groups become apparent.

Entry qualification

Considering participants' entry qualifications all MBO participants were *leaver*s. The difficulties in the transition of MBO students and improving

success rates of MBO students in UAS has been a focus for government initiatives, educational policy and research for a number of years (Rijksoverheid, 2018; Vervoort and Elffers, 2018; Veld, 2016). Usually MBO students that come from a related programme, in this case, for example, students from an IT related MBO programme, show a much higher retention in UAS, often higher than that of HAVO students (Veld, 2016). In this research, with only one participant from an IT related MBO and two from unrelated MBO programmes, it is hard to draw any conclusions.

In the Dutch education system, the route from HAVO to a UAS is considered a direct one (figure 1.2). HAVO education should prepare students adequately for continuing their education in a UAS. HAVO students form the largest group of students in UAS education (Gans, 2010), but also show a noticeably high drop-out rate. This can partly be explained by students choosing the wrong study programme (Meens, 2018). In this research, the HAVO students are evenly distributed over the three participant groups, with three in each group. This also means that 2/3 of all HAVO participants did not progress to year 2. This is slightly higher when comparing this to numbers provided by the researched programme (table 5.4), that show that 77 of the of the 174 HAVO students, 44.3% of the HAVO students the cohort, left the programme.

Cohort 2018-2019 qualification	Number of students	% of cohort	Number of leavers	% of leavers by qualification	% of total cohort
MBO	79	26.1%	37	46.8%	12.2%
HAVO	174	57.4%	77	44.3%	25.4%
VWO	23	7.6%	9	39.1%	3.0%
Other	27	8.9%	11	40.7%	3.6%
Total	303		134		44.2%

Table 5.4 Overview students cohort 2018-2019

There appears to be no clear explanation for this difference.

The second largest group to enrol in Dutch UAS are the MBO students. In cohort 2018-2019 they make up 26.1%. The three MBO students that participated in my research formed 18.8% of the participants and all of them left during the year, compared to 46.8% of all MBO students in the cohort. The MBO students all reported difficulties with the fact that most classes were in English and with the level of mathematical knowledge required.

The direct route for VWO students is to RU. When VWO students fail their first year at an RU a number of them switch to the more practice oriented UAS. In my research, two participants came from VWO, one *persister* and one *stayer*. Because of this small number, no direct conclusions can be drawn.

Neither of the two 21+ participants, one *leaver* and one *persister,* progressed to year 2. In table 5.4 the 21+ entry exam falls within the category ‘other’, together with students that have a foreign diploma. The fact that there were only two 21+ participants makes their results hard to reflect on.

Making any kind of generalisation about different entry qualifications based on the small numbers within the participant groups is difficult. Of the three selection criteria, educational background appears to have the smallest influence on their retention. It does appear to be of possible influence on an individual level, especially related to level of English and mathematics a participant had when starting the programme.

Previous experience in higher education

The second criterion for participant selection was *previous experience in HE*. Around 18% of all HE students switch study programmes (Vereniging Hogescholen, 2016), usually after their first year, especially if this was unsuccessful. In the literature the transition to HE is identified as a major stumbling block for new students (Cole, 2017; Cohen-Schotanus et al., 2019) and by comparing participants with and without HE experience my research gives insight into the influence having prior HE experience might have in adjusting to HE and this particular programme.

When looking at the three participant groups, a pattern becomes visible in relation to HE experience (table 5.5).

Participant group (n=)	**First HE experience**	**Previous HE experience**
Leavers (7)	6	1
Persisters (5)	3	2
Stayers (4)	1	3

Table 5.5 Comparison of first and previous higher education experience in participant groups

For six of the seven *leavers,* the CS programme was their first HE experience. Three of the five *persisters* had not tried HE before; two already had HE experience. For one of the *persisters* the CS programme was the fifth programme she had tried. Only one of the four *stayers* was new to HE.

This means nine of the ten participants with no HE experience did not progress to year 2, compared to three of the six participants that did have HE experience. This shows that in this research participants for whom this is not

the first HE experience were apparently more successful in making the transition to the CS programme than those that have to get used to both studying in HE and navigating the CS domain. The six participants that switched from another HE programme appeared to use experiences from their first transition to HE to adjust to the CS programme. It would be interesting for the CS programme to explore this, so they can give more attention to developing possible skills for success with those who are new to HE.

Programming experience

On the basis of programming experience the findings show small differences between the *leavers*, *persisters* and *stayers* (table 5.6).

Participant group	Good/reasonable	Limited	Minimal/none
Leavers	2		5
Persisters	1	1	3
Stayers	1	1	2

Table 5.6 Programming experience in participant groups

Ten out of the sixteen participants had no or minimal programming experience, with five of those participants in the *leavers*. On the other hand, two of the four participants with reasonable to good programming skills were also *leavers*.

Having programming experience can influence how well new students adjust to the programming courses and their sense of belonging. Kori et al. (2016) found that having programming experience gave students an advantage,

because they scored higher grades in their first semester. This can have a positive effect on their motivation and thereby influencing retention.

> It really helped having some programming experience. When things are explained and you think: o yeah **I've seen that before**, or I read about that. So it really helps and **you get it much quicker**, that **really helps**. (Bryan_persister:1)

Of the five participants that had a reasonable amount of programming experience, with programming languages such as Python, C# or Java, that went beyond basic knowledge, only one was allowed to stay on the programme. The reason why a participant left or why they ended up as a *persister* cannot always be attributed to problems in the programming courses of the curriculum. The CS curriculum consists of more than programming courses alone, therefore negative or positive experiences with other courses, can just as much be a factor in CS students' retention, independent of programming experience.

One of the *leavers* with reasonable programming experience left because of a combination of problems with the mathematical elements in the analysis courses and the fact that he had difficulty with the amount and level of English. The other *leaver* with programming experience left because of personal issues. One of the reasonably experienced programmers in the *persisters* did not acquire the 48 ECTS because he could not function in the project teams. These experiences give a more nuanced view of the possible positive influence of programming experience to retention in a CS

programme. Although the CS programme does not keep records of the programming experience in new students, the fact that most of the participants had no or very minimal programming experience does reflect the experience of most CS programmes (Gordon, 2016; Kori et al., 2016).

5.3 Comparing psychological capital factors in participant groups

In interview 1, near the start of the programme and where the most explicit questions on the participants' views on PsyCap and its factors were asked, there appeared to be no distinctive differences in the views of the different participant groups. The scale exercise in interviews 2 and 3 provided the opportunity to explore the participants' views on their own PsyCap development. As described in section 4.6, the purpose of the scale exercise was to gain insight into whether PsyCap or individual factors increased, decreased or stayed the same over the course of the year. Figure 5.1 shows the average results of the scale exercise of each participant group for PsyCap and each of its factors. This provides a first indication of the changes in view within the different participant groups over time.

The relative positioning between two ratings was more important than the numerical score the participants gave a PsyCap factor at a specific time. Figure 5.1 shows that almost all ratings for interview 1 were placed on the higher half of the scale.

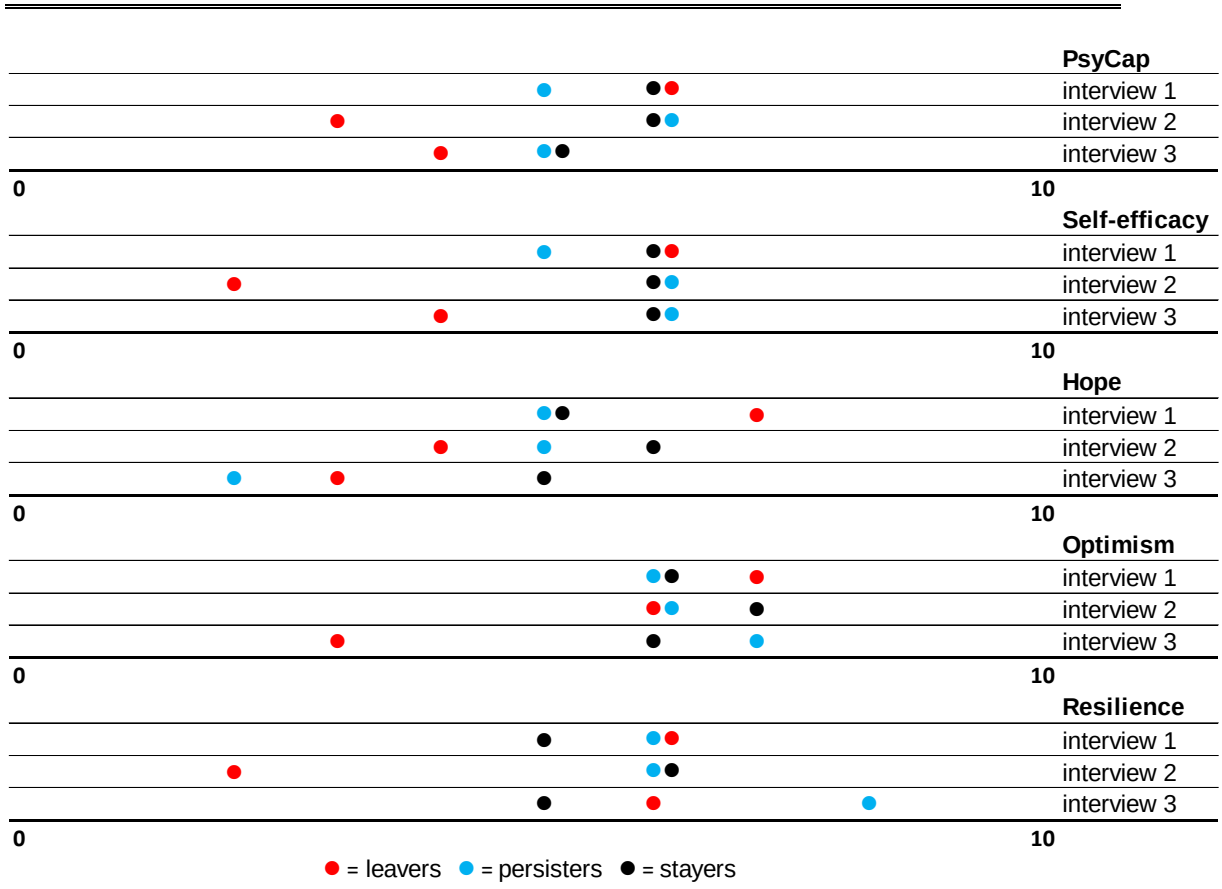


Figure 5.1 Overview of average results scale exercise

In general, the *stayers* and *persisters* show a more stable image of their PsyCap and its factors than the *leavers*. This can be explained by the fact that *stayers* and *persisters* both completed the whole year, rather than part of it. Through the course of the year some of the ratings appeared to decline.

The factor with the apparent largest decline was hope. The *leavers* apparently have high hope at the beginning of the year, higher than the *persisters* and *stayers*, but show a steady decline. The *persisters* also appeared to lose hope in interview 3, probably related to their chances of achieving 48 ECTS. Optimism was rated relatively stable throughout the year in all participant groups. Only one *leaver* took part in interview 3, making it a single rating for this group.

Figure 5.2 shows the ratings of the different participant groups for PsyCap. The different capital letters in different colours represent the initial of each participant within the participant group, so the spread in ratings between participants and participant groups can be viewed. This presentation format is also adopted in figures 5.3, 5.4, 5.5 and 5.6. *Leavers* Henry, Simon and Andrew are not included in figures 5.2 to 5.6 because they had left the programme before interview 2 and did therefore not do the scale exercise. *Leavers* Osman, David and Charlie did not take part in interview 3. If a participant gives two ratings for an item, for example, hope for the current situation and hope for a future situation, a ☐ together with the participants' initial represents the future oriented item.

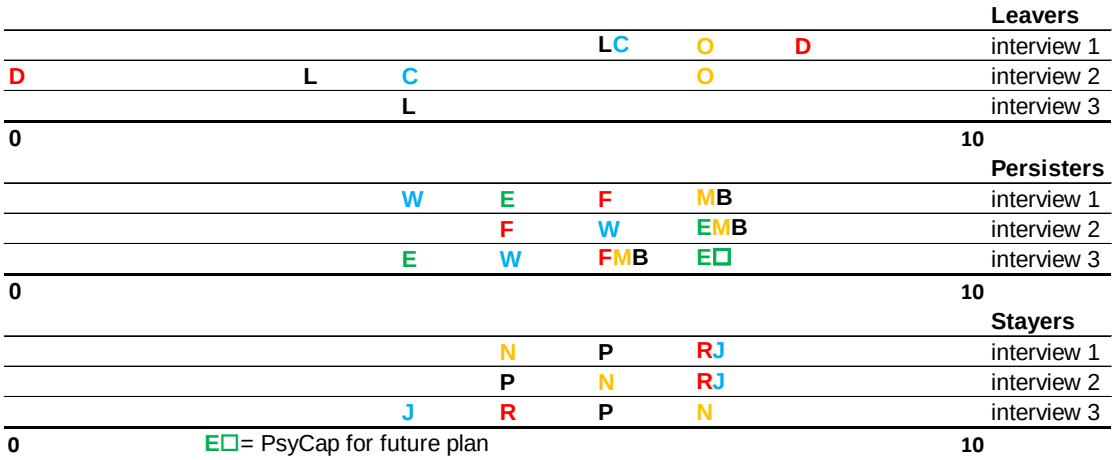


Figure 5.2 Psychological capital in the different participant groups

Figure 5.2 shows that PsyCap declines in three out of four *leavers* in interview 2, with a very sharp decline from very high in interview 1 to very low in interview 2 (**D**). Four of the five *persisters* show an increase in PsyCap, whereas the *stayers* show two stable ratings, one decrease and one increase in the same time frame. The *stayers* appear to have smaller differences in the ratings of the different interviews compared to *persisters* and *leavers*. In

sections 5.3.1 to 5.3.4 the results of the scale results for the individual PsyCap factors are discussed to gain insight into which ones contribute to changes in participants' PsyCap.

5.3.1 Self-efficacy

The word self-efficacy was unknown for all participants, but after explaining the meaning to them, they recognised the concept. In the interviews the participants were asked to reflect on their self-efficacy and its relevance, especially in relation to studying CS. In interview 2 and 3 participants had to rate their self-efficacy in the scale exercise (figure 5.3).

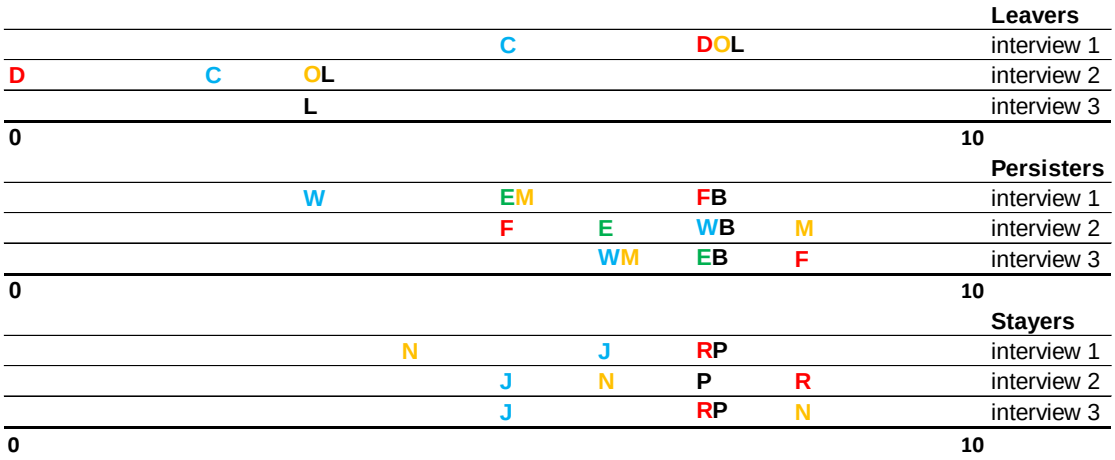


Figure 5.3 Self-efficacy in the different participant groups

Based on the participants' self-assessment in the scale exercise the *leavers* show a decline in self-efficacy in interview 2. An explanation for this might be that two of the four *leavers* in interview 2 had already left the programme at that point. This is also the case for the *leavers*' results for other PsyCap factors. Self-efficacy appears to be relatively high in the *persisters* in interview 3. This is interesting because most of them already knew at that point that they would not be able to continue in the CS programme.

From the interview data it becomes apparent that all participants, except *leaver* Henry, saw the relevance of self-efficacy, especially in relation to CS. Participants related the potential increase or decrease of self-efficacy to positive or negative study experiences and results.

> I think it is important in a study programme such as this, because you are **really thrown in at the deep end if you have no prior knowledge**, so than you need to have it. **I think I have it, but it is a bit tricky** (Miranda_persister:1)

> … I'm a bit ahead at this point, so **I don't hope that my self-efficacy decreases**, but more that I will be challenged more in the sense that **I have to work for it to understand it** (Paul_stayer:1)

In the scale exercise, the self-efficacy of the *persisters* and *stayers* appear to show more resemblance to each other than the *leavers*, possibly indicating a relation to making a wrong choice in study programme for the *leavers* (Meens, 2018).

5.3.2 Optimism

When asked to define optimism, almost all participants found it difficult to make a clear distinction between hope and optimism. Four of the seven *leavers* said they felt there was no distinction between hope and optimism. One of the five *persisters* and none of the four *stayers* shared this opinion. Comparing hope and optimism helped the participants to point out where the two factors overlapped or differed for them.

I see them basically as **the same** (Charlie_leaver:1)

Hope is more that in this particular case or in this specific situation **I believe it will work out for me**. […] And **optimism is more: we can do this**, this is going to be all right (Richard_stayer:1)

The results for optimism in the scale exercise (figure 5.5) appear to stay relatively stable over the year compared to the other PsyCap factors (figure 5.3, 5.4 and 5.6).

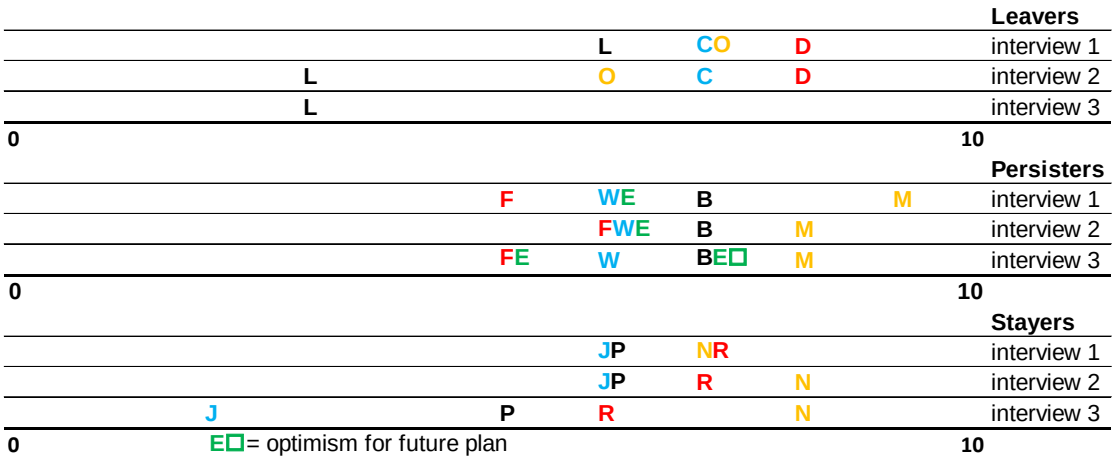


Figure 5.4 Optimism in the different participant groups

Leaver Liam's results stand out, because compared to others his rated optimism was relatively low. This was not explored in the interview because, as noted before, the rate itself is less important than the comparison in position, that in this case remained the same between interview 2 and 3. In general the results for optimism are found in the higher half of the scale and they show little movement across the different interviews.

optimism stayed the same, but it could be that the next time it is here or here, but for now it stayed the same. (Richard_stayer:2)

Of the four PsyCap factors optimism appears to be the most stable factor for all participants groups.

5.3.3 Hope

Almost all participants indicated in the interviews that they regarded hope as something that can increase or decrease, depending on the situation. Only *leaver* Henry felt hope was fixed. Almost all participants in all participant groups expressed hope for finishing the first year or the CS programme successfully. Two *stayers* specifically spoke about hope for certain things in the learning environment in interview 2, such as the hope that the programme lives up to their expectations and the hope for pleasant peers and lecturers.

> **I hope to finish this programme**, or at least to **make it through the first year** (Andrew_leaver:1)

> …**hope for good grades**, in the sense that I want to get good grades, I want to pass, preferably in the shortest time possible. But also **hope that you'll have nice class mates** with whom you can get along and that you'll have nice and **good lecturers**… those are things you can have hope for (John_stayer:1)

When analysing the results of the scale exercise for each participant group, for hope (figure 5.4), it becomes apparent that the leavers appear to show a larger decline in ratings in interview 2 than the other two groups, although the leavers rated their hope slightly higher than the other two groups in the first interview.

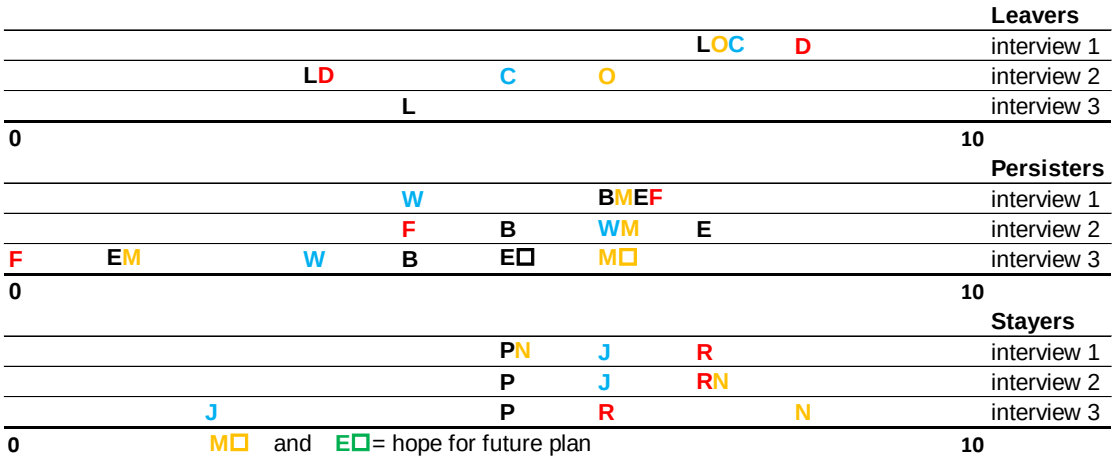


Figure 5.5 Hope in the different participant groups

The *persisters* appear to show stable results when comparing their self-assessment in interviews 1 and 2 (figure 5.4), but a sharp decline in interview 3. An explanation for this could be that some of the *persisters* knew at the time of interview 3 that it would be impossible or very unlikely that they would achieve 48 ECTS by the end of the year and *persisters* Miranda and Emma had already made new plans for the next year. In interview 3 these two *persisters* indicated they experienced two different types of hope: one for the current CS programme and one for their new plans, marked in figure 5.4 with a ☐ and their initial. This suggests that hope is situation specific and that hope for one thing, such as a specific study programme, is low and for another it is high, depending on the pathways and agency (Snyder et al., 1991b), as described in section 2.3.3, experienced by the participant.

The way hope appeared to decline in the *leavers* and *persisters* indicates that it is an important factor in relation to retention.

> … **after failing my exam I think it has gone a little**, also because I failed the resit (Murat_leaver:2)

> …well **hope has literally passed**…I'll just put in on 0

(Fred_persister:3)

The *stayers* showed stable results in relation to hope (figure 5.4). The only deviating result in the *stayer* John is related to personal issues he was experiencing at the time of the interview. This also influenced his rating for optimism and resilience.

> I would like to make a remark that this [the PsyCap factors] relates to my personal issues, so **at the moment my mind set is not what it was and usually is**, but that has underlying reasons. (John_stayer:3)

The influence of a decline in hope on PsyCap and retention is further discussed in section 5.4.

5.3.4 Resilience

For the participants, there was a direct link between the, often problematic, process of programming and the necessity of resilience in learning to programme. When asked about their views on resilience, participants described very concrete examples of when they needed or displayed resilience.

> I have faith in my resilience. I often had the experience that **I coded something 100 times and that it didn't work** and that I worked on it for hours on end. […] **I tried so many different methods**… but eventually…really late at night…**I found what it was**, but I had been working for 10 hours at that point […] At the moment I don't have

anything to apply it to, so maybe that is why **my resilience is low at the moment**. I am the kind of person that **if I don't have anything to put my back into, that I give up easily**, that if I don't have the motivation to finish it at this moment, that I want to say: I'll finish it later. I'm prone to procrastinate in that way (Fred_persister:1)

…then it [resilience] is quite important, because when you look at programming itself, it is **not just the setback itself**, but **also the setback when you solved the bug**, the computer programme is able **to read more code and find more bugs**. In CS, this is very important. Because it is **not just to have the attitude to deal with the setbacks, but also to see them as a lesson in their own right** (Richard_stayer:1)

The results of the scale exercise (figure 5.6) show a larger diversity between the participant groups then in the other PsyCap factors.

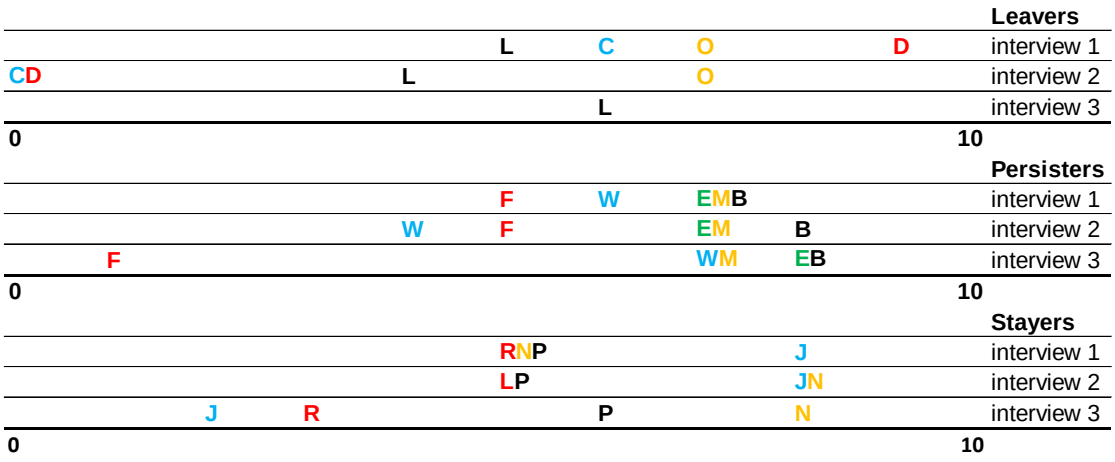


Figure 5.6 Resilience in the different participant groups

Again, the largest decline of resilience appears to be in the *leavers* in interview 2. There seems to be an increase in resilience in two and a stable

high rating in two other of the five *persisters* in interview 3. Similarly, the *stayers*' resilience appears to decline for two and remain stable for the other two of the four participants in interview 3.

> …well I have to, really. I have failed so many things, that if I still want to continue, **I really have to make a push for it** and don't let myself get depressed (Bryan_persister:3)

This could be explained by the fact that for some of the *persisters* and *stayers* it could still go either way, being forced to stop or allowed to continue, depending on the results of the final exam period, making them draw upon their resilience at this stage of the academic year.

5.4 Development of psychological capital

In interview 3 participants were asked to draw a graph to represent how they experienced the fluctuations of the PsyCap factors over the course of their first year.

At first glance it might appear that the scale and graph exercise are similar. In both exercises, participants were asked to give a visual interpretation of the PsyCap factors, but there are two main differences. First, the scale exercise was a snapshot of a specific point in time, whereas the graph exercise was a retrospective review of the full academic year, enabling the participants to put their experiences into a larger time frame. Second, drawing the development throughout the year also showed what happened before the first interview and in between the interview rounds. The scale exercise of a participant might

show almost the same rates for a particular PsyCap factor for two different interview rounds, but the graph of the same participant might demonstrate that between those two interviews a specific PsyCap factor had a sharp rise or decline, indicating that the development of PsyCap was not as straightforward as the scale exercise would show.

The graphs the participants created in interview 3 were compared with the scale exercises to evaluate if the relative increase and decrease of the different factors matched the patterns the participants produced in the graphs. The graphs of eight of the ten participants in interview 3 matched the way the PsyCap factors were rated in the scale exercise. Five graphs, two *persisters* and three *stayers*, matched on all corresponding PsyCap factors to their respective scale exercises and three *persisters*' graphs matched on most PsyCap factors. S*tayer* Richard felt he was not able to do the graph in interview 3, because he felt his recollection of the different factors would be negatively influenced by his current mental state, due to personal issues. The graphs of *leaver* Liam, *persisters* Miranda, William and Fred and *stayers* Paul and Noa are discussed and shown in figures 5.7 to 5.12 to illustrate similarities and differences in the development of PsyCap and its factors among individual participants and participant groups by relating the graphs to the scale exercise and the interview data. Because of the diversity in graphs within the participant groups, more than one graph of the *persisters* and *stayers* are shown.

Leavers

The graph of the only *leaver*, Liam, that took part in interview 3 showed very few similarities with the ratings in his scale exercise. In his scale exercise, there was not much difference between the factors in interviews 2 and 3, but his graph (figure 5.7) showed a dramatic drop in all factors during period 3.

After making the decision to leave at the end of period 3 an apparent rise in the factors is visible, indicating a recovery for the PsyCap factors and a possible recharge for future plans.

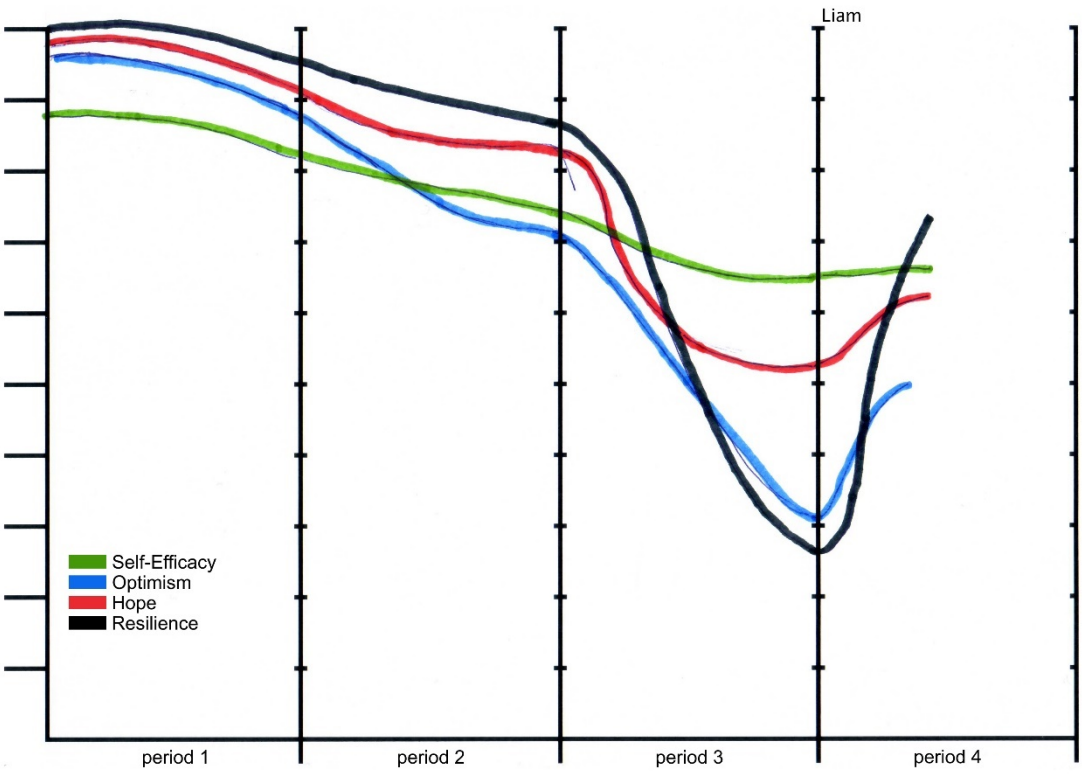


Figure 5.7 Graph exercise Liam_leaver:3

Liam expressed that making the decision to leave the programme relieved him.

> It really was a relief. I immediately **felt better**. And the fact that **I no longer experienced the pressure from school**, that really plays a role (Liam_leaver:3)

Unfortunately, all *leavers* left the programme before interview 3 with its graph exercise, so no further leaver results can be discussed here.

Persisters

All three *persisters*' graphs in this section appear to show noticeable changes in period 3 in hope, but also in self-efficacy and resilience.

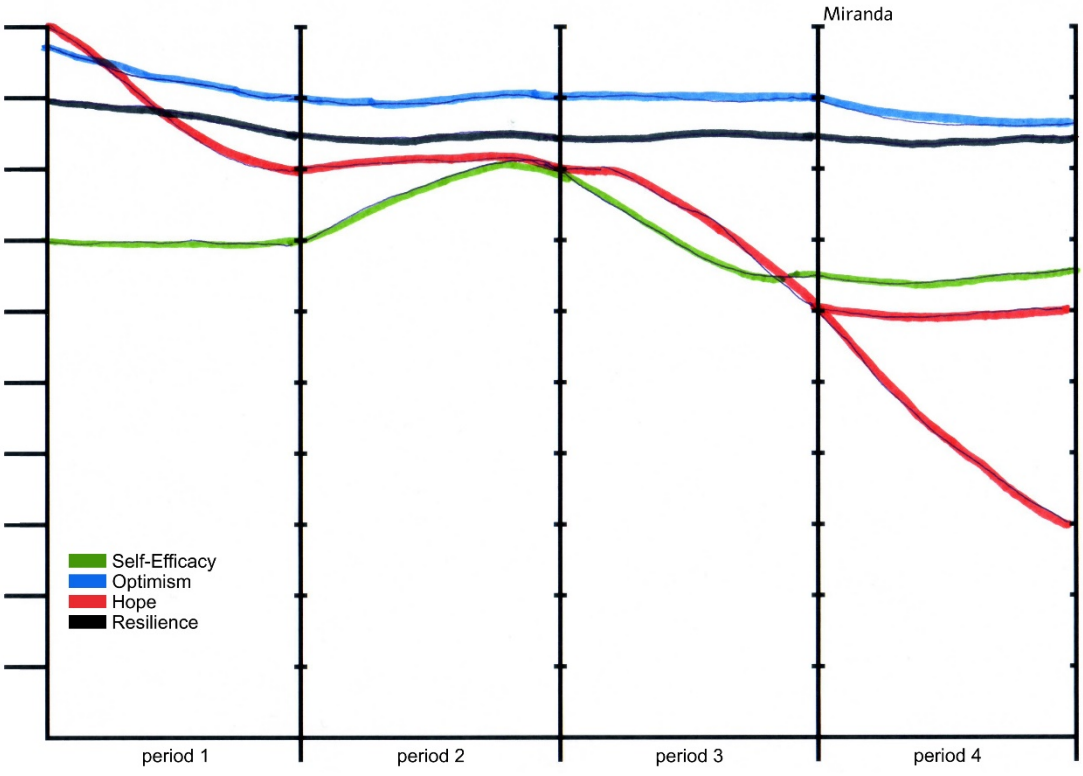


Figure 5.8 Graph exercise Miranda_persister:3

Persister Miranda's graph (figure 5.8) shows that she rated her hope extremely high at the start of the year, but that it had noticeably declined by the time interview 1 took place, just before the end of the first period.

During period 3 it appears that Miranda's hope declines sharply, but also shows a split into two strands. According to the interview data and scale exercise the lower line represented the hope she had for the CS programme and the higher line represented the hope for new plans she had. There also appears to be a temporary rise in self-efficacy visible between interviews 1 and 2, that took place in the beginning of period 3, that was not noticeable in the scale exercise. This apparent increase in self-efficacy related to changes she made in her study approach at the time.

> In the second period, **I felt I understood more** [about programming], so I would make that line like this (Miranda_persister:3)

She felt this gave her more control over the situation and over the subject matter, thereby increasing her self-efficacy. When the following exams showed no improvement in grades, self-efficacy declined.

Persister William's graph (figure 5.9) shows very wavy lines and it appears that he experienced more fluctuation in his experiences of the factors, especially self-efficacy and hope compared to the other participants, both within and outside his participant group.

The development of hope in William's graph matches his relative results in the scale exercise, but in the graph the decline in hope appears to occur sooner than in the scale exercise. His self-efficacy shows the smallest resemblance to the scale exercise.

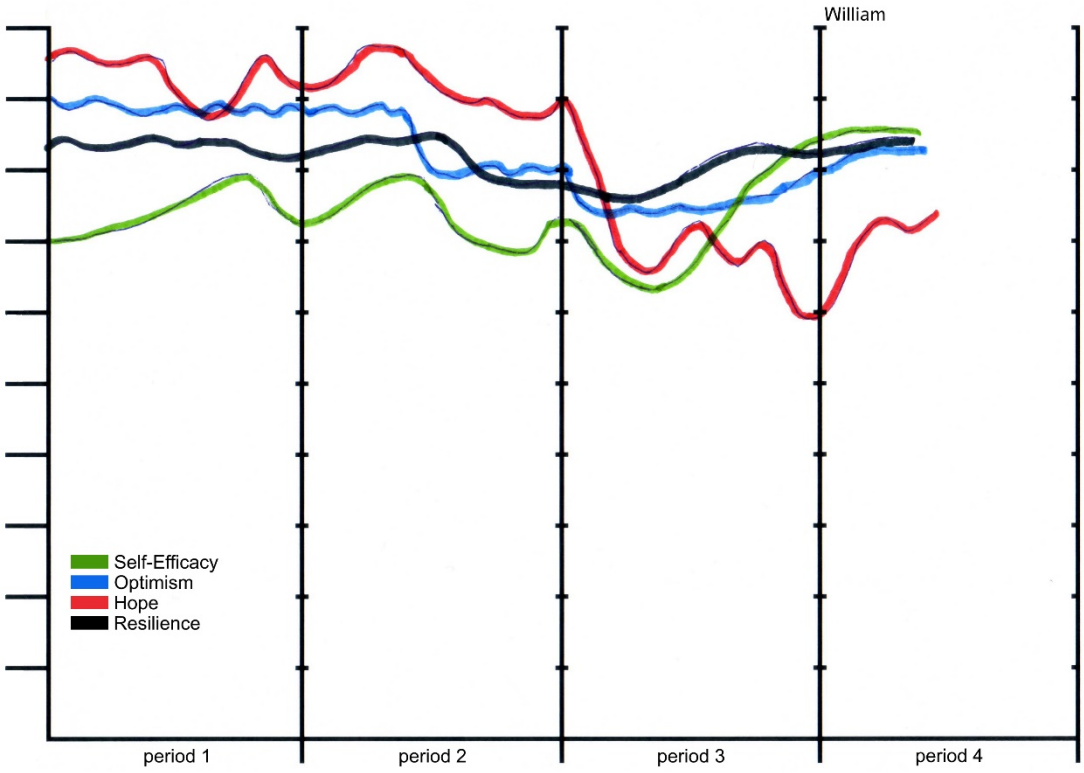


Figure 5.9 Graph exercise William_persister:3

The graph shows that he experienced the high point of his self-efficacy around interview 3, whereas in the scale exercise it was highest around interview 2 with a drop in interview 3. His reflection in the interview show the same fluctuations:

> There it [self-efficacy] **was low**. And then suddenly I noticed: oh, this is **going rather well**. And during the next period **we learned even more**, but then I noticed: **I can't do this**. Still **I felt confident** for the outcome of the period. And that more or less came true. Here [period 3] **I gained knowledge** through the extra classes (William-persister:3)

His optimism graph appears to show a more distinctive decline than was noticeable in the scale exercise.

Persister Fred's graph (figure 5.10), shows a different pattern than that of the other two *persisters* in figures 5.8 and 5.9. Fred's hope appears to decline dramatically in period 3, following his decision to quit the Project course and thereby making it impossible to reach 48 ECTS. The apparent decline in hope seems to have no or little negative effect on the other three factors.

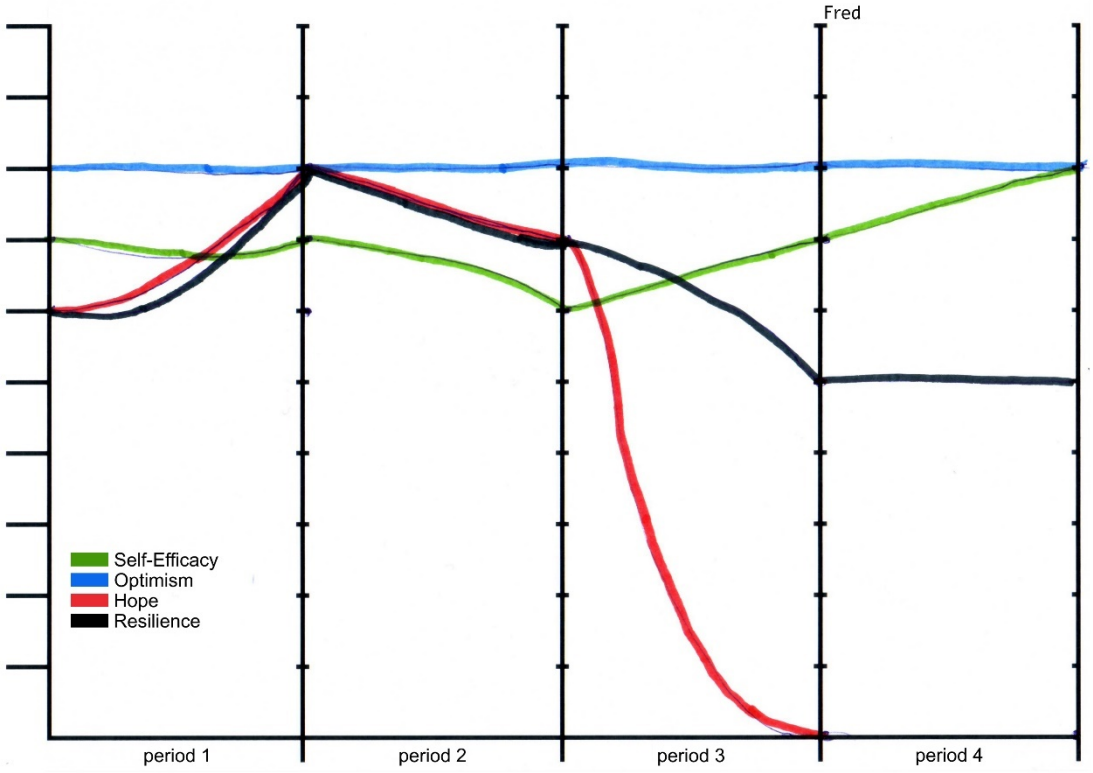


Figure 5.10 Graph exercise Fred_persister:3

Although resilience shows a decline in the graph, the drop is less than in the scale exercise. During the drawing of the graph for resilience he reflects:

> Hope to me is situation specific. I will make them the same [lines for hope and resilience], no not exactly the same, because I still made the exams, **I still had resilience for that, although it wasn't much.** It doesn't go down to 0 like hope to continue the programme does (Fred_persister:3)

His optimism is unaffected by any of his experiences and at the point where his hope drops, his self-efficacy rises. This matches his scale exercise. The interview data shows that he decided that he did want to continue in CS, just not in CS education. His self-efficacy for programming appeared to have increased, because he felt sure of his programming capabilities and intended to look for a job in IT rather than pursue a degree in CS.

Stayers

Stayers Paul and Noa's graphs (figures 5.11 and 5.12) appear to show changes in period 3, similar to those in the *persisters*.

The graph of *stayer* Paul in figure 5.11 matches his scale exercise on all factors, but shows an interesting difference with the other graphs.

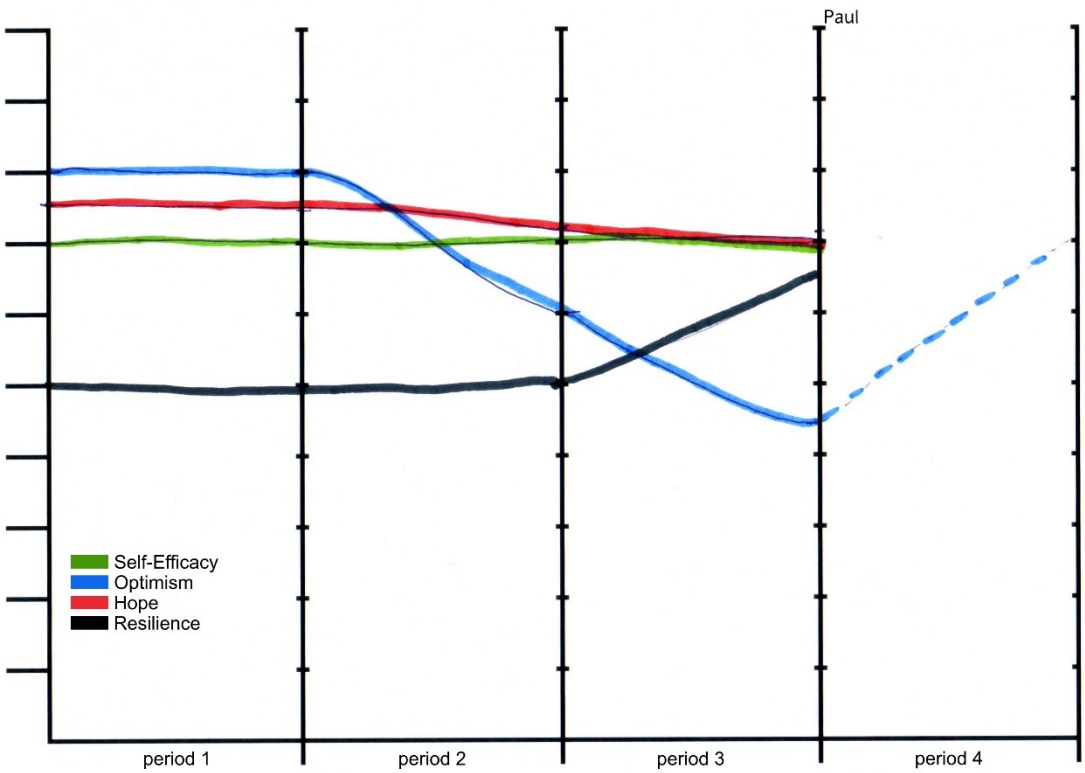


Figure 5.11 Graph exercise Paul_stayer:3

Where in figures 5.7 to 5.10 optimism mostly seem to follow the curves of the other factors or remain a more or less stable line throughout the year, Paul's optimism in figure 5.11 declines right after the first exam period and steadily falls, up until the point of interview 3 and he expects it to rise from that point on, hence the dotted line. Paul's interview data reveal that during periods 2 and 3 he was experiencing personal issues that influenced his emotions.

> I went to the student counsellor because… well I was also having sleeping problems […] In hindsight **I should have gone sooner**, because I have had these issues in the past, but at the time everything went well, so I didn't think it was necessary (Paul_stayer:3)

Noa's graph (figure 5.12) matches almost all factors in his scale exercise, with only an earlier recovery of resilience in the graph than in the scale exercise. Between interviews 2 and 3 there are apparent declines in optimism, hope and resilience, that are not visible in the scale exercise, because interviews 2 and 3 took place at the beginning of period 3 and period 4. The interview data shows that Noa suddenly experienced a complete lack of motivation in period 3.

> In the first period, I did not really know what to expect, but I knew I wanted to solve things. The second period **it went a bit up and down**, because sometimes I couldn't do things. The third period…. I **totally lost my motivation**, it really went down. And now **I'm rebuilding things** (Noa_stayer:3)

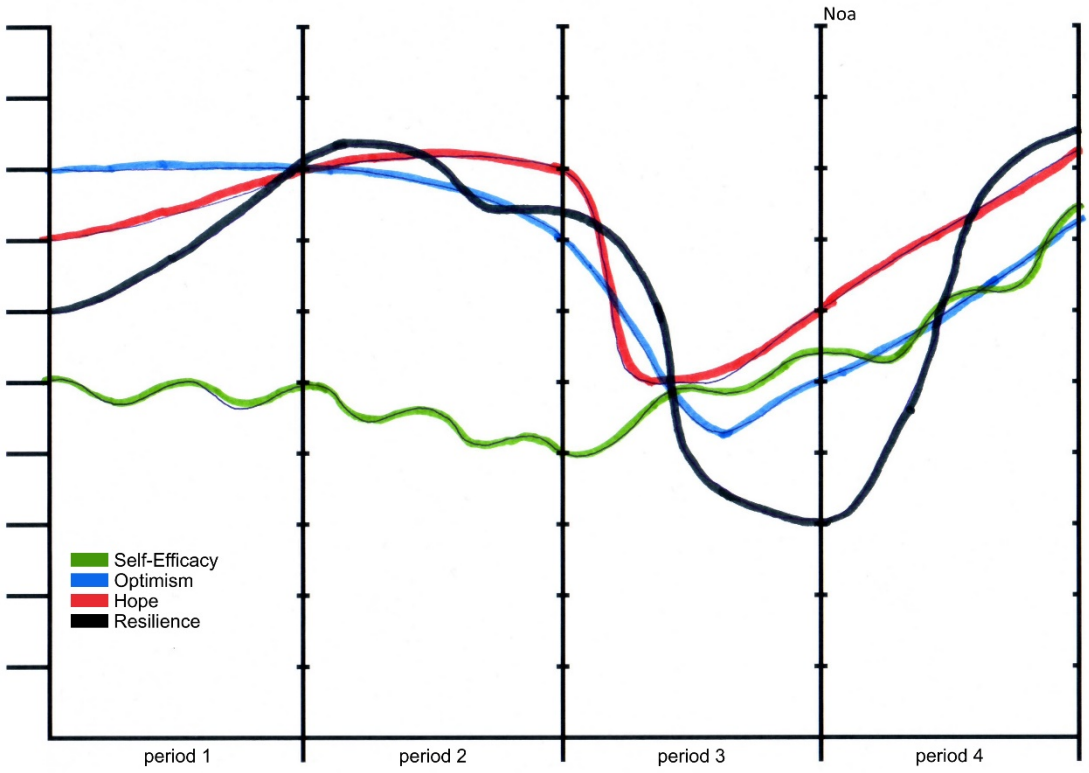


Figure 5.12 Graph exercise Noa_stayer:3

He was not enjoying programming as much as before, but did not know how to get his motivation back or what he wanted to do, should he decide to leave the programme.

When Noa unexpectedly did reasonably well in the exams of period 3, this reignited his motivation. He realised reaching 48 ECTS was still possible and he felt he knew what he needed to do to achieve this. The graph shows that he expected the four PsyCap factors to be at the same level at the end of the year as they were for three of the four factors in period 2.

5.4.1 Interaction between the psychological capital factors

Most of the participants identified that there is a connection or even an interaction between the four PsyCap factors.

> What we just talked about with the resilience… it should still be attainable, so you still have to **look at it with optimism** and say **this is still doable for me and yes then there is the resilience**, but if it is not attainable anymore, then the resilience goes away. And **if it is not attainable anymore, then your hope diminishes** like: this is not going to work anymore. But it depends… because if you think: I can't do this, the others [factors] will go down. And if you think: **I can do this, then your hope increases and the others follow** (Bryan_persister:1)
>
> **It is like a circle, it influences each other**. If you have hope, then optimism rises and if you have optimism then you sort of develop expectations of yourself like: I'm doing things on my level now, I can do this. When you receive a bad or a good grade then resilience kicks in like: oh it went really bad or this went really well, but it goes around in a circle, sort of. **They are separate from each other, but they are connected to each other** (Simon_leaver:1)

Identifying hope as a catalyst for the other factors became evident when participants reflected on the interaction between PsyCap factors and other experiences, such as coming to terms with disappointing exam results, curriculum difficulties, or positive results. This can be explained by the fact that all participants struggled with their results and had to explore different pathways and establish their own agency as described by Snyder et al. (1991b), for them to still be able to pass the first year. If they did see pathways and experienced agency for their situation, this then boosted their resilience and self-efficacy. *Stayer* Paul illustrates what needs to be done and

what needs to work out for him to get 48 ECTS, and follow the pathway he has identified.

> …so, I think that I…, maybe with a bit of help from a fellow student who does reasonably well in everything. **I think I'll manage** that and that I will definitely get those 2 ECTS for that, I think, I hope. And then there is Analysis 3, I still **have to do an assignment**, that is a JSON library that I have to create. And then I **have to make sure that I pass** development for this period and pass the development resit for the previous period. **Then everything should work out**. There was this moment of doubt, when everything went wrong, but **I still saw a way out** and I think I still try to focus on that to just get at least 48 ECTs and that I'll retake the rest next year (Paul_stayer:3)

There appears to be an interplay between hope, self-efficacy and resilience that are often reactions to experiences, such as passing or failing an exam.

5.5 Influence of participants' experiences on psychological capital

This section marks the beginning of the second part of the findings. The findings in sections 5.6 to 5.8 relate to research question 2 presented in section 5.1 and explore the three main themes that could be identified besides PsyCap: transition to HE (5.6), transformation (5.7) and *troublesome experiences* (5.8). Within these themes, sub-themes were identified to explore specific directions within the theme. All themes and sub-themes focus on how the experiences influenced or were influenced by PsyCap.

The analysis of the interview data in relation to the theme transition to HE, initially follow the sub-themes identified by Cole (2017): expectations, social and academic integration and first-year stagnation. Because social and academic integration present such different perspectives I decided to discuss them in separate sections. The factors related to first-year stagnation were closely related to academic integration, so the two are discussed in one section.

5.6 Transition to higher education

As stated in section 2.3, students' experiences in the transition to HE is a major part of successful continuation of their study programme (Briggs et al., 2012; Coertjens et al., 2017a). This theme explores participants' experiences of transition into HE by exploring their expectations, social integration, academic integration and first-year stagnation, and their relation to PsyCap. These themes are consistent with those identified by Cole (2017),

5.6.1 Participants' expectations

The way in which students' expectations influence their retention is closely connected to how realistic their expectations are (Cole, 2017; McGhie, 2017). One way for students to inform themselves about their prospective new study programme is by visiting open days and so-called 'trial days', where they get to experience one or two classes or workshops of their chosen study programme. Half of the sixteen participants mentioned visiting one or more open days. Only a few of them also mentioned taking part in a trial day.

> **I didn't go to a trial day, but I did visit two open days**: one in the beginning of the year and the other one was at the end when you should have already submitted your application (Miranda_persister:1)

> …that [the trial day] **was nice and fun**. And **I already met people** that ended up in my class, so that was kind of funny (Liam_leaver:1)

Participants that did not visit open days or trial days informed themselves through the university website or through friends. When asked why they eventually chose to apply for CS, all participants expressed an interest in computers or in the way computer technology can be applied. It appears that many participants had a limited view of the study programme and what it would mean to study CS.

> to be able **to create something** yourself – a game or something, or just a website or an app…**I don't have a clear idea of what I want to do** with computer science, because there are a lot of things that I like (Bryan_persister:1)

> … and then I went to an open day at this UAS and I looked at the Communication and Multimedia Design programme and CS. I went with CS, because it is **something completely different**. I would like **to try this** and **I think it will be interesting to learn**, about programming, how things work in CS… it is such a technical domain (Simon_leaver:1)

The limited view of CS in new CS students is also identified by Gordon (2016), who states that they often identify themselves as a computer oriented

person, usually because of an interest in computer games or social media. However, Gordon (2016) claims many students underestimate the necessary commitment in learning how to program.

Overall, the participants reported positive expectations, with eleven of the sixteen participants believing they can learn to programme and ten participants indicating that the CS programme will enable them to meet new people.

> …and **of course, meeting new people**. I always enjoy meeting new people. New faces, new connections, yes I really like that (Andrew_leaver:1)

Most participants expected that a CS programme would require a lot of self-study and that they would have to work hard, but also that they were feeling motivated and that they felt they could do this, for some this was in relation to HE in general and for others more specific in relation to the CS programme.

> I can pass this degree, I'm convinced of that. I don't think I'm the smartest or a mathematical genius, but **I am convinced I can do this** (Noa_stayer:1)

Three of the seven *leavers* indicated that they expected many classes and also boring classes, whilst in the other two groups these negative views were not present. Another difference was that three of the five *persisters* expected they were going to struggle with learning to programme, compared to one participant in each of the other two participant groups. The expectations

chosen from the mind map are otherwise quite evenly distributed between the participants groups, also when checked between the different entry qualifications or between students for whom it was their first HE experience and those with previous HE experience.

The positive expectations of the participants seem to indicate high levels of PsyCap at the start of the academic year, similar to the graphs of section 5.4. As can be expected at the beginning of a new phase in their life most participants expressed positivity and motivation, although some felt anxious about whether they could do it, despite being motivated.

5.6.2 Social integration

The second theme within transition to HE is social and academic integration (Cole, 2017; Tinto, 1987) that includes the role of others and a sense of belonging. Because of the different orientation of social and academic integration, these themes are discussed in separate sections.

Social integration can be found in the way the student feels connected to their peers, lecturers and the institution (Severiens and Schmidt, 2008). The main positive influence of social integration on the participants occurred in the way the peers did not match the participants' negative expectations in my research. Their peers were not the expected stereotypical nerds, but more like themselves.

The largest negative influence on social integration can be found in the way participants acknowledge that they did not ask peers, peer coaches or

lecturers for help in time. This possibly had a negative influence on participants' Psycap. Although this has a social aspect, it also relates to academic integration.

The academic year for the researched CS programme starts with a special 'introduction week', mainly to assist students' social integration. This week is a combination of informative, programme related, and social activities, such as information on timetables, a tour of the building, a visit to an IT company and a treasure hunt and barbecue. Although students often feel apprehensive about this week, because they do not know anyone and are unsure what to expect, the participants in this research valued the experience in how it helped them to connect with their peers.

> That is why I really liked the introduction week. **I was really able to make friends that week**, because you were divided into different groups and I still am… well I don't talk to everyone from that group on a daily basis, but with most of them I do. **The introduction week really helped** with that [getting to know peers](Charlie_leaver:1)

Around 86% of Dutch UAS students live at home (CBS, 2018) as there are no campuses or halls of residence in the more regional oriented UAS. This means social integration mainly takes place before, during and after classes. A few participants mentioned meeting fellow students socially, but twelve of the sixteen participants reported they only have contact with peers on study related issues.

Ten of the sixteen participants expected there to be differences between themselves and their peers. Their expectations, or the expectations of people close to them, often showed stereotypical views of the CS student population as ‘nerds’.

> I expected that there would be **fewer students with a migrant background** like me and **more the nerd type**. That is what I thought, **but they are really normal people** that just happen to have an interest in computer science (David_leaver:1)

> I thought that **they would be these really quiet, typical nerds, with those glasses and everything** and that they would be constantly…, but **it was completely different**. I think they are… I like them all. There are even some hipster type of students. I thought: Oh, I didn’t know that they are also into IT. I also **expected fewer girls**, but that **also turned out better than expected** (Emma_persister:1)

> And yes, **most of the time they are not very talkative**, that doesn’t help. **And me… maybe the same**, I don’t know. **Often it was a bit too much individually focussed** (Liam_leaver:3)

Lewis et al. (2016) identified the CS stereotypes as, being singularly focused, asocial, competitive and male. Although the participants acknowledged that some fellow students fitted the stereotype, seven of the sixteen participants stated that the reality did not match their negative expectations and they experienced that most fellow students were very similar to themselves. Five of the sixteen participants, one *leaver*, one *persister* and three *stayers*, also

indicated that they did not feel connected to their fellow students at all or only to a few, but also indicated this was part of their personality.

The participants' social integration appears not be affected by the reality that peers left the CS programme. Some acknowledged that they were sad to see people go they felt connected to, but twelve of the sixteen participants felt that students leaving had no impact on them or on possible doubts they might have themselves of leaving the CS programme.

> **You don't get doubts yourself**, because there a plenty of **other people left that are nice too**. I think it's too bad they dropped out, but **it doesn't influence me and my attitude towards the study programme very much**. Although it is a pity to see (Noa_stayer:2)

Since social support from various sources, both outside and inside the study programme is imperative for social integration (Tinto, 1987; Tinto, 1993), the role of others on the participants' social integration is explored next.

5.6.2.1 Role of others

Participants indicated that outside of the CS programme parents, partners and friends were important sources of social support, both in the lead up to the start of the academic year as well as providing support throughout the year. This may have positively influenced participants' PsyCap, both at the beginning and during the year.

Twelve of the sixteen participants indicated that their parents supported them in their choice to apply to the CS programme.

> Everyone, **parents and friends**, **everyone is very supportive of what I do**. I don't have any problems (Osman_leaver:1)

> **At first my mother had doubts** whether it would be doable, but I proved her wrong when I passed the entry exam and was accepted. **Now she is fully supportive** and now thinks that it was the right choice for me (Liam_leaver:1)

Parents and partners were often mentioned by the participants as the main person they shared their day-to-day experiences with. They were also often the first person with whom the participant discussed doubts about leaving the programme or their decision to leave, rather than peers or friends outside of the CS programme. Four participants mentioned having friends outside the study programme that have a connection to CS.

> I have **certain friends that might be able to help me** and I trust them in that sense. So, in case it goes wrong, **I have a back-up if I can't fix it on my own**. I'm sure he'd make time for me then, so that knowledge influences me in a way (Fred_persister:1)

These friends played an important role before making the decision to apply to a CS programme, but also offered some security for help, if needed.

People within the CS programme can also contribute in the development towards a successful CS student by enhancing social integration. This can come from peers, but also from peer coaches. In the researched CS programme, peer coaches are second and third year students of this

particular CS programme. They are employed by the UAS for a small number of hours to help first-year students. Although they mainly assist the students academically with extra tutoring on programming or other subjects, they also contribute socially with organizing events or just by being a link to older students. They also help with general HE skills such as planning and study strategies. Research on peer tutoring in CS indicates that there is no direct positive influence on retention (Cottam et al., 2011), but participants in this research that used this voluntary service were positive about it. The fact that it was actively promoted by the lecturers indicated to the participants that it was an established additional source of support or explanation.

> Yes, I did go to the peer coach classes a couple of times. And **the first two times it wasn't something that really helped me**, so I stopped going. Then we got an assignment in our analysis class to create a digital 'connect four' game. Our peer coach sent us a message that he was going to go over the assignment and explain how to approach it and tips and tricks… **I went to that class and that really helped a lot** (Charlie_leaver:1)

> It was something that our lecturer also already said, that you really have to do that [go to the peer coaches], so **yes, I'll definitely do that**. One of the other lecturers, the one we have for the project, he explained something that I didn't understand, 'constructors' or something…**yes, maybe it is a good idea to ask the peer coaches** (Bryan_persister:3)

The participants knew the peer coaches were there, but often hesitated to go. Participants said they might want to use the peer coaches, but later interviews showed they did not go or went later than would have been helpful for their situation. Participants generally seemed hesitant to ask for help from peer coaches or lecturers. Although it is good they want to solve issues themselves, but asking for help earlier could have been helpful for some of the participants. Not utilising the available social support structure, possibly leads to problems in academic integration and thereby negatively influencing participants' PsyCap.

5.6.2.2 Sense of belonging

Giannakos et al. (2017: 2370) identified that in CS education *"high levels of social support contribute to students' overall sense of belonging in their program, and, ultimately, their likelihood of persistence".* Ten of the sixteen participants in this research have no explicit CS background, so establishing a sense of belonging is one of the things that has to develop together with all other items connected to transition to HE.

> **I feel very much at ease** at this study programme, because they give you **freedom**. They give you **room for improvement and self-development**. And there is… they always offer…**they always offer help**, if you need it, but **you have to accept the help and go there yourself**, but they go over the material with you again (William_persister:2)

> I like it here, **it is all a bit much in the beginning, but I'm starting to notice that everything falls into place and that I'm getting used to things**. In the beginning it was all too much, it still is, but I have the idea that it gets better (Liam_leaver:1)
>
> **It takes some getting used to for me, because I'm not used to working in groups**. So, I really **have to change myself a little** in giving feedback to other people and maybe teach them: hey this is how you do this, maybe that sort of thing (Paul_stayer:1)

The three comments from the interviews above illustrate the three opinions that were found across all participants' interviews. Seven of the sixteen participants, three *leavers*, two *persisters* and two *stayers*, felt they belonged in their environment and could clearly express why. Six participants, three *leavers*, two *persisters* and one *stayer*, felt neutral to positive about their sense of belonging. A smaller group of three participants, one *leaver*, one *persister* and one *stayer*, experienced trouble adjusting. The direct effect sense of belonging has on competence and performance as identified by Taheri et al. (2018) was not found in these groups of participants.

In my research, participants' social integration appeared to be quite shallow and mainly functioning on a practical level, within the class context of discussing assignments or collaborating with fellow students in projects.

5.6.3 Academic integration and first-year stagnation

Academic integration and first-year stagnation appear to have a large influence on the participants' PsyCap in my research. This section focuses on preparations and prior experience; experiences with learning computer programming; working in projects; the experience of having English as the language of instruction; and the influence of first exam results. All these elements appear to affect the participants' academic integration and PsyCap, to the extent that it can lead to them leaving the CS programme or not being allowed to continue.

CS programmes in UAS in the Netherlands do not have entry requirements other than one of the following qualifications: MBO level 4, HAVO or VWO diploma or a 21+ entry exam pass. There are no additional requirements for basic programming knowledge or specific maths grades students should have.

The curriculum of the researched CS programme has the same course structure in each of the four periods of the academic year. Courses named Development, Analysis, Project and Skills are offered in each of the periods, with different content, often building on knowledge from the previous period. Table 5.7 offers a characterisation of the courses that are mentioned in some of the participants' quotes.

Course	Characterisation
Development	Main computer programming courses, each consecutive course builds on the previous course.
Analysis	Closely related to the programming course, but focus on related issues such as the mathematical underpinning of computer programming.
Project	Realistic group assignment. Each project runs for a semester.
Skills	CS related professional skills such as project management, giving and receiving feedback, research and reports. Runs simultaneously to the project.

Table 5.7 Characterisation of courses in the researched computer science programme

The experience of the researched CS programme aligns with findings by Gordon (2016) that the majority of CS students have very little or no programming experience when they enter HE.

> I expected that everything would be **easy to understand**, because on the website it said that **you didn't need prior programming knowledge**, but that is a bit of a **disappointment** (Emma_persister:1)

As mentioned before, CS students often underestimate the effort needed to learn how to programme (Gordon, 2016) and research has shown that having some prior experience in programming has a positive effect on the transition to a CS programme (Hagan and Markham, 2000; Kori et al., 2016).

A big hurdle in achieving academic integration is the difference between what is expected of students in secondary education and what is expected of students in HE in relation to study approach (Coertjens et al., 2017b). In HE, students are expected to have a greater command of self-regulatory skills than in secondary education. None of the participants reported that they had experienced academic difficulties during their secondary education, but almost all reported having academic difficulties in their current CS programme. Some difficulties during participants' secondary education were

related to participants' personal or motivational issues, but participants reported no difficulties in their learning approach or the level of the subjects. Half of the sixteen participants indicated that their secondary education was (too) easy and that they did not feel challenged. In their perception, they hardly had to study or put extra effort into their work and still got pass grades.

> To a certain extent…**I had to put some effort in it, but it wasn't super hard**. If I had really made an effort I could have done VWO, but I didn't and I'm glad I didn't, because than I wouldn't have had any spare time (John_stayer:1)

These experiences, together with ten of the sixteen participants having very limited or no programming experience can be seen as complicating factors in terms of the academic integration. Trautwein and Bosse (2017) acknowledge the importance of social integration in the transition to HE, but emphasise that academic integration, especially when looking at personal, content-related and organisational elements, can offer a deeper insight into difficulties in the first-year transition process.

Sections 5.6.3.1 to 5.6.3.3 focus on these elements by Trautwein and Bosse (2017). The personal element is found in the participants' preparations and prior experience; the content-related element in the participants' experiences with learning computer programming; and the organisational element by looking at the participants' experiences in relation to projects and collaborating with others and how this appeared to have affected the participants' PsyCap.

5.6.3.1 Preparations and prior experience

The participants not only had different entry qualifications, but also varied in how they were prepared or prepared themselves for their new study programme.

> **I did not do anything beforehand**, such as learning certain things, but I have accepted that **I need to show more effort**, take more responsibility (Henry_leaver:1)

> **I did an online course**. I started in February with this course, it is a self-study programme. Just to see if I would like it. And if I would like it, it would receive a certificate, that's always handy both for my degree and in general. This would **give me some prior knowledge, even though we use something else here** than Java (John_stayer:1)

Participants indicated that they had been excited about going into HE and expected that it would require them to change, but also that they were not sure how they could prepare themselves for the transition or specifically for studying CS. Most of the participants, especially those with little or no programming experience, appeared to display a laisser-faire approach. This attitude together with the observation that CS students often underestimated the effort needed for a CS study (Gordon, 2016), creates a potentially risky situation for a great number of students from the start. The participants' positive expectations at the start of the year are also reflected in the PsyCap perceptions in the scale and graph exercises presented earlier in this chapter.

5.6.3.2 Learning computer programming

Because computer programming is the core of the CS programme, participants' progress in learning and applying programming skills is an essential part of their academic integration. Gordon (2016: 11) claims that there is a gap between the students' *"expectations of what a CS related degree will include, and the actuality of degree content and requirements"*. This can partly be explained by the limited view of what CS and programming is that most students have. This was evidenced in interviews with the participants.

> my expectations of learning how to program…**at first I thought that it would be very easy**. It is just numbers, things I have done before, but when I looked more closely **it is a lot more difficult than I expected**. There is a whole lot of maths behind it and a lot of thinking, you have to make a lot of notes, the order of things (David_leaver:1)

> Sometimes you're in class and **you're paying attention and you understand what it's about…or not**. Or you don't understand and **no one really asks why** or when you are going to use this. **We are learning things, but for what purpose?** This would help me in an exam if I would know in what situation I would use this or to know which of the things I've learned I need to use in this situation (Bryan_persister:2)

Overall, almost all participants experienced difficulties with learning how to programme during the academic year. This appears to have a large impact on

participants' PsyCap. Academic integration and first-year stagnation in relation to the difficulties with learning to programme are closely connected to *troublesome experiences* (5.8).

5.6.3.3 Projects and collaboration with peers

Projects are an important part of curricula at UAS in the Netherlands. They are a way to let students experience realistic assignments from their chosen professional domain. Throughout the years of study, the complexity of the projects increases. Many Dutch UAS CS programmes do not start with projects until the second semester, because of the large differences in programming skills between students in the first semester. The researched CS programme starts with projects in the first semester, but the first half of the project does not require any programming. During the first period of ten weeks the project teams have to create a functioning board game and in the second period they have to add a digital component to their board game.

The interviews showed that the projects played an important role in the participants' experiences, but in different ways. It was a positive source of motivation for some, both in the way they felt they learned from other team members and because as a team they can do more than as individuals. This was especially expressed by participants with little programming experience. McCartney et al. (2016: 12) identified working on projects for CS students as *"a motivation for learning"* and as *"support for learning".* In contrast, it can also be a source of irritation and even frustration. This can be caused by conflicting

personalities, differences in motivation or different levels of programming skills. Projects appear to affect participants' PsyCap, positively or negatively.

> I think **I'm most proud of the high grade for project A**. What was it again…9.4 it was. I thought: wow, a good grade to begin with and **I can do this, I can take this forward**. Just the fact that I received the ECTS for that…Yes, the project really makes me feel… **yes I want to do this again, I enjoy this so much** (Emma_persister:3)

> I like the project group, but **I prefer to have individual assignments**, because this time I am lucky with my team, but I know that usually you are…you don't know how it will go within the team. And I do think that, especially being in a class in general, **you are kind of stuck to a team**. I don't like that I know that **there is at least one person in my class that is disadvantaged by the project group he is in**. That is why **I prefer to work alone** structurally (Richard_stayer:1)

In year 1, the added challenge is the fact that team members leave the CS programme during the project, which requires a redistribution of tasks and responsibilities in a project team. Another challenge is that on average 20% of students in a technical programme like CS in the Netherlands have a disability (Steenkamp, 2017). In CS related studies this often relates to autistic spectrum related disabilities (ASD). Although there is very little research on the specific number of students with ASD in STEM related studies such as CS, it is a commonly held view that these students often choose a STEM related study programme (Wei et al., 2013). Two participants reported an ASD

diagnosis. Even for students without an ASD diagnosis working together in a group can be challenging.

> My first project group… **it was such a struggle to work together** and that was no fun. I realised that I shouldn't take over other people's tasks. In that project, **I really covered for someone else**. And he received a higher grade than me eventually. I really hate that. I am no longer going to take on other people's responsibilities, let him fall flat on his face, let him figure it out, not my problem. **This is my biggest change this year: let other people do their own work and not put it on my plate** (Paul_stayer:3)

Working in a team requires collaboration skills that programmes often assume students have or that they will develop naturally. Offering some *"scaffolds"* in self-directed learning could help all students in learning how to do projects in CS (McCartney et al., 2016: 13) and thereby possibly positively influence PsyCap.

In addition to the more general focus of academic integration, Cole (2017) states that first-year stagnation looks into the actual element or elements that cause participants' motivation and development of approaches to deep learning to stagnate. In the interviews, the factors that caused first-year stagnation all relate to the academic integration.

The first signs of stagnation were visible in interview 1 with the students that were the first to leave the CS programme. Henry, the first participant to leave in October 2018, indicated that he experienced his MBO education, as very

easy and he acquired his diploma without much effort needed. He also admitted that he did not do any preparation for programming. The fact that he left the programme before the first exams was surprising to me, because although Henry talked about how difficult he found the course, he also spoke about recognising he needed to put in more effort and prepare for the exams. Interestingly, Henry disclosed that he did not consider himself to be a very resilient person.

> Maybe it is a bad thing to say about yourself, but **when something gets very difficult, I'm inclined to give up and say: I give up**, I'm not doing this anymore (Henry_leaver:1)

First-year stagnation became more visible in interview 2. By that time, five participants had already left the programme, two of which took part in interview 2 after leaving. Interview 2 revealed that participants experienced doubts about whether this programme suited them or if they were able to master programming. Doubts appeared quite early on in the academic year, especially for *leavers* and *persisters*. The stayers had doubts about smaller issues, but overall remained positive about continuing.

> I have…and that sounds strange, but for **weeks every morning when I woke up and every evening before I went to sleep, I thought about what I wanted to do**. Continue with the programme? Leave the programme? Am I going to continue or am I going to quit? After a while I had **this list with things I really enjoyed about the programme**, but **the list of things that were negative in the programme in my**

> **opinion was much longer**. That's why ultimately, I decided to quit (Charlie_leaver:2)
>
> **I'm very scared that I won't make it**, that I just don't understand it. **I do like it**, that is not the problem, but **I'm also scared I don't put enough time into it**, even though I spend time in the library almost every day or studying at home. It is just…**it is just very difficult really** (Emma_persister:1)

These views are consistent with findings by Meens (2018) that the quality of motivation declines after the transition from secondary to HE. Also in students that were still in the programme during and after interview 2, it becomes apparent that adjusting to HE and the reality of learning to programme does not go smoothly for most participants. This influences their initial motivation and PsyCap. Besides the difficulties in learning how to programme, two other main factors for stagnation were identified: English as language of instruction and influence of exam results

5.6.3.4 English as the language of instruction

One of the things that hindered some participants was the fact that a large majority of the classes are taught in English by international lecturers for whom English is also not their first language. Nine of the sixteen participants were not aware before they started that most classes would be in English and most of those who did acknowledged that it took time to adjust. Although participants understood that this was because of universal English terminology, source material and computer languages within the CS domain,

six participants indicated that this hindered their academic integration. Three participants stated that if they had known, they would have applied for a different, Dutch taught, CS programme.

Research by Soosai Raj et al. (2018) on the role native language plays in learning to programme has shown no distinct differences in the results between students that are taught computer programming in English or in their native language combined with English, but that the students report feeling more positive about the class and more at ease in class if they are taught in their native language and English.

> **English is not my strongest subject** and the classes are in English, so I go to the peer coaches for **questions and additional explanations in Dutch and this helps** (Osman_leaver:2)

> **I really liked that we had a Dutch lecturer for programming**, I really liked that. And he was very good at explaining, at least that's what I thought. I really understood what he explained and **that made me feel good**. He explained it very well (Bryan_persister:3)

The level of discomfort about being taught in English or the comfort of being taught in Dutch appeared to have a large influence on the participants' emotional state, thereby probably influencing their PsyCap. Being taught in English was not the sole reason participants left, but five of the seven *leavers* and three of the five persisters indicated they considered it to be a complicating factor.

5.6.3.5 Influence of first exam results

In general, the results of the first exam period in November 2018 appeared to be indicative for the results at the end of the year. The *stayers* did well in the first exams and passed almost everything. The *persisters* showed mixed results; passing some exams but failing others. The *leavers* failed almost all exams in the first exam period. Academic integration in the first weeks of the transition to HE in a CS programme appears, therefore, to be essential for successful progress in the year.

> **I expected to get at least a 6 in the analysis 2 exam**, but if I look at the overall results, I think to myself: the average grade was 4.7 or something like that, well at least I'm slightly above that. But it is **still a bit sad if you expected you passed the exam** (Miranda_persister:2)

The factors of academic integration and first-year stagnation appeared to have a large influence on the participants' emotional state, thereby probably influencing their PsyCap. Some participants experienced difficulties in several factors of academic integration and first-year stagnation presented here, leading to their departure.

5.7 Transformation

As discussed in the theoretical framework in Chapter 3, transformation is an important characteristic within TC (Meyer and Land, 2006c). Crossing thresholds changes the student to a different version of themselves. Some of these changes are small and hardly noticeable, others can be radical shifts in

thoughts or behaviour. Meyer and Land (2005) mainly discuss the transformation of identity, while Moström et al. (2009) identify four transformations in their research with CS students: thinking like computer scientists, identity, behaviour, and confidence. My research focuses on the transformation into a student in HE (5.7.1) and transformation into a computer scientist (5.7.2). Transformation into a student in HE relates to the behaviour aspect identified by Moström et al. (2009) and looks at the changes students made throughout the year to become successful students. The transformation into a computer scientist relates to the transformation of identity discussed by Meyer and Land (2005) and Moström et al. (2009). Transformation in relation to TC will be further discussed in section 6.2.

5.7.1 Transformation into a student in higher education

As discussed before, half of the sixteen participants experienced their secondary education as easy, to very easy, and acknowledged they did not have to put much effort in to pass tests or exams at school. Half of these eight participants had little or no programming experience, this meant that to successfully find their way in this particular CS programme, they had to transform the way they looked at and planned their study activities. Although most of them recognised they had to do more or start earlier than previously, effectively making this transformation appeared to be difficult for them.

> I guess I've changed a bit. It **is not really fully in effect**, but I know that I have to put **more time and effort into it**. I have to **become more actively involved**. It [programming] is not something you pick up just

by going to the classes. **You really have to do it** before you begin to understand it (Paul_stayer:3)

In period 2 I did… **I started earlier with revising**, **but probably still not early enough**. In period 3 I started revising… well basically from the start. If I had a day off, I'd start revising and **I also made a lot of summaries**. I also did that in period 1 and 2, but much later in the period (Miranda_persister:3)

Because not all changes participants made led to noticeable results, participants were not always aware of the transition they underwent. All participants indicated that they expected to, or planned to, change their study approach and most of them acknowledged during interview 1 that they needed to put in more time and effort. The *persisters* and *stayers* appeared to have a clearer, more realistic idea on how they intended to do this. The *leavers* often used vague descriptions in the interviews, such as more or better, without making concrete what this entailed. The same participants also used words that downplayed their intended actions with words such as maybe and possibly.

…**maybe study on a specific day of the week**, then I can ask someone…. I have…I know people in year 3 or 4, so **maybe I'm going to propose a specific day of the week to them**, so they might be able to help me on those days for an hour or so (Osman_leaver:2)

I just have to study the things I haven't understood yet. **Just go over everything again generally**. Just like that (Liam_leaver:2)

The *persisters* and *stayers* seem to specify their intended study related actions more and in later interviews explain what further changes they made in their approach. This led to a full or partial transformation in their study approach compared to when they started the programme. The changes that were most successful in *persisters* and *stayers* are: practice more, set specific times in their agenda for studying, and studying with someone else. Because around 18% of all 260 000 first-year students in Dutch HE (Inspectie van het Onderwijs, 2019) switch their study programme, it can be assumed that some of the *leavers* and *persisters* will apply their newly acquired HE study approaches in a new study programme. The positive or negative experiences in relation to the successfulness of the participants' transformation into an HE student probably influenced their PsyCap.

5.7.2 Transformation into a computer scientist

During their first year, transformation occurred in the way the participants begin to see or identify themselves more as (future) computer scientists or start to realise that they do not see themselves in that way.

At the beginning of the year the participants' identity seemed to be close to the secondary student identity. The compulsory nature of secondary education means that students in general feel that it is something they need to undergo and that there is a structured way subjects are delivered and tested. In contrast, HE is not compulsory and students experienced more freedom than before. This also meant that the individual student needs to take more responsibility for their own learning and personal needs, finding intrinsic

motivation. Some participants were more successful in handling this challenge than others.

> I've **become much more studious** in the way that I want to **know more about it** and that I really want to know this and remember this. **I really want to know how things work** (Bryan_persister:3)

> If you have to do something for the project or an assignment **and you are able to do it, that's what I find so amazing**. For example, we're working on the project and I make certain elements for that and eventually you'll get there. **That feeling you get when you let it run and it runs**… and it does exactly what you want and it works…yes, that's what I really love. […] you have something and you experiment with it, play with it and… yes, **I really enjoy doing this and I really enjoy doing this at home too** (Noa_stayer:3)

It becomes apparent that to make the switch to transform their identity into becoming a (future) computer scientist, participants needed to experience a spark to ignite or continue intrinsic motivation for programming. To achieve or sustain this, the participant needed the experience of successfully completing programming assignments, projects or exams. Achieving intrinsic motivation can positively influence PsyCap, especially self-efficacy. In turn, it is plausible that PsyCap influences motivation. Realising that they could achieve the programming requirements of the course helped the participants to visualise the possible identity of computer scientist. Seeing themself as a programmer, in its turn, helped to keep the motivation going.

> Well that **gave me such a boost for the next projects**, because I knew that with every project you need to programme more. I thought: well if it goes like this, then you can easily…then next projects are going to be easier than you thought. That is something I really noticed. **That I thought: this is going to work out.** That gave me… **you have more hope for the next periods really** (William_persister:2)
>
> **Passing the exam gave me a little peak in my motivation**. If I would have failed this, **if I would have had an insufficient score, then my motivation would have probably dropped through the floor** (Paul_stayer:3)

In general, the *leavers* expressed more doubts about their choice of study programme or commented on the difficulty of programming. In the *persisters'* group, doubts and difficulties were also expressed, but their balance tipped more towards motivation for CS. In interview 3 the persisters' doubts about passing year 1 increased. Interestingly, three of the five *persisters* still intended to do something programming related if they had to leave the CS programme. The *stayers* also expressed difficulties and sometimes had doubts about whether they would be able to get the required 48 ECTS, but had no doubts about whether programming was suitable for them.

In summary, the three participant groups reflected different levels of transformation. The *leavers* did not noticeably transform whilst in the CS programme. The *persisters* transformed partially, either towards becoming an HE student when they improved their study approach or towards a future for

themselves in something IT related, but not CS, or a bit of both. The *stayers* made the transformation both as HE students and as (future) computer scientists. Similar to the previous section, the positive or negative experiences in relation to the successfulness of the participants' transformation into computer scientists probably influenced their PsyCap.

5.8 Troublesome experiences

Compared to transition to HE and transformation (5.6 and 5.7), *troublesome experiences* operates on a more meta level, because it is always combined with or a reaction to another experience. In addition to the already existing concepts of troublesome knowledge (Perkins, 1999), troublesome language (Meyer and Land, 2006a), and troublesome affect (Felten, 2016), I introduced the notion of *troublesome experiences* in chapter 3 and defined it as "a *cognitive, affective and/or skills experience that obstructs students from further development",* because the struggles CS students experience go beyond the knowledge being troublesome. *Troublesome experiences* relate to knowledge and skills that the student, to some extent, already possesses in the form of ritual, inert or tacit knowledge, but which they have trouble retrieving or applying to the existing knowledge (Shinners-Kennedy, 2016). Additionally, there is also a strong affective component as a reaction to the *troublesome experiences*.

As found in sections 5.6 and 5.7 many of the participants' experiences are potentially *troublesome experiences*. Learning how to programme and the build-up and aftermath of the exams can become *troublesome experiences*

for some. This can partly be explained by the idea of student syndrome, identified by Smith (2010) as a characteristic in CS students. It means they leave work until very close to the deadline, similar to work approaches in the CS domain. This approach can be problematic for new CS students, because they might have trouble estimating the time needed for a specific task, due to lack of CS experience. It can also be a problem in *"large single pieces of coursework or end of course exams - where students can fail without an easy recovery pathway"* (Gordon, 2016:13). Participants acknowledged that keeping focused on the deadlines and exams for different courses at the same time was troublesome.

> The **second exam period was a bit more stressful**, not because of the exams, but **because the project deadline was in the week before the exams**. And because the project was nearly finished it was just a matter of… well it wasn't tight per se, the project itself. It was more… is it finished enough to pass? And **then it was a choice of putting the effort in the project and passing that and maybe fail the exams.** The exams themselves were… more difficult also, but it was more that… the **second exam period probably suffered from the stress for the project** (Fred_persister:2)

The exam results can be troublesome in the way that the results forced participants to think about or rethink their plans and expectations. Again, these are emotive experiences.

> It also depended on the results, because **if I failed in a disastrous way, then it is very probable that I'll switch study programmes**. I always think that **if it doesn't go well in the beginning, it won't go well in the end** (Charlie_leaver:1)
>
> **When I heard that I failed the exam**, and then that I failed another exam and another exam. **At that point, I was really fed up with everything**. Then I found out that **I did pass another exam and I thought: thank goodness**! (Bryan_persister:3)

In CS programmes, courses build on the knowledge and skills acquired in the previous period. So, period 2 builds on period 1 and period 3 builds on period 2. A student that has failed one or more exams, might have trouble grasping the knowledge and skills in the next period. This led to some participants expressing an increase in the troublesomeness in their study experience. Overall, participants found the CS programme challenging, with some negative, but also some positive outcomes when a *troublesome experience* was conquered.

> ...but in this case, there is one concept that you have to use in this assignment that just…. I just don't get it… it's just not my thing. **This one part is just not my thing and at the moment it causes me a lot of problems** (John_stayer:3)
>
> That was a bit below par for me, but **it has improved greatly**. There **are still obstacles I run into**, so I don't want to rate myself to high. **I**

> **understand the current topics**, but really applying it in writing programming code, that is something I struggle with (Noa_stayer:2)

Participants related 'success' to passing exams. They only seemed to think about the *"product of learning"*: passing an exam, and not so much about the *"process of learning"*: how they learn (Rattray, 2018: 8). With the importance of reaching at least 48 ECTS in year 1, the participants' focused on passing exams, rather than effective learning. Although understandable, it demonstrates a more short-term focus than the longer-term insights into the process of learning.

Some of the participants' personal lives overshadowed their academic experiences when they encountered personal issues. Five participants said they were experiencing personal circumstances that made their study experiences more troublesome. Personal circumstances ranged from health related issues such as insomnia, chronic fatigue syndrome and depression to problems in the home environment. Three participants also said they had a disability that could have an impact on their study results and experiences. Two reported being on the autistic spectrum and one had dyslexia. These personal circumstances and disabilities added an extra complicating factor to studying in general as well as studying CS, making studying itself a *troublesome experience*.

> Last time **it took me months to become myself again**… before I was able to concentrate and things like that. **Also, to be able to just think straight and not this sort of 'inner-paralysis' feeling**. I don't know

how to explain it differently, although paralysis is a bit too extreme… (Richard_stayer:3)

After a while I felt so messed up. **I really felt super unhappy**. So, **it was really tough to come to school every day, but also just to think about the study programme**. That was when I decided that I was not going to pass if I continued in this way (Liam_leaver:3)

The interview data showed that the whole experience of the transition to HE, combined with a challenging curriculum of knowledge and skills, often delivered in the participants' second or sometimes even third language can cause *troublesome experiences*. At the same time participants were dealing with personal issues that sometimes by itself, but often in relation to doing a challenging CS programme caused *troublesome experiences* for them. Most of the *troublesome experiences* found in the interviews related to academic integration and first-year stagnation and appeared to have a noticeable influence on their PsyCap.

5.9 Summary and conclusions

This chapter presented findings from the interview data and the graphic elicitation exercises to identify experiences that contributed to the participants' PsyCap and retention. Of the PsyCap factors, hope appeared to have a large influence on participants' decisions about leaving or continuing. In turn, hope appeared to influence self-efficacy and resilience. Optimism appears to be the most stable PsyCap factor, less effected by short-term experiences.

Although a wide range of experiences have influenced the participants, difficulties relating to academic integration and first-year stagnation appeared to play a vital role in the participants' PsyCap and retention. Overcoming small and large *troublesome experiences* in academic integration contributed to the participants' transformation into HE students and future computer scientists. The *troublesome experiences* influenced the participants PsyCap, but PsyCap also influenced how a participant approached *troublesome experiences*.

Chapter 6: Findings and experiences from a threshold concepts perspective

6.1 Introduction

This chapter aims to explore the findings and experiences presented in chapter 5 by using TC (Meyer and Land, 2006c) as an overarching tool for analysis. It relates to the third research question of this research study:

> *RQ3 How do threshold concepts relate to the psychological capital and experiences of first-year computer science students?*

This research question enables the findings and experiences to be connected. First, troublesome experiences, liminality and thresholds are explored (6.2), followed by transformation (6.3). Using TC as an overarching analytical tool leads to the presentation of an explanatory model on transition to HE from a TC perspective (6.4).

6.2 Troublesome experiences, liminality and thresholds

Because of the interrelatedness of *troublesome experiences*, liminality and thresholds in the participants' experiences, they are discussed together in this section and with reference to PsyCap, discussed in chapter 5.

The *troublesome experiences* the participants in this research encountered varied in nature, but always had an affective component, such as stress, anxiety or frustration, together with a problem that was knowledge or skill related or both. It is probable that this affected the participants' PsyCap. Some *troublesome experiences* related to specific courses or because courses were

delivered in English. Troublesomeness was also found in working with other students in a project team. Five participants struggled with personal issues that were troublesome and that made studying even more difficult.

> I felt it got more difficult at first because it was **a lot of different new things really. Things that are not common for a regular person**. It sort of came from a blind corner. **It's a bit more stressful** (Noa_stayer:2)

> I'm getting better at it and it's still not perfect. **It is far from being perfect and it will probably never be perfect, but it has improved**. Even though the last couple of weeks… last week I really had a bad week in relation to sleeping (Paul_stayer:2)

Troublesome experiences are closely linked to liminality, the *"transformational state"* in the process of learning described by Meyer and Land (2005: 380). This liminal space (Land et al., 2014a) or liminal tunnel (Vivian, 2012) is a *"space of discomfort and transformation while grasping a concept"* (Reeping et al., 2017: 4). For student learning this means that learning in the liminal space takes place by *"oscillating between and confusing the new and old understandings, emotional response and the feeling of being 'stuck'"* (Sanders and McCartney, 2016: 92, Meyer and Land, 2005), but the real mechanics behind navigating the liminal space remain unclear and my research did not provide any new insights towards this.

All participants experienced stuckness at some point for one or multiple reasons. This often contributed to the *troublesome experiences*. Berg et al.

(2016: 115) explain that this is *"as much connected to their understanding of what it takes to be a student and its requirements, as to stuckness connected to discipline related issues"*.

> For analysis, I didn't pass the resit, because **I just didn't understand the questions.** I felt it was much more difficult. And in the second exam period… **I don't know what happened, but I just couldn't study, I just couldn't do it**, so I didn't do well in that exam either (Emma_persister:2)

Stuckness at a specific threshold can sometimes easily be resolved when one missing bit of information stands in the way of moving on and crossing the threshold irreversibly.

> **I was stuck and couldn't get it** and then I asked [the lecturer] how should I do this? He said well you don't put that there, but underneath this. Then I was like: ooooh duh! **And then It was fine. Then he didn't need to explain it any further,** because I already got it. **The penny dropped and I moved on to the next level**. Now I get that part. (Bryan_persister:2)

When the stuckness related to a larger or more complex threshold, it appeared to lead to first-year stagnation. McCartney et al. (2007: 158) identify four major strategies successful CS students use to become 'unstuck': *"inputs / interaction, concrete / do stuff, abstract / understand stuff and 'use the force'"*. By this they mean that successful CS students interact or ask others such as peers or lecturers, gain experience by doing assignments, try to

connect abstract knowledge to other things, and use their willpower. Although determination and PsyCap are not the same, I feel these two appear to be related, demonstrating the usefulness of PsyCap in relation to CS.

Rattray (2018: 9) states that students should be encouraged to focus on both the outcomes and the process of learning to feel *"less intimidated by encounters with troublesome knowledge"*. This also seem to apply to *troublesome experiences*. Half of the participants reported they found their secondary education (too) easy, implying they had little experience with troublesome knowledge or *troublesome experiences* and with accepting troublesomeness as a common aspect of learning.

The *troublesome experiences* and stuckness of the participants often prevented them from navigating the liminal space and crossing a threshold. This could be a large *troublesome experience*, such a passing an exam, but could also be as small as finishing a particular assignment. In trying to find a way to overcome the troublesomeness and cross a threshold, liminality can also be seen as *"a suspended state in which understanding can approximate to a kind of mimicry or lack of authenticity"* (Land et al., 2014a: 201). This adoption of a form of *"compensatory mimicry"* (Meyer and Land, 2006b: 24), is a way to compensate or mask partial mastery of a concept (Thomas et al., 2015) or as a *"serious attempt to come to terms with conceptual difficulty, or to try on certain conceptual novelties for size"* (Meyer and Land, 2005: 383). The interview data also shows that participants used mimicry to overcome liminality in learning computer programming.

> It does happen**, just particular things in the study materials, that you just accept and then eventually you see the logic behind it**. Then it becomes a lot more clear (Liam_leaver:2)

> For example, with development, that **I don't understand at that time**, but then I go to the practical classes and **then I ask things and then I do get it**, so that goes well. **I don't understand the theory behind it, but I do know what to do to get it working** (Emma_persister:2)

Research by Eckerdal et al. (2007) on CS students navigating the liminal space found that many adopt mimicry at some stage in the learning process, even though most lecturers see that as unwanted behaviour. Eckerdal et al. (2007: 125) suggest looking at mimicry in CS education more positively explaining that *"although some students do not progress past mimicry, it can be a step to gaining a full understanding of the subject".* By adopting mimicry until the participant fully understands a subject, it also pauses or postpones any effect not fully understanding could have on students' PsyCap.

Research by Land et al. (2014b) and Rattray (2016) connects navigating liminality directly with PsyCap, and research by Rattray (2018) connects liminality and troublesome knowledge. My research aligns with their findings that navigating liminality and overcoming *troublesome experiences* can be described as an affective experience. These feelings and emotions may be closely linked to the PsyCap factors:

> In the second period, it all became more difficult and it all went much deeper. You are confronted with a lot. **In the beginning, I found it all**

> **a bit scary** and I thought: what is all this? But the more the period progressed and **I really put time and effort into studying** and making mock exam questions… I found that I picked it up quickly and **really understood it and this made me very self-confident** (Noa_stayer:2)

This comment highlights the resilience in relation to a specific *troublesome experience* of being scared and confused, but also how his successful actions influenced Noa's self-efficacy and confidence. Eckerdal et al. (2007) also identified the strong emotional reactions of their participants on the learning process in CS and highlight that the emotions of students towards programming are rarely mentioned in the literature.

Although in the interviews the *troublesome experiences* in learning computer programming were primarily viewed from the participants' perspective, some of the difficulties experienced could have a connection with the lecturer's perspective. Meyer and Land (2006a: 7) point out that in education there is:

> the difficulty experienced by expert practitioners looking back across thresholds they have personally long since crossed and attempting to understand (from their own transformed perspective) the difficulties faced from (untransformed) student perspectives.

In CS education, the lecturers not only have knowledge about programming, but they have also mastered the skill of programming. Some of the lecturers may find it difficult to go back to when they first experienced programming to understand their students better. The peer coaches mentioned earlier, played an important part bridging the gap between lecturers and students, as they

were previously first-year students and often relate to others how they experienced the first programming courses. In addition, their help was in Dutch. The participants often realised the benefits of the peer coaches only in the later stages of the year. Contacting the peer coaches earlier could have helped some participants navigate liminality in relation to learning computer programming.

All participants experienced the exams and resits as major structural *troublesome experiences.* For *s*ome students the *troublesome experience* relating to an exam was experienced as an obstacle, whilst for others it acted as a threshold The implications of passing or failing exams influenced the students emotional state and motivation, but also their belief in a possible positive outcome. Besides these structural *troublesome experiences*, there were also smaller assignment *troublesome experiences* the participants overcame, but they themselves mainly focused on the major *troublesome experiences*. For most participants, the small and large *troublesome experiences* led to difficulties in navigating liminality and stuckness and thereby hindering them to cross thresholds in their development.

6.3 Transformation

Transformation into an HE student and transformation into a computer scientist are easily connected to the transformative characteristic in TC. The biggest driver for the participants' transformation in their study approach were the exam results. This appears to drive and change how they prepared and participated in their classes and when and how they prepared for exams and

resits. From the interviews, it appeared that the *persisters* and *stayers* were more able to reflect on their experiences and use the insights gained to make concrete changes in their study approach. As previously stated, the *leavers* were, in general, less precise in their answers in the interviews on what they were going to change or what they had changed by saying, for example, they have to do more or start earlier without being more specific what this entailed.

> I did more. I made more assignments**. I looked more closely at the PowerPoint presentations** of the classes. And **I really practiced a lot** with the assignments we were given, but it took me much longer to make those assignments than the others really (David_leaver:2)

> Especially with analysis I really **went over the material multiple times, in different ways**… **I wrote different kinds of summaries**. And I really started practicing and that really helped me, but **maybe I didn't start early enough**, because I started three weeks before the exam...I started already with that. But **this period I have already started with everything now** (Miranda_persister:2)

> With development… yes, **I have to read the material more closely and pay more attention** to how they describe things, like the code I just showed you, because **I know now that I will need this in the exam**. In general, **we make the assignments in class together with the person sitting next to me.** We then just look… this is it, this is what I'm filling in **and if it doesn't work, then you ask: do you know how to solve it**? (John_stayer:2)

Transformation into a computer scientist only appears to take place if the participant sees themselves, consciously or unconsciously, as a part of the CS programme or as a (future) programmer. This transformation is also closely related to their exam results and their motivation for the programme and their sense of belonging. Although it was not directly asked in the interviews, if participants considered themselves (future) programmers, their responses show if there was some enthusiasm for programming or whether they experienced doubts if this was the right programme for them.

> So far… **I'm not sure if it is something for me, if programming is for me**. Some things… let me just say some things… yes that is something for me and other things just aren't. I would give it a 6 at the moment (Osman_leaver:2)

> **I can see myself working with this in future**. It is fun and you can do a lot of different things with it (Bryan_persister:2)

> **I still really like it. I like programming**. I don't like looking at the theory behind everything, because I'm really a practice-oriented person. **It is interesting to learn the theory behind things, but I enjoy doing it most** (Paul_stayer:3)

Identifying oneself as a programmer is the first step to transformation into a computer scientist.

As described in the theoretical framework in chapter 3 the TC related research of Flanagan and Smith (2008) in the CS domain identified three

computer programming learner identities: the *bemused*, the *confused* and the *transformed*. Although they identified these three learner identities for students with no programming experience, their learner identities can also be applied in this research where ten out of the sixteen participants have very little or no programming experience. Three of the seven *leavers*, the participants that left early in the academic year, such as Henry, Simon, and Andrew who acquired no ECTS at all, can be seen as the *bemused*. For them programming itself was the threshold and they were *"operationally challenged"* (Flanagan and Smith, 2008: 92), because they could not programme at all.

Four *leavers* together with all the *persisters*, that received between 12 and 32 ECTS, can be considered as the *confused*. According to Flanagan and Smith (2008: 92) they *"experience local thresholds in the grasping of one or more specific aspect of programming"*. Because of this they end up *"conceptually challenged"*. They were able to grasp some of the complex interaction in programming, but struggled with others. For *leaver* Charlie, this local threshold was not related to programming, because he was already a quite experienced programmer, but had to do with the mathematical knowledge he required for the analysis courses. This gap in mathematical knowledge is likely to be caused by the fact that in his MBO education mathematics was taught at a lower level than at HAVO and VWO.

The *stayers* all acquired over the 48 ECTS necessary to pass year 1 except for John. Even though John had only obtained 30 ECTS, he was allowed to continue on the basis of the student counsellor's advice because of serious

personal circumstances. The *stayers* can be considered *transformed* students and similar to the *confused* participants they experienced local thresholds. *"The 'transformed' student is able to overcome the local threshold and able to understand complex interactions, after which transformation follows"* (Flanagan and Smith, 2008: 92). Transformed students will experience difficulties, but because they have effective programming skills they are considered *"locally challenged"*. Overcoming the *troublesome experiences* appeared to contribute to the transformation of the participants.

6.4 Model for transition to higher education from a threshold concepts perspective

As chapter 5 and the previous sections in chapter 6 showed, there is a large interrelatedness between the major themes of this research: transition to HE, *troublesome experiences*, transformation and PsyCap. In order to develop a model that visualises this interrelatedness, I return to concepts explored in the literature review in chapter 2 and the theoretical framework in chapter 3, together with the findings in chapter 5 and the TC perspective in chapter 6 and this will gradually build towards the presentation of my model for transition to HE from a TC perspective.

Throughout this thesis, transition to HE specifically looked at expectations, social integration, and academic integration and first-year stagnation (Cole, 2017).

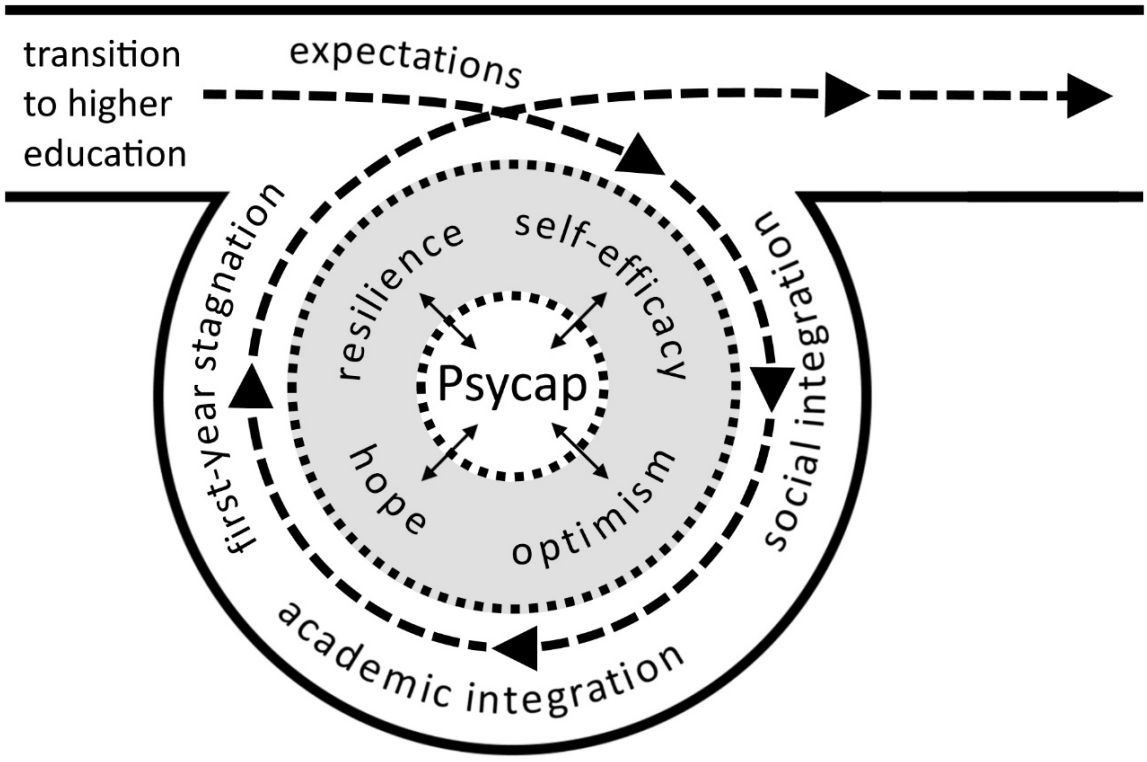


Figure 6.1 Interrelatedness of transition to higher education and psychological capital

Figure 6.1 shows the interrelatedness of transition to higher education and PsyCap by visualising how the participants' experiences in relation to expectations, social integration, and academic integration and first-year stagnation are influenced by their PsyCap and its factors, but also that their experiences influence their PsyCap or individual PsyCap factors or the interplay between them. The circular shape of the figure represents the participants' learning cycle(s) and the non-linear nature of participants' experiences.

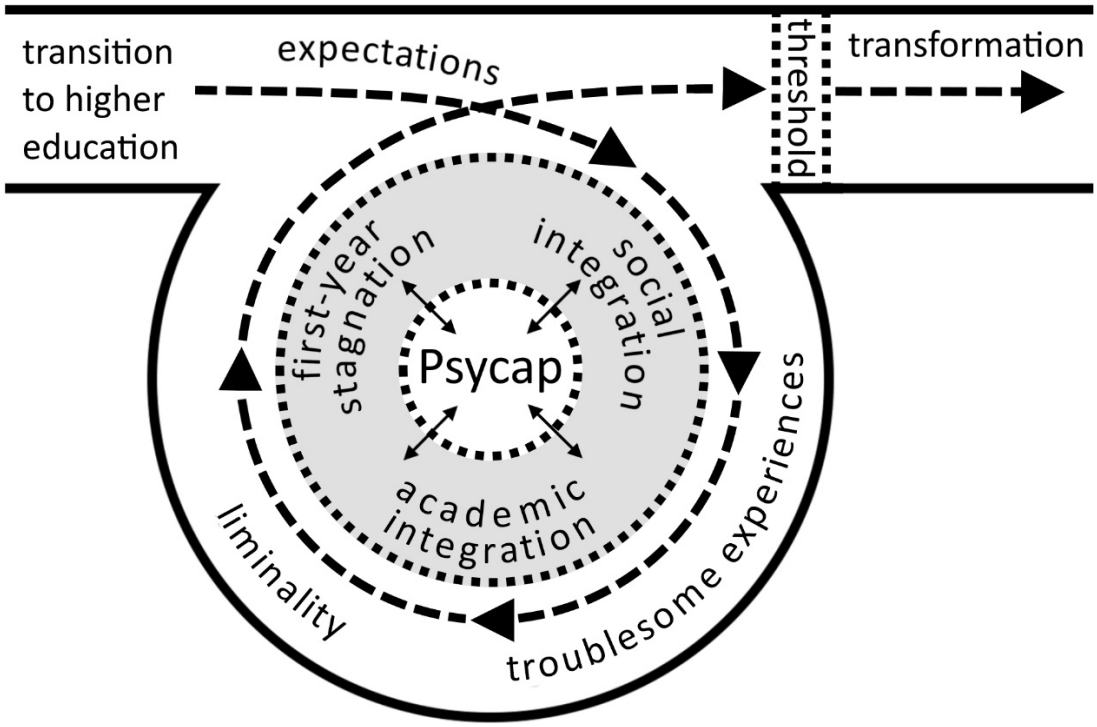


Figure 6.2 Interrelatedness of transition to higher education, psychological capital and threshold concepts

In figure 6.2 troublesome experiences, liminality and threshold are added. The findings in chapter 5 showed that the participants' troublesome experiences and their efforts to navigate liminality related to their social integration, academic integration and first-year stagnation. When the liminal space is navigated successfully the student crosses a threshold, leading to transformation. The PsyCap factors are no longer visible for readability of the model, but the two-sided arrows still indicate the two-way influence of the participants' experiences on PsyCap and its factors.

Figure 6.3 shows all the elements of my research combined into one model of transition to HE from a TC perspective to bring the different findings and their interrelatedness together as a whole by combining the concepts presented in figure 6.1 and 6.2. Although this research took place in a CS programme context, the model is also applicable in other study programme contexts.

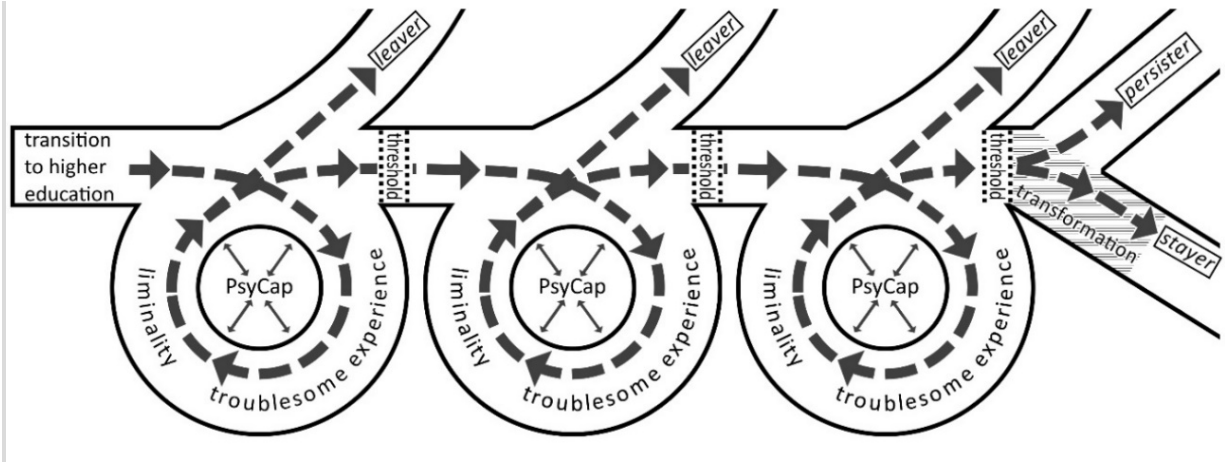


Figure 6.3 Model for transition to higher education from a threshold concepts perspective

Starting on the left is the transition to HE, that continues throughout the first year and which has many perspectives. As mentioned before, transition to higher education in my research focused on expectations, social and academic integration and first-year stagnation (Cole, 2017). Once the student transitions to HE and starts their academic year, they are bound to experience one or more *troublesome experiences,* related to social integration, academic integration and first-year stagnation. This is represented in the model by three circles. In reality the students will have encountered more than the three *troublesome experiences* throughout the academic year and they may well have experienced several different *troublesome experiences* simultaneously.

In experiencing the *troublesome experiences* and attempting to navigate liminality there are three possible outcomes for the student visible in each of the cycles in figure 6.3:

- liminality is navigated and the student passes the threshold

- the student decides to leave the programme because they cannot pass the threshold

- the student is not ready to pass the threshold, but also not ready to leave the study programme and stuckness results in going around the same cycle again

The students' PsyCap is influenced by the *troublesome experiences* and vice versa. A decline in hope that then affects self-efficacy and resilience, causing a decline in PsyCap, can result in a student leaving the study programme. Returned hope, for example when exams were unexpectedly passed, can fuel self-efficacy and resilience and result in an increase of PsyCap.

As the final cycle in figure 6.3 shows, a student either leaves during the academic year (*leaver*) or continues for the whole year (*persister* and *stayer*). The difference between a *persister* and a *stayer* is whether they have enough ECTS to progress to year 2. The *stayer* is considered to have made a full identity transformation, turning into an HE student that successfully passed year 1 and into a potential future computer scientist. The *persisters* have made a partial transformation. Some acquired a study approach they can apply in a new study programme or realised where they want to move professionally. This is represented in my model by the shaded transformation area that is smaller for the *persisters* than for the *stayers,* indicating a partial or full transformation. Not continuing in year 2 for the *leavers* and *persisters* does not make them unsuccessful. If a *leaver* or *persister* finds out this study programme does not fit their interests or ability, this can also be considered a

successful experience if it helps them in finding something that is right for them.

The overview of transition models presented by Cheng et al. (2015) in chapter 2 seems to relate only to students that continue and eventually graduate from the study programme they started, because all the models assume the student reaches the point of adjustment or transformation. In my research only a very small group of students reached this adjustment stage fully. The experiences of the participants that did not continue, *leavers* and *persisters*, are disregarded in the models discussed by Cheng et al. (2015). The model presented here (figure 6.3) offers a way of accounting for all possible student outcomes of *leavers*, *persisters* and *stayers.*

6.5 Summary and conclusions

This chapter looked at the findings of chapter 5 from a TC perspective to connect the different themes and elements of the research. *Troublesome experiences* and difficulties in navigating liminality and therefore crossing thresholds were a common thread in the participants' experiences and appeared to have a large influence on their PsyCap. The participants' experiences also led to transformational experiences of their identity, as an HE student and/or as a (future) computer scientist. The degree of transformation varied for *leavers*, *persisters* and *stayers*. The findings of chapter 5 and the TC perspective of chapter 6 resulted in the presentation of an explanatory model for transition to HE from a TC perspective that included *leavers*, *persisters* and *stayers*.

Chapter 7: Discussion

7.1 Introduction

Following chapter 5 with the presentation of the findings and chapter 6 with the TC perspective on the findings, this chapter discusses the findings in relation to the literature review to highlight important similarities or differences and to identify key findings. Following the order of chapter 5, PsyCap and the transition to HE is discussed first (7.2), followed by PsyCap and *troublesome experiences* (7.3), PsyCap and transformation (7.4) and the model for transition to HE from a TC perspective (7.5).

7.2 Psychological capital and transition to higher education

Transition to HE is one of the major stumbling blocks in relation to student retention (Cohen-Schotanus et al.; 2019, Cole, 2017) and therefore an area of interest for this research. According to Tinto (1993) students take pre-entry attributes such as prior schooling and skills with them when entering HE. In my research the focus on transition to HE led to three selection criteria for the participants: entry qualification, prior experience in HE, and programming experience, because it was expected that these three criteria could be of influence on the students transition to HE and retention. This research found that the selection criteria are not solely responsible for a participant leaving, persisting or staying. In general, the *persisters* and *stayers* more often had prior HE experience and programming experience than the *leavers*. This is similar to the positive effect of both prior study experience and programming experience identified in CS students by Barker et al. (2009) and Kori et al.

(2015), Kori et al. (2016). All new students in all study programmes in HE need to adapt to the new environment, but in CS programmes there is the additional challenge of getting used to computer programming, so students not only have to cope with the transition to HE, but also to the transition into the CS domain.

My research focused on three themes within transition to HE: expectations, social and academic integration and first-year stagnation (Cole, 2017). The majority of findings within these themes are not specifically CS related, but are experienced in a CS context. The participants had varying expectations, both about studying in HE and studying CS. Participants that visited open days and trial days or those that had some programming experience tended to have more realistic views of the CS programme and the effort learning to programme would require from them. Some of the expectations were based on how easy participants experienced their secondary education and for some, previous education gave them an unrealistic expectation of their capabilities, but also often a lack of study skills. The importance of realistic expectations in a CS programme was also identified by Kori et al. (2015), who noted that expectations is one of the variables in student retention that is difficult to influence.

The participants' expectations influenced their social and academic integration. In relation to social integration and expectations, almost all participants were pleasantly surprised by their fellow students. Most of them expected the other students to be the 'stereotypical nerd' and were surprised peers were much more like themselves. This is similar to research by Lewis et

al. (2016: 30) who also found new CS students had stereotypical thoughts on studying CS and that these stereotypes were not *"requirements of the field"*, but could influence whether a student chooses CS or not. In my research, the stereotypes were limited to participants' expectations regarding their peers and not so much in relation to the CS domain, but it could influence students' choice for a different study programme. This is a new contribution to research into CS programmes. In my research, being unexpectedly similar to peers helped participants to find like-minded people to collaborate or socialise with, albeit superficially, and this contributed to participants' sense of belonging. When peers left the programme, most participants found this regrettable, but did not feel it impacted them a great deal. This loose social connection between the participants and the CS programme and peers possibly contributed to participants not asking for help from peers, peer coaches or lecturers in time, thereby contributing negatively to retention. Although the low social integration appears not have impacted the participants' PsyCap and retention, efforts to improve social integration could lead to an improved sense of belonging and increased retention.

In my research, academic integration was one of the major hurdles for the participants; and its connection to expectations, first-year stagnation and *troublesome experiences*, makes it the largest negative influence on the participants' PsyCap and retention. The adjustment to HE, with more freedom, but also much more personal responsibility for learning, and the additional difficulty of acquiring CS knowledge and skills was not easy for the participants. Similar to findings by Lowe and Cook (2003), participants

persisted in their secondary education study habits and it took most of them a while to explore different study approaches and to overcome different academic and personal thresholds. The lack of study skills appeared to hinder the participants' ability to navigate liminality. Most of the participants' difficulties in academic integration were related to the programming curriculum. This combination of academic and personal experiences that influence student retention in CS aligns with Giannakos et al. (2017) and Kori et al. (2015). The emotions experienced whilst adjusting to HE, learning to programme, and passing or failing exams appeared to be very influential on the participants' PsyCap, especially when academic results caused a decline in hope to pass the year.

Period 3 appeared to be a crucial time for the *persisters'* and *stayers'* PsyCap. It appeared to be influenced by the participants' academic progress and motivation and at the same time their PsyCap appeared to influence their approach to their academic work. For the *leavers,* it remains unclear if they also had a shared crucial experience, because all but one of them left before the graph exercise took place. It appears that the exam results of periods 1 and 2, together with difficulties in academic integration on the courses had the largest influence on their PsyCap.

Academic integration and first-year stagnation (Cole, 2017) are closely related in this research, because my research focuses solely on experiences in the first year. In this research, first-year stagnation is not only caused by the programming curriculum, although most academic difficulties can be found in the programming or programming related courses. One other main

experience that participants indicated influenced their first-year stagnation was the fact that in this CS programme the majority of programming courses are taught in English. Dutch is the first language for most students and English their second language, and sometimes third or fourth language. An added problem is that for almost all of the non-Dutch speaking lecturers English is also not their first language. Soosai Raj et al. (2018) found no differences in grades between CS students taught in their native language or in English, but that students felt more at ease in their first language. In my research almost all programming courses are taught and examined in English, so there is no comparison possible for grades. The practical and emotional difficulties some participants experienced being taught in English and the apparent influence it had on retention, leaves the impression this had a larger impact on results than found by Soosai Raj et al. (2018).

The interplay between social and academic integration in the transition to HE is deemed important by Tinto (1993) and Briggs et al. (2012) in relation to student retention. My research shows that the social integration in the participants appears to be minimal. Although the participants appear not to have experienced this as negative, stimulation of social integration by the CS programme could possibly lead to, for example, students not trying to solve everything themselves, but asking for help in time rather than too late. This could successfully influence the participants' experiences with liminality. At the same time academic integration appears to be problematic on different levels and in different areas for almost all participants. Whether it is related to study strategies, programming, or being taught in English, it affected

participants' academic integration and PsyCap and prevented some of them from crossing thresholds.

CS programmes could benefit from paying more attention to the academic integration of their new students. This can be done by giving lessons on study skills, but also by offering small concrete programming exercises in the first weeks to build the students' programming self-efficacy. Passing the first exam period successfully, and conquering the first structural thresholds, could build students' PsyCap to confidently continue in period 2 with increased self-efficacy, hope and resilience. CS programmes should think about how they could improve the success rates in the first exams, for example by integrating formative assessments during the period, to give students a realistic view on their progress.

7.3 Psychological capital and troublesome experiences

Academic integration and first-year stagnation often lead to what I refer to as *troublesome experiences.* This concept combines the already existing separate concepts of troublesome knowledge, threshold skills and troublesome affect to better reflect the participants' troublesomeness. As explained in section 3.3, in learning to programme not only the knowledge can be troublesome but troublesomeness can also lie in the programming skills required, and learning to programme has a strong affective element. *Troublesome experiences* occur when participants are unable to cross a specific threshold, obstructing them from further development.

The affective dimension of *troublesome experiences* and the participants' efforts to navigate liminality was very influential in this research and the way it influenced the participants' PsyCap. If a threshold was conquered, the participants' *troublesome experiences* had a positive influence on PsyCap, but cases of stuckness had a negative influence. Participants that are more successful at navigating the liminal space seem to accept the *troublesome experiences* more as part of the learning process and part of a bigger picture, rather than an isolated problem to conquer or become stressed about, similar to findings by Rattray (2018).

Not only the transition to HE, but also studying CS is considered a highly emotive experience (Cole, 2017; Eckerdal et al., 2007). Looking at PsyCap and its factors, self-efficacy, optimism, hope and resilience, in a qualitative way provided the opportunity to follow participants' emotional development throughout the year and its influence on their retention. The interviews have shown that PsyCap and its individual factors change throughout the year, often varying from experience to experience. It influences and is influenced by the participants' *troublesome experiences*. This means that having a base level of PsyCap is needed and also expected at the beginning of the year to cope with first experiences after the transition to HE. This confirms the quantitative findings of You (2016) that showed a positive relationship between learning empowerment and engagement with PsyCap and vice versa, demonstrating the interplay between the two.

As Dawkins et al. (2013) recommended, the longitudinal approach of this research enabled me to gain insight into the development of the PsyCap

factors. The findings show that optimism is the most stable of the four factors. Most participants see optimism as a general mental state with a more long-term character. Rand (2018) also considers optimism a wider concept than hope, and states that optimism is less specific about the role of the individual on expectations of good outcomes. In my research, optimism appears to have the smallest influence of the four factors on student retention. The other three factors: self-efficacy, hope and resilience show a strong interplay, with hope being the driving force, fuelled by self-efficacy and resilience. As long as the participant has hope, self-efficacy and resilience are essential 'tools' to successfully pursue this hope. When hope decreases, this appeared to immediately negatively influence self-efficacy and resilience.

Although self-efficacy, hope and resilience have proven their value in various educational and PsyCap research, the identification of this interplay and the dynamics between them contributes to both retention and PsyCap research in the way that it brings these dynamics to light. Dawkins et al. (2013) critiqued the quantitative measurement of the PsyCap factors as not being able to identify their synergistic effect, but this qualitative approach has brought these dynamics to light.

7.4 Psychological capital and transformation

Whether a participant ended up as a *leaver*, *persister* or *stayer* depended on the number or the level of complexity of the *troublesome experiences*, level of stuckness in the liminal space and the number of uncrossed thresholds. This

led to no noticeable transformation in the *leavers*, partial transformation in the *persisters* and full transformation in the *stayers*.

The way *leavers*, *persisters* and *stayers* have developed or transformed themselves closely relates to the programming learner identities: the *bemused*, the *confused* and the *transformed* student (Flanagan and Smith, 2008) presented in section 3.2.1. The comparison between the different participant groups shows that whether a student leaves, persists or stays, is the result of the differences in what the participants do with their prior experiences in secondary education, HE, or programming in trying to adjust to their new CS environment, and how this influences or is influenced by their PsyCap.

The level of transformation experienced is closely related to how the participants reflected on their experiences within the different courses and with the exams and resits, and how this led to changes in their study approach or strategies. This is similar to the different models presented by Cheng et al. (2015), but especially to the development of learner identity (Briggs et al., 2012). At the beginning of the academic year, most participants with no previous HE experience relied on the study strategies they had used in their secondary education (Lowe and Cook, 2003). Failing the assignments or the exams led participants to make changes, but some of them, especially the *leavers*, had difficulties in converting their plans and intentions into actual changes. Although some changes were made after the first and second exam round, in general, this was still not sufficient and led to some participants increasing their adoption of study strategies. Meyer and Land (2005: 376)

point out that the process of transformation is not *"unidirectional"* and that it might *"involve oscillation between stages, often with temporary regression to an earlier status"*, similar to what was said about moving through the liminal space in 6.2 (Sanders and McCartney, 2016; Meyer and Land, 2005). Although some participants greatly improved their efforts, some of them saw little or no improvement coming from their changes. Schneider and Preckel (2017) already identified that learning strategies and motivation are important student related predictors of achievement, so actively improving this could benefit retention in HE institutions.

7.5 Model for transition to higher education from a threshold concepts perspective

The model for transition to HE from a TC perspective (figure 6.1) integrated different elements from my research. It is an addition to existing models for transition to HE (Cheng et al., 2015), because it not only looks at students that continue in the programme (*stayers*), but also identifies two different groups of students that either leave during the year (*leavers*) or stay the whole year, but do not continue (*persisters*). The presented model is a general modal for HE, not specifically aimed at CS programmes. It can be applied to a specific student group, for example *leavers,* or to a specific study programme. Identifying the specific *troublesome experiences*, actions to navigate liminality and difficulties to cross thresholds that lead to leaving, persisting or staying in a specific study programme could offer insights into the actual experiences hindering students' progress.

7.6 Summary and conclusions

This chapter discussed PsyCap in relation to participants' experiences with transition to HE, their *troublesome experiences*, especially in their academic integration and first-year stagnation, and their transformation. Their efforts to navigate liminality and to cross thresholds had a large affective dimension that affected their levels of PsyCap, at the same time their PsyCap influenced their efforts and experiences, transforming the participants into *leavers*, *persisters* or *stayers*. The interplay between self-efficacy, hope and resilience, with hope as its main driver, appeared to be essential in participants' retention. The interrelatedness of the different elements of this research was visualised in an integrated model for transition to HE from a TC perspective.

Chapter 8: Conclusions

8.1 Introduction

This concluding chapter starts with revisiting the research questions for this research (8.2, 8.3 and 8.4). This is followed by the contribution to knowledge this research provided (8.5). Then, considerations for CS programmes emerging from my research (8.6) and suggestions for future research (8.7) are discussed. The concluding comments (8.6) close this thesis.

8.2 Psychological capital and first-year computer science students' retention

The findings presented in chapter 5 enabled me to answer the following research question:

> *RQ1 How does psychological capital influence first-year computer science students' retention?*

This research has shown the participants' *troublesome experiences* have a strong affective element. These feelings and emotions appeared to influence the participants' PsyCap, at the same time PsyCap seemed to influence how participants responded to the *troublesome experiences*. Of the four PsyCap factors: self-efficacy, optimism, hope and resilience, it appears that there is a strong interplay between self-efficacy, hope and resilience. In this interplay, hope is the catalyst for positive action, which then fuels self-efficacy and resilience. Optimism is found to be a more stable PsyCap factor than the other three and appears little influenced by individual experiences. A strong

decline in participants' hope, often caused by the realisation that achieving the required 48 ECTS was no longer possible, caused the decline of self-efficacy and resilience and, in some participants, also of optimism. As long as there was hope, the participants would think of pathways to reach their goal, utilising their agency to apply their self-efficacy and resilience.

Starting the research, I assumed that self-efficacy and resilience would prove to be the most influential PsyCap factors in relation to CS students' retention. Although they both are certainly essential in the whole process, it is hope that turns out the be the driver of the students' efforts to complete the academic year or individual courses successfully.

8.3 Experiences influencing first-year computer science students' psychological capital and retention

The exploration of the participants' experiences presented in chapter 5 led me to answering the following research question:

> *RQ2 What experiences influence first-year computer science students psychological capital and retention?*

The participants' experiences are influenced by their transition to HE and specifically the transition to a CS programme. This was examined more closely by looking at the participants' expectations, social integration, academic integration, and first-year stagnation. Positive influences on retention were found in how closely the participants' expectations matched the real situation, especially in relation to expected difficulty of programming or

the study effort and strategies required. Also, having some programming or prior HE experience appeared to have a small positive influence on retention. Participants were positively surprised when their peers turned out to be similar to them, when most of them expected them to be ‘nerds’. This influenced their sense of belonging.

Social integration of the participants seemed fairly superficial. Contacts with peers were mostly project or assignment related and peers leaving did not appear to affect the participants emotionally. The superficial social integration possibly led to participants to waiting too long with asking for help from peers, peer coaches and lecturers. The lack of social integration in the participants could have been influenced by the fact that Dutch UAS are not campus based. This possibly influences the way Dutch UAS students socialise, compared to those in other countries.

Academic integration and first-year stagnation showed the largest negative influence on retention. Academic integration through finding motivation and enjoyment in programming appeared to be very important, but proved difficult to achieve for most participants. Conscious changes in study strategies, such as studying together, starting exam preparations earlier than in previous periods and asking lecturers and fellow students more questions, all appeared to have a positive influence on the participants’ emotional state, but it did not lead to more positive exam results for most participants.

Transformation appeared to occur on two levels: transformation into an HE student and transformation into a (future) computer scientist.

This will be further discussed in section 8.4.

8.4 A threshold concepts perspective on psychological capital and computer science students' experiences

In chapter 6 the findings of chapter 5 were placed in a TC perspective to answer the following research question:

> *RQ3 How do threshold concepts relate to the psychological capital and experiences of first-year computer science students?*

The continued *troublesome experiences* of the participants had a strong affective element. This was mainly experienced by the participants in programming courses and other elements of academic integration. Feelings of frustration, insecurity and anxiety tested and eroded the participants' PsyCap. Navigating liminality became more troublesome for the participants with lower or declining levels of self-efficacy, hope and resilience. Those that did manage to navigate liminality at least to a certain extent, achieved full or partial transformation.

Participants experienced a range of *troublesome experiences* and thresholds and had varied success in navigating liminality. The participants all identified the exams as major thresholds as failing them would eventually lead to not being allowed to continue. Learning how to programme was, for almost all participants, the most *troublesome experience* and despite most of them trying various strategies to navigate the liminality, few succeeded in doing so. For others, the *troublesome experiences* were found in collaboration in

projects, studying in English or in adjusting to studying in HE in general. Transformation was found in two ways: transformation into an HE student and transformation into a (future) computer scientist. Of the different participant groups, the *stayers* made these transformations fully, most *persisters* made a partial transformation, either towards becoming an HE student or a computer scientist or a bit of both. The *leavers* did not noticeably transform during their time on the study programme.

8.5 Contribution to knowledge

This research offers contributions to knowledge in three main areas: research design, transition to HE from a TC perspective, research design and insights.

Research Design

In the design for this research three contributions to knowledge can be identified. First, in this research the three research domains: student retention in HE, CS programmes and PsyCap are combined for the first time (figure 1.1). This makes it a contribution to knowledge on its own, as well as adding to the discourse in the three separate research domains.

Second, the application of a qualitative research approach. This not customary in research in two of the three research areas that are combined in this research: CS programmes and PsyCap. The qualitative approach adds a different perspective and a wider interpretation of the role of PsyCap on CS students' retention than is possible when taking a quantitative approach. Looking qualitatively at CS students' experiences offered rich insights,

especially in the emotional aspect of their first-year experiences throughout the academic year.

Finally, the application of the different graphic elicitation exercises that were a structural part of the longitudinal data collection process add to the discourse on how to collect rich data on lived experiences from some CS students that are not very communicative.

Transition to HE from a TC perspective

Researching the transition to HE from a TC perspective led to two contributions to knowledge. First, is the introduction of a new concept: *troublesome experiences*. This addition to TC combines troublesome knowledge, threshold skills and troublesome affect to explore the combined elements of troublesomeness that influenced the participants' experiences in this research.

Second, is the development of a new model for the transition to HE from a TC perspective, presented in section 6.3. The model was developed to demonstrate the interrelatedness of the different elements in this research. The contribution to knowledge of this model can be found in the integration of PsyCap and TC, but also in the way this model not only looks at the continuing students (stayers), but also acknowledges *leavers* and *persisters* in the transition to HE.

Insights

From the research findings there were two additional insights. The first relating to the dynamics between the PsyCap factors, by identifying the importance of hope in relation to retention and the interplay hope has with self-efficacy and resilience.

The second insight gained from interviewing CS students challenged the assumptions regarding the widespread stereotypical and negative expectations participants had of their peers that turned out to have a positive effect on their sense of belonging when their peers turned out to be just like them.

8.5.1 Limitations

Next to all the contributions of my research, I acknowledge that there are some limitations. The first limitation is the small group size of 16 participants that provided the data. Although the selected participant group is reasonably representative of the whole cohort, the findings still remain the experiences of a relatively small group. They can therefore be seen as indicative rather than generalisable. I have sought to mitigate this limitation by selecting participants based on three selection criteria to ensure a variation within the sample group while at the same time creating a reasonable representation of the whole cohort.

Second, the research was conducted in a UAS, a form of professional HE that is very specific to a small number of countries, such as the Netherlands,

Belgium, Germany, Austria and Finland. This makes a direct comparison or translating the findings into different HE settings difficult at first glance. By providing the contextual data and presenting this research as a case study I have tried to enable others to make comparisons.

Third, the fact that this research is insider research has both advantages, such as access to participants, and disadvantages. A main disadvantage is the value and robustness of insider research. Since most insider research in universities consists of case studies the criticism on case study research also applies here, such as that it only leads to practical knowledge and not theoretical knowledge (Flyvbjerg, 2006). This research aims to offer "practical adequacy" (Sayer, 2010: 69) and "exemplary knowledge" (Thomas, 2011: 31) to gain insight into the complex domain of CS students' retention.

To counter potential influences of myself as tutor I applied the criteria for establishing rigour in qualitative research developed by Lincoln and Guba (1985): truth value, consistency, applicability, and neutrality as described in section 4.6. According to Noble and Smith (2015) neutrality of qualitative research can be achieved when truth value, consistency and applicability have been addressed. Although they address qualitative research in general, it could also be applied to qualitative insider research.

8.6 Considerations for computer science study programmes

Beyond the academic world this research could have an impact in the way CS programmes adapt their programmes in relation to their students' affective needs.

The transition to HE is an important phase for all students, with the added difficulty of learning to programme in CS programmes. Most HE programmes seem to assume that students have study skills and know ‘how to study’, but this research has made apparent that many students have very little knowledge and experience with study skills and learning strategies and how they can adapt what they do have to what they need. More attention for this in the first semester in HE could have a positive effect on students’ retention.

This research showed that for CS programmes it is important to stimulate the development of self-efficacy, hope and resilience in students. This can be achieved, for example, by giving CS students small and concrete programming exercises and assignments in the first period or semester. Programming exercises exist from primary school level onwards, so by starting at a very easy level and adapting programming exercises to fit the individual students’ level of progress would allow the students to experience they can do this and hopefully spark the intrinsic motivation for programming, especially in students with no or little programming experience. Raising self-efficacy, hope and resilience in the first weeks of the transition to HE, especially in CS, could help students successfully make the transition towards academic integration. Furthermore, it may help to keep them going when the programming assignments become more challenging and more abstract, and eventually lead to the transformation of students into computer scientists. At the same time, it is important not to neglect the needs of students with programming experience, otherwise there is a risk they will lose motivation. Another option would be to stimulate and, where possible, make preparation

mandatory by doing specific programming exercises for students before the start of the academic year to ensure all students have the same minimum starting level in programming.

Since hope proved to be such an important factor within PsyCap, it is important for HE programmes to foster hope. The researched CS programme has many summative exams at the moment. Students' hope could be preserved longer by replacing the summative exams in the first semester with formative tests or formative assessments. This would give the student insight into their development and give late-bloomers an equal opportunity of passing year 1. Cole (2017) points out that these matters of organisational structure, such as a rigid exam structure, can hinder students in achieving academic integration.

8.7 Future research

The multifaceted nature of this research offers various possibilities for future research in relation to CS or STEM student retention. Additionally, it provides ideas for more PsyCap research in HE or further research into the application of graphic elicitation in longitudinal qualitative research.

First, conducting similar research in other CS programmes, either nationally or internationally, could offer deeper insight into the role of PsyCap in first-year CS students' retention. This can also be found by repeating the research in the same CS programme in one or more new CS cohorts to see if it leads to similar findings.

Second, similar research, but in another HE programme than CS, could give insight into the role of PsyCap in first-year students' retention in general. Preferably this would be in another STEM programme, because of the higher drop-out compared to non-STEM programmes (Gordon, 2016; Giannakos et al., 2017; OECD, 2008).

Third, combining a similar qualitative approach to this research could be conducted together with the quantitative PCQ (Luthans et al., 2007) measurement to compare if and how the two sets of data relate, thereby providing more support to the lived PsyCap experience and the dynamics between the different factors. Further research could also explore apparent trends of PsyCap over a longer period of time in a combined quantitative-qualitative approach.

And finally, exploring the application of graphic elicitation as interview stimulus for collecting richer interview data, either in a CS students' context or in other situations where this could be beneficial to the data collection.

8.8 Concluding comments

Although this research only scratches the surface of the myriad of variables that influence first-year CS students' retention, it also shines a new light on factors that were undervalued before, especially in a CS context. Acknowledging the affective side of students' experiences enables researchers and educators to gain a better understanding into why and where students struggle and how best to help them navigate this liminality. I am happy to see that this perspective is gaining interest in STEM programmes

and I am glad to have made a contribution in this direction. I hope my research forms the basis for more qualitative research or for more retention research in CS programmes and other STEM programmes.

Personally, I have also crossed a lot of thresholds and struggled my way through several *troublesome experiences* and liminal spaces to transform to the researcher I am today. Similar to the participants, my PsyCap was influenced by my experiences in carrying out the research and writing the thesis and these experiences in turn influenced my PsyCap, which was also an interplay between self-efficacy, hope and resilience. For me, this proves the value of PsyCap in understanding and hopefully stimulating student experiences and retention.

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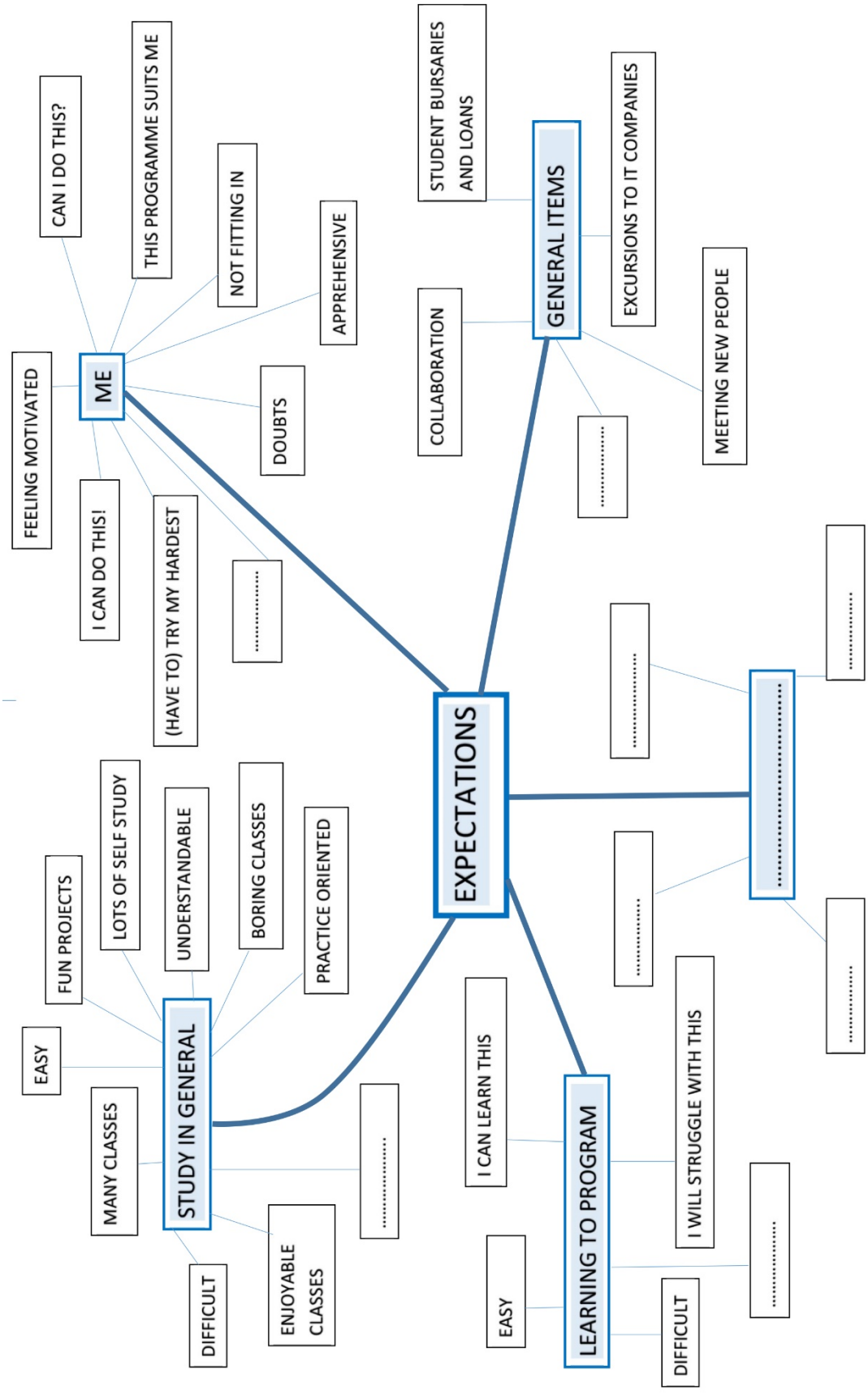
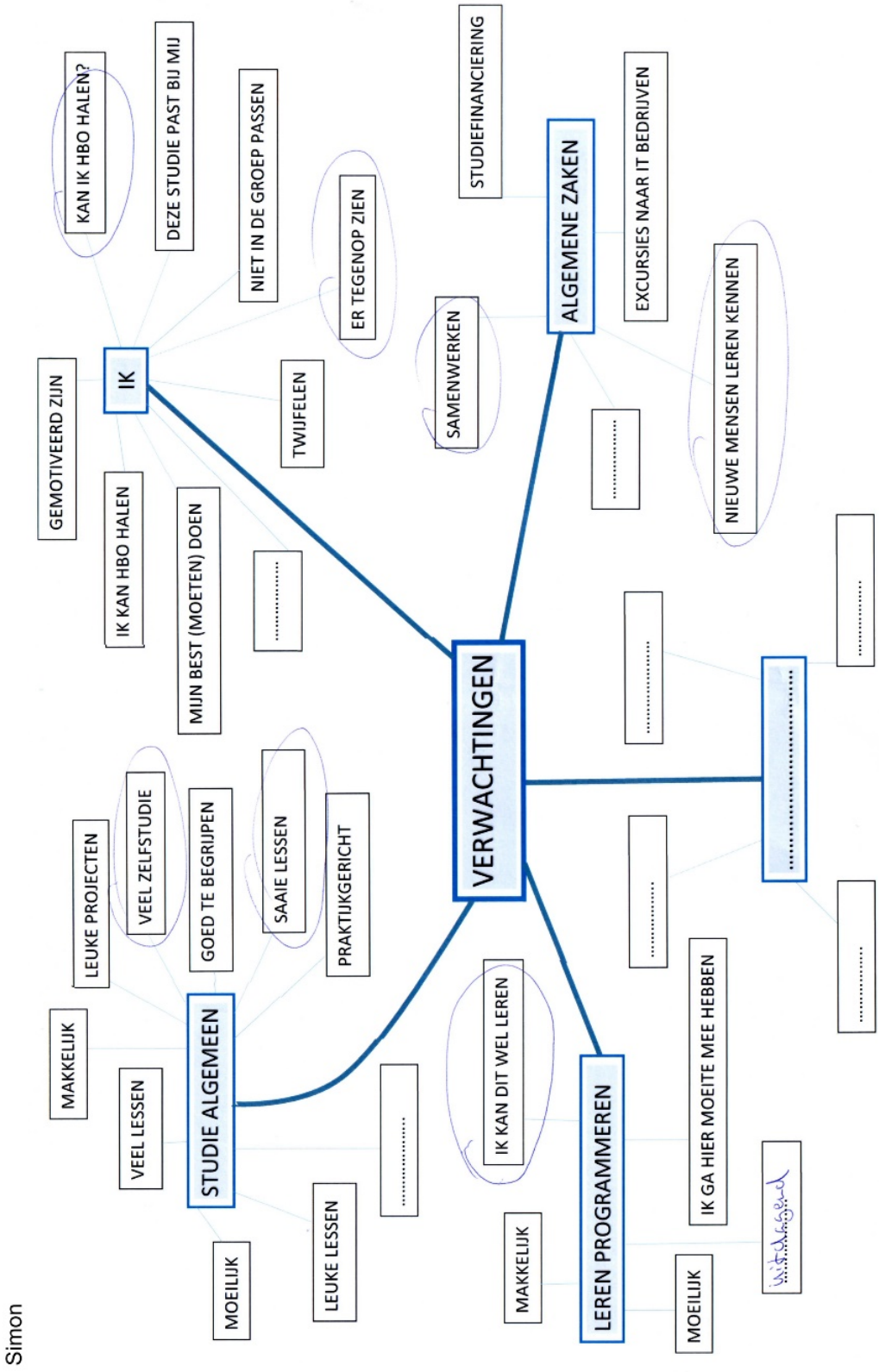
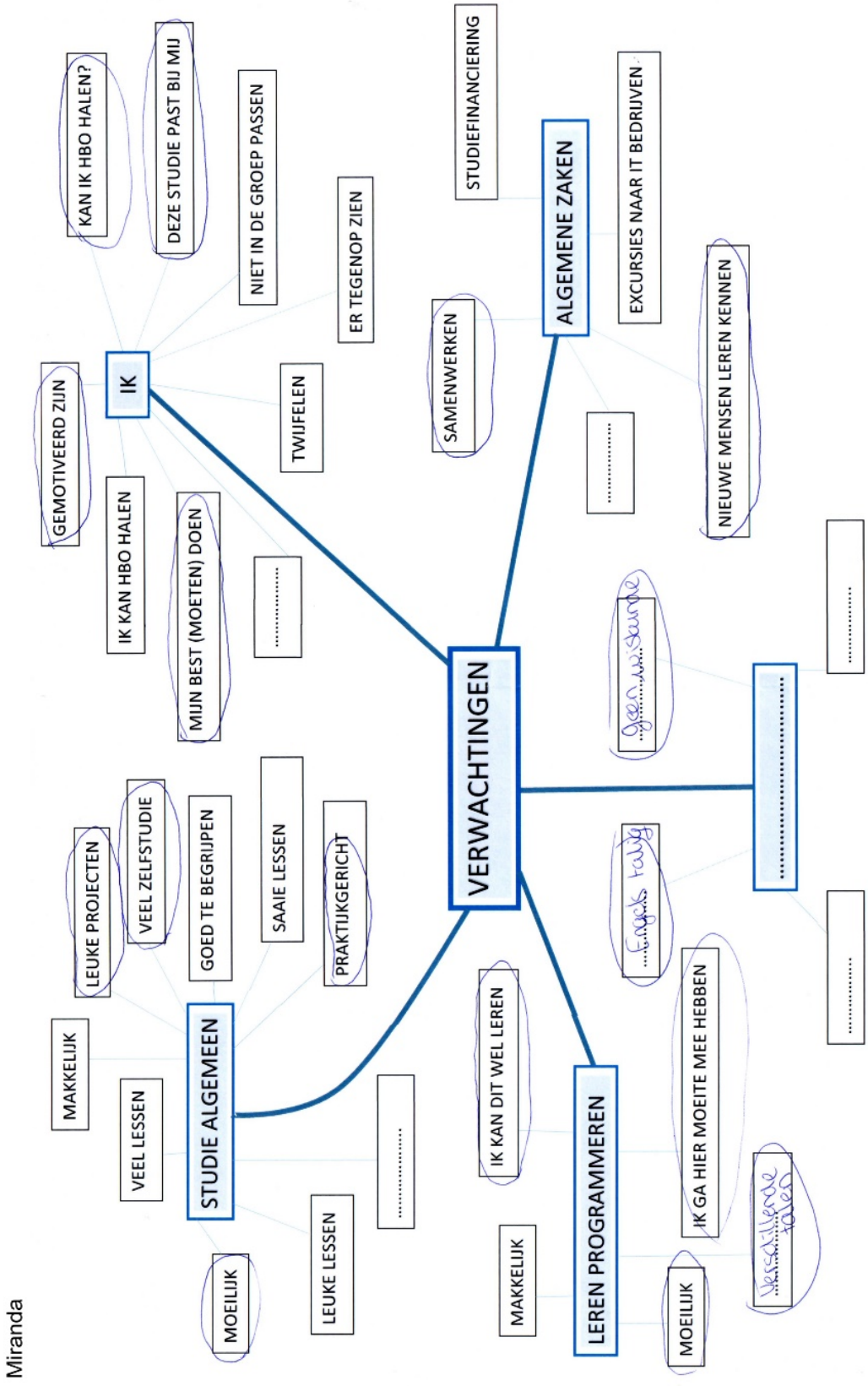
Appendix 1: Mind map exercise



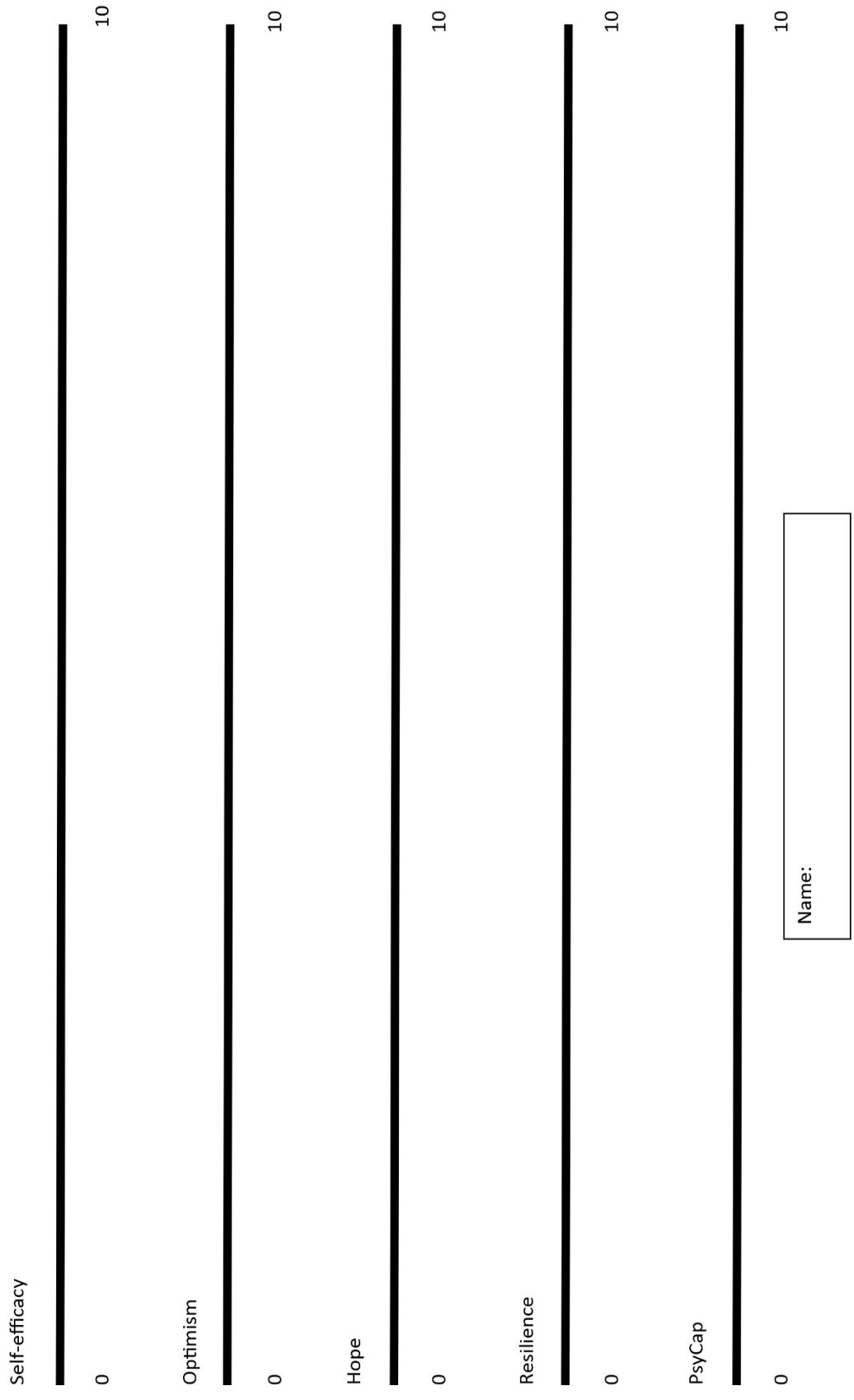
Appendix 2: Mind map exercise example 1



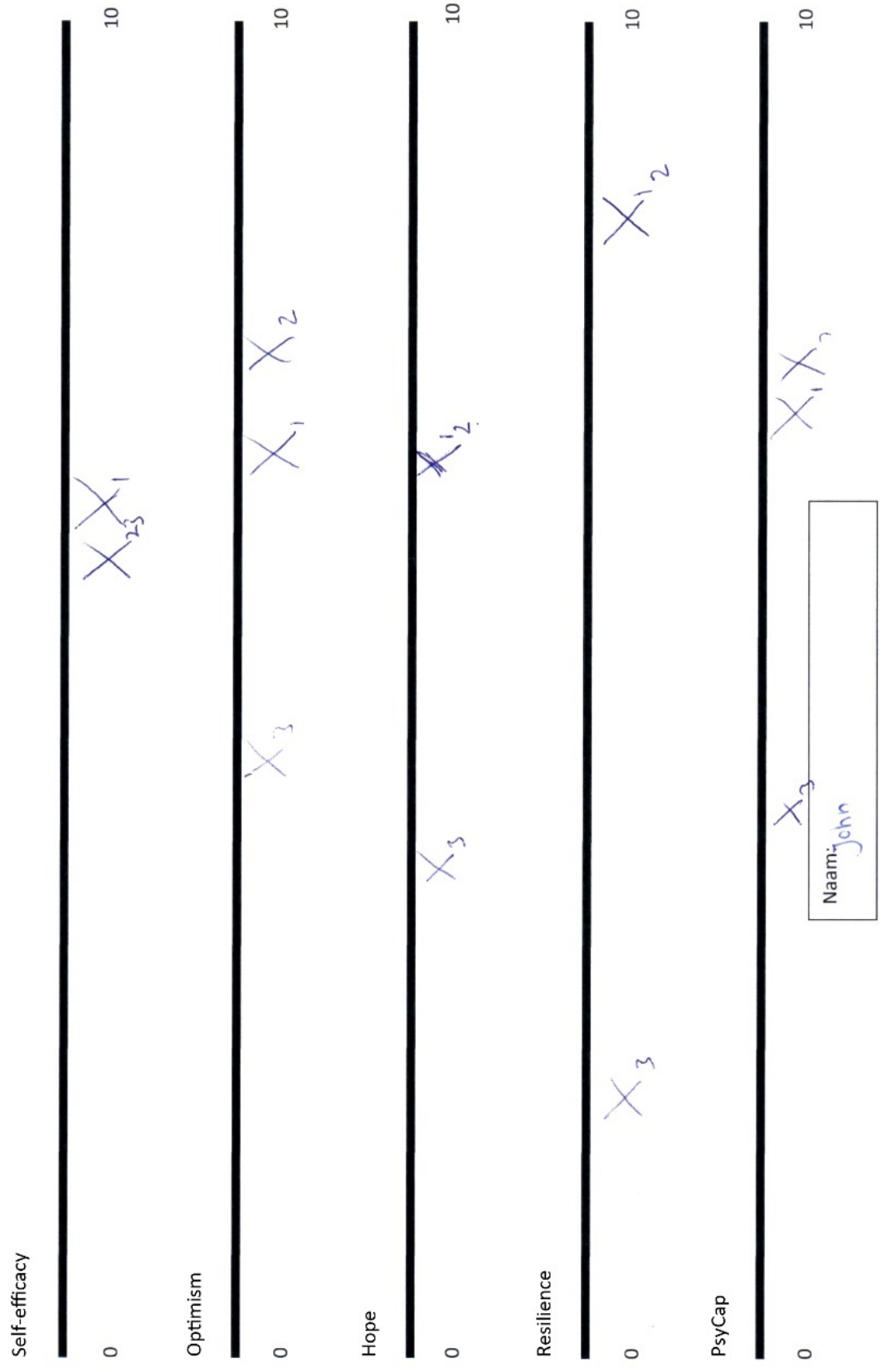
Appendix 3: Mind map exercise example 2



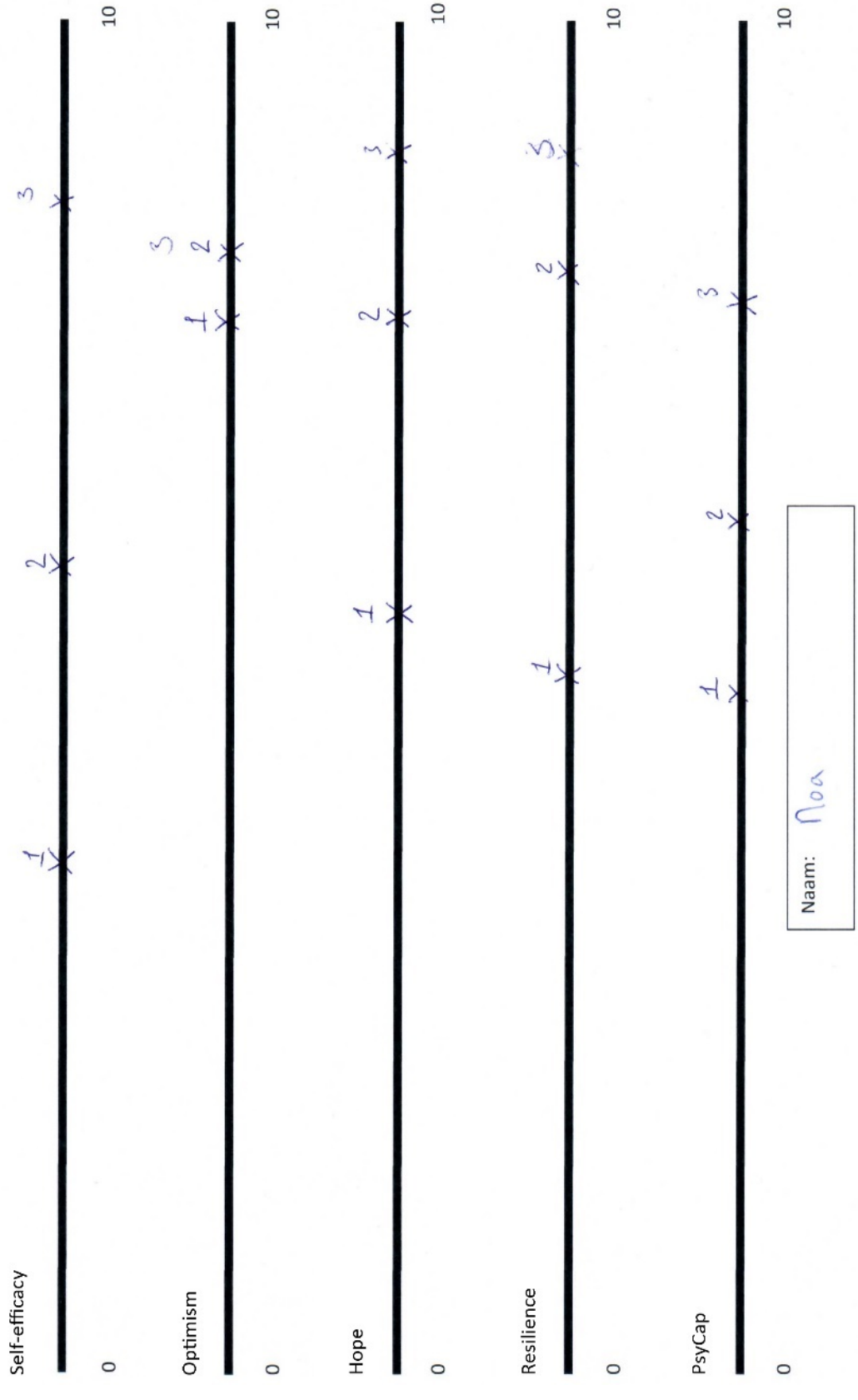
Appendix 4: Scale exercise



Appendix 5: Scale exercise example 1



Appendix 6: Scale exercise example 2



Appendix 7: Graph exercise