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Supervisors: Prof. Margus Pedaste, PhD
Institute of Education, University of Tartu, Estonia

Olev Must, PhD
Institute of Education, University of Tartu, Estonia

Opponent: Prof. Liz Thomas, PhD
Edge Hill University, United Kingdom

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LIST OF ABBREVIATIONS

AIC	Akaike Information Criteria
A-LMRT	An Adjusted Lo–Mendell–Rubin Likelihood Ratio Test
BIC	Bayesian Information Criteria
CFI	Comparative Fit Index
EFA	Exploratory Factor Analysis
GPA	Grade Point Average
ICT	Information and Communication Technology
IT	Information Technology
LPA	Latent Profile Analysis
RMSEA	Root Mean Square Error of Approximation
SCCT	Social Cognitive Career Theory
SEM	Structural Equation Modelling
SRMR	Standardized Root Mean Square Residual

LIST OF ORIGINAL PUBLICATIONS

The dissertation is based on the following original publications, which are referenced in the text by their Roman numbers:

I. **Kori, K.**, Pedaste, M., Niitsoo, M., Kuusik, R., Altin, H., Tõnisson, E., Vau, I., Leijen, Ä., Mäeots, M., Siiman, L., Murtazin, K., & Paluoja, R. (2015). Why Do Students Choose to Study Information and Communications Technology? In: *The European Procedia Social and Behavioral Sciences* (pp. 2867−2872). Elsevier.

II. **Kori, K.**, Altin, H., Pedaste, M., Palts, T., & Tõnisson, E. (2014). What Influences Students to Study Information and Communication Technology? In: L. Gómez Chova, A. López Martínez, I. Candel Torres (Ed.). *INTED2014 Proceedings* (pp. 1477−1486). IATED Academy.

III. **Kori, K.**, Pedaste, M., Altin, H., Tõnisson, E., & Palts, T. (2016). Factors That Influence Students' Motivation to Start and to Continue Studying Information Technology in Estonia. *IEEE Transactions on Education*, *59*(4), 225−262.

IV. **Kori, K.**, Pedaste, M., Tõnisson, E., Palts, T., Altin, H., Rantsus, R., Sell, R., Murtazin, K., & Rüütmann, T. (2015). First-year Dropout in ICT Studies. *EDUCON2015, IEEE Global Engineering Education Conference, 18–20 March 2015, Tallinn University of Technology, Tallinn, Estonia. IEEE*, pp. 444−452.

V. **Kori, K.**, Pedaste, M., & Must, O. (2017). Integration of Estonian Higher Education Information Technology Students and Its Effect on Graduation-Related Self-efficacy. In *International Conference on Learning and Collaboration Technologies* (pp. 435–448). Springer, Cham.

VI. **Kori, K.**, Pedaste, M., & Must, O. (*accepted*). The Academic, Social and Professional Integration Profiles of Information Technology Students. *ACM Transactions on Computing Education*.

Author contributions:

The current dissertation uses data collected in the project "Conceptual framework for increasing society's commitment in ICT: approaches in general and higher education for motivating ICT-related career choices and improving competences for applying and developing ICT". Therefore, articles I–IV in the current dissertation have been written with a wider project team.

The role of the author in articles I–IV has been participation in designing the studies, formulating research questions, planning and carrying out data collection; however, the main role was analysing the data and writing the articles.

When the project ended in 2015, the author continued searching for a model for investigating the retention of IT students, which was not the aim of the previous project. Therefore, articles V–VI have fewer authors. In articles V–VI the author's main role was formulating research questions, looking for theoretical bases, analysing the data and writing the articles.

1. INTRODUCTION

1.1. Research problem

As the role of Information Technology (IT) is growing in society, more IT specialists are needed in the labour market. The forecasts suggest, however, that the labour market needs will not be met in the European Union and that 913,000–1,300,000 IT workers could be missing by the year 2020 (Gareis et al., 2014). Also, it is important to have a larger number of IT workers with a degree – that is, IT graduates – in the labour market to fill in the jobs.

In Estonia, IT can be studied in seven higher education institutions (Järve et al., 2015), and every year, student candidates have to compete for the available study places. As to why young people choose IT careers, studies have shown that IT sophistication (Akbulut & Looney, 2009) and participating in computing activities at school (McGill, Decker & Settle, 2016) are the prior academic learning experience that pushes students towards choosing a career in IT. Beside the academic experiences, it has been found that stronger social support and higher self-efficacy result in choosing IT related careers (Rosson, Carroll & Sinha, 2011); the choice is also influenced by employment opportunities (Divjak, Ostroski & Palma, 2010). So, there is a variety of aspects that may have an effect on students' decision to study IT at the higher education level.

Despite the keen interest in studying IT at the higher education level, the number of IT graduates in the European Union has been decreasing since 2006 (Gareis et al., 2014), causing a shortage of IT workers in the labour market. Therefore, it needs to be investigated how to retain the existing IT students and get more IT workers to the labour market.

The average dropout rate in the IT field is 19% in the European Union (Hüsing et al., 2013), but a study about 15 European countries (including Estonia) shows that the number of IT students who actually graduate each year makes less than half of the number of IT students who enrol in the same calendar year (Pereira, 2016). The dropout rates in Estonia are much higher than the European Union average. The statistics in HaridusSILM database (2017) show that in Estonia, the annual number of IT students who drop out is much higher than the annual number of students who graduate. Figure 1 concludes the entrance, dropout (total of the first, second and third study year) and graduation rates from 2006 to 2016 in 3-year Bachelor and applied higher education studies. The first year of studies has a big impact on students' decision to either continue the studies or drop out (Tinto, 2006). In Estonia, 29.8% of IT students drop out during the first year – a figure significantly higher than in other fields, where the first-year dropout rate is around 18% (calculations based on EHIS, 2015). Therefore, the scope of this dissertation is first-year higher education IT studies. Dropout is a gradual process (Finn, 1989), which means that certain small changes (e.g., skipping lectures) start to occur long before the actual dropout. This suggests that during the first year, it is still possible to influence students to choose to continue their studies.

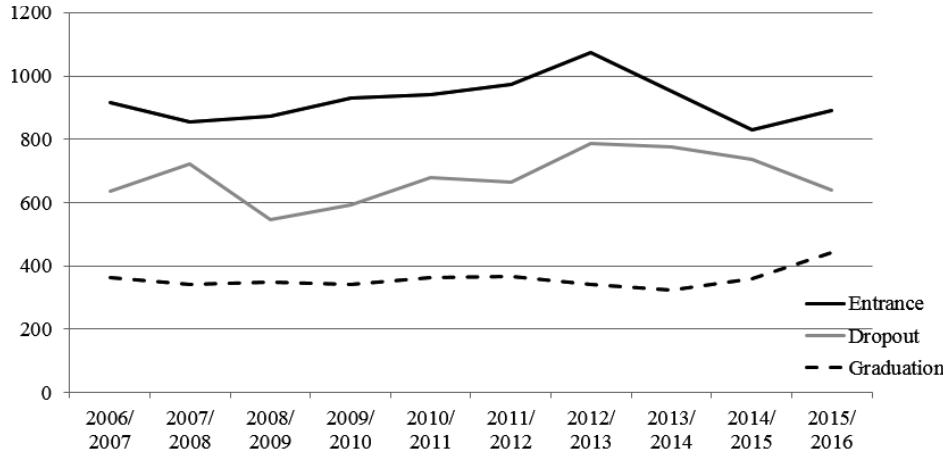

Figure 1. Entrance, graduation and dropout rates registered in Estonia on academic years 2006/2007–2015/2016 in Bachelor and applied higher education studies in the IT field (based on HaridusSILM, 2017)

The current dissertation is related to the project "Conceptual framework for increasing society's commitment in ICT: approaches in general and higher education for motivating ICT-related career choices and improving competences for applying and developing ICT", which was supported by the European Regional Development Fund through the programme for supporting research and development in information and communication technology (for more information see http://ict.ut.ee). The project involved the Institute of Education, Institute of Computer Science and Institute of Technology of the University of Tartu; Tallinn University of Technology; and the Estonian Information Technology College – these higher education institutions are responsible for teaching most of the information technology students in Estonia at the higher education level. In addition, the Estonian Association of Information Technology and Telecommunications was involved as a representative of enterprises, and foreign partners from Germany, the Netherlands, Greece, and Finland advised the project. The main aim of the research project was to produce recommendations that should be applied in general schools and higher education institutions to positively influence students' ICT-related attitudes, knowledge, and skills. The project started in April 2013 and ended in August 2015. During that period data was collected through questionnaires from IT student candidates and IT students at three higher education institutions in Estonia. The instuments used for the data collection were developed in the project, and the current dissertation uses the data collected in the project. The project involved practitioners who taught IT students in higher education institutions; therefore, the data collection and instruments were more data-driven and based on practical experiences rather than derived from theoretical models for describing retention and dropout. As a main result of the project, a report was written that concludes

recommendations to pupils, higher education students, parents, general education schools, higher education institutions, IT companies, and policy makers (see What happens to IT education in Estonia?, 2015). The project was mostly descriptive, and the topic was therefore further investigated in the current doctoral study. The role of the author of this dissertation was searching for a theoretical background for the collected data. Therefore, the dissertation starts with investigating bivariate relations between different factors that have an effect on entry into higher education IT studies and on the retention of IT students, and searching for the model that can be used for investigating the retention of IT students. When the theoretical background was found, the role of the author was modelling the project data based on the theoretical background.

After the project ended, the research focused mainly on student retention, which is a widely researched topic. However, different terms are used for investigating retention at the higher education level, such as *attrition*, *dismissal*, *dropout*, *mortality*, *persistence*, *stopout*, and *withdrawal*. In the current dissertation, the term *retention* is used; according to Berger and Lyon (2005), retention "refers to the ability of an institution to retain a student from admission to the university through graduation" (p. 7). *Dropout* is used in this dissertation as the opposite of retention. Dropout also "refers to a student whose initial educational goal was to complete at least a bachelor's degree but who did not complete it" (Berger & Lyon, 2005, p. 7). The problem of low retention or graduation rates in the IT field is a very practical one, but a scientific approach is needed to alleviate the practical problem. Scientific knowledge about what has an effect on retention can help universities to increase retention rates in their IT curricula. Therefore, factors that are important in the retention of IT students are investigated in the current dissertation.

Many bivariate relations between factors that have an effect on retention or dropout can be found in the literature. Some studies suggest that motivation is a significant factor in retention, as it activates and directs learning (Kleinginna & Kleinginna, 1981). There are different types of motivation (e.g., intrinsic, extrinsic or amotivation (Deci & Ryan, 1985; Ryan & Deci, 2000)), and the motivation types are shown to be associated with academic achievement (Gottfried, 2009) and dropout (Abar, Abar, Lippold, Powers and Manning, 2012). Therefore, IT students' motivation is one factor that is investigated in the current dissertation. In addition, self-efficacy has been found to be important in student retention, as it is related to academic performance (e.g., Alivernini & Lucidi, 2011; Caraway et al., 2003), which is an important factor predicting retention (Araque, Roldan & Salaguero, 2009; Belloc, Maruotti & Petrella, 2011; Stratton, O'Toole & Wetzel, 2008). Graduation-related self-efficacy can be defined as a student's perception about their ability to graduate their studies. As the current dissertation focuses on the first year of higher education IT studies, data about graduation rates are not yet available and retention of first-year students is investigated through graduation-related self-efficacy.

When investigating bivariate relations in retention, Larsen et al. (2013) conducted a systematic literature review that gave an overview of a big variety

of different factors (11 categories) that influence the dropout or retention of students. However, a less complex model of retention may give a more systematic overview of what to focus on while investigating retention in higher education IT studies. Many models have been created to explain retention. According to Tinto (1986), theories about retention can be economic, psychological, organizational or sociological. The sociological theory includes one of the most well-known comprehensive dropout models, also created by Vincent Tinto (1975, 1993). According to the integration model, students' individual characteristics such as family background, individual attributes and pre-college schooling influence students' initial commitment to the university. Commitment has an effect on students' integration into the academic and social system. The academic system includes academic performance at the university (formal activity) and interactions with the faculty and staff (informal activity). The social system includes formal extracurricular activities and informal interactions in the peer group. Academic and social systems have an effect on academic and social integration, which influence, again, students' commitment to the university, which is important in deciding whether to drop out or not. So, Tinto's model shows that the more students are academically and socially integrated into the university, the higher the probability that the students are retained. However, Tinto's model (1975, 1993) is somewhat out of date. The current university environment is different, because students often do not live on the university campus and many students are working during their studies. For example, in Estonia, 61% of all higher education students are working (Beerkens, Mägi, Lill, 2011). Therefore, the model in its existing form does not seem to suit the current IT studies and may need further development.

The original retention model by Tinto (1975) has been validated by many studies (e.g., Cabrera, Castenada, Nora, & Hengstler, 1992; Pascarella & Terenzini, 1980). Some newer studies have also shown that both academic and social integration are important in student retention, e.g., in community college (Karp, Hughesm & O'Gara, 2010), but some studies suggest that academic integration and social integration may not have an equal role in retention. For example, Daividson & Wilson (2013) suggest that the role of social integration on university campus has decreased owing to the small number of residential students, whereas Troelsen & Laursen (2014) argue that national culture greatly influences retention and in Denmark, social integration is less important in retention than academic integration. Tinto's model has also been criticized for not being suitable for minority and non-traditional students (Hurtado & Carter, 1997). A more suitable model for non-traditional students was created by John P. Bean (1980, 1983). The model includes external factors such as the opportunity to transfer, family commitments, and the financial situation, which are more important for non-traditional students (Burrus et al., 2013). However, the external factors are not controllable by the university, and Tinto's model seems to be more suitable for research focusing on what universities can do to increase retention rates.

A few studies have been conducted about retention that focus on the IT field, but these are rather rare. Indeed, dropout reasons in IT may differ from those in other fields, as the IT field itself is relatively new and developing rapidly. IT workers thus have to keep up with work that is changing all the time. Dropout rates are also higher in the IT field than in other fields (calculations based on EHIS, 2015), which suggests that dropout reasons in the IT field may differ from those in other fields. Because of the lack of IT workers in the labour market, IT companies often hire students, who then need to divide their time between work and studies. This suggests that besides academic and social integration that come from Tinto's model (1975, 1993), professional integration might be important in the retention of IT students. The What Works? model also detects three spheres of engagement in student retention and success: academic, social and professional (Thomas, 2012). The three spheres are overlapping, the academic sphere being the most important. According to Thomas (2012), professional services include a variety of services that institutions provide to support their students, e. g., library and learning centres, pre-entry information, advice and guidance, financial advice, counsellors, careers information and guidance, chaplains, disability services, writing skills and math centres. These contribute to developing students' capacities at the higher education level and beyond. In addition, a study of 12 European countries has shown that those students who have more work experience find professional employment faster after graduation than those who graduate at a young age without any work experience (Kivinen & Nurmi, 2014). Therefore, the role of professional integration in the retention of IT students is also investigated in the current dissertation.

Some studies suggest that lack of time is one of the main reasons why IT students fail to graduate (Benda, Bruckman & Guzdial, 2012; Kinnunen & Malmi, 2006). Lack of time may be caused by students' professional integration and working during studies. Research in Estonian IT studies shows working during studies to be one of the main dropout reasons (Altin & Rantsus, 2015; Järve, Kallas & Räis, 2015). Students who work do not have enough time to commit to their studies, which may result in dropping out (Polidano & Zakirova, 2011; Taylor, Lekes, Gagnon, Kwan & Koestner, 2012). Besides working and time management related issues, some studies have found academic reasons to play a part in the retention of IT students. The introductory courses, such as introductory computer science (Benda, Bruckham & Guzdial, 2012; Zingaro, 2015), programming (Watson & Li, 2014) and mathematics (Divjak, Ostroski & Hains, 2010), have proven difficult for students, and therefore, dropout rates are high in these courses. About one third of IT students do not pass the introductory courses (Bennedsen & Caspersen, 2007). In addition, social factors (e.g., interactions with peers) have been shown to have an important effect on retention in IT studies (e.g., Barker, McDowell & Kalahar, 2009; McCartney et al., 2016). So, literature suggests that in the IT field, academic, social and professional integration might all be important in student retention.

Despite the research done in developing theories about retention, retention rates have not increased; thus, it is important to investigate what universities can do in practice to increase their retention rates (Tinto, 2005). Some studies have applied interventions to increase retention rates in IT studies, such as organizing social events for students before the courses start (Talton et al., 2006), increasing academic and social integration through mentoring programmes (Borzovs, Niedrite & Solodovnikova, 2016) and offering additional courses for students who have less prior knowledge of the field (Borzovs, Niedrite & Solodovnikova, 2016). The researchers have mostly focused on interventions that are the same for all the students and there is less focus on different student groups. However, dropout reasons are very individual (Kinnunen & Malmi, 2006) and one support system may not be suitable for all students. Simpson (2013) defines student support as different activities from organizing student support (e.g., staff development) to direct interactions with students (e.g., mentoring). In IT studies, this support can be a type of intervention that increases the retention rates of students who have potential to work in the IT field. Larsen et al. (2013) found six types of interventions that universities have applied for supporting the students: 1) introductory courses, 2) didactic interventions at course level, 3) interventions at institutional level that enhance academic or social integration, 4) improving the selection process at admission, 5) personal conversations with students, and 6) counselling and possible reorientation when the student has made a wrong choice of study. The current dissertation takes a more personal approach to describing IT students' characteristics based on Tinto's model that has been developed further and divides students into groups based on similar profiles. Based on the profiles, it is possible to develop interventions for increasing integration and retention rates of students with similar characteristics. Therefore, the dissertation provides suggestions as to which interventions could be further investigated and applied to higher education IT studies to see an effect on the integration and retention of students.

1.2. Focus of the research

The research is divided into two phases. The first phase is Exploration, which is partly related to the project "Conceptual framework for increasing society's commitment in ICT: approaches in general and higher education for motivating ICT-related career choices and improving competences for applying and developing ICT". The aims of the Exploration phase are as follows:

- to create a system of factors that influence students' enrolment in higher education IT studies and the retention of IT students; and
- to find a model that can be used for investigating retention in IT studies.

The following research questions are posed for the Exploration phase:

1) Which factors have an effect on students' entry into higher education IT studies and on the retention of IT students?
2) Which model can be used for investigating retention in IT studies?

The second phase of the research is Modelling. Based on the Exploration phase, Tinto's model (1975, 1993) was chosen as the basis of the Modelling phase, and students' academic and social integration was investigated. However, lately, the role of professional development of students has gotten more attention in research (e.g., Thomas, 2012; Thomas, Hill, O'Mahony & Yorke, 2017) and the lack of IT workers in the labour market offers students opportunities to work during their studies. Therefore, professional integration was investigated in the Modelling phase as well. The aims and research questions were specified after the Exploration phase; the aims of the Modelling phase are the following:

- to explain the role of academic, social and professional integration in predicting retention in higher education IT studies; and
- to distinguish IT student profiles based on academic, social and professional integration.

As self-efficacy has been found to be related to the actual outcomes and the data about actual graduation rates was not available for all the students who participated in the studies, retention of the IT students is investigated through graduation-related self-efficacy in the Modelling phase. The following research questions are posed for the Modelling phase:

3) How can first-year IT students' graduation-related self-efficacy be predicted by academic, social and professional integration factors?
4) Which first-year IT student profiles can be distinguished based on academic, social and professional integration factors?

The research questions are addressed in the following original publications:

Articles I, II and III explore research question 1. In Articles I and II, reasons for entering IT curricula are described. In Article III, factors that influence students to enter higher education to study IT and to continue their studies are investigated.

Article IVcontributes to answering research question 2. In Article IV, an appropriate model for investigating retention in the IT field is sought.

Article V contributes to answering research questions 2 and 3. In Article V models are created to predict IT students' graduation-related self-efficacy.

Article VI addresses research question 4 and describes IT student profiles based on academic, social and professional integration.

2. THEORETICAL BACKGROUND

The following chapters provide the theoretical outline of the dissertation. Firstly, an overview is given of what influences career choices in general and more specifically in the IT field. This is followed by an overview of retention studies and retention models, the role of motivation and self-efficacy in retention, and IT specific retention studies. The last section of the theoretical part shows what has been done in universities to increase retention rates.

2.1. Entering higher education

Students may choose to enter higher education studies for many reasons. The Social Cognitive Career Theory (SCCT) (Lent, Brown & Hackett, 1994) explains career choices by intrinsic and extrinsic factors. The SCCT comes from Bandura's (1986) Social Cognitive Theory, which views psychosocial phenomena as determined by environmental, personal, and behavioral factors. One important factor that influences choice of behavior is self-efficacy (Bandura, 1986). Self-efficacy refers to people's belief about their ability to perform successfully in a certain activity or task (Bandura, 1994). This suggests that if students have higher self-efficacy for a certain career, they are more likely to choose this career for their higher education studies.

The SCCT suggests that students' career choices are influenced by their learning experiences, outcome expectations, career self-efficacy, and career interest (Lent, Brown & Hackett, 1994; Tang, Pan & Newmeyer, 2008). Learning experiences influence career choice indirectly through self-efficacy or through outcome expectations, whereas the last two influence career choice directly or through career interest. The SCCT has been applied by many authors for investigating career choices, and the results have supported the theory (e.g., Dickinson, Abrams & Tokar, 2016; Dutta et al., 2015; Inda-Caro & Rodriguez-Menéndez, 2016).

The SCCT has been used to investigate career choice in the IT field, e.g., in the information systems curriculum. Akbulut and Looney (2009) showed that in addition to self-efficacy, outcome expectations and interest, IT sophistication was a learning experience that could influence students' choice to study information systems. This means that the degree to which students perceive IT to be sophisticated affects their decision to study information systems. However, it was found that IT sophistication did not directly influence student interest. The influence emerges through self-efficacy and outcome expectations (Akbulut & Looney, 2009). Based on their results, Akbulut and Looney (2009) suggested that students could be attracted to the field if sophisticated IT was developed in introductory information systems classes. So, IT related classes at the general education level are important in influencing career choices in IT. This shows that academic integration has an effect on career choices, as students who have learned IT before may want to continue the studies at the higher education level.

The importance of prior experience has also been shown by McGill, Decker and Settle (2016), who investigated if participating in computing activities in school has an effect on students' career choice. They found that 20% of male and 24% of female students who participated in computing activities chose a computing related major. Especially male students reported the computing activity to have influenced their career choice. This suggests that prior academic experiences with IT have an effect on young people's IT related career choices.

Rosson, Carroll and Sinha (2011) investigated the role of social-cognitive factors (self-efficacy and social support) on students' career orientation. They found that strong social support and high self-efficacy are associated with strong orientation toward careers in computer and information science careers. However, they detected some gender differences. In the case of male students, low self-efficacy was related to less social support; that did not apply to female students, however. Many female students who reported having low self-efficacy considered themselves to have high social support among their peers. It can be concluded from the study that in addition to self-efficacy, social integration has an effect on IT related career choices.

Some studies have used the exploratory approach in investigating IT related career choices. For example, Divjak, Ostroski and Palma (2010) found four factors influencing motivation for choosing IT studies: 1) employment opportunities – opportunities for advancement, a good income and additional jobs; 2) social factors – influence by someone known personally, e.g., relatives, parents or friends; 3) curriculum attractiveness – students enjoyed the study programme or liked learning in it; and 4) other reasons – uncertainty as to what to study or a lack of success in their first choice. The *employment opportunities* factor shows that students think about their future professional integration when choosing the curriculum. In addition, the factor termed *social factors* again shows social integration to be important in career choice. Similar results were produced by the studies that used the SCCT (Akbulut & Looney, 2009; Rosson, Carroll & Sinha, 2011). In conclusion, academic integration, social integration and professional integration have been found to have an effect on choosing an IT related career.

2.2. Retention

The current dissertation focuses on retention, with the term *dropout* being used as an opposite to retention. Students may drop out of one curriculum or university and continue the studies in another curriculum or university, therefore, retention is difficult to measure. Hagedorn (2005) described 12 different enrolment paths that students might follow in the university. These included, for example, stopping out and coming back a few years later, transferring to another university, dropping out of courses, getting suspended for lack of academic progress, and so on. These different enrolment paths make it difficult to define which student is a dropout and which is not. In addition, Larsen et al. (2013) distinguish five institutional levels at which university dropout can occur:

change in course of study within the same faculty at the same university; change in department within the same faculty at the same university; change in faculty within the same university; change at university level; and dropout at university system level. Different types of dropout can also be categorized chronologically: non-starters, informal dropouts, formal dropouts, academic failures, non-continuers, and students who transfer to another curriculum (Kember, 1995). Therefore, there are many different ways to look at dropout and retention, but in the current study, dropouts are defined as students who leave the IT curriculum that they started and it is not known if they continue their IT studies later or change curricula.

Although many students drop out of their studies, dropout does not always have to be seen as a negative event. When students achieve the goal they had in college and then drop out, then neither the students nor the university failed (Bean, 1990). In addition, the studies are not a negative experience for dropouts if they can transfer the collected credit points to another related subject of study or use the acquired skills in the labour market (Larsen et al., 2013). From a university's point of view, dropout is not a negative event if the students were not able to maintain their position in the academic field of the university (Larsen et al., 2013). This suggests that it should be acceptable that some students drop out of higher education studies, but it becomes a probem when the retention rates are too low to meet the labour market needs.

Researchers have used different approaches to investigate retention. Larsen et al. (2013) explain the economic, psychological, organizational and sociological approaches as follows. According to the economically grounded theory, dropout is a rational decision based on the relationship between students' estimated investment in education and estimated return on education. The psychologically grounded theory focuses on factors like study behaviour, perception of and attitude towards studying. This means that the university can reduce dropout by creating a constructive alignment between learning outcomes, learning activities and assessment criteria. The organizationally grounded theory explains retention by focusing on participation, communication and membership in academic communities within the university. The sociologically grounded theory considers social and institutional structures as the most important in explaining retention. In addition to these approaches, Bean (2005) described four perspectives from which researchers investigate retention. Studies conducted from the theoretical perspective investigate theories about factors that affect students' decision to either remain in college or leave. Studies from the policy perspective investigate, at the government level, access to college and how funding affects retention, and at the institutional policy level how academic programmes and activities affect retention. Studies from the institutional research perspective focus on a single institution and the effectiveness of retention programmes and dropout reasons in the given institution. Studies from the individual perspective investigate background characteristics, institutional experiences, student behaviour, and attitudes in retention. Thus, there are different perspectives that researchers can adopt when investigating retention and dropout.

Many bivariate relations between factors that influence retention can be found in the literature. Larsen et al. (2013) conducted a systematic literature review that gives an overview of a big variety of different factors that influence student dropout or retention. The following 11 categories were concluded from the literature: 1) sociodemographic background of students, 2) academic competencies/pre-requisites for studying, 3) preparation for studying, 4) motivation for studying, 5) learning strategies, 6) study conditions, 7) social and/or academic integration within university/adaptation to university life, 8) overall evaluation of university life, 9) outside opportunities for dropouts (e.g., favourable business cycles), 10) economic situation of students, and 11) living conditions, including housing, family and personal situation or support and student jobs. However, a less complex model of retention could give a more systematic overview of what to focus on when investigating retention in higher education IT studies.

2.2.1. Retention models

The first studies about retention originate in the USA of the 1930s, but systematic approaches began to emerge in the 1960s, when the number of higher education students underwent a rapid growth (Berger, Ramirez & Lyons, 2005). The first widely recognized dropout model was created by Spady (1970). The model followed the sociologically grounded theory and suggested that academic potential, normative congruence, grade performance, intellectual development and friendship support influence satisfaction and commitment, which have an effect on the dropout decision. Spady's model (1970) contains both an academic and a social part, but a later empirical study showed that the role of academic experience was dominant (Spady, 1971). As a follow-up, Tinto (1975) developed one of the most well-known retention models, which also followed the sociologically grounded theory. Tinto revised the model during the next decades and the revised model was published in 1993. Tinto's integration model (1975, 1993) includes the following factors that have an effect on retention: individual characteristics (family background, individual attributes, prior schooling), commitments, and students' integration into the academic and social system (see Fig. 2.). The academic system includes academic performance at the university (formal activity) and interactions with faculty and staff (informal activity). The social system includes formal extracurricular activities and informal interactions in the peer group. Therefore, the model suggests that higher academic and social integration results in higher retention. According to Thomas (2012), academic and social integration is related to belonging, which refers to students' sense of connectedness with the university. Academic and social integration can be related to each other, and sometimes it is difficult to differentiate if a factor is academic or social. Davidson and Wilson (2013) found that interaction with tutors in the university can be both academic and social integration. The interaction is academic when the tutor addresses course-

related and organizational matters, whereas when the tutor is addressing personal and non-course related matters, the interaction is social.

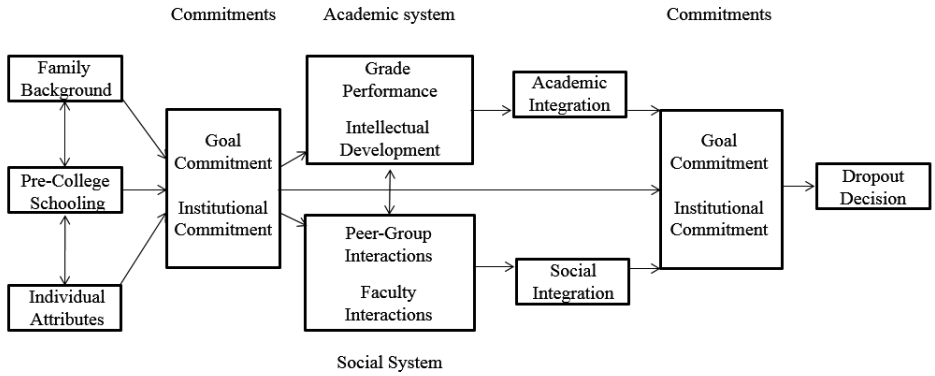

Figure 2. Model of student retention (Tinto, 1975, 1993)

Tinto's model (1975) has been validated by many authors (e.g., Cabrera, Castenada, Nora, & Hengstler, 1992; Pascarella & Terenzini, 1980). Newer studies have also shown that both academic and social integration are important in student retention (e.g., Karp, Hughes & O'Gara, 2010). However, some studies suggest that the role of social integration on university campus has decreased, because the number of students who live on university campus is much smaller now compared to the time when Tinto created the model (Davidson & Wilson, 2013). Tinto's model has also been criticized for not being suitable for distance education students (Rovai, 2003) and minority and non-traditional students, because their beliefs and attitudes may be contrary to traditional students' beliefs and attitudes (Hurtado & Carter, 1997). Non-traditional students can be defined as students who are older than 24, those who have family and work responsibilities that affect their studies (Bean & Metzner, 1985) or those who study in distance education programmes (Rovai, 2003). Higher education IT students can also be considered to be non-traditional, as many of them have work responsibilities. Therefore, Tinto's (1975, 1993) model in its original form may not be suitable for IT studies.

A model more suitable for non-traditional students was created by John P. Bean (1980, 1983). Bean's model shares some similarities with Tinto's model and research has shown that the models are overlapping (Cabrera et al., 1992). Both of the models include background variables and academic and social integration, which have an effect on students' attitudes, commitments and retention. The main difference between the models is that Bean's model (1980, 1983) also includes external factors such as opportunity to transfer, family commitments, and financial situation. These factors cannot be easily controlled by the university, but they are important for non-traditional students (Burrus et al., 2013).

As many IT students work during their studies and the other external factors in Bean's model (1980, 1983) cannot be controlled by the university, Tinto's integration model was used in the current dissertation.

The two widely used retention models developed by Tinto and Bean have also been further elaborated on by other researchers. Braxton, Shaw Sullivan & Johnson (1997) investigated the extent of empirical support for each of the positions in Tinto's model. As not all the positions in the model received strong support, they suggested revising the model. Braxton, Hirschy and McClendon (2004) revised Tinto's model in two different ways: 1) to make it more suitable for residential colleges and universities and 2) to make it suitable for commuter colleges and universities. As the environments in residential and commuter colleges/universities are different, they created two different models. The role of social integration is more important for residential students than those students who study in commuter colleges/universities.

Burrus et al. (2013) summarized the theories about retention to create a new model that should be suitable for all different types of institutions, different types of students (including non-traditional students) and accounts for retention beyond the second year of studies. The model includes a big variety of factors that have an effect on retention, with the factors being divided into three categories: 1) factors that put students on the track toward retention (e.g., preparation, motivation, study skills), 2) factors that pull students off the track (e.g., family and health issues), and 3) factors that keep students on track (e.g., self-management, social support). Rovai (2003) synthesized a model of retention for distance learning which was based on the studies of Tinto (1975, 1987, 1993) and Bean and Metzner (1985). Rovai (2003) combined these models with the skills required for online students, the special needs of distance education students, and the requirement to harmonize learning and teaching styles. The model included the skills and characteristics needed prior to admission (skills: e.g., computer literacy, time management, reading and writing; characteristics: e.g., age, gender, academic performance) and internal and external factors that have an effect on students after admission (internal, e.g., academic and social integration, study habits, satisfaction, self-esteem, learning and teaching style; external, e.g., finances, employment, family responsibilities). However, none of these further developed models seems to be a good fit for IT studies because of the lack of focus on professional work environment, which is important for IT students. As academic and social integration formed the basis of Tinto's model as well as the models developed further based on Tinto's model, these two types of integration were chosen as the basis in the current study, and possibilities of adding professional work environment to the model were sought. In the current study academic integration is defined as interaction with the faculty in the academic system, which includes academic performance, grades, and intellectual development. Social integration means interactions with peers and faculty in both the university environment and extra-curricular activities.

At least one model can be found that adds professional development of the students to academic and social integration – the What Works? model of student

retention and success, which shows how students' engagement can be supported by three types of services: academic, social and professional (see Fig. 3) (Thomas, 2012; Thomas et al., 2017). Academic engagement is related to effective learning; social engagement takes place in social spaces, clubs and societies, students' unions and student accommodation; and professional engagement includes participation in development services, which contributes to developing students' capacities at the higher education level and beyond (Thomas, 2012). However, academic engagement is the most important in student retention and success (Thomas, 2012). This model may have a better fit for IT students, as it includes professional services, which go beyond the higher education level. In the What Works? model professional services include a wide range of activities that could support students in university and after graduation: e.g., library and learning centres, pre-entry information, advice and guidance, financial advice, counsellors, careers information and guidance. However, in the current study the idea of students' professional development was used in a narrower context – integrating students into the work environment.

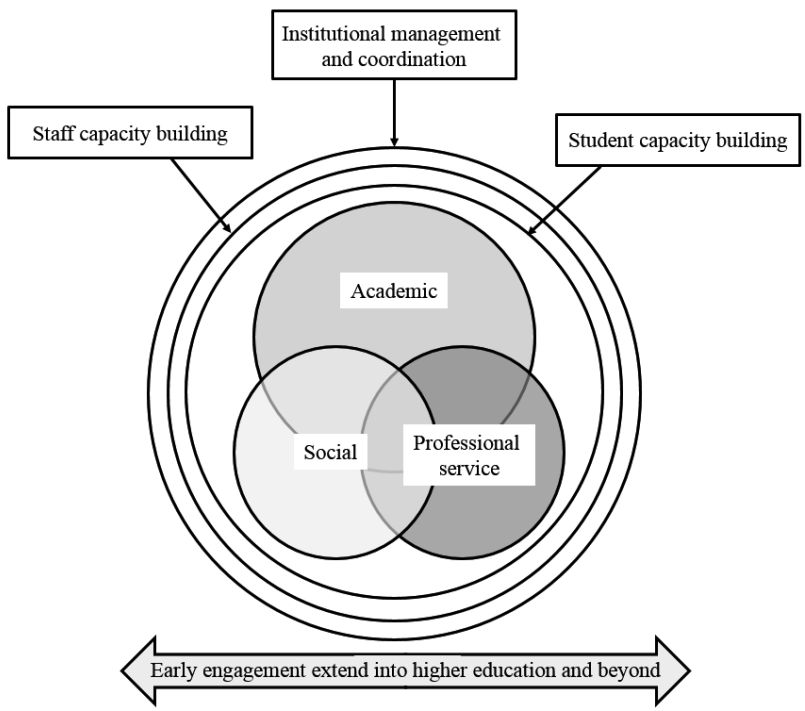

Figure 3. The What Works? model of student retention and success (Thomas, 2012; Thomas et al., 2017)

2.2.2. The "British" and the "German" approach in retention

Larsen et al. (2013) conducted a systematic literature review and concluded that studies about retention in Europe follow two different approaches. The "British" approach is more data-driven, has big sample sizes and mostly uses data from university records and other secondary data sources. Therefore, such studies do not focus on students' intrinsic factors like motivation or personal perspectives and within-university factors like learning processes or study conditions. The "German" approach is more theory-driven and uses theories that originate in the USA. Such studies collect data by questionnaire surveys and therefore have lower response rates and smaller sample sizes. Differently from the "British" approach, these studies focus more on students' intrinsic factors and experiences at the university.

The studies following the "British approach" mostly focus on students' background and academic integration. As for students' background, according to Larsen et al. (2013), studies have found the following aspects to have an effect on student retention:

- parents' education,
- age of students,
- gender,
- citizenship,
- being married or cohabiting,
- residency at university town or not,
- social class background,
- socioeconomic background,
- getting financial aids, and
- students' income.

As for academic integration, according to Larsen et al. (2013), studies have shown that academic performance (e.g., grades) at the higher education level and academic performance prior to higher education (e.g., academic preparedness, secondary school grades) have an effect on retention. Also, the quality of teaching and students' entry scores have been found to influence retention. In addition, there have been studies that have looked at academic and social integration factors combined by investigating the peer effect on student retention. According to Larsen et al. (2013), students who have better grades than their peers are more likely to drop out because of the mismatch between individual academic abilities and peer abilities (according to Larsen et al., 2013).

A few studies that follow the "British approach" have also investigated social integration related factors to some extent. According to Larsen et al. (2013), the studies suggest that students who live on university campus are more socially integrated than those who live off-campus (e.g., with their parents), and therefore, the students who live on university campus exhibit a lower probability of dropping out.

None of the studies that follow the "British approach" have directly investigated the professional integration of students. One study found, however, that the unemployment rate in the given country affects the retention of more underprivileged male students. When unemployment rates are higher then dropout rates are also higher (according to Larsen et al., 2013).

Studies having the "German approach" have investigated how all three types of integration (academic, social and professional) and students' background affect retention. Based on Larsen et al. (2013), examples of background factors that are important in retention are the following:

- parents' education level,
- gender,
- discipline,
- financial problems, financial support or financial aids,
- family problems (e.g., parental duties), and
- illness.

According to Larsen et al. (2013), studies with the "German approach" have found about academic integration that students' academic achievement (e.g., grades, study progression, failing exams), intelligence (higher intelligence – higher probability of dropout), academic workload and the difficulty level of courses have an effect on retention. Concerning academic integration, the studies have also investigated the role of motivation and self-efficacy in retention and found these to be significant.

Larsen et al. (2013) have also reported studies following the "German approach" to have found contrary results about the role of social integration in retention. Some studies have shown that social integration is related to lower dropout rates, and with the learning environment being part of social integration, which influences retention, closer contact between students and teachers could increase retention rates. But as a contrary result, some studies have found that, as opposed to academic integration, social integration does not, in fact, have a significant role in retention, and therefore, counselling and support services provided before exams do not have a significant effect on retention.

Studies having the "German approach" have found, according to Larsen et al. (2013), working during studies to be one of the reasons why students drop out and workload over 20 hours per week to increase the probability of dropout. In conclusion, compared to the "British approach", more studies following the "German approach" have investigated the role of social and professional integration in retention, while both approaches have investigated academic integration and students' background variables.

2.2.3. The role of motivation in retention

Study motivation also plays a part in student retention, as it activates and directs learning (Kleinginna & Kleinginna, 1981). According to the Self-Determination Theory (Deci & Ryan, 1985), motivation can be divided into intrinsic and extrinsic motivation based on the different reasons that give rise to an action. Intrinsic motivation comes from interest in and enjoyability of an action, while extrinsic motivation is driven by a separable outcome (Deci & Ryan, 1985). Both of these motivation types can be divided into three subcategories (see Table 1). The three subcategories of intrinsic motivation are to know, towards accomplishments, and to experience stimulation. The three subcategories of extrinsic motivation are identified, introjected, and external regulation. In addition to intrinsic and extrinsic motivation subcategories, amotivation can be differentiated. Amotivation refers to a lack of motivation (Ryan & Deci, 2000) and has been found to potentially cause dropout (Vallerand & Bissonnette, 1992). In general, it has been found that higher levels of motivation result in higher academic achievement (Bruinsma, 2004) and contribute to lower dropout rates (Hardre & Reeve, 2003). Gottfried (2009) found that intrinsic academic motivation correlates positively with school achievement. Studies have also shown the type of motivation to be associated with high school dropout – students with identified and introjected extrinsic motivation and students with external regulation were at the highest risk of dropping out of high school (Abar, Abar, Lippold, Powers and Manning, 2012). As studies suggest that the type of learning motivation may be associated with academic achievement and retention, the seven subcategories of motivation are under investigation in the current dissertation.

Table 1. Different types of motivation (based on Deci & Ryan, 1985; Ryan & Deci, 2000)

Intrinsic motivation	to know	person wishes to learn to get new knowledge
	toward accomplishment	person wishes to accomplish something
	to experience stimulation	person does something because it is satisfying and gives a good feeling
Extrinsic motivation	identified	person accepts the regulation because the activity is judged as valuable/useful and fits their value system
	introjected	person performs an action out of obligation to avoid anxiety, shame, and pressure
	external regulation	person acts to satisfy an external demand or obtain an external reward contingency, the locus of control is purely external
Amotivation		person has a lack of motivation

2.2.4. The role of self-efficacy in retention

Self-efficacy has been found to be important when choosing a career for further studies (e.g., Dickinson, Abrams & Tokar, 2016; Dutta et al., 2015; Inda-Caro & Rodriguez-Menéndez, 2016; Lent, Brown & Hackett, 1994; Tang, Pan & Newmeyer, 2008;), but it is also an important factor in student retention. Self-efficacy is related to the real academic performance (e.g., Alivernini & Lucidi, 2011; Caraway et al., 2003). For example, Bandura, Barbaranelli, Caprara and Pastorelli (1996) found that children's academic self-efficacy is directly associated with scholastic achievement and indirectly associated with academic aspirations, prosocial behaviour and decreasing proneness to despondency. Also, in IT studies it has been found that self-efficacy in a computer science or programming course is related to the course grade (Ramalingam, LaBelle & Wiedenbeck, 2004; Watson, Li & Godwin, 2014; Wiedenbech, 2005). This means that students with higher self-efficacy are more likely to have better academic achievement, which has been found to be an important predictor of student retention (Araque, Roldan & Salaguero, 2009; Belloc, Maruotti & Petrella, 2011; Stratton, O'Toole & Wetzel, 2008).

The current study focuses on graduation-related self-efficacy. Graduation-related self-efficacy refers to students' perception of their ability to graduate. This means that if students have higher graduation-related self-efficacy at the beginning of their studies then they believe that they are able to graduate. The results of previous studies (e.g., Alivernini & Lucidi, 2011; Bandura et al., 1996; Caraway et al., 2003) also indicate that higher self-efficacy results in higher academic achievement and higher retention rates.

2.2.5. IT specific retention studies

Few IT field specific retention studies can be found in the literature. Dropout reasons in the IT field may be slightly different from other fields, because the IT field is relatively new and developing very fast. This means that IT workers have to keep up with work that is changing all the time. In addition, because of the lack of IT workers in the labour market, IT companies often hire students, who then need to divide their time between work and studies. Kinnunen and Malmi (2006) studied dropout in the computer science course and found that dropout reasons cumulate individually. The main reasons for dropping out of the course were lack of time and lack of motivation. Both of these reasons were affected by the perceived difficulty of the course, general difficulties with time management and study planning or the decision to prefer something else. Benda, Bruckman and Guzdial (2012) also found computer science students to have problems with time management. Working during studies may be one reason why students do not have enough time for studying, which may cause dropping out (Polidano & Zakirova, 2011; Taylor, Lekes, Gagnon, Kwan & Koestner, 2012). Studies in Estonia have also shown working during studies to

be one of the dropout reasons in the IT field (Altin & Rantsus, 2015; Järve, Kallas & Räis, 2015). However, when students are working, they are more integrated professionally. Therefore, working during studies could have both a negative and a positive effect on studies.

Altin and Rantsus (2015) conducted interviews with Estonian IT students who dropped out of their studies during the first year. They found that the main reason for dropping out was the wrong curriculum choice and that many students went to study something else after dropping out of IT. The other reasons for dropping out were as follows: personal/health/financial reasons; the studies did not meet students' expectations; the study load was too high or the courses were too difficult; the students were working and did not have time for studying; and some students wanted to continue IT studies in a different curriculum. Some of these dropout reasons demonstrate weak academic integration: e.g., the studies did not meet the expectations, the study load was high, and the courses were too difficult. Other studies have also shown that some of the introductory courses in IT are difficult and the dropout rates are high in these courses: e.g., introductory computer science (Benda, Bruckham &Guzdial, 2012; Zingaro, 2015), programming (Watson & Li, 2014), and mathematics (Divjak, Ostroski & Hains, 2010). In a global sample, it has been found that an average of one third of the students drop out of introductory courses (Bennedsen & Caspersen, 2007), but prior experience in IT, such as programming experience (Hagan & Markham, 2000; Kori, Pedaste, Leijen & Tõnisson, 2016), may help students pass these courses and get better grades.

A few studies have shown the importance of social integration in IT studies. According to McCartney et al. (2016), social and peer interactions are one of the four themes that are important in computing students' motivation for self-directed learning. Barker, McDowell and Kalahar (2009) showed interaction between students to be the biggest retention predictor in computer science.

2.2.6. Increasing retention rates

A substantial amount of research has been done about theories of retention, but actual retention rates have not increased. Many studies have presented suggestions as to what can be done to increase retention rates, but only a very small number of studies have been conducted about the effect of applying interventions. Therefore, it is important to investigate what universities can do to actually increase retention rates (Tinto, 2005). Braxton and Mundy (2001) categorized 47 suggestions for increasing retention rates that were published in the articles of the special issue of the Journal of College Student Retention. They found that most of the suggestions could be divided under three principles of effective retention described by Tinto (1993): 1) commit to students' welfare, 2) commit to the education of all students, and 3) commit to the integration of all students into the academic and social communities. Similarly to the last principle, Thomas (2012) suggests that to increase student retention and

success, students need to be engaged in the academic sphere, social sphere, and, in addition to the aspects emerging from Tinto's model, in the professional sphere. The last one contributes to developing students' capacities that are needed in higher education and beyond. The current dissertation also focuses on Tinto's last principle, as some suggestions are given about what universities can do to better integrate students and thus increase the retention rates. In addition, Thomas et al. (2017) point out that effective retention interventions should have six characteristics: be mainstream, be proactive and developmental, be relevant, be well-timed and use appropriate media, be collaborative (including staff and students), and be monitored. So, these characteristics should be taken into account while designing interventions for student retention.

Researchers have applied interventions for increasing student retention in higher education (e.g., the What Works? programme (Thomas, 2012; Thomas et al., 2017)), but few studies focus on the retention of IT students. Researchers have recommended for IT studies that to increase retention rates, teaching methods should be improved (e.g., Järve et al., 2015; Zingaro, 2015; McCartney et al., 2016). For example, it has been suggested that implementing project based learning could motivate students and support their learning in computing (MaCartney et al., 2016) and that pedagogical techniques, such as peer instruction, could increase learning interest in the computer science course (Zingaro, 2015). Therefore, university teachers should use more effective teaching methods, improve their pedagogical skills (Järve et al., 2015) and, through that, better motivate their students to study IT. In addition, it has been suggested that universities should offer more flexible study times (e.g., alternative times for participating in lectures) and different study forms (e.g., distance learning and evening studies) for IT students to increase retention rates (Järve et al., 2015). This could especially support those students who are working during their studies and cannot attend classes at regular times. To decrease students' workload during studies, it has been recommended that stipends should be offered to more students to decrease their financial need for working (Järve et al., 2015).

As study assignments took a lot of time and communication between students and teachers was not good enough, Benda, Bruckaman & Guzdial (2012) suggested that instructional design solutions are needed for an online course of introductory computer science. It has also been argued that counselling IT students could support their career choices and help prevent dropout (Järve et al., 2015). The main dropout reason in the University of Latvia in the first semester of computer science studies is that students who have been admitted to the curriculum do not actually start their studies (Borzovs, Niedrite & Solodovnikova, 2016). Therefore, Borzovs, Niedrite & Solodovnikova (2016) recommended creating a self-assessment test for potential students that would help them to understand if computer science studies are suitable for them (e.g., personality tests, logic tests, mathematics tests). In addition, that kind of entrance test could be useful for universities for finding the best IT students, who would also be more likely to graduate.

A few studies in the IT field have taken a more practical approach and applied interventions for increasing retention rates. The University of Illinois have applied an intervention that increases first-year students' social integration already before the courses start (Talton, Peterson, Kamin, Isreal & Al-Muhtadi, 2006). The university organizes Scavenger Hunt, which is a community building activity that helps students make friends, feel part of the department and increases retention. The University of Latvia have applied a more personal approach to first-year computer science students to increase their academic and social integration (Borzovs, Niedrite & Solodovnikova, 2016). The university offers a mentoring programme that has shown positive results on retention – the students who have a mentor are more likely to continue during the second semester than those who do not have a mentor. In addition, the University of Latvia supports students' academic integration by offering additional mathematics courses to the students who get less than a certain amount of points in the mathematics exam. This means that they differentiate a group of students who need additional academic support and offer a course to them.

Still, the interventions have mostly been applied in small-scale studies, and, so far, retention rates have not increased in the IT field in general. Studies that have been conducted usually focus on interventions that are the same for all students, but dropout reasons cumulate very individually (Kinnun & Malmi, 2006), and students with different profiles may need different types of support to graduate. There are some studies that have differentiated student profiles: for example, profiles of achievement goal orientation (Pastor, Barron, Miller & Davis, 2007; Tapola & Niemivitra, 2008); profiles of motivation (Bråten & Olaussen, 2005); or profiles of achievement goals, goal instructions and external feedback (Dina & Efklides, 2009). However, retention related studies are mostly variable-oriented and there is not much research available about retention related student profiles. Therefore, the current dissertation takes a person-oriented approach to distinguish IT student profiles based on academic, social and professional integration. The focus of the person-oriented approach is not on the factors that have an effect on retention but on the relationships between them (Bergman, Magnusson, & El-Khouri, 2003) that form the different student profiles. The person-oriented approach investigates variables of various subgroups that include students with similar profiles (Pastor et al., 2007). This means that the focus is on students' personal characteristics that form subgroups with similar profiles. Knowing student profiles helps universities to develop interventions and support systems for different types of students to increase their retention rates.

Researchers have suggested that students need support in their studies to be successful. This means that students need support to become more engaged and effective learners and thus improve their academic outcomes and progression opportunities after graduation (Thomas, 2012). For instance, universities could improve student success and retention rates by offering students easily accessible academic, personal and social support (Tinto, 2004). To increase students' interest, motivation and engagement, content-informed interactions should be

supported and scaffolding is needed for learners to think and work with content (Järvelä & Renninger, 2014). Simpson (2013) defines student support as a variety of activities from organizing and management of student support, which also includes staff development, to direct interactions with students (e.g., tutors, mentors, advisers). According to Simpson (2013), the support could be either academic or non-academic (counselling) support. Academic support means supporting students' cognitive, intellectual and knowledge issues (e.g., developing learning skills, explaining concepts, giving feedback), whereas non-academic support refers to supporting students in affective and organizational aspects (e.g., advising, assessing non-academic skills, administration). As students with different characteristics may need different types of support for graduating, the current dissertation takes a more personal approach and divides students into groups with similar profiles.

3. RESEARCH DESIGN AND METHODS

The following chapters give overview of the research design and methods used in the current dissertation. Firstly, research design and study flow of articles are explained. Then the procedure of data collection and samples of each article are described. This is followed by the overview of the instruments used in the study and data analysis methods used in the articles.

3.1. Research design

The studies in the current dissertation can be divided into two phases: Exploration and Modelling (Figure 4). The Exploration phase is more descriptive and explores which factors influence students' entrance into higher education IT studies as well as the retention of IT students and which model can be used for investigating retention in IT studies. Based on the Exploration phase, research questions for the Modelling phase were formulated. In the Modelling phase, actual models are created based on the theory that was explored previously.

The results of the Exploration phase are presented in Articles I, II, III and IV. The Exploration phase started with reviewing literature on what influences career choice and retention in higher education. This was followed by the first study, which in presented in Article I. The data was collected from IT student candidates during admission. The candidates answered open-ended questions about factors that influenced them to choose to study IT at the higher education level. A qualitative approach was used in Article I for analysing the student candidates' answers, and the results provided input for designing the questionnaires that were used in the next data collections. In the study presented in Article II, data was collected by a questionnaire that IT students filled in at the beginning of the first semester of their studies. In this study, a qualitative approach was used to describe the defining moments that were important for choosing IT curricula, and a quantitative approach was used to describe IT students' perceptions about graduating and working in the IT field. Starting from Article III, only the quantitative approach was used. Data from IT students were collected at the beginning of the first semester and at the beginning of the second semester, and factors influencing entrance and retention were differentiated. The Exploration phase ended with Article IV, which sought a model that could be used for predicting retention in higher education IT studies.

Based on the theory and empirical data collected in the Exploration phase, Tinto's model (1975, 1993) was chosen as the basis of the Modelling phase. The Modelling phase started with a study presented in Article V, where structural equation modelling (SEM) was used to create a model that shows the effect of social, academic and professional integration on the graduation-related self-efficacy of first-year IT students. Based on this model, in Article VI, a person-oriented approach and latent profile analysis (LPA) was used to classify the IT students. Based on the results of the Modelling phase, suggestions are provided as

to which interventions could be further investigated and applied to higher education IT studies to see an effect on the integration and retention of students.

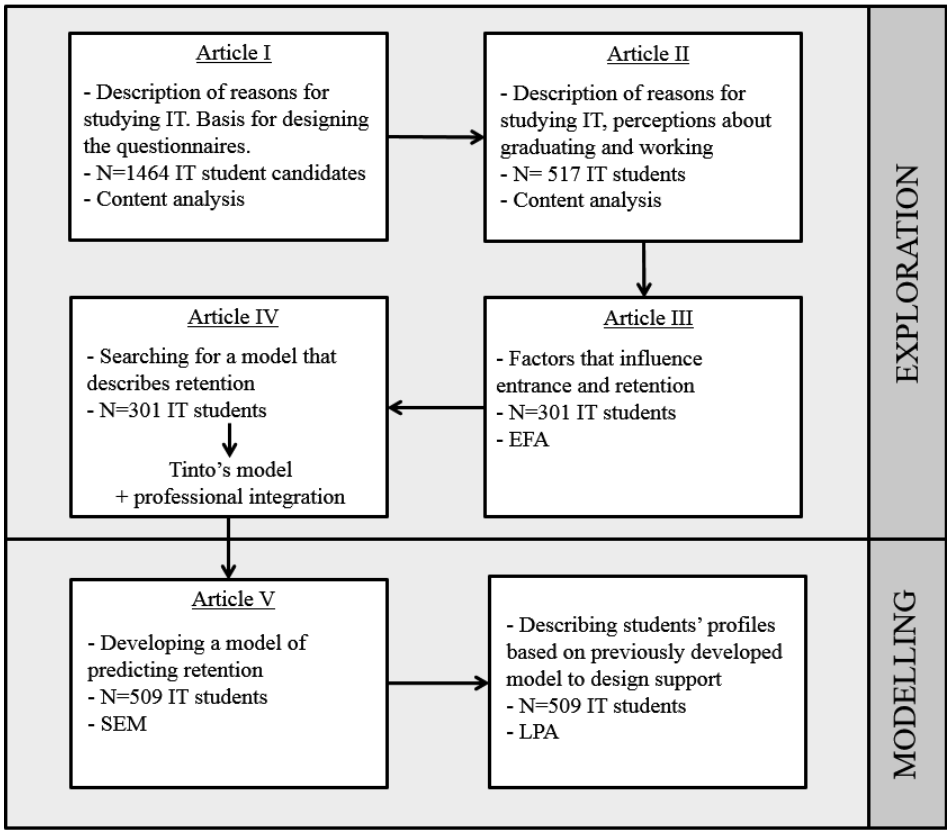

Figure 4. Study flow of the articles from the methodological point of view

3.2. Procedure and participants

The sample for the study presented in Article I consisted of 1464 IT student candidates who applied for IT curricula at the Bachelor or applied higher education level in the year 2013 at three higher education institutions in Estonia: University of Tartu, Tallinn University of Technology and Estonian Information Technology College. The first two institutions offer only full-time studies, whereas the third one offers different study forms: full-time studies, evening studies, and distance studies. The students applied for seven out of eight different IT related curricula in all study forms (see Table 2), covering a big variety of curricula in the IT field. One curriculum (Informatics) was not included in the data collection because by the time of the data collection, admission to this curriculum had already started. Out of the 1464 candidates, 581 were accepted

to these seven curricula. From these 581 students, 379 filled in a questionnaire at the beginning of the first semester of studies and thus formed most of the sample in Article II. In addition, 138 students from the eighth IT curriculum (Informatics) filled in the questionnaire, so that the entire sample for Article II consisted of 517 students from all eight IT curricula that these three higher education institutions offered (see Figure 5).

Table 2. Higher education institutions and the IT curricula in which the students studied

Higher education institution	**Curriculum**
University of Tartu	Computer Science
	Computer Engineering
Tallinn University of Technology	Informatics*
	Computer and Systems Engineering
	Business Information Technology
Estonian Information Technology College	IT Systems Administration
	IT Systems Development
	Information Systems Analysis

* The curriculum was not included in the study presented in Article I

The sample for the study presented in Article III and Article IV consisted of the same IT students who started their studies in 2013 and filled in two questionnaires (301 students): at the beginning of the first semester and at the beginning of the second semester. In Article V and Article VI, the 301 IT students from the previous analysis were included, and, in addition, 208 IT students who started their studies in 2014 were included in the sample. Figure 5 gives an overview of the samples in each article. For studies presented in Articles III–VI, it was important that the students filled in both of the questionnaires. So, the students who did not fill in either the first or the second questionnaire were not included in the analysis. This caused a decrease in the sample size. Moreover, some of the students dropped out during the first semester and could therefore not fill in the questionnaire at the beginning of the second semester. This means that the students who dropped out early were not included in the sample and the majority of the sample thus consists of those students who were retained during the first study year.

Data for the study presented in Article I was collected electronically. One open-ended question was added to the electronic admission application form in the Estonian Admission Information System (SAIS). The question was the following: “What are the main reasons that influenced you to apply to an Informatics or Information Technology related curriculum?” Also, some background information was collected from SAIS about students’ gender, universities and curricula they applied for.

Data for the next studies (Article II – Article VI) was collected by using questionnaires at the beginning of the first and second semester. To increase the

validity of the data collection, all IT students at the three higher education institutions were given the opportunity to respond, with the data being collected in the same way and during the first few weeks at the beginning of the semester. The questionnaire was filled in during the main lectures on paper. A paper-based questionnaire was used to collect more answers from the students who might not have been motivated to fill in the questionnaire electronically at home. Still, the students who did not participate in the lectures had the chance to respond to the questionnaire electronically, but only few of them (less than 5% of respondents) used this opportunity.

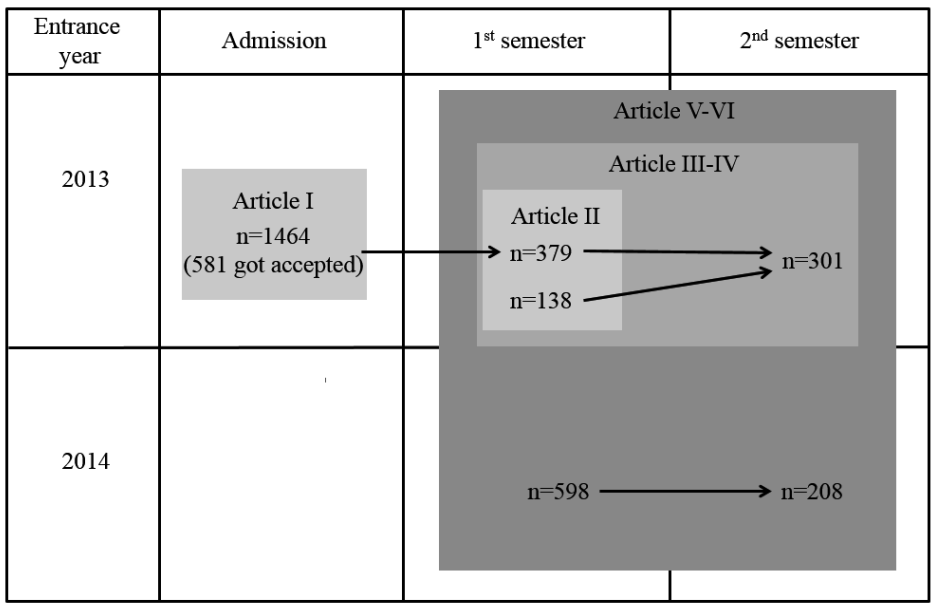

Figure 5. Overview of samples of studies presented in the six articles

3.3. Instruments

Two questionnaires were used to answer the research questions formulated for the dissertation. The first questionnaire was filled in at the beginning of the first semester and the second questionnaire at the beginning of the second semester. The questionnaires were used for data collection in studies presented in Articles II–VI. The questionnaires were designed in the project "Conceptual Framework for Increasing Society's Commitment in ICT: Approaches in General and Higher Education for Motivating ICT-Related Career Choices and Improving Competences for Applying and Developing ICT". As suitable questionnaires were not found in the literature, the questionnaires were developed in the project team based on bivariate relations affecting retention (see Larsen et al., 2013), results of Article I and experience of experts who taught IT students in higher education

institutions. During the development process, expert discussions with the same experts took place to increase the validity of the questionnaires.

The research questions for the Modelling phase were formulated after the Exploration phase; therefore, the questionnaires were not based on the three types of integration (academic, social and professional) that are in focus in the Modelling phase. Still, the questions in the questionnaires enabled to investigate academic, social and professional integration. The two questionnaires were generally very similar and consisted of different types of questions: multiple-choice questions; open-ended questions that required a longer written answer; and questions that required a short written answer (one or two words). However, some questions in Questionnaire 1 focused on factors that influenced students to choose an IT curriculum and that caused their interest in IT. In Questionnaire 2, the questions focused more on factors that influence retention in IT studies. Still, most of the questions were the same in the two questionnaires to see how students' perceptions change during the first year. The questions in the questionnaires can be divided into seven parts: 1) academic integration, 2) social integration, 3) professional integration, 4) evaluations of what influenced students to enter IT studies or continue the studies, 5) Academic Motivation Scale (AMS-C 28) College (CEGEP) version (Vallerand et al., 1989), 6) background information, and 7) graduation-related self-efficacy. Appendix 1 gives an overview of all the questions in the questionnaires that were related to academic, social and professional integration, which were the focus of the current dissertation. There were two questions about academic integration in Questionnaire 1, but in Questionnaire 2 more questions were added about previous IT studies and how students are doing in the current studies. The questions were added to Questionnaire 2 because at the beginning of the studies answering those questions might have been difficult for the students due to very little experience regarding higher education IT studies. The total number of academic integration related questions in Questionnaire 2 was 11. In Questionnaire 1 two questions were asked about social integration and one question about how much students communicate with peers after school was added to Questionnaire 2. Seven questions about professional integration were included in both of the questionnaires. The initial aim of the project did not include focusing on the professional integration of students, but, based on the experiences of the experts, several questions about professional integration were still included in the questionnaires. The next part of the questionnaires included items that were developed based on student candidates' open-ended answers (Article 1). The student candidates' open-ended answers were categorized, and in Questionnaire 1 students evaluated 20 items about how much these influenced them to enter IT studies. In Questionnaire 2 these items were modified and students evaluated how much these influenced them to continue their studies. Also, the students responded to the Academic Motivation Scale (AMS-C 28) College (CEGEP) version (Vallerand et al., 1989) once during the first study year (the students who started in 2013 responded to it in Questionnaire 2, whereas the students who started in 2014 did so in Questionnaire 1). The scale consists of 28 items

which the students were asked to assess on a 7-point scale, indicating to what extent each of the items corresponded to the reasons why they entered higher education studies. It determines seven constructs of motivation: intrinsic motivation to know; intrinsic motivation toward accomplishment; intrinsic motivation to experience stimulation; identified extrinsic motivation; introjected extrinsic motivation; external regulation; and amotivation. There were two background questions in both of the questionnaires (age and gender), which were found to have an effect on retention based on the literature. Last but not least, graduation-related self-efficacy as a measure for retention was investigated by one question in both of the questionnaires: "How strong is the probability of you finishing your studies?"

In addition, data was collected from the three universities about students' academic achievements. Information about students' GPA and number of collected credit points was available for the first and second semester. This information was required for answering research questions 3 and 4, because GPA and collected credit points show academic integration at university.

3.4. Data analysis

The data analysis methods used in this dissertation are the following: content analysis, exploratory factor analysis (EFA), structural equation modelling (SEM), and latent profile analysis (LPA). Content analysis and EFA were used to analyse the data for answering the first research question. The results of content analysis are presented in Articles I and II. Two raters evaluated IT students' answers to open-ended questions to inductively develop the coding schema of categories. In each open-ended question, two raters specified the categories until it was possible to reach 80% of accuracy between them. The results of EFA are presented in Article III. EFA was used to explore which factors could be identified from IT students' evaluations of the items that influenced them to enter higher education IT studies and which factors influenced them to continue their studies. For EFA, principle axis factoring was used with the Varimax method of rotation with Kaiser normalization. Parallel analysis was used to determine the number of factors (Horn, 1965; Zwick & Velicer, 1986).

SEM was used to analyse the data in order to answer the third research question. The results of SEM are presented in Article V. In this article, SEM was used to develop a model that predicts graduation-related self-efficacy based on academic, social and professional integration. The model fit was evaluated by CFI, SRMR and RMSEA.

To answer the fourth research question, data was analysed with LPA. The results of LPA are presented in Article VI. LPA was used to identify IT student profiles based on academic, social and professional integration. The model with the best number of profiles was identified based on a combination of model results, theory and fit statistics. The following fit statistics were used to evaluate the models: BIC, AIC, entropy and A-LMRT.

4. FINDINGS

In the findings chapter, the results of each article are presented in the order of the research questions. The first subchapter gives an overview of the factors that influence students to enter and continue higher education IT studies. The second subchapter focuses on the models that can be used for investigating the retention of IT students and a model of IT students' graduation-related self-efficacy is created. The third subchapter describes the profiles of first-year IT students.

4.1. Factors that influence students to enter and continue IT studies

The first research question of the Exploration phase was "Which factors have an effect on students' entry into higher education IT studies and on the retention of IT students?" This research question was addressed in Article I, II and III.

4.1.1. Reasons for choosing and continuing to study IT

Article I aims at investigating the reasons why student candidates apply for IT curricula. Therefore, IT student candidates answered an open-ended question while applying to higher education studies. The following question was asked from 1464 student candidates: "What are the main reasons that influenced you to apply to an Informatics or Information Technology related curriculum?" The answers were divided into 14 categories (see Table 3), and every student had the chance to write several reasons in his/her answer. To increase the reliability of the data analysis, three researchers were included in developing the coding-schema and inter-rater reliability between the two raters was calculated (the Cohen's Kappa value was 0.79).

The 14 categories were divided under three terms: *intrinsic motivation*, *extrinsic motivation*, and *other*. Intrinsic reasons were more popular than extrinsic reasons. The following popular answers can be placed under intrinsic motivation: interest (55.4%); prior experience that caused interest in studying IT (17.8%); and personal development (16.6%). The most popular reasons under extrinsic motivation were the importance of IT education in the future (13.1%); job opportunities in the labour market (11.8%); and fast development of the IT field, which makes it an important field to study in a future perspective (9.4%). Other reasons that did not fit under these categories were expressed by 27.1% of the student candidates.

Many categories can be linked to academic and social integration from Tinto's model (1975, 1993) (see Table 3). All the categories that were divided under intrinsic motivation were linked to academic integration. Prior experience (category 5) shows clearly that students have been academically integrated into IT studies before (e.g., in school or learning by themselves). Prior academic

integration in IT could cause interest in IT (category 1), liking IT (category 3), feeling that IT is suitable for them (category 2), and wanting to continue IT studies (category 4). In addition, IT related academic integration shows to the students that the IT field gives them the opportunity for personal development (category 6) and self-realization (category 7). In addition, student candidates expressed reasons for studying IT that did not fit under the listed categories (category 14). Some of the reasons that students expressed and that were categorized under *other* show social integration. For example, some student candidates reported that someone had recommended entering IT studies to them or had been a role model for them. Nevertheless, many answers under this category are not related to social integration.

Table 3. The main reasons why student candidates applied for IT curricula

Type of motivation	**Category of reasons why students choose to study IT (%)**	**Type of integration**
Intrinsic motivation	1. Interest (55.4%)	Academic/professional integration
	2. Suitability (4.4%)	Academic integration
	3. Likeability (8.5%)	Academic integration
	4. Continuing studies (6%)	Academic integration
	5. Prior experience (17.8%)	Academic integration
	6. Personal development (16.8%)	Academic integration
	7. Self-realization (7.3%)	Academic/professional integration
Extrinsic motivation	8. Necessary at work (2.8%)	Professional integration
	9. Salary (3.3%)	Professional integration
	10. Labour market (11.8%)	Professional integration
	11. Stipend (0.3%)	-
	12. Field development (9.4%)	-
	13. Importance in the future (13.1%)	Professional integration
Other	14. Other (27.1%)	Some of the answers related to social integration

Student candidates expressed several categories that cannot be linked to academic and social integration but show the importance of work environment and professional integration (see Table 3). The following categories under extrinsic motivation were linked to professional integration: necessary at work (category 8), good salaries in the IT field (category 9) and prospects in the labour market (category 10). Also, when students reported that the IT field woud be important in the future (category 13), they could have meant that IT would be important for their job in the future. Two of the categories under intrinsic motivation can also be linked to professional integration: 1) in addition to academic experiences, interest in studying IT (category 1) was caused by working in the IT field; and 2)

self-realization (category 7) also meant doing something challenging at an IT related job. Still, two of the categories under extrinsic motivation were not clearly linked to any type of integration: stipends for IT students (category 11) and the fast development of the IT field (category 12).

The categories from Article I were the basis for creating the items in the questionnaire that the students evaluated at the beginning of the first and second semester. Article III aims at exploring which factors can be identified from IT students' evaluations of the items that influenced them to enter higher education IT studies and which factors influenced them to continue their studies. The results of parallel analysis show that four factors can be differenciated from both cases: 1) what influenced students to enter higher education IT studies and 2) what influenced students to continue their studies (see Fig. 6).

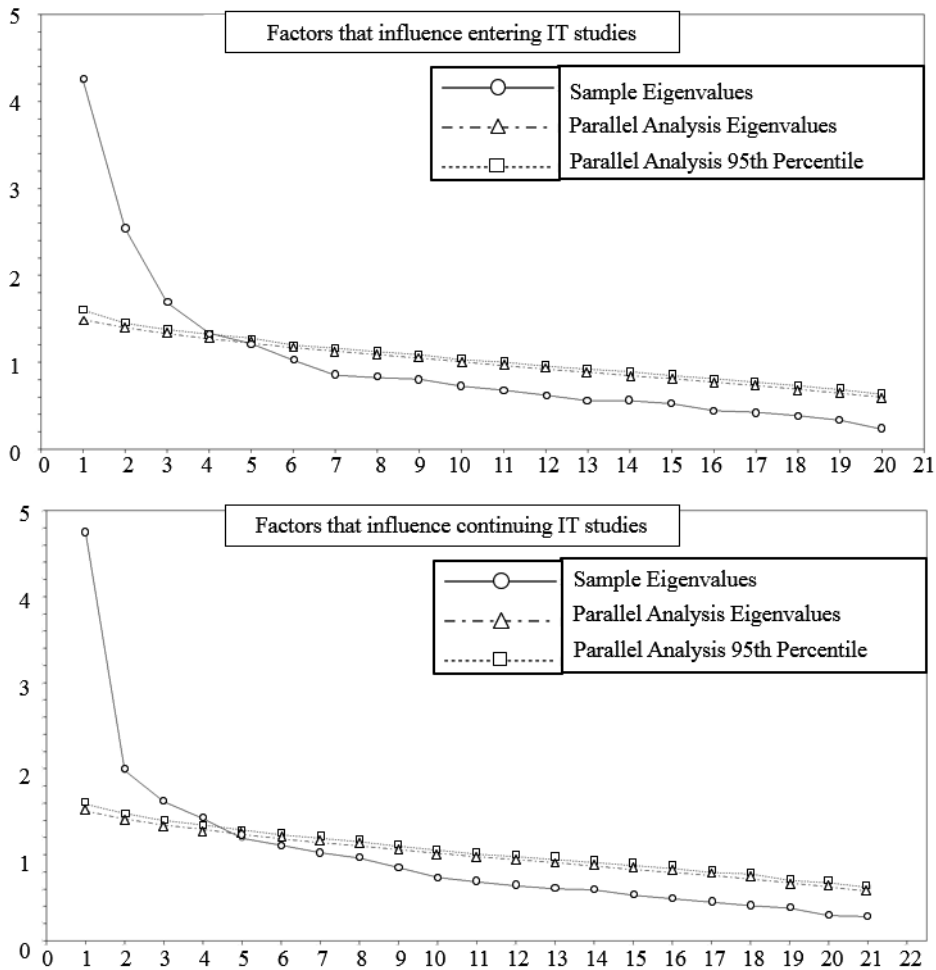

Figure 6. The number of factors determined with parallel analysis

Three factors were found with EFA to be influencing both entering IT studies and continuing IT studies: personal contact with IT, reputation of the IT field and development (Fig. 7). In addition, one factor was found to be only influencing IT students to enter IT studies – continuing IT related studies. Also, one factor was found to be only influencing IT students to continue their studies – learning environment. Cronbach's alpha values were also calculated for each factor: the values were between 0.61 and 0.76. Values above 0.7 show that the results are reliable, whereas values between 0.6 and 0.69 show marginal reliability (Cohen, Manion & Morrison, 2007).

The factor termed *continuing IT related studies* is linked to academic integration (see Fig. 7). This factor included items related to previous experience with studying IT. The *learning environment* factor is linked to social integration. This factor included items related to socialization with other students or faculty. Some of the items in these two factors were, however, very similar. The item related to the teacher who teaches IT (in school or university) was included in both continuing studies and learning environment. The teacher item can belong to both academic and social integration, because a teacher addresses both course-related academic activities and non-course-related social activities. Similarly, participating in IT events, hobby groups or competitions can be linked to both academic and social integration. IT events, hobby groups or competitions address IT studies related academic activities and social activities with other people who participate.

Some items related to professional integration were placed under factors that influenced both entering and continuing the studies. In particular, the *personal contact with IT* and *reputation of IT field* factors included items that show professional integration: e.g., prior work-related contact and future prospects and good salaries in the labour market.

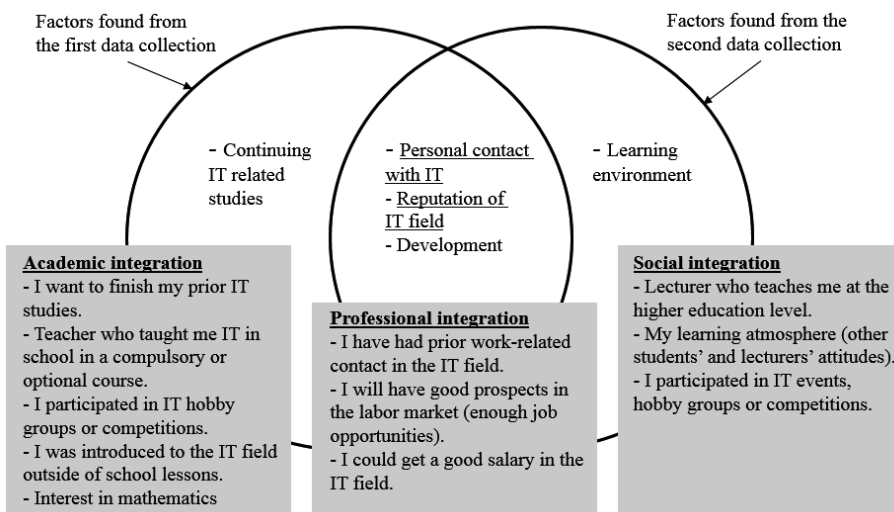

Figure 7. Factors that influence students to enter IT studies and continue IT studies. Only items related to academic, social and professional integration are presented.

4.1.2. Interest in IT

The main reason for choosing an IT curriculum was interest in IT, which shows intrinsic motivation to study. Therefore, Article II firstly investigates what caused the interest in IT. At the beginning of the first semester, the students were asked about the defining moment that had caused their interest in IT. The answer categories and their relationship with different types of integration are shown in Table 4. To increase the reliability of data analysis, two researchers were involved in developing the coding-schema and the inter-rater reliability was calculated (Cohen's Kappa value higher than 0.80).

Many of the reasons that had caused the respondents' interest in IT can be linked to academic or social integration. The most popular answers were linked to academic integration. Academic integration is linked to experience of doing something with computers (category 1), because this type of activities support intellectual development. Computer lessons (category 2) can be directly linked to academic integration, and interest in mathematics (category 8) can also be linked to academic integration, because students have experience in learning mathematics, which is an important part of IT studies as well. Emotional answers (category 9) can be linked to academic integration, because the answers show that the students had prior experience of learning IT, which had caused the emotional answer, such as "I like IT". One category was directly linked to social integration – someone who recommended the IT field or was a role model (category 3).

Table 4. Reasons that caused students' interest in IT

What caused interest in IT? (%)	**Type of integration**
1. First computer, experience of doing something by myself: solving computer-related problems (helping others), building a computer, software developing or trying to make a computer game, web page design (36.3%)	Academic integration
2. Computer lessons in school or participation in some other course or competition (9.4%)	Academic integration
3. Family member or friend works in the IT field and recommended the field or was a role model (8.8%)	Social integration
4. Everyday work related to or other contact with IT (6.6%)	Professional integration
5. Computer games (5.6%)	-
6. The field in general is important/promising right now and for the future (5.2%)	Professional integration
7. No clear "defining moment", interest developed over time or had been there all along (5.2%)	-
8. Interest in mathematics (3.6%)	Academic integration
9. I like it, it is suitable, I can manage it very well, I want to commit myself to this field (emotional point of view) (2.5%)	Academic integration
10. Later, it is possible to earn a good salary (2.5%)	Professional integration
11. Other: e.g., I had to make a decision, media, relating hobby to IT (14.2%)	-

There were three categories that did not fit under academic or social integration but were related to professional integration: professional contact with IT (category 4); possibility to earn good salaries (category 10); and the category that shows that the person is future oriented and that includes the importance of the IT field (category 6). There were also some categories that cannot be clearly linked to academic, social or professional integration. These were playing computer games (category 5); interest developed over time (category 7); and the answers that were grouped under other reasons (category 11). *Playing computer games* could be linked to either academic or social integration: when a person plays games together with other people, then it could be social integration; whereas when a person plays educational games, then it could be academic integration. Similarly, *interest developed over time* could be linked to either academic or social integration: a person could have had social contact and/or academic experiences that cumulated and caused the interest in IT. The *other reasons* category included aspects from all different types of integration.

4.1.3. Students' perceptions about working and graduation

Article II aims at investigating the perceptions of the IT students who just started their higher education studies. Perceptions about working show that professional integration was already important for students when starting their IT studies. 8% of the students were working in the IT field when they started their higher education studies, and 14% of the students had prior work experience in the IT field. The students who were not working in the IT field evaluated the probability of them starting to work in the IT field during their higher education studies. Most of the students' answers were between 40% and 59%, but there were also some (14.9%) who were sure about starting work during their studies (probability 80–100%). The most important reason why students chose to start working while studying was their financial situation (42%), followed by work experience (28%), finding a suitable job (12%), having enough time after school (9%), and other reasons (6%). Only 3% of the students reported that under no circumstances would they start working during their studies.

The IT students also evaluated the probability of graduating from their IT studies, which shows their graduation-related self-efficacy, referring to how confident the students are about their own ability to graduate. The results show that most of the students were quite sure of their ability to graduate – 59.9% of the students reported the probability to be 80% or higher. Still, there were some students whose graduation-related self-efficacy was quite low: 9.3% of the students perceived the probability of their graduation to be less than 60%.

4.2. Model of predicting retention in IT studies

The second research question of the Exploration phase was "Which model can be used for investigating retention in IT studies?" This research question was addressed in Articles IV and V.

4.2.1. Bivariate relations in retention

Many bivariate relations between variables that influence retention can be found in the literature. Article IV concludes different factors that may have an effect on retention based on the literature. The factors found in the literature were student demographics, students' income, performance at the university, motivation, social integration, and institutional characteristics. These factors also include academic and social integration from Tinto's model, but some factors include professional integration similarly to the previous results. Academic integration is related to performance at the university, which includes the average grade and collected credit points per semester. Students' performance at the university was found to be affected by their studies prior to the university. This means that better grades prior to the university, better performance in mathematics and certain programming experience result in better performance at the university.

Social integration is one of the factors found in the literature that has been shown to be important in retention or dropout. Social integration includes student involvement (energy devoted to studies, time spent on campus, active participation in student organizations), relations with other students and with the institution, and the environment on university campus. Active social integration could result in higher retention rates, but stressful social interactions may influence dropout.

Professional integration is related to students' income, because working during studies increases students' income. Professional integration is also related to performance at the university, because students have less time to commit to the performance at the university while working. In addition, it was found that the employer's attitude to studying has an impact on the retention of students.

However, a model of retention could provide a more systematic overview of retention than the bivariate relations found in the literature. Based on the results of the literature and the Exploration phase, Tinto's model (1975, 1993) was chosen as the the basis for the Modelling phase. In addition to academic and social integration that are included in the model, professional integration was investigated, as working during studies was found to be important for IT students. Therefore, the following third research question was formulated for the Modelling phase: "How can first-year IT students' graduation-related self-efficacy be predicted by academic, social and professional integration factors?" This was addressed in Article V.

4.2.2. Model of IT students' graduation-related self-efficacy

Firstly, in Article V, a theoretical model based on bivariate relations in retention was created, which, however, did not show a good fit in the empirical analysis. Then, to get a model with a better fit, a model of academic, social and professional integration was created for predicting graduation-related self-efficacy. The final model created with SEM is presented in Figure 8, and it shows an

adequate fit: CFI=0.970, SRMR=0.069 and RMSEA=0.086. The following cut-off values of goodness-of-fit values were used: for CFI 0.95 or above, for SMRM 0.08 or below (Hooper, Coughlan & Mullen, 2008), and for RMSEA 0.1 or below (Maccallum, Browne & Sugawara, 1996). The model describes 94.1% of graduation-related self-efficacy through academic and professional integration. The academic integration part of the model included 2nd semester GPA, intrinsic motivation, and studies' accordance with expectations. Some of these factors were also predicted by students' gender. The professional integration part of the model included IT work experience and estimated working probability in IT, which formed the latent variable Work. However, professional integration (β=0.969, p<0.05) had a much bigger effect on graduation-related self-efficacy than academic integration (β=0.037, p=0.05). Social integration was left out from the model to get a better model fit.

The value of this model lies in showing how important the role of professional integration is in the retention of IT students. The results suggest that academic and social integration have a weaker effect on the retention of IT students than professional integration. However, there is a limitation that should be considered when interpreting the results of the model. Professional integration has a very strong effect on graduation-related self-efficacy and the regression residual is low. It might be that for students, the work variable is almost the same as graduation-related self-efficacy.

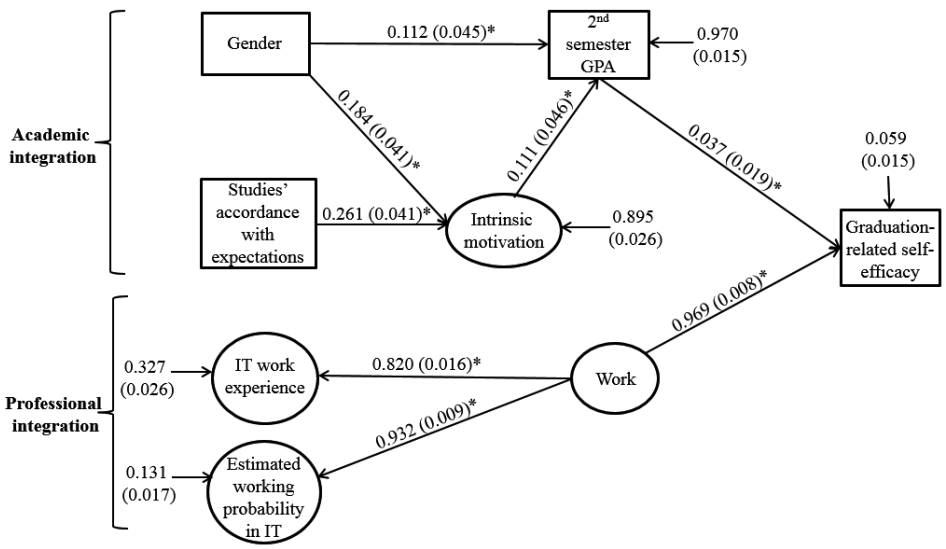

Figure 8. Standardized model of IT students' graduation-related self-efficacy. Fit indexes: CFI=0.970, SRMR=0.069 and RMSEA=0.086. * marks statistically significant (p<0.05) regression coefficients.

4.3. Profiles of IT students

The fourth research question was "Which first-year IT student profiles can be distinguished based on academic, social and professional integration factors?" This research question was addressed in Article VI.

In Article VI, LPA was used to distinguish student groups based on their response profiles. The variables included in the analysis were based on the previously created SEM model (Article V). These were IT work experience, estimated working probability in IT, 2nd semester GPA, intrinsic motivation, studies' accordance with expectations, and graduation-related self-efficacy. Gender was also included in the previously created model, so student profiles were compared based on gender.

The best model was chosen based on a combination of model results, theory and fit statistics (Ram & Grimm, 2009). The 4-profile model was theoretically sensible and showed the best fit based on AIC, BIC, entropy, and A-LMRT. The four IT student profiles are presented in Figure 9. The profiles were more similar in academic integration related variables such as studies' accordance with expectations and intrinsic motivation. Bigger differences appeared in professional integration (IT work experience, estimated working probability), graduation related self-efficacy, and 2nd semester GPA. Students in Profile 1 and Profile 2 had lower graduation-related self-efficacy, but the profiles differed mostly in IT work experience – students in Profile 1 exhibited quite high IT work experience, whereas almost none of the students in Profile 2 had IT work experience. Students in Profile 3 and Profile 4 had high graduation-related self-efficacy, but the profiles differed again in IT work experience – students in Profile 3 exhibited quite low IT work experience, whereas almost all students in Profile 4 had IT work experience. In addition, gender differences appeared between the profiles – there were significantly fewer female students in Profile 1 and Profile 3 and more female students in Profile 2 and Profile 4.

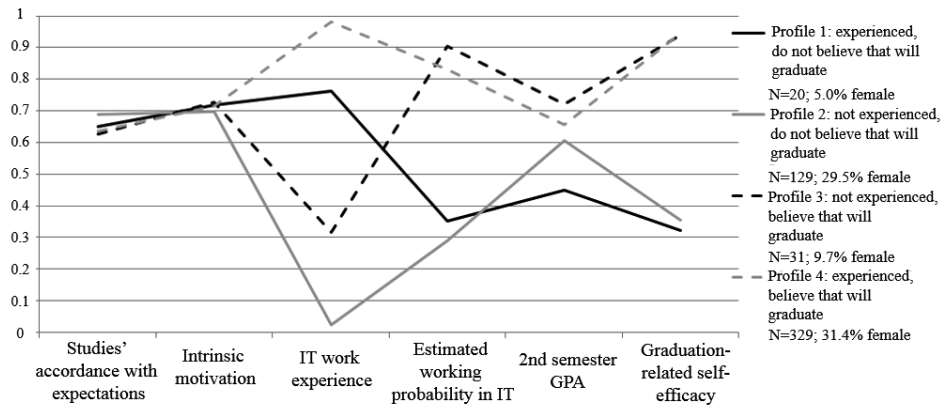

Figure 9. Four IT student profiles

5. DISCUSSION

There is a global need for IT specialists, but low retention rates in higher education studies raise the problem of the number of graduates not meeting the labor market needs. Dropout rates are especially high during the first year of IT studies.

Retention in general is a widely studied topic, but research focusing on the IT field is rather rare. Several models have been created to investigate retention (e.g., Bean (1980, 1983); Tinto (1975, 1993)). However, retention in the IT field may be slightly different from other fields, as it is relatively new and developing very fast. Also, because of the lack of IT workers in the labour market, IT companies often hire students, who need to divide their time between work and studies. The previously created models in their original form may not be suitable for current IT studies, because nowadays students often do not live on university campus and are often working during their studies. Therefore, the current dissertation develops one of the well-known models of retention (Tinto, 1975, 1993) further to make it more suitable for current IT studies.

5.1. Model of academic, social and professional integration

Tinto's retention model (1975, 1993) shows that academic and social integration are important in student retention. The current study detected, however, that work environment and professional integration are even more important in the retention of IT students. Therefore, Tinto's model was developed further by adding work environment and professional integration (see Fig. 10). Work environment is closely related to academic and social systems, because in the work environment, students are academically integrated if they solve work-related problems and develop themselves academically; and they are socially integrated at work when they communicate with other people who work in the IT field. Other studies have also shown that academic, social and professional spheres are overlapping (Thomas, 2012; Thomas et al., 2017). Davidson and Wilson (2013), for instance, pointed out about student-tutor interaction that the interaction is academic when the tutor addresses course-related and organizational matters but that the interaction could also be social when the tutor is addressing personal and non-course related matters (Davidson & Wilson, 2013). The result of the current study were similar: the item about the teacher who teaches IT in school or university and the item about participating in IT events, hobby groups or competitions include both academic and social aspects.

The results of the current study suggest that the role of academic, social and professional integration changes from entering higher education studies to continuing the studies during the first year. It was found that when students are choosing what to study at the higher education level then academic, social and work-related professional integration are all important, but the role of academic and professional integration is greater than the role of social integration. Other

studies have also shown that IT related studies prior to university, describing academic integration, have an effect on career choices in IT related fields (Akbulut & Looney, 2009; McGill, Decker & Settle, 2016). Therefore, IT studies at the general education level could motivate students to choose an IT related career and all students should have an opportunity to learn IT in school. The important role of professional integration in IT related studies is shown by Divjak, Ostroski and Palma (2010), who found that employment opportunities, such as opportunities for advancement, a good income and additional jobs, influence motivation for choosing an IT related career. Although the results of the current study showed that the role of social integration in students choosing IT studies was quite small, other studies have demonstrated the importance of social integration in career choice (e.g., Divjak, Ostroski & Palma, 2010; Rosson, Carroll & Sinha, 2011).

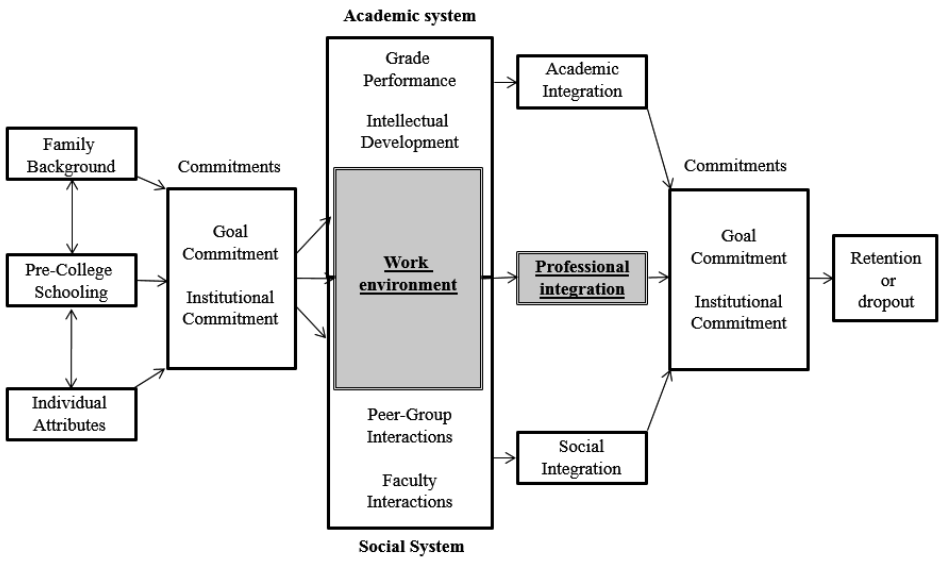

Figure 10. Model to predict retention and dropout in IT studies (developed further based on Tinto's model (1975, 1993))

Academic and professional integration were also found to have an effect on IT students' graduation-related self-efficacy in predicting student retention. Professional integration was found to be the major predictor of IT students' graduation-related self-efficacy, but the role of academic integration was much smaller. Social integration was left out to get a better model. Other studies have also shown that the role of social integration in retention is smaller than the role of academic integration (Davidson & Wilson, 2013; Larsen, 2000). The reason for the less significant role of social integration could be that fewer students live on university campus (Davidson & Wilson, 2013). Still, social integration is related to professional integration, as students who work in the IT field are

communicating more with IT workers and are included in their community. This means that social integration may not be related to university environment as much as to work environment.

The level of academic, social and professional integration may change during higher education studies (see Fig. 11). The role of academic integration is already big prior to higher education studies (in general school), remains so throughout higher education studies until graduation and starts decreasing after that. However, academic integration should not disappear after graduation, because the IT field is changing very fast and IT workers need to be academically integrated to keep up with the changes. The role of social integration is already big before higher education because of the relationships in general school and personal life. However, the role of social integration grows when students enter university because of the wider social network there. The social network also grows when students start working and therefore continues growing after graduation as well. Whereas social integration is more related to relationships in school prior to higher education studies, it becomes more related to work environment during higher education studies and after graduation. The role of professional integration is usually small before higher education studies, because students do not usually work during their general education studies. Professional integration becomes more important in higher education, when students come into contact with work environment. After graduation, the role of professional integration becomes the most important, as people spend most of their time in the work environment then instead of university.

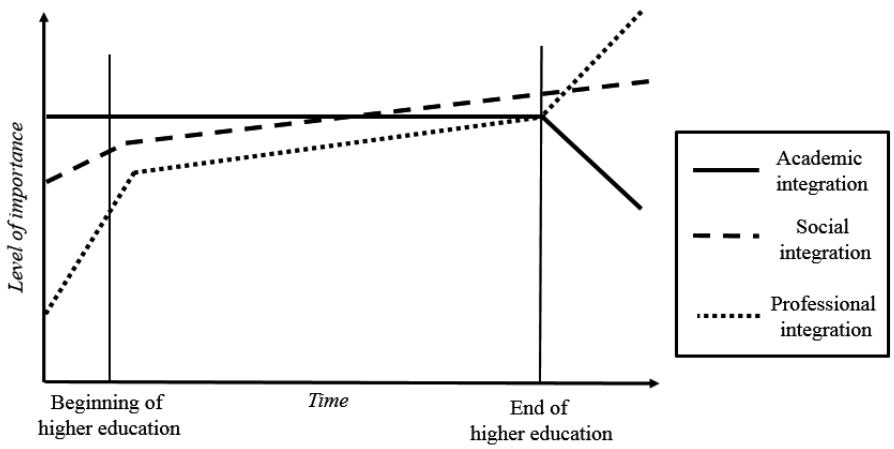

Figure 11. Change of integration during higher education studies

Still, there may be people who have very different paths of integration. For example, some people spend years working before entering higher education studies, some study something else at the higher education level and decide to come back years later to study IT, some do not want to work during their

studies, etc. Therefore, change of integration does not describe all students but the main changes in integration for an average IT student.

5.2. The role of motivation in entering IT studies and in retention

Intrinsic and extrinsic motivation also play a role both in choosing what to study and in retention. The results of this dissertation suggest that intrinsic motivation for choosing an IT curriculum shows academic or professional integration and extrinsic motivation shows professional integration. This means that academic experiences (e.g., learning IT in general school) have caused an interest in IT and students want to continue IT studies or work in IT field for reasons that come from within. The image of the IT field, job opportunities and salaries in the IT field, on the other hand, are external factors that raise extrinsic motivation for studying IT at the higher education level. Academic integration could also be related to extrinsic motivation (e.g., students study the subject because they fear parental sanctions for not doing it or believe that it is valuable for their future career (Ryan & Deci, 2000)), but the results of the current dissertation did not show this relationship. Studies have shown that higher motivation results in higher academic achievement (Bruinsma, 2004) and contributes to lower dropout rates (Hardre & Reeve, 2003). The SEM model created in the current dissertation shows that intrinsic motivation has an effect on IT students' GPA, and, through that, intrinsic motivation has an indirect effect on students' graduation-related self-efficacy.

Motivation is closely related to interest and engagement, meaning that all three are therefore important in the learning process (Järvelä & Renninger, 2014). Järvelä and Renninger (2014) concluded that to increase students' interest, motivation and engagement, content-informed interactions should be supported and scaffolding for learners to think and work with content needs to be provided (Järvelä & Renninger, 2014). One way to do that is to give students authentic and meaningful learning tasks (Crosling, Thomas & Heagney, 2008; Järvelä, Veermans & Leinonen, 2008). Studies have found that making connections between their own lives and what they are learning increases students' motivation and academic achievement (Hulleman & Harackiewicz, 2009). In IT studies, these authentic and meaningful tasks could come from real IT companies, showing students that these tasks are important in their current or future work and professional development. On one hand, this could increase students' motivation, which is related to academic achievement (Bruinsma, 2004; Gottfried, 2009). On the other hand, solving real IT work related tasks increases professional integration, and the results of this study suggest that higher professional integration results in higher retention rates. Other studies have also suggested that higher education curricula should assist students in developing skills that are needed in their future life and future employment (Barrie, 2005). Based on the model that predicts retention, the role of professional integration

and social integration should increase during the studies, but, at the same time, academic integration should be kept stable. Therefore, adding real IT work related learning tasks to higher education curricula could help to increase professional, academic and social integration, and, through that, retention rates. In addition, it helps students to be more successful in their future employment.

5.3. Supporting the retention of IT students with different profiles

As there are students who have different paths of integration in their life, there are also students with different profiles, who therefore need different types of support to cope with their studies and graduate. Knowing student profiles could help universities to design interventions for each student group and apply the interventions to increase retention rates. Still, not all students need to graduate. Weaker students who are not able to maintain their position in the academic field of the university may drop out, which is not necessarily a negative event for the university (Larsen et al., 2013). In addition, some researchers argue that dropout is not a negative event for students if they achieved their goal in higher education (Bean, 1990). This means that students acquire the specific knowledge and skills that they need at work but not the learning outcomes that are needed for graduating. Nevertheless, many students need support from the university to reach their goals.

The results of the current study show that professional integration has an important role in dividing students into groups with different profiles. This suggests that universities should pay more attention to the professional integration of IT students. In order to increase professional integration as the model predicting retention suggsests, some changes are needed in the curricula. For example, work practice could be implemented in the studies starting from the first semester to integrate students professionally. Through professional integration, academic and social integration could increase as well, being related to professional integration. However, this requires collaboration with IT companies so that workplace based learning could be organized. The importance of workplace based learning has been shown, for instance, in medicine (e.g., Karani et al., 2014; Rees, Sinha, Davies & Quinn, 2016) and teacher education (e.g., Gijebels, Kyndt, Peeters & Schelfhout, 2017; Leijen et al., 2015), as it merges knowledge that students gain from the university and practice that they get in the workplace (Raelin, 2008). To make workplace based learning more meaningful, a reflection procedure should be linked with the practice (Leijen et al., 2015; Raelin, 2008; Rees et al., 2016). This means that universities should include reflection in the work practice and guide it so that students could gain new practical knowledge that could be applied both at university and at work.

The importance of work experience and professional integration has also been shown by Kivinen and Nurmi (2014), who found on the sample of 12 European countries that students who are older and have work experience in the

field of their studies will find professional employment quite fast after graduation, whereas young students who graduate quickly need a longer period after graduation to start their professional career. This means that it is beneficial for students to work during their higher education studies. If curricula were designed in collaboration with IT companies and included workplace based learning, it would be easier for students to combine work and studies. This might increase retention rates and help students graduate sooner and already with work experience.

The results of the current study also show that some student profiles exhibit lower grades than others and supporting their academic integration could help them to keep up with the studies. Especially during the first year of studies, students have to pass general courses that have been found difficult for them and where dropout rates are high, e.g., introductory computer science courses (Benda, Bruckham & Guzdial, 2012; Zingaro, 2015), programming courses (Watson & Li, 2014) and mathematics courses (Divjak, Ostroski & Hains, 2010). As the model that predicts graduation-related self-efficacy suggests, the role of academic integration should be kept stable during studies. Therefore, students who have problems with certain courses may need some type of extra seminars or courses that help them to study more and cope with the difficult courses. Thomas (2012) also suggests that academic support is the most important in effective student retention and success. As an example of academic support, the University of Latvia has implemented an intervention where IT students with lower academic achievement in mathematics have to take a Compensatory Course of High School Mathematics during their first year of studies (Borzovs, Niedrite & Solodovnikova, 2016). Therefore, offering extra seminars or courses could be added to the IT curricula to help keep the level of academic integration stable and retain certain student groups.

6. CONCLUSIONS AND IMPLICATIONS

6.1. Conclusions

Retention at the higher education level is a widely investigated field, but only few studies have focused on retention in IT related curricula. Therefore, the current dissertation focused on different factors that influence IT students when they start their studies and the retention of IT students; and on the different profiles of first-year IT students. In the dissertation, Tinto's model of retention (1975, 1993) was developed further to make it more suitable for the European context and IT studies. The first phase of the research was Exploration, for which two aims were set: 1) to create a system of factors that influence students' enrolment in higher education IT studies and the retention of IT students; and 2) to find a model that can be used for investigating retention in IT studies. Based on the Exploration phase, two more aims were specified for Modelling, the second phase: 3) to explain the role of academic, social and professional integration in predicting retention in higher eduction IT studies; and 4) to distinguish IT student profiles based on academic, social and professional integration. The main conclusions of the dissertation are presented by the four research questions that were formulated.

RQ 1. *Which factors have an effect on students' entry into higher education IT studies and on the retention of IT students?*

- Academic, social and professional integration are all important in influencing students towards choosing to study IT as well as in the retention of IT students. However, the role of academic, social and professional integration is not equal here. Academic integration is very important when students are choosing what to study at the higher education level. Social integration becomes more important during studies and has an effect on student retention. Professional integration is highly important both in influencing students' decision to choose an IT curriculum and in the retention of IT students at the higher education level.

RQ 2. *Which model can be used for investigating retention in IT studies?*

- Academic and social integration from Tinto's model can be used for investigating retention in higher education IT studies. However, work environment and professional integration should be added to the model, as a large number of IT students are interested in working during their higher education studies. Therefore, the model including academic, social and professional integration can be used for investigating retention in IT studies.

RQ 3. *How can first-year IT students' graduation-related self-efficacy be predicted by academic, social and professional integration factors?*

- The role of professional integration is the most important in predicting the graduation-related self-efficacy of first-year IT students. In addition, academic integration has a weaker effect on graduation-related self-efficacy, and social integration alone has no effect on graduation-related self-efficacy. However, academic and social integration are closely related to professional integration. Students are academically integrated at work when they solve work-related problems and develop themselves academically. Students are socially integrated at work when they communicate with other IT workers.

RQ 4. *Which first-year IT student profiles can be distinguished based on academic, social and professional integration factors?*

- Four first-year IT student profiles can be distinguished based on academic, social and professional integration. The profiles of IT students are more similar in academic integration related factors and bigger differences appear in professional integration and graduation-related self-efficacy.
- Students in the profile *experienced, do not believe that will graduate* experienced difficulties with their studies and need support in academic integration (e.g., extra courses). Students in profiles *not experienced, do not believe that will graduate* and *not experienced, believe that will graduate* exhibited weak professional integration, and organizing practice in the workplace may help to increase their graduation-related self-efficacy. Students in the profile *experienced, believe that will graduate* seemed to be academically, socially and professionally integrated and do not need any additional support during the first year of studies. However, some of these students might still drop out and may therefore need support in later study-years.

6.2. Implications

The current dissertation provides implications with respect to future research and practice in higher education IT curricula. Also, directions for further empirical studies are offered.

Scientific implications:

- Based on Tinto's retention model (1975, 1993) and the What Works? programme (Thomas, 2012; Thomas et al., 2017), the model of retention was developed further in the current dissertation by adding work environment and professional integration to academic and social integration. The role of professional integration

is the most important in the retention of IT students, and, therefore, the model that includes three types of integration (academic, social and professional) is more suitable for investigating retention in IT curricula. In addition, professional integration is closely related to academic and social integration.

- The role of academic, social and professional integration changes during higher education studies. Academic integration is more important in choosing IT studies than professional and social integration. However, the role of professional and social integration grows during university studies, and professional integration becomes the most important type of integration after graduation.

Practical implications:

- The results of the current dissertation suggest that if students are more professionally integrated, their graduation-related self-efficacy is higher, which could have a positive effect on their retention. As the role of professional integration is so important, universities should pay more attention to integrating their students professionally (e.g., by adding workplace based practice, authentic and meaningful real IT work related tasks).
- Distinguishing four IT student profiles suggests that IT students have different levels of integration and students with different profiles may therefore need different types of support to graduate. As both those students with work experience and those with no work experience could have low graduation-related self-efficacy, all students need support in order to graduate. The support could be offered through changes in the curriculum (e.g., the content of the courses, organizing workplace based practice, mentoring the students) that support academic, social and professional integration.

Directions for further studies:

- The importance of professional integration in IT studies suggests that collaboration between IT companies and universities may be needed to better integrate students professionally. However, it needs further investigation whether this collaboration would actually result in higher professional integration and higher retention rates of students. The professional integration could be, for example, some type of workplace based practice that starts already during the first semester and is supported by the university (e.g., through reflection tasks). Workplace based practice has been applied to teacher education and medical education but could be beneficial in IT education as well. In further studies, the characteristics of effective workplace based practice in IT studies should be described based on theory and the workplace based practice should be designed based on these characteristics. After that, it could be implemented in IT curricula to investigate the actual effect on professional integration and retention. In addition, the benefit of

including authentic and meaningful learning tasks in the curricula could be investigated in further studies. Real-life work related tasks could help to motivate students to study and to integrate them professionally. Therefore, in further studies, real-life work related tasks could be designed based on theory and implemented in IT curricula in order to investigate how these tasks influence students' professional integration and retention.

- Since academic integration has an effect on students' choice to study IT, all students should have the opportunity for IT related academic integration in general school (e.g., IT lessons). Currently, IT studies at the general education level are not compulsory in Estonia and the content of the courses varies considerably between schools. Therefore, it should be further investigated if carefully designed compulsory IT courses in the national curriculum have a positive effect on students. It should also be further studied what the content of these IT courses should be and if the students who have participated in the courses actually have a better overview of what IT is and if they want to study IT at the higher education level.
- Students who are not doing well in university courses could be supported by integrating them academically. It needs further investigation if additional seminars or courses and a more personal approach could be offered to them to help them cope with the difficult studies. Also, it should be further studied what kind of additional seminars or courses are the most beneficial for IT students. Based on the theory, these additional courses or seminars could be designed and implemented with students who have difficulties with the studies to investigate the effect on academic integration and retention rates.

7. LIMITATIONS

Considering the design and results of the current dissertation, some limitations can be pointed out that should be considered when interpreting the results. The main limitations are the following:

- Data was collected by a cross-sectional study from first-year IT students. Still, longitudinal data is needed to see how the level of different types of integration change during the studies and to find empirical evidence for the model that predicts retention through academic, social and professional integration. In addition, collecting data from the students who drop out of universities could give a broader overview of all the aspects that are important in the retention of IT students.
- Filling in the questionnaires took place at lectures, but some students were not present. These students got the questionnaire by e-mail, but only few of them responded to the electronic questionnaire. Therefore, the sample of this study does not represent all the IT students. The students who participated in the study were more likely to participate in the lectures and continue their studies after the first study year than those students who did not participate in the study.
- The questionnaires for the data collection were created in a project based on bivariate relations that have an effect on retention and the experience of experts who taught IT students in higher education institutions. The theoretical background of academic, social and professional integration was formed later, and therefore, the questionnaires did not exactly fit the model of academic, social and professional integration. However, the questionnaire included components of academic, social and professional integration that were used in the data analysis. The results show that the role of social integration was very small in retention, but it could actually be bigger. The measure of social integration could be changed for further studies.
- In the Modelling phase of the dissertation, students' graduation-related self-efficacy was used in the analysis, but not the actual graduation rates. The actual graduation rates were not available for all the students. The students who started in 2013 should have graduated in 2016, but about one third of the students were still studying in the academic year 2016/2017. This shows that quite often it takes more than three years for IT students to graduate. Therefore, for future studies longitudinal data needs to be collected to see which students actually graduated, which dropped out, which changed curricula, and which got to the IT labour market.
- Another limitation is related to the graduation-related self-efficacy. It was measured only through one question in the questionnaire: "How strong is the probability of you finishing your studies?" Asking more questions about graduation-related self-efficacy could give more reliable results. In addition, the graduation-related self-efficacy measured during the first study year

gives an idea of the students who are at a higher risk of dropping out, but graduation-related self-efficacy may change during the next years of study because of the influence of various factors. Therefore, the graduation-related self-efficacy could be different during the next years and students who exhibited high levels of graduation-related self-efficacy may have lower graduation-related self-efficacy during the next years and still drop out.

- The results of the Modelling phase show that professional integration has a substantial role in predicting graduation-related self-efficacy and the regression residual is low. However, this result seems to be too good. It might be that for IT students professional integration is almost the same thing as graduation-related self-efficacy. The result could also be influenced by the fact that the questions about working probability and graduation-related self-efficacy were located next to each other in the questionnaires. However, professional integration also included the variable about previous work experience, which was not located next to the previously mentioned questions. Therefore, for future studies more questions could be asked about professional integration and graduation-related self-efficacy to prevent such problems.

APPENDICES

Appendix 1. Overview of academic, social and professional integration related questions in the two questionnaires that were used in the data collection.

Dimension	Questions in Questionnaire 1	Questions in Questionnaire 2
Academic integration	2 questions: - How informed are you about the curriculum you are studying? - How well does the curriculum meet your expectations?	11 questions: - When did you start to learn programming? - Which was the first programming language you learned to use? - How long did you study informatics/computer science in school? - What was the main content in your informatics/computer science class? - How informed are you about the curriculum you are studying? - How well does the curriculum meet your expectations? - How well do your studies (lecturers, teaching methods) meet your expectations? - In your studies, how balanced are the theoretical knowledge and practical skills? - How complicated are your university studies compared to high school studies? - How pleasant are your university studies compared to high school studies? - How does a negative grade (failure) influence your motivation to continue your studies and graduate?
Social integration	2 questions: - How many of your friends are also IT students? - How many of your friends work in the IT field?	3 questions: - How many of your friends are also IT students? - How many of your friends work in the IT field? - With how many of your coursemates do you communicate regularly after school?

Dimension	Questions in Questionnaire 1	Questions in Questionnaire 2
Professional integration	7 questions: - Do you work in the IT field? - How informed are you about job opportunities in the IT field? - How high is the probability that you will start working in the IT field during your studies? - How high is the probability that you will work in the IT field after your studies? - What kind of jobs would you want to do in the IT field? - Have you worked in the IT field before? Yes / No If YES, then how long? If YES, then what kind of work have you done in the IT field? If YES, then how has the work experience influenced your interests? - In what circumstances do students start working during their studies (or if you already work, then why)?	7 questions: - Do you work in the IT field? - How informed are you about job opportunities in the IT field? - How high is the probability that you will start working in the IT field during your studies? - How high is the probability that you will work in the IT field after your studies? - What kind of jobs would you want to do in the IT field? - Have you worked in the IT field before? Yes / No If YES, then how long? If YES, then what kind of work have you done in the IT field? If YES, then how has the work experience influenced your interests? - In what circumstances do students start working during their studies (or if you already work, then why)?

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SUMMARY IN ESTONIAN

Akadeemilise, sotsiaalse ja professionaalse integratsiooni roll kõrgkoolis infotehnoloogia õpingutes üliõpilaste edasijõudmise prognoosimisel

Infotehnoloogia (IT) roll ühiskonnas kasvab ning tööturule on pidevalt vaja juurde uusi IT-oskustega töötajaid (Gareis et al., 2014). Üliõpilased on küll huvitatud IT-erialade õppimisest, kuid eriala lõpetajate arv Euroopa Liidus on langemas (Gareis et al., 2014), sest suur hulk üliõpilasi katkestab õpingud. Euroopa Liidus on keskmine väljalangevus IT-erialadelt kokku 19 % (Hüsing et al., 2013), kuid Eestis katkestab õpingud juba esimese õppeaasta jooksul 29,8 % IT üliõpilastest (arvutused EHIS, 2015 põhjal). Seetõttu on käesoleva doktoritöö fookuses IT-õpingud Eesti kõrgkoolides esimesel õppeaastal.

Kirjandusest võib leida mitmeid seoseid tunnuste vahel, mis mõjutavad kõrgkoolis edasijõudmist või väljalangemist. Larsen jt (2013) viisid läbi süstemaatilise kirjanduse analüüsi ja leidsid, et kõrgkoolis edasijõudmist mõjutavad tegurid saab jagada 11 kategooriasse: 1) üliõpilase sotsiodemograafiline taust, 2) akadeemilised pädevused/eeldused õppimiseks, 3) ettevalmistus õppimiseks (sh sobiva õppekava valik, õpingutele seatud ootused), 4) motivatsioon õppimiseks, 5) strateegiad, mida õppimisel kasutatakse, 6) õppetingimused (sh õppekava, õpingute koormus, õppejõud, füüsiline ja vaimne kliima), 7) sotsiaalne ja/või akadeemiline integratsioon kõrgkoolis, kohanemine kõrgkooliga, 8) üldine hinnang kõrgkoolielule, 9) väljalangejate võimalused väljaspool kõrgkooli (nt töövõimalused), 10) üliõpilase majanduslik olukord (sh õppemaksu maksmine, stipendiumi saamine) ning 11) üliõpilase elamistingimused (isiklik olukord, pere olukord ja toetus ning töötamine õpingute ajal). Need kategooriad annavad väga laia pildi erinevatest edasijõudmist mõjutavatest teguritest, kuid tervikliku mudeli kasutamine edasijõudmise uurimisel annaks süstemaatilisema ülevaate kui nende seoste eraldi uurimine.

Esimesed süstemaatilisemad lähenemised kõrgkoolis edasijõudmise uurimisel pärinevad USA-st 1960ndatest aastatest (Berger, Ramirez & Lyons, 2005). Ühe tuntuima väljalangemise mudeli on koostanud Vincent Tinto (1975, 1993). See mudel näitab, et edasijõudmise ennustamisel on olulised üliõpilase individuaalsed tunnused (nt pere taust, individuaalsed omadused, kõrgkoolile eelnevad õpingud), pühendumine õpingutele, akadeemiline ja sotsiaalne süsteem. Mudel näitab, et mida rohkem on üliõpilased akadeemiliselt ja sotsiaalselt integreeritud, seda suurem on tõenäosus õpingud lõpetada. Siiski on see mudel üsna vana ning ei sobi sellisel kujul Eesti IT-üliõpilaste edasijõudmise uurimiseks.

Vabade töökohtade tõttu IT-tööturul lähevad paljud IT-üliõpilased õpingute ajal tööle. See viitab, et lisaks akadeemilisele ja sotsiaalsele integratsioonile Tinto mudelis on ka professionaalne integratsioon IT-üliõpilastele oluline. Thomas (2012) ja Thomas jt (2017) eristasid ülikoolis kolme sfääri, millesse üliõpi-

lased on kaasatud: akadeemiline, sotsiaalne ja professionaalne. Viimane neist tähendab selliste oskuste omandamist, mida üliõpilased vajavad nii ülikoolis õppides kui ka pärast õpingute lõpetamist (nt igapäevaelus ja tööl). Seetõttu uuritakse käesolevas doktoritöös ka professionaalse integratsiooni rolli IT-üliõpilaste edasijõudmisel.

Kõrgkoolis edasijõudmine on küll laialt uuritud valdkond, kuid väljalangemise määrad pole vähenenud. Mitmed kõrgkoolid on proovinud erinevaid sekkumisi IT-erialadelt väljalangemise ennetamiseks. Näiteks on sotsiaalse integratsiooni tõstmiseks organiseeritud üliõpilastele üksteisega tutvumiseks üritusi (Taltna jt, 2006), akadeemilise ja sotsiaalse integratsiooni suurendamiseks mentorprogramme (Borzovs, Niedrite & Solodovnikova, 2016) ning akadeemilise edasijõudmise toetamiseks lisakursusi (Borzovs, Niedrite & Solodovnikova, 2016). Enamasti on kõigi üliõpilaste puhul rakendatud ühte sekkumist, kuid väljalangemise põhjused on väga erinevad (Kinnunen & Malmi, 2006) ning üks sekkumine ei pruugi kõigile sobida. Seetõttu kasutatakse käesolevas doktoritöös personaalset lähenemist, et eristada sarnase profiiliga üliõpilasi. Teades üliõpilaste profiile, saab kõrgkool erinevat tüüpi üliõpilastele pakkuda vastavat toetust, et suurendada nende edasijõudmist.

Käesolev doktoritöö koosnes kahest osast: avastusetapp ja mudeldamisetapp. Avastusetapi eesmärgiks oli luua ülevaate teguritest, mis omavad tähtsust IT-eriala valimisel ja õpingutes edasijõudmisel ning leida mudel, mis sobiks IT-erialadel edasijõudmise kirjeldamiseks ja toetamiseks. Avastusetapile sõnastati kaks uurimisküsimust:

1) Millised tegurid omavad tähtsust IT-eriala valimisel ja õpingutes edasijõudmisel?
2) Milline mudel sobib IT-erialadel edasijõudmise uurimiseks?

Avastusetapi tulemuste põhjal keskenduti mudeldamisetapis IT-üliõpilaste akadeemilise, sotsiaalse ja professionaalse integratsiooni uurimisele. Mudeldamisetapi eesmärgiks oli selgitada akadeemilise, sotsiaalse ja professionaalse integratsiooni rolli IT-õpingutes edasijõudmise ennustamisel ning IT-üliõpilaste profiilide eristamisel. Mudeldamisetapile sõnastati kaks uurimisküsimust:

3) Kuidas saab akadeemilise, sotsiaalse ja professionaalse integratsiooni kaudu prognoosida esimese aasta IT-üliõpilaste lõpetamisega seotud enesetõhusust?
4) Milliseid IT-üliõpilaste profiile saab eristada akadeemilise, sotsiaalse ja professionaalse integratsiooni põhjal?

Andmeid koguti esmalt üliõpilaskandidaatidelt vastuvõtuprotsessi käigus vabavastuselise küsimusega, et saada teada, millised tegurid on vastajaid mõjutanud IT-erialale kandideerima. Seejärel koguti andmeid kõrgkooli vastuvõetud IT-üliõpilastelt küsimustikega esimese ja teise semestri alguses akadeemilise, sotsiaalse ja professionaalse integratsiooniga seotud tegurite kohta. Lisaks saadi kõrgkoolidest andmeid üliõpilaste akadeemilise edasijõudmise kohta.

Avastusetapis leiti, et akadeemilisel integratsioonil on kõige olulisem roll IT-eriala valikul, kuid õpingutes edasijõudmise mõjutamisel on akadeemilise integratsiooni roll väiksem. Professionaalse integratsiooni olulisus paistis välja

nii eriala valiku mõjutamisel kui ka edasijõudmise mõjutamisel. Sotsiaalse integratsiooni roll eriala valikul oli väike, kuid muutus olulisemaks õpingute käigus edasijõudmise mõjutamisel. Seega on kõik kolm integratsioonitüüpi IT-õpingutes olulised ning seetõttu valiti mudeldamisetapi aluseks akadeemiline ja sotsiaalne integratsioon Tinto (1975, 1993) mudelist ning lisaks professionaalne integratsioon, mida on käsitlenud ka Thomas (2012) ning Thomas jt (2017).

Mudeldamisetapis loodi mudel, mis võimaldab prognoosida IT-üliõpilaste lõpetamisega seotud enesetõhusust. Professionaalse integratsiooniga seotud teguritel on selles mudelis kõige suurem roll lõpetamisega seotud enesetõhususe prognoosimisel. Akadeemilise integratsiooni roll oli mudelis väike, kuid sotsiaalne integratsioon jäi täiesti välja, et saada parem mudel. Ka teised uuringud on näidanud, et sotsiaalse integratsiooni roll kõrgkoolis on väiksem kui varem, sest üliõpilased ei ela enam nii palju ülikoolilinnakutes (Daividson & Wilson, 2013). Loodud mudelis olnud tegurite põhjal leiti IT-üliõpilaste integratsiooniprofiilid. Ka profiilide võrdlemisel selgus, et professionaalse integratsiooniga seotud tegurite roll profiilide eristamisel on oluliselt suurem kui akadeemilise integratsiooniga seotud tegurite roll.

Tulemustest võib järeldada, et erinevat tüüpi integratsioonide olulisus muutub õpingute jooksul. Kui akadeemiline integratsioon on oluline juba enne kõrgkooli ja erialavaliku tegemisel, siis esimesel kõrgkooliõpingute aastal kasvab oluliselt professionaalse integratsiooni roll, mis toob omakorda kaasa sotsiaalse integratsiooni olulisuse kasvu. Oluliseks saab just sotsiaalne integratsioon töökeskkonnas.

Käesoleva doktoritöö panus teadusesse seisneb Tinto mudeli (1975, 1993) täiendamises. Töökeskkond ja professionaalne integratsioon lisati mudelisse, et kohandada seda kaasaegsete IT-õpingute jaoks. Doktoritöö tulemused näitavad, et selline mudeli täiendus on mõistlik, sest professionaalsel integratsioonil oli kõige suurem roll kõrgkoolis IT-õpingutes edasijõudmise prognoosimisel ja IT-üliõpilaste profiilide eristamisel. Töö praktiline väärtus seisneb kõrgkoolidele tehtavates soovitustes, mida saaks IT-üliõpilaste edasijõudmise toetamisel teha, kuid nende tõhusus vajab edasist uurimist. Alustada võiks juba üliõpilaste vastuvõtu tõhustamisest, et saada kõrgkooli motiveeritumad ja erialale sobivamad üliõpilased. Üliõpilased, kellel on õpingutes raskusi või kelle eelteadmised on väiksemad, vajavad toetust akadeemilises integratsioonis (nt lisaseminare, kursusi, konsultatsioone). Kõrgkoolid peaksid tegema koostööd IT-ettevõtetega, et üliõpilased saaksid õpingutes lahendada päris tööga seotud ülesandeid, mis neid rohkem motiveeriksid. Koostöö IT-ettevõtetega on vajalik ka õppekavaarenduses – õppekavadesse võiks olla planeeritud praktika mõnes IT-ettevõttes, mis tõstaks üliõpilaste professionaalset ja sotsiaalset integratsiooni ning aitaks teooriat ja praktikat omavahel paremini siduda.

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PUBLICATIONS

CURRICULUM VITAE

Name: Külli Kori
Date of birth: September 12, 1989
Citizenship: Estonian
Work address: University of Tartu, Faculty of Social Sciences, Institute of Education, Salme 1a, Tartu 50103
Phone: +372 5623 7966
E-mail: kulli.kori@ut.ee

Education:

2013– …	University of Tartu PhD studies in Education
2011–2013	University of Tartu Master studies in Secondary School Science Teacher (Teacher of Biology)
2008–2011	University of Tartu Bachelor studies in Genetic Engineering
1996–2008	Türi Secondary School

Professional employment:

2014– …	University of Tartu, Faculty of Social Sciences, Institute of Education, Junior Research Fellow of Educational Technology
2013–2014	University of Tartu, Faculty of Social Sciences and Education, Institute of Education, Specialist of Technology Education

Field of research:
Retention in higher education IT studies, educational technology

Publications:

Kori, K., Pedaste, M., & Must, O. (*accepted*). The Academic, Social and Professional Integration Profiles of Information Technology Students. *ACM Transactions on Computing Education*.

Kori, K., Pedaste, M., & Must, O. (2017). Integration of Estonian Higher Education Information Technology Students and Its Effect on Graduation-Related Self-efficacy. In *International Conference on Learning and Collaboration Technologies* (pp. 435–448). Springer, Cham.

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ELULOOKIRJELDUS

Nimi: Külli Kori
Sünniaeg: 12. september, 1989
Kodakondsus: Eesti
Aadress: Tartu Ülikool, sotsiaalteaduste valdkond,
haridusteaduste instituut, Salme 1a, Tartu 50103
Telefon: +372 5623 7966
E-post: kulli.kori@ut.ee

Haridustee:

2013– …	Tartu Ülikool haridusteaduse doktoriõpe
2011–2013	Tartu Ülikool gümnaasiumi loodusteaduste õpetaja magister (bioloogiaõpetaja)
2008–2011	Tartu Ülikool geenitehnoloogia bakalaureus
1996–2008	Türi Gümnaasium

Teenistuskäik:

2014– …	Tartu Ülikool, sotsiaalteaduste valdkond, haridusteaduste instituut, haridustehnoloogia nooremteadur
2013–2014	Tartu Ülikool, sotsiaal- ja haridusteaduskond, haridusteaduste instituut, tehnoloogiahariduse spetsialist

Teadustegevus:
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Kori, K., Pedaste, M., & Must, O. (*accepted*). The Academic, Social and Professional Integration Profiles of Information Technology Students. *ACM Transactions on Computing Education*.

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