

University of Helsinki, Institute of Behavioural Sciences,
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Henna Asikainen

SUCCESSFUL LEARNING AND STUDYING IN BIOSCIENCES

Exploring how students' conceptions of learning, approaches to learning, motivation and their experiences of the teaching-learning environment are related to study success

Academic dissertation to be publicly discussed, by due permission of the Faculty of Behavioural Sciences at the University of Helsinki in the Athena Building (Siltavuorenpenger 3 A), Lecture hall 302 on the 17th of January, 2014 at 12 o'clock.

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Helsinki 2014

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Abstract

The aim of this doctoral thesis is to explore successful learning and studying in biosciences at two levels. Its purpose is to examine how students' conceptions of learning and their approaches to learning as well as their experiences of the teaching-learning environment are related to study success during Bachelor level studies in the context of biosciences. The aim of this doctoral thesis is to further examine how students' studying develops during their bachelor studies. This doctoral thesis applies a mixed-method approach.

The first two studies employed a quantitative approach to explore the relationship between students' approaches to learning, their experiences of the teaching-learning environment and academic achievement at general level. Study 1 focused on first-year studies and Study 2 on final-year studies as well as students' development during studies. The results showed that, in addition to interest in the subject, organised studying was related to study success during bachelor studies. The deep approach to learning in the first year predicted study success in the final year. Organised studying, in addition to peer support, was also related to academic progression in the first year. Furthermore, the deep approach to learning developed during Bachelor studies and was positively related to changes in students' experiences of teaching.

The last two studies explored successful learning and studying at course level. Study 3 explored students' study profiles in two different bioscience courses with different exams. The results revealed a contradictory relationship between students' learning processes, assessment and study success: the results suggest that, due to inappropriate assessment, course grades do not necessarily reflected the quality of learning outcomes. Study 4 explored the variation in students' conceptions of learning by applying a phenomenographic approach. The results revealed that a broad variation in students' conceptions of learning, which emphasised the integration of knowledge and evaluation of different viewpoints.

This doctoral thesis argues that organised studying and effort management plays a crucial role in effecting students' study success and progression at the university. The results also suggest that students develop in their deep approach to learning during university studies, and their conceptions of learning are relatively sophisticated. In addition, the results show that inappropriate assessment can cause students with poor learning outcomes to receive higher grades.

Keywords: approaches to learning; conceptions of learning; the teaching-learning environment; study success

Henna Asikainen

MENESTYKSELLINEN OPISKELU JA OPPIMINEN BIOTIETEISSÄ

Lähestymistapojen oppimiseen, oppimiskäsityksien, motivaation ja oppimisympäristökokemusten yhteys opintomenestykseen

Tiivistelmä

Tämän väitöskirjatutkimuksen tavoitteena oli tutkia miten opiskelijoiden oppimiskäsitykset, lähestymistavat oppimiseen sekä kokemukset oppimisympäristöstä ovat yhteydessä siihen, miten opiskelija menestyy opinnoissaan kahdella tasolla: kurssitasolla ja yleisellä tasolla. Tarkoituksena oli myös analysoida, kuinka opiskelijat kehittyvät opiskelussaan kandiopintojen aikana. Tutkimuksien kontekstina oli kandivaiheen opinnot Bio- ja ympäristötieteellisessä tiedekunnassa.

Kaksi ensimmäistä osatutkimusta analysoivat yhteyksiä opiskelijoiden lähestymistapojen, oppimisympäristökokemusten ja opintomenestyksen välillä. Osatutkimus 1 tarkasteli ensimmäisen vuoden opintoja ja Osatutkimuksessa 2 tarkasteltiin kolmannen vuoden opintoja sekä sitä, miten opiskelijat ovat kehittyneet opintojensa aikana. Tulokset osoittivat, että suunnitelmallinen opiskelu sekä kiinnostus aiheeseen olivat yhteydessä menestykseen opinnoissa kandiopintojen aikana. Syväsuuntautunut lähestymistapa ensimmäisenä vuotena ennusti menestystä opinnoissa kolmantena vuotena. Suunnitelmallinen opiskelu ja kokemus muiden opiskelijoiden tuesta olivat yhteydessä opintojen etenemiseen ensimmäisenä vuotena. Tulokset osoittivat myös, että syväsuuntautunut lähestymistapa oppimiseen kehittyi kandiopintojen aikana ja tämä muutos oli positiivisesti yhteydessä siihen, miten opiskelijat kokivat opetuksen.

Kaksi jälkimmäistä osatutkimusta tarkastelivat oppimista ja menestymistä opinnoissa kurssitasolla. Osatutkimuksessa 3 tarkasteltiin opiskelijoiden opiskeluprofiileja kahdella eri Bio- ja ympäristötieteellisen tiedekunnan kurssilla, joissa arvostelu tapahtui laadullisesti erilaisilla tenteillä. Tulokset toivat esiin ristiriitaisia yhteyksiä opiskelijoiden oppimisen, arvioinnin luonteen ja menestyksen välillä. Tulokset antoivat empiiristä näyttöä siitä, kuinka sopimaton arviointi voi saada aikaan sen, että huonoilla oppimistuloksilla voi pärjätä tentissä todella hyvin. Osatutkimuksessa 4 tutkittiin opiskelijoiden oppimiskäsityksien variaatiota soveltaen fenomenografista tutkimusotetta. Tutkimuksessa löydettiin

laaja variaatio opiskelijoiden oppimiskäsityksissä, jossa painottui tiedon yhdisteleminen isompiin kokonaisuuksiin sekä eri näkökulmien tarkastelu.

Tämä väitöskirjatutkimus osoittaa, että suunnitelmallisella opiskelulla on ratkaisevan tärkeä rooli siinä, miten opiskelijat menestyvät ja etenevät yliopisto-opinnoissaan. Tulokset havainnollistavat myös, että opiskelijat kehittyvät syväsuuntautuneessa lähestymistavassaan opintojen aikana, sekä sen, että heidän oppimiskäsityksensä ovat suhteellisen kehittyneitä. Lisäksi tämä väitöskirjatutkimus osoittaa, että arvosanat eivät välttämättä kerro suoraan siitä, miten hyvin opiskelijat ovat oppineet.

Avainsanat: lähestymistavat oppimiseen; oppimiskäsitykset; oppimisympäristö; opintomenestys

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Helsinki, December 10, 2013

Henna Asikainen

To Aino

CONTENTS

1 INTRODUCTION.....	1
2 THEORETICAL FRAMEWORK	3
2.1 Conceptions of learning	3
2.2 Approaches to learning.....	7
2.3 The relation between conceptions of learning and approaches to learning	11
2.4 The effects of the teaching-learning environment on student learning	12
2.5 Development of approaches to learning.....	14
2.6 The relationship between the approaches to learning and achievement in studies	17
3 OVERALL AIMS OF THE STUDY	19
4 METHODOLOGY	23
4.1 Bachelor studies in the Faculty of Biological and Environmental Sciences	23
4.2 Participants	24
4.3 Materials.....	26
4.4 Analyses	27
5 RESULTS	33
5.1 The relationship between students' approaches to learning, their perceptions of the teaching-learning environment, study success and academic progression in their first year of studies (Study I)	33
5.2 Impeding and enhancing factors in studying their relation to the students' approaches to learning and their study success in first-year studies (Study I)	36
5.3 The relationship between approaches to learning, perceptions of the teaching-learning environment and study success in their third year of studies (Study II)	37
5.4 The development of approaches to learning and perceptions of the teaching-learning environment during bachelor studies and their relation to each other (Study II).....	39

5.5 Students' study profiles comprising their descriptions of their approaches to learning, motivation and learning outcomes in two bioscience courses (Study III)	40
5.6 High and low achievers study profiles in two biosciences courses with different exams (Study III).....	44
5.7 Variation on students' conceptions of learning (Study IV)	45
5.8 Combinations of high and low achieving students conceptions of learning, approaches to learning, motivation and self-reported learning outcomes (Studies III & IV).....	49
6 DISCUSSION.....	53
6.1 Approaches to learning, perceptions of the teaching-learning environment and study success	53
6.2 Development of approaches to learning and perceptions of the teaching-learning environment.....	55
6.3 High and low achieving students' study profiles.....	56
6.4 Conceptions of learning.....	58
6.5 Methodological issues	59
7 GENERAL DISCUSSION	63
7.1 Practical implications	67
7.2 Limitations of the study.....	68
7.3 Conclusions	70
7.4 Future research	71
REFERENCES	73

List of tables

Table 1.	Overview of the studies exploring students' conceptions of learning	6
Table 2.	Overview of recent longitudinal research on students approaches to learning during studies in higher education in Western countries	16
Table 3.	Participants of the doctoral thesis	25
Table 4.	Analyses of the doctoral thesis	31
Table 5.	The relationship between approaches to learning, perceptions of the teaching-learning environment, study success and academic progression	34
Table 6.	First-year students' perceptions of factors impeding and enhancing progression in studies	37
Table 7.	The change in approaches to learning and the teaching-learning environment by paired sample t-test.....	39
Table 8.	Regression analyses.....	40
Table 9.	Distribution of the high and low achievers study profiles in two courses	45
Table 10.	Critical aspects that differentiate between the learning conceptions.....	49
Table 11.	Distribution of students representing different conceptions of learning	49
Table 12.	High achievers' conceptions of learning, study profiles and self-evaluated learning outcomes	50
Table 13.	Low achievers' conceptions of learning, study profiles and self-evaluated learning outcomes	51

List of figures

Figure 1. The components of this doctoral thesis	19
Figure 2. An overview of the phenomenographical analysis.....	30
Figure 3. The relationship between perceptions of the teaching-learning environment, approaches to learning, study success and study pace.....	35
Figure 4. The predictors of academic achievement in the first year	36
Figure 5. The relationship between approaches to learning, perceptions of the teaching-learning environment and study success in the final year of bachelor studies with standardised estimates	38

ORIGINAL ARTICLES

This thesis is based on the following four original publications, which are referred to in the text by their Roman numerals (Studies I–IV):

Henna Asikainen (née Rytönen)

- I** Rytönen, H., Parpala, A., Lindblom-Ylänne, S., Virtanen, V., & Postareff, L. (2012). Factors affecting bioscience students' academic achievement. *Instructional Science*, 40(2), 241–256.
- II** Asikainen, H., Parpala, A., Lindblom-Ylänne, S., Vanthournout, G. & Coertjens, L. (Accepted with revisions). The development of approaches to learning and perceptions of the teaching-learning environment during Bachelor level studies and their relation to study success. *Instructional Science*.
- III** Asikainen, H., Parpala, A., Virtanen, V. & Lindblom-Ylänne, S. (2013). The relationship between student learning process, study success and the nature of assessment. A qualitative study. *Studies in Educational Evaluation*, 39(4), 211–217.
- IV** Asikainen, H., Virtanen, V., Parpala, A. & Lindblom-Ylänne, S. (2013). Understanding students' conceptions of learning in the context of biosciences. *International Journal of Educational Research*, 62, 36–42.

1 INTRODUCTION

Universities are facing challenges in educating students to be life-long learners and versatile experts. Successful learning and studying in higher education should involve students in deep-level learning and understanding of their own fields. The Bologna declaration in European countries emphasised that the students should be able to develop by continuously building their expertise and knowledge base in their own fields and learn skills such as problem solving and critical thinking. Recent studies have, however, suggested that university studies do not necessarily support the development of this kind of understanding (Halinen, Ruohoniemi, Katajavuori, & Virtanen, 2013; Murtonen, Olkinuora, Tynjälä, & Lehtinen, 2008). According to a British survey, only every other bioscience student experienced that university studies offer good or excellent support for developing skills needed for the working life such as problem solving (Scott, 2005). In addition, it has been found that although course objectives in biology courses aim to support the development of different cognitive skills, the assessment of some courses is mainly focused on evaluating lower-level cognitive skills (Momsen, Long, Wyse, & Ebert-May, 2010).

In the field of biosciences, the understanding of biological phenomena has been under transformation in the 21st century. New theories of evolution and genomic data are likely to make scientists re-evaluate the meanings of profound concepts in biology and the paradigm in biology has shifted away from linear, reductionist thinking toward studying complicated, interconnected systems (Goldenfeld & Woese, 2007). Woese (2004, p.175) argued that “The molecular cup is now empty. The time has come to replace the purely reductionist “eyes-down” molecular perspective with a new and genuinely holistic, “eyes-up,” view of the living world, one whose primary focus is on evolution, emergence, and biology's innate complexity.” Furthermore, research concerning successful studying at the university-level have mainly concentrated on students who are studying in soft sciences (Diseth, 2003; Diseth, 2007b; Marton & Säljö, 1976a; Marton & Säljö, 1984; Van Rossum & Schenk, 1984). Studies examining successful studying in the science context are less common, and some of these studies have produced contradictory results: a positive relation between memorising fragmented knowledge and study success have been found in the science context (Lizzio, Wilson, & Simons, 2002). In addition, science students have been found to be more likely to adopt a surface approach to learning than students in the soft sciences (e.g. Eley, 1992; Lawless & Richardsson, 2002).

The first-year of university studies can be regarded as important for university studies. Students enter university studies with different expectations, study

habits and prior knowledge. These factors can affect the way students adapt to a new learning environment. The delay of studies has been a problem among university students especially during the first study year (Constantini & Vitale, 2011). In Finland, studying at the university is free of charge and students graduate and proceed to working life relatively late compared to other European countries (OECD, 2002). For example, in the past decade at the University of Helsinki the average time to complete both Bachelor and Master degrees in the field of science has been seven years instead of the pre-scheduled 5 years. According to McCune (2007) students' engagement in their study practices in biosciences can be supported by emphasising students' development in understanding the ways of thinking and practising in their own field, their own construction of knowledge and their own responsibility in their studies.

Studies concerning students' development on their approaches to learning during their university studies have produced contradictory results. The most recent longitudinal studies have reported that students do not develop in their deep approach to learning (aka critical thinking and relating ideas) during university studies (Ballantine, Duff, & McCourt Larres, 2008; Lietz & Matthews, 2010; Zeegers, 2004). In addition, a few longitudinal design studies have found a decline in the deep approach during studying (Lietz & Matthews, 2010; Wilding & Andrews, 2006). These studies raise the question of what kind of learning and studying is supported during university studies.

The purpose of this doctoral thesis is to explore successful learning and studying in biosciences at two levels. At a general level, the aim is to examine how students' approaches to learning and perceptions of the teaching-learning environment are related to academic achievement during Bachelor level studies in the Faculty of Biological and Environmental Sciences. In addition, the aim is to analyse how students' approaches to learning develop during university studies and how changes in their perceptions of the teaching-learning environment are related to that development on the general level. Furthermore, the aim of this doctoral thesis is to explore students' own descriptions of their approaches to learning, study motivation and self-reported learning outcomes at course level and to examine how these factors are related to study success in the courses that have exams of different nature. In order to understand learning in the context of the biosciences more deeply, one aim is to explore students' conceptions of learning in the biosciences and examine how they are related to their study processes and study success at the course level.

2 THEORETICAL FRAMEWORK

This section gives an overview of the theoretical framework of this doctoral thesis. First, the focus is on studies on students' conceptions of learning and approaches to learning and how these are related to each other. Second, this section describes different aspects of the teaching-learning environment and how they are related to students' approaches to learning. Third, this section focuses on the research into the development of students' approaches to learning in university studies. Finally, the relationships between approaches to learning, perceptions of the teaching-learning environment and study success are discussed.

2.1 Conceptions of learning

In the 1970s, research at the University of Gothenburg concentrated on examining students' learning in its context and aimed to study, how students' themselves experienced learning. In their studies, Marton and Säljö (1976a; 1976b) found that students' learning outcomes or understanding differ qualitatively among different students. In these studies, a phenomenographic approach was introduced which concentrated on exploring students own views of the phenomena (Marton, 1981). Säljö (1979) conducted an interview study with 90 participants between 16–70 years of age and found the following five qualitatively different conceptions of learning: learning as 1) quantitative increase in knowledge, 2) memorising, 3) the acquisition of facts, procedures, etc., which can be retained and/or utilized in practice 4) the abstraction of meaning and 5) an interpretative process aimed at understanding reality.

In the first conception in Säljö's (1979) study, quantitative increase in knowledge, learning was seen as merely adding new knowledge to previous knowledge and comments about learning were very vague. The second conception, memorising, emphasises the reproducing of facts from books or what the teacher has said. Learning is seen as active reproduction of separate facts, unlike the first conception where the activity is not evident. In the third conception, Learning as the acquisition of facts, procedures, etc., which can be retained and/or utilized in practice, is similar to the former category where learning is seen as reproducing separate facts, but the emphasis is on remembering facts which are valued as practically useful. In these first three categories what is learned is not seen as changing your view but merely reproducing what you have read or heard. Säljö's (1979) fourth conception, the abstraction of meaning, emphasises the change in learning. Learning is not seen as reproducing but an

active, constructive process of abstracting meaning from the learning material. The learner is seen as active in selecting and capturing the meaning and main ideas in learning, not just looking for ready-made answers. The fifth conception, an interpretative process aimed at understanding reality, is similar to the former category, but the transfer from the learning situation to reality is a key element: what is learned should help to understand the reality around us.

Marton, Dall'alba and Beaty (1993) interviewed 29 Open University students about their conception of learning in Great Britain. They found considerable similarities to Säljö's (1979) earlier study. In addition, they found a sixth conception, learning as changing as a person. This conception describes learning as seeing in a different way and the new way of seeing things changes the learner as a person. This conception was only found among older participants who had progressed far in their studies. The first three conceptions in study of Marton et al. (1993) emphasise reproducing knowledge and learning has a quantitative nature whereas the last three and the latter three conceptions of learning focuses on the qualitative and active nature of learning which emphasises seeking meaning in learning. When analysing first year art students' open ended answers, Van Rossum and Taylor (1987) found similar conceptions of learning as Säljö (1979) did and also found a sixth conceptions called a conscious process, fuelled by personal interests and directed at obtaining harmony and happiness or changing society. This sixth conception was later called self-realisation (Van Rossum & Hamer, 2010). Similar categories have been found in several studies (Eklund-Myrskog, 1998; Marshall, Summer, & Woolnough, 1999; Van Rossum & Schenk, 1984; Virtanen & Lindblom-Ylänne, 2010).

Vermunt (1996) explored students' metacognitive, cognitive and affective learning functions by phenomenographic analyses of students' interviews. In this study, he explored students' mental models which he describes students' overall, coherent systems involving the conceptions of learning. Based on these phenomenographical analyses he differentiated five different ways that learning is experienced (Vermunt, 1998): *Construction of knowledge* refers to a view that emphasises the active role of the students' in constructing their own personal knowledge. *Intake of knowledge* represents the experience of learning as committing knowledge to memory as it is presented to them. *Use of knowledge* refers to a mental model which underlines the value of using knowledge in practical situations. *Stimulating education* describes a view which emphasises the role of education as continuously supporting and stimulating students learning activities. *Co-operative learning* describes a view of learning where studying together with fellow students is emphasised greatly. Furthermore, Lonka, Joram and Bryson (1996) studied conceptions of learning among people with different levels of expertise. They defined three core conceptions of learning: *Constructivity* refers to a view of learning that emphasises the students' active role in the

restructuring and modification of knowledge. The second concept, *active epistemology*, is closely related to constructivity but the emphasis is on the students' role in learning. Students see their role in learning differently. At one end students underline their own responsibility and intentions in learning whereas some students think that teachers are more responsible in learning by transferring the knowledge which students receive. The third core concept, *mental representation*, refers to the importance that mental representations have in the way students understand and solve problems.

Although, studies have found similarities in conceptions of learning in different contexts and students' conceptions of learning are regarded as quite stable, they are, however, dependent on the context (Eklund-Myrskog, 1998). Säljö (1982) suggested that the requirements of the social context partly affect the way students understand learning. He showed that some students change their conceptions of learning if they feel that the context requires a different kind of learning from them than that they are used to (Säljö, 1982). However, studies in different educational cultures have suggested that the overall structure of the variation can be similar in different cultures but some elements of the learning conceptions are emphasised more than others (Dahlin & Regmi, 1997; Marton, Watkins, & Tang, 1997). In Table 1, an overview of studies exploring students' conceptions of learning is presented. These particular studies have all been carried out in the Western higher education context and have been conducted qualitatively by independent analysis not aiming to produce any existing categories. In the study conducted by Van Rossum & Taylor (1987), the categories were not properly named, they were just numbered. However, in this study, a sixth conception was found. Thus, the names of the categories were collected from the book by Van Rossum and Hamer (2010). The comparison of these studies shows clear similarities in the variations of students' conceptions of learning in different contexts. Some clear differences can also be seen. In the studies conducted by Eklund-Myrskog (1998) and Marshall et al. (1999), the first conception, increase of knowledge, is not included in the variation. In addition, the most sophisticated conceptions differ between the studies. Marton et al. (1993), Van Rossum & Taylor (1987), Virtanen & Lindblom-Ylänne (2009) and Marshall et al. (1999) all emphasise a change in the most sophisticated conception whereas in the study by Eklund-Myrskog (1998) forming one's own conception is the most sophisticated conception. In addition, the variation of conceptions of learning in the study of Vermunt (1998) is quite narrow and the construction of knowledge is the most sophisticated conception.

Table 1. Overview of the studies exploring students' conceptions of learning

Säljö (1979)	Marton et al. (1993)	Van Rossum & Taylor (1987) / (Van Rossum & Hamer (2010))	Eklund-Myrskog (1998)	Marshall et al. (1999)	Virtanen & Lindblom-Ylänne (2009)	Vermunt (1998)
quantitative increase in knowledge	increase in one's knowledge	an increase in knowledge	remembering/ keeping something in mind	memorising definitions, equations and procedures	increase in knowledge	intake of knowledge
memorising	memorising and reproducing	memorising	understanding	applying equations and procedures	memorisation	use of knowledge
the acquisition of facts, procedures, etc., which can be retained and/or utilized in practice	applying	acquisition of useful facts	applying knowledge, based on understanding	making sense of physical concepts and procedures	applying of knowledge	construction of knowledge
the abstraction of meaning	understanding	abstraction of meaning	getting a new perspective	seeing phenomena in the world in a new way	understanding	
an interpretative process	seeing something in a different way	an interpretative process	forming a conception of one's own	change as a person	conceptual change	
	changing as a person	self realisation				

In the context of the biosciences, a similar wide variation of students conceptions have been found, where the most sophisticated conception of learning represented conceptual change (Virtanen & Lindblom-Ylänne, 2010). However, the emphasis of the conceptions was on reproducing and knowledge transform in learning to a large degree (Virtanen & Lindblom-Ylänne, 2010) which is in line with the results of Edmunds & Richardson (2009) who studied students' conceptions of learning quantitatively in different educational contexts. According to their study, biology students tended to obtain higher scores on scales measuring learning as intake of knowledge and use of knowledge than sociology students. Furthermore, research has also shown that students develop in their conceptions of learning during studies. In their study, Lonka et al. (1996) explored people with different levels of expertise. Their study showed that the levels of these three dimensions of conceptions of learning were positively related to the levels of expertise of the participants. In addition, Morgan and Beauty (1984) exam-

ined Open University students and found that their conceptions of learning clearly develop during their studies. Students' conceptions of learning are closely related to their approaches to learning. In the next section, students' approaches to learning are explored more closely.

2.2 Approaches to learning

In the 1970s, Marton and Säljö (1976a) explored 30 educational psychology students' ways of processing a scientific article and the way they were related to their level of learning outcomes. They found that students who have different learning outcomes also process the learning material differently. Two different ways of processing were found: surface processing meant that students concentrated on memorising the text as it was presented whereas deep processing indicated that students concentrated on the meaning of the text or its main message (Marton & Säljö, 1976a). They also found that students who applied deep-level processing understood the main message of the text better than students applying surface-level processing. In their other study, Marton and Säljö (1976b) found similar differences in study processes but also found that students changed their study processes according to their perception of the requirements. They found that deep processing could be changed to surface processing by asking students the kinds of questions that provoke it.

Lennart Svensson (1977) explored the same students' study processes in the same learning experiment as Marton and Säljö (1976a; 1976b), but concentrated on students' cognitive approaches in general studying and in a particular learning environment and their relation to study success. Svensson (1977) found similar qualitative differences in students study processes: students applying a holistic approach concentrated on the author's intention and tried to understand the meaning of the text and students applying an atomistic approach focused on separate details in the text and tried to memorise it. Svensson (1977) also suggested that students who applied a holistic approach succeeded better in their studies. Pask (1976) found similar categories as Marton and Säljö (1976a; 1976b) when exploring students study strategies: students applying a serialistic strategy in studying focus on details and concentrate on learning linearly one thing at a time: A student using a holistic strategy tries to understand the connections between different matters and to form an understanding of matters as a whole.

The initial interviews in Gothenburg concentrated on how students tackled a specific task. This work at the University of Gothenburg influenced both John Biggs and the Lancaster group in Great Britain to study these matters on a larger scale by exploring how students usually go about their studying. Biggs (1978) explored students study processes and developed a Study Process questionnaire

(SPQ) which differentiated three different dimensions of study processes which include students motivation and their study strategies: 1) Utilising 2) Internalising and 3) Achieving: Utilising describes meeting minimum requirements in studying and using reproduction though rote learning, internalising describes students interest in the academic subject and relating ideas with previous knowledge and the achieving approach describes competitive motives in learning and organised studying. Biggs later named these approaches to learning as surface, deep and achieving approaches (Biggs, 1987).

In Lancaster, Entwistle and Ramsden (1983) also explored students' study processes on a larger scale. The purpose of their studies was to explore approaches to learning in larger contexts by developing an instrument, the Approaches to Studying Inventory (ASI), and to explore the relationship between the results of Marton and Pask. The work of Biggs (1978) influenced the development of ASI and they found similar dimensions of approaches to learning. The deep approach to learning was defined as intention to understand and as a critical process in learning which was measured with two components: relating ideas and use of evidence (Entwistle & Ramsden, 1983). They also found a third approach to learning namely strategic approach, which emphasises the need to do as well as possible in courses directed by the assessment of the courses. The emphasis from achievement motivation has recently shifted to organising studying, because the intention to achieve has been shown to also result from a sense of responsibility in studying (Entwistle & Peterson, 2004). The recent version of the questionnaire (Approaches to Learning and Studying Inventory, ALSI) measures organised studying and effort management which includes time management, organised studying and effort in studies (Entwistle & McCune, 2004). Organised studying can be considered not so much an approach to learning as an approach to studying because it shows how students manage their time and put effort into their studying instead of describing their learning processes (Entwistle, 2009).

Marton & Säljö (1976a; 1976b) initially talked about ways of processing in reading an academic text. Svensson (1977) introduced the concept of approach in his studies suggesting that the concept of process is too narrow. The studies by Svensson and Marton were conducted with the same data and had highly overlapping results. Thus, one concept, approach to learning, was chosen to describe students intentions and process in studying (Entwistle & Peterson, 2004). In the study by Marton and Säljö (1976a) the students processed the article freely but in the study by Pask (1976) the students were required to use deep level processing. The first reported use of the concept "approach to learning" was when Marton (1976) used the concepts of deep approach and surface approach in his paper which summarised the results and conclusions of research done in the University of Göteborg. Furthermore, recent research has suggested

a division of the deep approach to learning. Vanthournout et al. (2013) have suggested that the motivational or intention component and the strategy component of the deep approach to learning can be considered as separate factors and not just part of the same concept. The division of intention to understand and the deep process as separate factors have also been the case in other recent studies (Parpala, 2010; Parpala, Lindblom-Ylänne, Komulainen, & Entwistle, 2013).

The dichotomy of the surface and deep approaches to learning is not so straightforward; students may also apply different combinations of approaches to learning. Earlier studies have found that Asian students have a tendency to both understand and memorise when studying. This is considered to be a 'paradox of the Asian student' (Kember & Gow, 1991; Kember, 1996). Even though the students emphasise memorising with understanding, the Asian students tend to score higher than Western students on the deep and achieving approaches to learning (Kember & Gow, 1991). Contradictory results have also been found. A recent study explored international students' approaches to learning in university studies and found that Chinese students tend to score higher on surface approach to learning than other international students but no differences were found in their scores for deep approach and organised studying (Sakurai, Pyhältö & Lindblom-Ylänne, 2013). Marton, Watkins and Tang (1997) explored Chinese high school students' experiences of learning and found two different ways of memorising: learning as committing words into memory and learning as committing meanings into memory where the object of learning was different. In other words, students can either memorise the text itself or memorise its meaning. Learning as understanding also had two different forms: understanding the meaning and understanding the phenomenon (Marton et al., 1997).

The distinction between learning by heart and memorising with understanding has also been found in Western culture. For example, Entwistle and Entwistle (2003) discovered combinations of understanding and memorising in a study where the participants were from a Scottish university. In a study conducted by Meyer (2000), three different forms of memorising by Australian first-year economics students were found by using factor analyses: memorising before understanding, memorising after understanding and memorising as rehearsal. Parpala et al. (2010) explored university students in different disciplines and found four different combinations in students' approaches to learning using latent profile analysis: Organised students, Students applying a deep approach, Students applying a surface approach and Unorganised students applying a deep approach. In the latter profile students' scores on the deep approach were high but their scores for Organised studying, that is to say, time management and effort in studying were quite low (Parpala et al. 2010).

Research has also shown that there is disciplinary variation in how students approach their learning. Eley (1992) studied Australian university students in

different subject areas and found that students studying the 'soft sciences' such as English literature, philosophy and politics scored higher on deep approach to learning than students studying the 'hard sciences' such as micro biology, biochemistry, mathematics, statistics, business and accounting. Lawless and Richardson (2002) found similar results: students studying in Arts courses scored higher on the deep approach than students studying science courses. Parpala et al. (2010) compared different combinations of approaches to learning in different disciplines and found no statistical significant differences in students approaches to learning in the Bioscience, the Arts and the Social Sciences but the study showed that unorganised students applying a deep approach was the most common cluster in the biosciences (Parpala et al., 2010).

The relationship between students' study process and motivation has been evident in several studies (Entwistle & Ramsden, 1983; Entwistle, 1998; Kyndt, Dochy, Struyven, & Cascallar, 2011; Lindblom-Ylänne & Lonka, 2000; Vanthournout, 2011). Students' motivation in learning usually is divided into extrinsic and intrinsic motivation: intrinsic motivation refers to doing something because of the initial interest or enjoyment and extrinsic motivation refers to doing something in order to bring about a separate outcome (Deci & Ryan, 1985; Ryan & Deci, 2000). Extrinsically motivated students are influenced by external rewards and focus on completion of courses, whereas intrinsically motivated students are interested in the subject area and the motivation reflect personal goals and leads to deep approach to learning (Entwistle, 1998; Fransson, 1977). Recent study has suggested that students' experiences on workload have an effect on the way motivation is related to approaches to learning: when students experiences of workload is high, autonomous motivation is related positively to deep approach and negatively on surface approach but when workload is experienced as low, these relations are not significant (Kyndt et al., 2011).

Motivation has also been studied in relation to study success. Generally it has been suggested that intrinsic motivation results to better learning outcomes (Deci, Koestner, & Ryan, 1999). Also a relationship between achievement motivation and study success has been found during first three years of studying (Busato, Prins, Elshout, & Hamaker, 2000). However, motivation does not always explain poor success in studies. According to a study exploring law-students, lack of motivation was not a problem with students who did not proceed in their studies: these students had problems describing their study processes and had trouble getting hold of studies (Haarala-Muhonen, Ruohoniemi, & Lindblom-Ylänne, 2011). In addition, a study conducted with veterinary students showed that highly motivated students who did not organise their studies had trouble getting enough credits (Ruohoniemi, Parpala, Lindblom-Ylänne, & Katajavuori, 2011).

2.3 The relation between conceptions of learning and approaches to learning

Students' conceptions of learning are related to the way they approach their learning. Van Rossum and Schenk (1984) explored this relationship by asking students to first read a text and explain its content and also describe their own learning process. According to their study, students who emphasise reproduction in their learning conceptions described their learning process as being passive and including memorising text as it is presented. The students whose conceptions of learning emphasised constructive learning reported being active in their learning processes and trying to understand the meaning of what the author is trying to say. This relationship between conceptions of learning and approaches to learning has also been replicated in recent studies: students who had high scores on construction of knowledge were more likely to adopt deep approach to learning and students who scored highly on intake of knowledge were more likely to adopt a surface approach to learning (Edmunds & Richardson, 2009; Richardson, 2010).

The relation between conceptions of learning and approaches to learning is not always so straightforward. Although Van Rossum and Schenk (1984) found that most of the students whose conceptions of learning emphasised construction of knowledge applied a deep approach to learning, a few of them applied a surface approach to learning and also vice versa. This kind of dissonance in students' combinations of different aspects of learning has been found in many studies (Boulton-Lewis, Wilss, & Lewis, 2003; Cano, 2005; Lindblom-Ylänne & Lonka, 1999; Lindblom-Ylänne & Lonka, 2000; Meyer, Parsons, & Dunne, 1990; Vermunt & Verloop, 2000). In exploring Australian university students' conceptions of learning and the way they went about learning using the phenomenographic approach, Boulton et al. (2003) discovered dissonance in the ways in which these factors were related to each other. They found some students, who experienced learning as personal growth but still used memorising in their studying. Cano (2003) found similar results when exploring school students quantitatively. Interestingly, opposite combinations of conceptions of learning and study processes have been found relating conceptions of learning which emphasise reproduction of knowledge to ways of learning and studying which emphasise analysing and relating ideas (Boulton-Lewis et al., 2003; Cano, 2005).

One explanation of these dissonant study profiles is that students are in a process of changing their study processes (Lindblom-Ylänne & Lonka, 1999). Studies have also suggested that the way students study is in conflict with the way the learning environment requires them to study and this creates friction between the students study processes and the requirements of the learning envi-

ronment (Vermunt & Verloop, 1999). The study of Lindblom-Ylänne and Lonka (1999) also suggested that the changes in students study processes were caused by the demands of the learning environment which were different that the students were used to. In the next section the role of the learning environment in affecting students learning is discussed.

2.4 The effects of the teaching-learning environment on student learning

The learning environment greatly influences how students learn and study at the university. This section focuses on the role that the teaching-learning environment plays in affecting student learning. A learning environment can be defined in many different ways and it can refer for example to the physical, social or cultural aspects of the environment. In the ETL-project, Entwistle, McCune and Hounsell (2003) introduced the concept teaching-learning environment to describe possible influences and support on the quality of students learning. The term teaching-learning environment describes different aspects of the academic environment that are potential in supporting student quality learning and engaging them with studying including aspects of course design and organisation, teaching and assessing, staff-student relationship and student cohort (Entwistle et al., 2003). The concept teaching-learning environment is used in this doctoral thesis.

According to previous studies, positive perceptions of the teaching-learning environment are positively related to the deep approach to learning and, respectively, negatively related to the surface approach to learning (Entwistle & Ramsden, 1983; Entwistle et al., 2003; Parpala et al., 2010; Richardson, 2005; Richardson, 2006). Thus, students who apply a deep approach to learning, systematically experience their teaching-learning environment more positively than students who apply a surface approach to learning. It has been shown that not so much the teaching-learning environment itself, but students' perceptions of it are related to the way they go about learning (Entwistle, 2009; Fransson, 1977).

The central concept in supporting students' deep approach to learning is constructive alignment. According to Biggs (1996), teaching should be based on constructive alignment, which means that different aspects of teaching, such as the learning objectives, teaching methods and assessment, should support each other and be designed to promote the deep approach to learning (Biggs, 2003). Aligned teaching is not a method itself but a framework which can be applied in different teaching situations (Biggs, 2001). The main aim is to support students' own constructions of knowledge by making the learning objectives and requirements clear to them (Biggs, 1996). Students' perceptions of alignment in teach-

ing have been found to be positively related to a deep approach to learning and negatively related to a surface approach to learning (Entwistle et al., 2003; Parpala et al., 2013). Another important framework for the relationship between teaching and learning is the Teaching for understanding framework designed to support students to develop understanding (Wiske, 1998). The framework consists of four central aspects (Wiske, 1998): 1) The generative topics should be central to the subject area and interesting for the students, 2) specific understanding goals should be presented to students, they should emphasise the central issues in the discipline and help students to clarify what they need to understand, 3) students should be supported and engaged in their understanding with rich performances of understanding which promote students multiple intelligences by supporting students' construction and demonstration of knowledge in several ways, 4) Students' understanding should be measured with ongoing assessment which should be based on visible criteria following from the generative goals and supporting students construction of knowledge and they should be made in a collaboration between teachers and students.

The role of assessment in impacting student learning has been strongly emphasised. The early study conducted by Marton and Säljö demonstrates that students' change the way they study according to their perception of what is required of them. Biggs (1996) refers to the impact of the assessment of students learning as the backwash effect. In particular, studies have shown that students' experiences of assessment methods influence their engagement in learning (Reid, Duvall, & Evans, 2007; Struyven, Dochy, & Janssens, 2005). Scouller (1998) has shown that students whose perceptions of the assessment was that it required lower level of information processing, were likely to adopt a surface approach to learning and students who saw the assessment as requiring higher levels of processing were likely to adopt a deep approach. In addition, students' perceptions of a heavy workload and inappropriate assessment seem to be related to a surface approach to learning (Biggs, 2003; Lizzio, Wilson & Simons, 2002).

Although students' experiences of the teaching-learning environment and their approaches to learning are closely linked to each other, the relationship between them is not so simple. Influencing students' approaches to learning can be difficult, because students perceive the teaching-learning environment in different ways. Teaching which is properly aligned, can also promote a surface approach to learning (Shapard, 2000). In addition, although the effect of assessment is widely acknowledged, it is not always apparent. For example, it has been shown that at a course level, the changes in students' perceptions of assessment were not related to changes in the deep approach to learning, the initial deep approach seem to explain the deep approach at the end of the course more strongly than students' perceptions of assessment (Gijbels, Segers, & Struyf,

2008). Thus, some students are not affected by the assessment of the courses but study according to their own objectives and study paths (McCune & Entwistle, 2011).

Students' perceptions of the teaching-learning environment vary in various educational contexts and subject areas (Entwistle, Tait, & McCune, 2000; Haara-Muhonen, Ruohoniemi, Katajavuori, & Lindblom-Ylänne, 2011; Parpala et al., 2010). Parpala et al. (2010) explored students' perceptions of the teaching-learning environment in ten faculties at the University of Helsinki and showed variation in students' experiences: law students experienced the teaching-learning environment most negatively and veterinary students experienced it most positively. Students' perceptions of the teaching-learning environment in the biosciences were quite positive but very average compared to students' perceptions in other faculties (Parpala et al., 2010).

2.5 Development of approaches to learning

One purpose of university studies is to enhance students' critical thinking skills and deep expertise in their fields. Exploring students' change in their approaches to learning can offer us insight to how students develop in their studying at the university. A positive development in students' deep approach to learning is in line with the aims of university studies. The first longitudinal study of the development of approaches to learning was conducted by Watkins and Hattie (1985). They explored 540 Australian tertiary students' approaches to learning in their first year and in their third year using ASI and found a decline in deep approach during studies. Biggs (1987) found similar results with 2365 university and college students using cross-sectional data: a decline in both deep approach and achieving approach was found. Recent studies concerning the development on students' approaches to learning during university studies have been ambiguous. The most recent longitudinal studies concerning the change in students' deep approach to learning during studies suggest that the deep approach does not develop during studies (Ballantine et al., 2008; Rodriguez & Cano, 2007; Watkins & Hattie, 1985; Watkins & Ismail, 1994; Zeegers, 2004). In addition, a few longitudinal design studies have found a decline in the deep approach after a three-year period of studying (Lietz & Matthews, 2010; Wilding & Andrews, 2006). Table 2 shows an overview of recent longitudinal studies of the development of approaches to learning during studies in higher education. Based on these studies it can be concluded that university studies in general do not promote significant changes in students' deep approach to learning: None of these studies report on the development of the deep approach to learning.

Students' development in their studying during university studies has been also examined widely by exploring students' learning patterns using Vermunt's

Inventory of Learning Styles (ILS) (Vermunt & Vermetten, 2004). One component in the ILS is students' cognitive processing strategies which describe the thinking strategies that students use when they process subject matters and they are made up of *deep processing*, *stepwise processing* and *concrete processing* strategies (Vermunt & Vermetten, 2004). Deep processing strategy comprises items measuring relating and structuring as well as critical processing. Similarities between the deep approach to learning and deep processing have been suggested although they represent different frameworks (Vermetten, Lodewijks, & Vermunt, 2001). The studies concerning the change in students deep processing during university studies have suggested more promising results: in some of the studies deep processing has been found to increase during studies (Donche & Petegem, 2009; Donche, Coertjens, & Van Petegem, 2010; Vanthournout, Donche, Gijbels, & Van Petegem, 2011).

It seems that development in students' approaches to learning is not very straightforward. Studies exploring changes in students' approaches to learning by implementing students to learning environments which are designed to promote students deep approaches to learning are partly consistent with this view. The results of these studies have also been ambiguous (Baeten, Kyndt, Struyven, & Dochy, 2010). Some studies have found an increase in students' deep approach after implementing a student-centred learning environment (Abraham, Kamath, Upadhy, & Ramnarayan, 2006; Gordon & Debus, 2002). But contradictory results have also been found. For example, introducing students to a course with a constructivist learning environment was found to be unsuccessful in increasing students' deep approach (Gijbels, Coertjens, Vanthournout, Struyf, & Van Petegem, 2009; Vanthournout et al., 2013).

Table 2. Overview of recent longitudinal research on students' approaches to learning during studies in higher education in Western countries

Study	Partici- pants	Duration	Question- naire	Method	No significant changes	Change
Ballatine, Duff & Larres (2008)	286 ac- counts and business students	1 year	ASSIST	Repeted- measures ANOVA	Deep approach	Surface approach + Achieving approach +
Edmunds & Richardson (2009)	1371 students	3 years	Modified LSQ		Deep approach Surface approach	
Jackling (2005)	54 account students	2 years	SPQ	Repeted measures manova	Deep Motive Surface approach Achieve- ment strategy	Deep strategy + Achievement motive -
Lietz & Matthews (2011)	116 Interna- tional Arts or Science students	2 years	SPQ	Paired sample t-test	Surface approach	Achievement approach – Deep approach -
Rodrigues & Cano (2007)	81 teacher education college students	2 years	SPQ	Repeted- measures ANOVA	Deep approach	Surface approach -
Zeegers (2001)	43 science students	30 months	SPQ	Repeted- measures ANOVA	Deep approach	Achieving approach -
Wilding & Andrews (2006)	322 univer- sity students (first measure- ment month before entry to university college)	1,5 years	SPQ	Paired sample t-test		Deep approach – Achieving approach – Surface approach +

The discussion of the stability of students' learning outcomes has been ongoing recently. In the earlier studies, Marton and Säljö (1979a; 1979b) suggested that students' study processes depend on the requirements of the context. However, longitudinal studies have suggested that students' approaches to learning are relatively stable during studies (e.g. Edmunds & Richardson, 2009; Zeegers, 2001). It has also been suggested that the deep approach is more stable in different learning environments whereas the surface approach is more changeable (Wilson & Fowler, 2005). Haggis (2003) suggests that it could be almost impossible to promote the development of the deep approach to learning if it is not

already present. McCune and Entwistle (2011) have suggested that some students have a disposition to understand for themselves which means that these students' deep approach to learning is high and stable across courses because they have a strong willingness to fully understand the subject they study. Some studies have suggested that although longitudinal studies show little change at group level, it does not mean that there are no changes when exploring the development in approaches to learning more individually (Lindblom-Ylänne, Parpala, & Postareff, 2014; Vanthournout et al., 2013). According to Richardson (2011), the stability of students' approaches to learning over time could indicate also the similarities in their learning environments during studies. Despite the strong relationship between students' perceptions of the teaching-learning environment and approaches to learning, the previous studies exploring the relation between the changes in students' perceptions of the teaching-learning environment related to the changes in their approaches to learning have been scarce.

2.6 The relationship between the approaches to learning and achievement in studies

Marton and Säljö (1976a; 1976b) showed in their early studies that students who applied deep level processing had qualitatively better learning outcomes than students applying surface level processing. Svensson (1977) also showed that students applying an atomistic approach failed more exams than students applying a holistic approach. Since then studies have shown that the deep approach to learning is positively and the surface approach to learning negatively related to better learning outcomes (Diseth, 2003; Entwistle & Ramsden, 1983; Marton & Säljö, 1976b; Marton & Säljö, 1984; Svensson, 1977). However, the studies exploring the relationship in students' approaches to learning and study success have also shown contradictory results. Some studies have found that the strategic approach has been more strongly related to study success than the deep approach (Diseth & Martinsen, 2003; Diseth, 2007a). In addition, some results contrary to expectations have found a positive relation between the surface approach and study success (Lizzio et al., 2002).

Students' progression in their studies has also been explored in relation to their approaches to learning. In a study which compared first year law students with fast and slow study pace suggested that the students who progressed fast in their studies, were motivated, used different study strategies and organised and planned their studying very well whereas the main reasons for slow progress in studies was lack of volition and poor time management (Haarala-Muhonen et al., 2011). In veterinary studies, students who applied the deep approach to learning earned the most credits whereas students who scored high on the deep approach but low on organised studying had earned the least credits (Ruohoniemi, Parpala,

Lindblom-Ylänne, & Katajavuori, 2010). In a study conducted with first year students in different subject areas, a negative relation between deep approach and earned credits was found (Kamphorst, Hofman, Jansen, & Terlouw, 2013).

There is also evidence that course grades and earned credits do not necessarily reflect the quality of students' learning outcomes. For example, in a study on psychology students, participants were assessed by a final exam, but the assessing of the exam answers was done in three different ways: teachers' assessment, quality score and a quantity score (Minbashian, Huon, & Bird, 2004). In their study, the quality score was formed on the basis of the quality of relevant information in the exam response which was evaluated using the SOLO taxonomy. The quantity score was based on a number of facts or pieces of information mentioned in the exam response. The grade given by the teacher was not related to approach to learning, but the quality score was positively related to the deep approach and the quantity score was positively related to surface approach (Minbashian et al., 2004). In addition, Scouller (1998) found that the surface approach to learning was positively related poor performance in assignment essays and deep approach to learning was positively related to poor performance in multiple choice exams. Furthermore, when considering earned credits, Kamphirst et al. (2013) showed that the deep approach to learning was negatively related to earned credits but positively related to students own evaluation of their competence.

3 OVERALL AIMS OF THE STUDY

The purpose of this doctoral thesis is to examine successful learning and studying in the biosciences at two levels. At the general level, the purpose is to examine the relationship between students' approaches to learning, perceptions of the teaching-learning environment and academic achievement during bachelor level studies. In addition, the aim is to explore students' development in their approaches to learning and experiences of the teaching-learning environment during bachelor studies and how these changes are related to each other at general level. Furthermore, the aim of this dissertation is to explore students' own descriptions of their approaches to learning, their study motivation and their learning outcomes at course level and examine how these factors are related to study success in two different biosciences courses with different exams. In order to understand learning in the context of the biosciences more profoundly, one aim is to explore students' conceptions of learning in biosciences and examine how they are related to their study profiles and study success at course level. In Figure 1, the components of this doctoral thesis are presented.

Figure 1. The components of this doctoral thesis

General level		
		Study success
Aim 1	Approaches to learning Experiences of the teaching-learning environment	Grade point average Accumulation of credits (1st year)
Aim 2	Development of Approaches to learning Experiences of the teaching-learning environment	
Course level		
Aim 3	Approaches to learning Motivation	exam grade self-reported learning outcomes
Aim 4	Conceptions of learning	
Aim 5	Combination of conceptions of learning approaches to learning motivation	exam grade self-reported learning outcomes

In order to get a general overview of successful learning and studying in the context of biosciences, the aim is firstly to analyse how students' approaches to learning and perceptions of the teaching-learning environment are related to success in their first year and in their final year of bachelor studies. Studies concerning this relationship have shown contradictory results. Especially in the science studies, a surface approach has been found to be in relation to study success. In addition, delay of studies have been found to be a problem especially in first-year studies success (Constantini & Vitale, 2011), and few studies have explored the relationship between students' approaches to learning, perceptions of the teaching-learning environment and study progression. Thus, the purpose is also to examine students' study progression in their first year: the aim is to explore what kinds of factors the students themselves feel impede or enhance their studying, and how these factors are related to the students' approaches to learning and their study success. Exploring the factors influencing students' study progression is important in order to receive important information about the ways students' study progression can be supported already at the beginning of their studies.

Secondly, the purpose is to examine how students' approaches to learning and their perceptions of the teaching-learning environment develop during bachelor studies and how they are related to each other. University students are expected to develop in their study processes during their university studies, but studies concerning the development of students' approaches to learning have had contradictory results. Richardson (2011) has stated that a lack of development of approaches to learning during studies could result from stability in the learning environment. Although there is a strong relationship between students' perceptions of the teaching-learning environment and approaches to learning, previous studies exploring how students' perceptions of the teaching-learning environment develop during studies and how these changes are related to development in their approaches to learning have been scarce.

Contradictory results concerning the relationship between students' approaches to learning and study success have raised the question that what kind of knowledge is required and assessed in university studies and what can be regarded as successful. In order to explore the relationship between learning and studying and study success more closely, the purpose is thirdly to examine students' own descriptions of their approaches to learning, study motivation and learning outcomes and how these descriptions are related to their course grades in two different bioscience courses with different exams. Measuring students' learning outcomes only with grades does not always reflect students' qualitative learning outcomes (Minbashian et al., 2004). In addition, assessment methods in bioscience courses do not necessarily measure the learning outcomes they are intended to measure (Momsen et al., 2010; Räsänen, Tuononen, & Postareff,

2012). Consequently, exploring successful studying only with grades is not enough. Learning outcomes should be also explored by taking into account different perspectives affecting students' learning. There are not many studies which combine students' self-reported learning outcomes and their actual course grades. Räisänen et al. (2012) have found that bioscience students' course grades did not necessarily mirror their experienced learning outcomes.

Students' conceptions of learning reflect their beliefs about learning in the context and are strongly related to a student's learning process (Sinatra, 2001). Encouraging deep-level understanding in a student whose conception of learning emphasises knowledge transfer can be difficult (Light, Cox, & Calkins, 2009). Thus, the aim is fourthly to closely explore the variation in students' conceptions of learning in the biosciences. Due to the changing mindset in understanding different phenomena in the biosciences, exploring students' conceptions of learning more profoundly is important in order to fully understand learning in the bioscience context. In addition, most in-depth studies concerning students' conceptions of learning have been conducted before the year 2000 (Marton et al., 1993; Säljö, 1979; Van Rossum & Schenk, 1984; Van Rossum & Taylor, 1987). The needs of modern life and universities have changed since 90', and thus, new in-depth studies of university students' conceptions of learning are needed in order to see, whether the variation and distribution of conceptions have changed to according the new needs.

Finally, the aim of this doctoral thesis is to combine the results of Study III and Study IV to get a more profound picture of the successful studying in the biosciences: Thus, the aim is to see what kinds of conceptions of learning, combinations of approaches to learning, motivation and self-reported learning outcomes students in two different courses have.

The research questions of this doctoral thesis are the following:

- 1. How students' approaches to learning and perceptions of the teaching-learning environment are related to achievement in bachelor level studies?**
 - a. How students' approaches to learning and their perceptions of the teaching-learning environment are related to study success and academic progression in their first year of studies? (Study I)
 - b. What kind of factors the students themselves feel impede or enhance their studying, and how these factors are related to the students' approaches to learning and their study success in first-year studies? (Study I)
 - c. How students' approaches to learning and perceptions of their teaching-learning environment are related to study success in their third year of studies? (Study II)

- 2. How students develop during their bachelor studies?**
 - a. How do students' approaches to learning and perceptions of the teaching-learning environment change during their bachelor studies? (Study II)
 - b. How are the changes in approaches to learning and perceptions of the teaching-learning environment related to each other? (Study II)

- 3. What kind of study profiles students in two different bioscience courses with different exams have?**
 - a. How students describe their approaches to learning, study motivation and learning outcomes in two bioscience courses? (Study III)
 - b. How high and low achieving students' descriptions of their approaches to learning, study motivation and learning outcomes differ in two courses with different nature exams? (Study III)

- 4. What kind of variation in students' conceptions of learning is found in the context of the biosciences (Study IV)?**

- 5. What kinds of combinations of conceptions of learning, approaches to learning, motivation and self-reported learning outcomes do high and low achieving students in two bioscience courses have? (Study III & IV)**

4 METHODOLOGY

This doctoral thesis applied a mixed-method approach which includes using and analysing both quantitative and qualitative data (Creswell & Plano Clark, 2007). The purpose of using the mixed method approach is to strengthen the research and minimise the weaknesses of using only the qualitative or quantitative research approach (Johnson, 2004). The mixed method research can be regarded as having a pragmatic paradigm: in the mixed method approach, different methods are used in a “what works” manner emphasising both subjective and objective knowledge (Creswell & Plano Clark, 2007). The approach in this doctoral thesis is *complementary* in nature. More precisely, a mixed method approach is applied in which a rich understanding of the overlapping but also different aspects of the phenomenon are examined to increase the interpretability and meaningfulness of the results (Creene, Caracelli, & Graham, 1989). The overall design of this doctoral thesis was set to explore successful learning and studying from different perspectives by first exploring successful studying at a general level and secondly, to qualitatively explore students’ own descriptions of their learning and studying at course level in two bioscience courses with different nature of exams. The purpose of Study I and Study II was to analyse quantitatively students’ learning processes and perceptions of their learning environments related to study success and academic progression and how these learning processes and perceptions of the learning environment developed during their bachelor studies. Studies III and IV were conducted at the course level. Study III explored how students’ descriptions of their approaches to learning, motivation and learning outcomes are related to their course grades in two bioscience courses with different nature exams. Study IV focused on the variation in students’ conceptions of learning.

4.1 Bachelor studies in the Faculty of Biological and Environmental Sciences

The context of this doctoral thesis was the Faculty of Biological and Environmental Sciences at the University of Helsinki. The Faculty was established in 2004 and it is a fairly new faculty. There are six different Bachelor programmes in the faculty. The largest of them is the Bachelor programme of biology which comprises seven different major subjects: fishery science, ecology and evolution biology, physiology, plant biology, genetics, general microbiology, environmental sciences. In this Bachelor programme, students can also major in biology.

The other Bachelor programmes comprise biochemistry, limnology and fishery science, environmental protection, biotechnology and environmental ecology.

The purpose of the first-year studies is to initiate students into different areas of biology. The first year studies are pre-scheduled for the students and all first year students take the same courses. Students also receive study counselling in their first study year: They fill out the ETLQ-questionnaire and receive written feedback about their learning compared to other students' scores and are given some advice on how to improve their learning and studying. In the second year the students are expected to choose their main subject and plan their own studies. After the first year, optional courses are emphasised more than compulsory courses. Students can choose courses from a wide range of optional courses. Biology students, for example, can choose their learning paths from 19 possibilities.

The Faculty of Biological and Environmental Sciences is a highly research-oriented faculty where teaching is based on recent research in the area. Learning culture in the faculty is very heterogeneous because of the various subjects it comprises. The courses include mostly lectures and practical laboratory work, but also field courses, seminars and web-based teaching. During the first year studies lectures are clearly the most common teaching method and written exams are the most common method of assessment in the Faculty of Biological and Environmental Sciences.

4.2 Participants

The participants of the Study I were first-year bioscience students who begun their studies in 2007 and in 2008. These students comprised students from the Bachelor programmes in biology, biochemistry as well as limnology and fishery science. In the survey given to the students, a total of 188 responses were obtained, comprising 93 first-year students who began their studies in 2007 and 95 students who began their studies in 2008. The total response rate was 74%. The participants consisted of 142 female and 46 male students. In 2008, a total of 68 percent of the students studying at the Faculty of Biological and Environmental Sciences were women and 32 percent were men. Thus, the male students in the present study were slightly overrepresented. A follow up study (Study II) was conducted with these same students. Altogether 103 (54.8%) of these students participated in the follow up study in spring 2010 and 2011 at the end of their third-year of Bachelor studies. Thus, the overall response rate in the follow up study was 40.7%. The participants in the follow up study comprised 78 female and 30 male students. The age in both Study I and Study II ranged between 18 and 55, although 80 per cent of the participants were under the age of 23.

In Study III and in Study IV, 24 students volunteered to be interviewed comprising 11 students studying in Course 1 and 13 students studying in Course 2. These students in the courses varied in many ways: In Course 1, eight of the students had their major subject in the Faculty of Biological and Environmental Sciences, two majored in chemistry and one majored in biotechnology. The students in Course 2 comprised nine students majoring in the Faculty of Biological and Environmental Sciences, one biochemistry student, one chemistry student, one mathematics student and one student studying educational sciences. The participants in Course 1 comprised one first-year student, three second-year students, three third-year students, and three students who had studied at the university for more than four years. Of the students participating in Course 2, there were four first-year students, five second year students, two third-year students and three students who had studied at the university for more than four years. In Course 1 there were two male and nine female participants and the age ranged between 19 to 26 years. In Course 2, there were four male and nine female students participating in the present study and the age of the participants ranged from 19 to 34 years old. A summary of the participants can be seen in Table 3.

Table 3. Participants of the doctoral thesis

Participants					
	N	Gender (female, male)	Response rate	Age	Subject
Study 1	Overall 188 2007 = 93 2008 = 95	(142, 46)	74%	18-55 (m=21.3, SD 4.2)	first-year bioscience students
Study 2	Overall 106 2007 = 55 2008 = 51	(78, 30)	40.7%	18-55 (m=21.5, SD=4.8)	third-year bioscience students (follow up)
Study 3 & 4	24	(18, 6)		19-34	16 biology majors, 8 minor students

4.3 Materials

Studies I and II focused successful studying on the general level. The questionnaire used in both studies is based on the Experience of Teaching and Learning Questionnaire (ETLQ) used in the ETL-project in Edinburg (Entwistle et al., 2003). The purpose of the project was to develop conceptual frameworks to lead the improvement of teaching and learning at the institutional, departmental and faculty levels. The project lasted for four years and a great number of studies were conducted in different faculties. The project ended in 2005. The original ETLQ measures students' perceptions of the teaching-learning environment and their approaches to learning in a specific course module (Entwistle et al., 2003). The part which measures students' approaches to learning consists of *The Approaches to Learning and Studying Inventory* (ALSI) (Entwistle & McCune, 2004) developed from the ASI created by Entwistle and Ramsden (1983). The questionnaire has been modified and developed for a Finnish context, and was found to be robust in this context (Parpala, 2010; Parpala et al., 2013). The original ETLQ consisted of 40 items concerning students' perceptions of the teaching-learning environment and 18 items concerning students' approaches to learning. In this doctoral thesis, a shortened version of the ETLQ was used comprising 11 items concerning students' approaches to learning and 21 items concerning perceptions of the teaching-learning environment. This shortened version was developed based on factor loadings, communalities and skewedness of the items. The study success was measured with the grade point average (GPA) and the academic progression with the amount of earned credits (ECTS) of the courses students had passed during their studies before March. In Study I, students were asked to choose three of the most important factors which they felt that enhanced and impeded their studies from among pre-selected factors (16 impeding and 19 enhancing). These factors were chosen to the questionnaire based on the results of a previous study which explored university students' open-ended answers of factors that they felt impeded and enhanced their studying (Myllylä et al. 2007). The alternatives comprised factors related to faculty-level procedures, teaching practices and students' own activities and personal life.

In Study IV, the interviews focused on the students' conceptions of learning in general. In the beginning of the interviews students were asked what learning in the university meant to them, what learning is according to their own conceptions and what they consider important in learning. The purpose was to create a wide picture of the ways the students experienced learning. Thus, the interviewer tried to encourage the participants to discuss their conceptions widely. Only clarifying questions such as "What do you mean by that?" or "Could you tell me more about that?" served to deepen the answers. The interviewer let the inter-

viewees openly discuss their conceptions. When students used words such as “understanding” or “memorising” they were asked to clarify what exactly they meant by them. The second part of the interviews concentrated on the particular courses that the students were studying in Study III. The participants were asked about their overall experiences of the course, their aims in the course, and how they went about learning. In addition, the students were asked how they had studied during the course, how they thought different aspects of the teaching-learning environment affected their studying, and how they evaluated their own learning outcomes in the course.

The interviews in Study III and Study IV were conducted to students who studied in two different bioscience courses. Both of the courses were compulsory bachelor’s-level courses and both had similar learning environments: About 80 students participated in both courses and the lectures were held in a large lecture hall where the teacher presented the subject matter to the students. The teachers in both courses were experienced and had taught these courses for several years, but had no pedagogical training. Both courses lasted for seven weeks and required passing a final exam with three to five tasks at the end of the course.

Although, the assessments of the courses were based on the final exams, the exams of the two courses were quite different. The teacher of Course 2 had a similar exam every year, which the students generally knew about. In addition, the exam consisted of four tasks comprising three short, rather simple essay-type tasks and one more demanding task. Students were required to complete three of the four tasks, meaning that the more demanding task was optional. In contrast, the exam for Course 1 asked a wider range of tasks, all of which were compulsory, and the exam required of the students a different level of understanding. Moreover, the tasks varied each year.

4.4 Analyses

In Study I, students’ approaches to learning and their perceptions of the teaching-learning environment were analysed with exploratory factor analysis (principal axis factoring) with direct oblimin rotation. The relationship between enhancing and impeding factors, approaches to learning and academic achievement as well as the differences between students who had passed or failed the first checkpoint were analysed with univariate analysis of variance (ANOVA). The relationship between approaches to learning, perceptions of the teaching-learning environment, academic progression and study success was first examined with Pearson’s correlation. The final analysis was conducted with Structural Equation Modelling (SEM) using Amos 7.0.

In Study II, confirmatory factor analyses were conducted to scales representing approaches to learning and experiences of the teaching-learning environment. The development of approaches to learning and perceptions of the teaching-learning environment at the group level was first analysed with paired sample t-test and secondly with Pearson correlations between change variables. The change variables were conducted to scales measuring approaches to learning and perceptions of the teaching-learning environment by subtracting the first measurement from the second measurement. For example, if a student's score on the deep approach was 4.5 in the second measurement and 2.5 in the first measurement then the value of the change variable would be 2. The final analysis of the relationship between changes in the approaches to learning and students' perceptions of the teaching-learning environment was conducted with stepwise regression analyses. The relationship between the approaches to learning, the perceptions of the teaching-learning environment and study success was analysed with structural equation modelling using Amos 18.

In Study III, the intention was to capture the essence of the individual students' studying process for the course. The analyses of students' approaches to learning were conducted by applying qualitative content analysis. First, different aspects of the students' approaches to learning in the course were explored, such as their description of their intentions in the course and how they described their study processes. The objects of the analyses were, firstly, the students' individual combinations of their approaches to learning, focusing on their intentions, and how they described their studying processes. Secondly, the analysis focused on the way students' described their study motivation for the course. Thirdly, the analysis concentrated on students' descriptions of their learning outcomes for the course.

First, the data were coded into wide categories which described different aspects of the students' approaches to learning, such as their intentions in the course and how they described their studying processes during the course. Second, broad themes were differentiated to categorise the students' approaches to learning, for example learning for understanding and memorising. These broad themes were further categorised by taking into account the effect of assessment and how they organised their studying. For example, students who applied deep-level processes were further categorised on the basis of how they organised their studying: students who were strong in organised studying and effort management were categorised in a different category than students who had trouble in time management. In addition, if a change in an approach to learning in the course was reported, it was further categorised. The categories were formed according to the individual student's approaches to learning.

Thirdly, the focus in the analyses on students self-reported learning outcomes concentrated on the way they themselves described how they have learned

during a course. To achieve this, the parts where students discussed their learning outcomes were highlighted and categorised according to whether the students reported if they had learned well or not. We were able to categorise all of the students' answers this way. The underlying reasons for the learning outcomes were different and these reasons seemed to represent the students' approaches to learning. For example, students applying a surface approach consistently reported poor learning outcomes. Fourthly, students' motivation to study in the course were analysed similarly. The parts were students' described their motivation in the course were categorised broadly as motivated and unmotivated students. These categories were further developed based on the explanations why they were motivated during the course. In some cases students described themselves as motivated, but it was unclear whether the motivation was intrinsic or external. Thus, these students were categorised as motivated. The individual students' study profiles were formed by combining all the categories together.

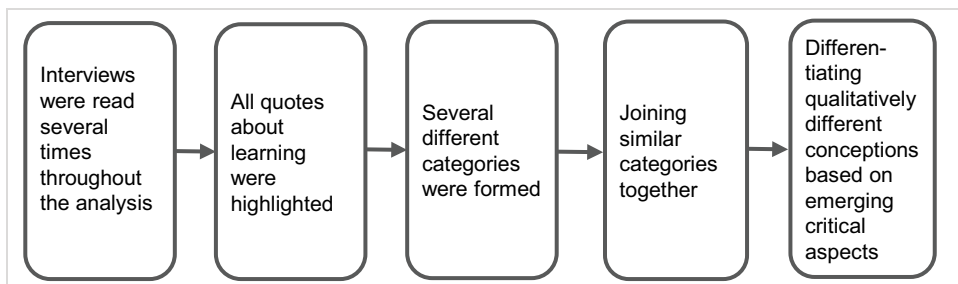
In Study IV, the focus was on forming a deep understanding of students' conceptions of learning based on students' own thoughts and experiences in the Faculty of Biological and Environmental Sciences. Therefore, a phenomenographic approach was applied. The phenomenographical approach is interested in the variation in people's experiences of a particular phenomenon (Marton & Booth, 1997; Åkerlind, 2005b). The focus is on the second-order perspective of the phenomenon, more precisely on capturing students' own views of the phenomenon. The phenomenographical approach has been developed from a strong empirical basis instead of a philosophical or theoretical one (Åkerlind, 2005b). The subjective experience of the world and the objective real world are not considered as separate; rather the world is constituted as an internal relationship between them (Marton & Booth, 1997).

In Study IV, instead of solely just concentrating on the variation of students conceptions of learning, the focus was on the individuals' conceptions of learning. The analyses were similar to Eklund & Myrskog (1998) and Tsai (2004) that aimed also to phenomenographically explore individual conceptions of learning. The data were first explored by trying to capture all the variation within the group. The interviews read through several times and all quotes about learning were highlighted and marked. Different quotations of students' conceptions of learning were moved to a spreadsheet application and divided into several different categories. The analysis of the conceptions did not focus on the verbs such as "understanding" or "memorising" but on the way students described the use of these verbs such as memorising or understanding. The quotations were not just short utterances such as "memorising facts" but students' own ideas or complete conceptions were categorised. The aim was to view the data as a whole and to find some structure and relationship between the mean-

ings. The analysis was conducted by trying to keep an open mind by looking beyond the first impressions and minimising predetermined views, which is a practice characteristic of phenomenographical analysis (Åkerlind, 2005b). Thus, the interviews were read and the categories were shaped several times.

As the analysis continued, we tried to explore the qualitative differences, similarities and overlap of different conceptions of learning. Some similar categories of conceptions of learning were merged together, and critical aspects between qualitatively different conceptions of learning started to emerge. The conceptions of learning were arranged in the spreadsheet application so that qualitatively different conceptions of learning were marked with different colours. The focus of the analysis was on the hierarchical relationship between individual conceptions, where conceptions in the lower-level categories are included in the higher-level ones. The hierarchical structure of the various categories of description was formed naturally. Finally, an outcome space was formed in which the different conceptions were logically and hierarchically related to each other based on critical aspects. When the different categories of description started to form on the spreadsheet, the interviews as a whole were read again. The final categories of descriptions were formed and sharpened by concentrating on the critical aspects of students' conceptions of learning. The overview of the phenomenographical analysis can be seen in Figure 2.

Figure 2. An overview of the phenomenographical analysis



The analyses in Study III and Study IV were conducted in co-operation with the second author, an expert in the field of biosciences, who offered more understanding of the content as well as the context and depth to the analyses. We constantly discussed and reflected upon our findings and thoughts during the analysis. The first and second author analysed the data independently and then met to discuss the analysis and compare their analyses. The third and the fourth authors also frequently commented on and discussed the categories. An overview of the analyses of this doctoral thesis can be seen in Table 4.

Table 4. Analyses of the doctoral thesis

Study	Data collection	Analyses	Method
Study 1	Survey Modified ETLQ	Factor structure of approaches to learning, perceptions of the teaching learning environment Relationship between approaches to learning, academic achievement and impeding or enhancing factors Relationship between approaches to learning, perceptions of the teaching-learning environment, study success and academic progression	Factor analysis, Principal axis factoring (oblimin) One-way ANOVA Pearson's correlation Structural Equation Modelling
Study 2	Survey Modified ETLQ	Confirmation of scales measuring approaches to learning and perceptions of the teaching-learning environment Development of approaches to learning and perceptions of the teaching-learning environment Relationship between the changes in approaches to learning and perceptions of the teaching-learning environment Relationship between approaches to learning, perceptions of the teaching-learning environment and study success	Confirmatory factor analysis Paired sample t-test Pearson's correlation of change variables Stepwise regression analyses Pearson's correlation Structural Equation Modelling
Study 3	interview	Variation in conceptions of learning	Phenomenographic approach
Study 4	interview	Students study profiles in two courses The relationship between conceptions of learning, study profiles and achievement	Qualitative content analysis Comparing high (grade 4 or 5) and low (failed the test or grade 1) achieving students' study profiles and conceptions of learning

5 RESULTS

In this section, the results of this doctoral thesis are demonstrated. First, the results of the two quantitative studies are presented by concentrating first on the first-year studies (Study I) and after that presenting the results of the follow-up Study II. Second, the results concerning students' study profiles comprising descriptions of their approaches to learning, motivation and self-reported learning outcomes and their relation to study success in two courses with different exams are presented (Study III). Third, the results of the phenomenographic study on the variation of students' conceptions of learning are presented (Study IV). Finally, the results combining the results of Study III and Study IV are demonstrated.

5.1 The relationship between students' approaches to learning, their perceptions of the teaching-learning environment, study success and academic progression in their first year of studies (Study I)

First, an exploratory factor analysis was conducted to scales measuring approaches to learning and perceptions of the teaching-learning environment. A four-factor solution was selected to items describing students' perceptions of their teaching-learning environment: Relevance and evoking interest (F1), Constructive feedback (F2), Peer support (F3) and Alignment (F4). The Cronbach Alphas ranged between 0.73 – 0.84. This solution presented the clearest matrix and explained 47% of the variance. A four-factor solution was also selected for items measuring students' approaches to learning: Organised studying (F1), Deep approach (F2), Intention to understand (F3) and Surface approach (F4). The Cronbach Alphas ranged between 0.68 – 0.76 except for the Surface approach (.59).

The correlation analyses showed that all factors measuring students' perceptions of their teaching-learning environment correlated positively with each other. In addition, the factors describing students' approaches to learning correlated positively with each other, except for the Surface approach, which was negatively related to the other approaches to learning. The correlations between the factors describing approaches to learning and perceptions of the teaching-learning environment showed that positive perceptions correlated positively with the Deep approach, Intention to understand and Organised studying and negatively with the Surface approach. Furthermore, study success and study pace were positively related to each other, but different factors were related to them.

Intention to understand, Organised Studying, Relevance and evoking interest, Constructive feedback and Alignment all correlated positively with study success and surface approach correlated negatively with study success. Academic progression however, correlated positively only with Organised studying and Peer support. The correlations can be seen in Table 5.

Table 5. The relationship between approaches to learning, perceptions of the teaching-learning environment, study success and academic progression

Items	Correlations									
	1	2	3	4	5	6	7	8	9	10
1 Relevance and evoking interest	1									
2 Constructive feedback	0.38*	1								
3 Peer support	0.42*	0.24*	1							
4 Alignment	0.45*	0.36*	0.20*	1						
5 Intention to understand	0.48*	0.11	0.32*	0.27*	1					
6 Surface approach	0.26*	-0.08	-0.09	-0.33*	-0.30*	1				
7 Organised studying	0.24*	0.19*	0.21*	0.28*	0.38*	-0.23*	1			
8 Deep approach	0.19*	0.17*	0.01	0.23*	0.15*	-0.16*	0.21*	1		
9 Study success	0.20*	0.17*	0.11	0.16*	0.21*	-0.18*	0.38*	0.04	1	
10 Academic progression	0.02	0.02	0.20*	-0.03	0.02	-0.05	0.36*	0.06	0.32*	1

First, a SEM model with variables measuring approaches to learning, perceptions of the teaching-learning environment and study success was build. Several models were tested. The final model was formulated based on theoretical assumptions, modification indices and correlations. The model fitted to the data well ($\chi^2 = 26.95$, $df = 19$, $p = 0.11$, $RMSEA = 0.047$, $CFI = 0.971$). The only factor predicting both study success and academic progression was Organised studying. In addition, Relevance and evoking interest was related to study success and only Peer support was related to study pace. Figure 3 shows the model. None of the other factors describing approaches to learning or perceptions of the teaching-learning environment predicted study success. The final analysis was

therefore carried out with only four factors in the model: Peer support, Organised studying, study success and study pace.

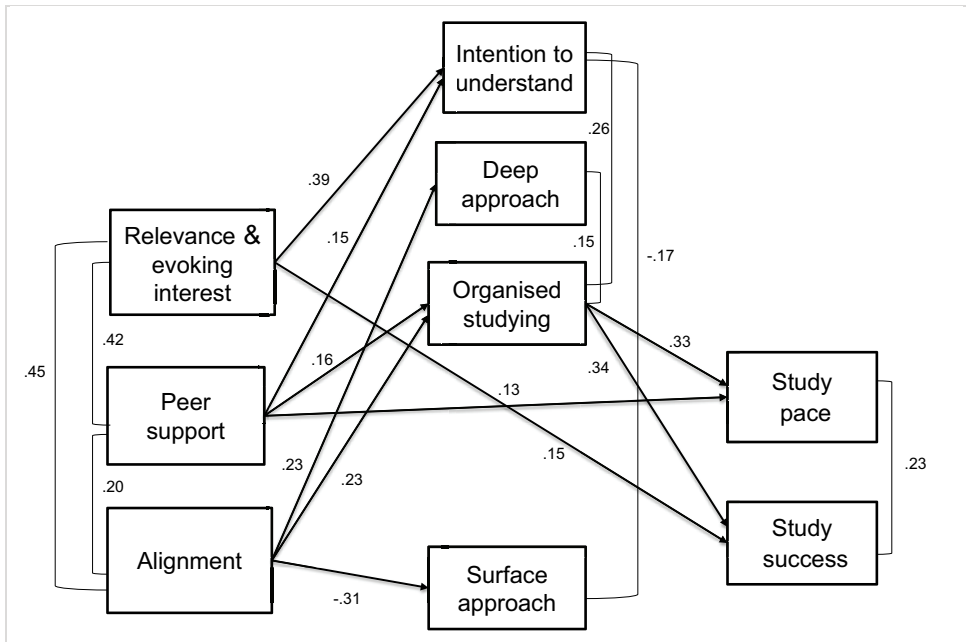


Figure 3. The relationship between perceptions of the teaching-learning environment, approaches to learning, study success and study pace

The final SEM model fitted the data well ($\chi^2 = .245$, $df = 1$, $p = 0.62$, $RMSEA = 0.00$, $CFI = 1$). Organised studying predicted both study success and academic progression. In addition, Peer support predicted students' progression in their studies. None of the other factors describing students' approaches to learning and their perceptions of the teaching-learning environment were related to neither study success nor study pace. Figure 4 shows the final model.

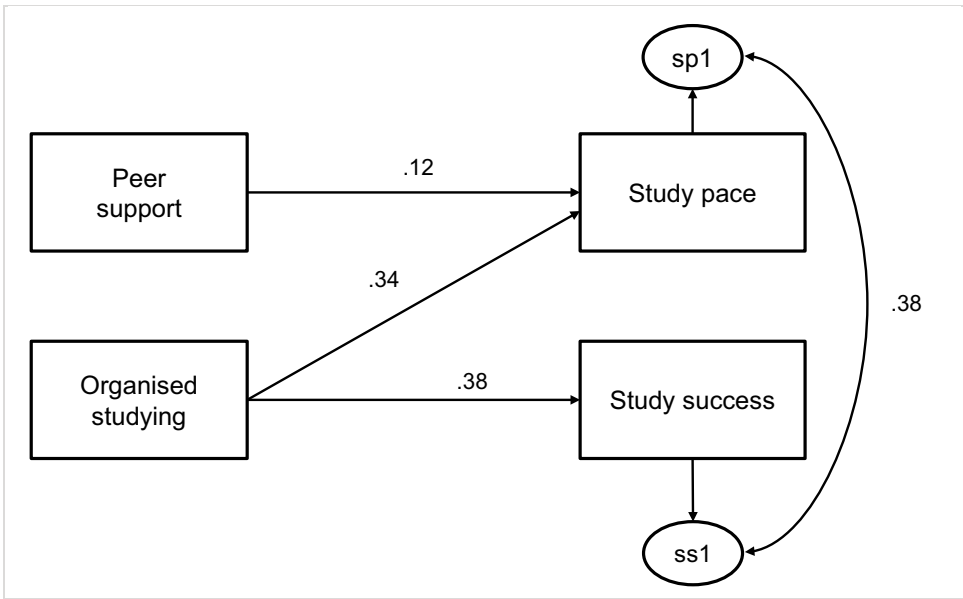


Figure 4. The predictors of academic achievement in the first year

5.2 Impeding and enhancing factors in studying their relation to the students’ approaches to learning and their study success in first-year studies (Study I)

In Study I, students chose difficulty in time management most frequently as an impeding factor in their studies. In addition, almost half of the students chose course overlap, inappropriate course schedules and lack of motivation as factors impeding their studying. Factors concerning students’ personal lives, such as family, friends or work, were seldom experienced as impeding factors for studying. Most of the students identified the Pre-set programme, Inspiring teaching and Peer support as factors enhancing studying. In addition, more than half of the students felt that Self-help, Diligence, Flexibility enhanced their studies. The impeding and enhancing factors are presented in Table 6.

The analysis showed that the enhancing factors selected by the students were related to their approaches to learning: students who experienced interesting teaching, self-help and diligence as enhancing factors scored significantly higher on organised studying than did students who did not find these factors enhancing. In addition, students who felt that self-help enhanced their studies scored higher on the deep approach and students who found that the pre-set programme enhanced their studies scored significantly lower on the deep approach than did those students who did not select it.

Table 6. First-year students' perceptions of factors impeding and enhancing progression in studies

Impeding factors	Percent (%)	Enhancing factors	Percent (%)
Difficulties with time management	59	Pre-set schedules	82
Course overlap	48	Interesting teaching	71
Inappropriate schedules	44	Peer support	67
Lack of motivation	44	Self-help	54
Tight schedule	40	Diligence	53
Concentration problems	39	Flexibility	52
Literature in other languages	28	Good learning experiences	46

The analyses also showed a relationship between students' selections of the impending factors and their approaches to learning. Students who chose difficulties with time management, motivational problems and concentration problems as impeding factors in their studies, scored significantly lower in organised studying than did students who had did not choose these factors. Furthermore, students who experienced difficulties with time management and concentration problems as impeding factors, scored significantly higher on the surface approach than did those students who did not find them impeding.

5.3 The relationship between approaches to learning, perceptions of the teaching-learning environment and study success in their third year of studies (Study II)

The scales measuring students' approaches to learning were first explored with confirmatory factor analysis which were made based on the scales found in previous studies (Parpala, 2010; Parpala et al., 2013). These analyses resulted in not including scales that measured the surface approach and intention to understand in the analyses. These scales only had two items and made the model fit worse. In the first measurement and in the second measurement a model with two scales, Organised studying and Deep approach, had the best model fit. In the first measurement the model fit was very good ($\chi^2 = 16.64$, $df = 13$, $RMSEA = 0.052$, $CFI = 0.972$) and in the second measurement an error covariate was added between two items measuring organised studying and it was acceptable ($\chi^2 = 20.30$ $df = 12$, $RMSEA = 0.081$, $CFI = 0.920$). Furthermore, the model fit concerning students' perceptions of the teaching-learning environment had the best model fit with four scales: Teaching for understanding, Peer support, Alignment and Interest and Relevance. The model fit of the first measurement

was good with a covariance between two items measuring Alignment ($\chi^2 = 102.41$ df = 70, RMSEA = 0.066, CFI = 0.927). The model fit of the four scales describing students' perceptions of the teaching-learning environment in the second measurement was also good ($\chi^2 = 97.42$ df = 70, RMSEA = 0.061, CFI = 0.946).

The SEM model included factors predicting study success in the final year of bachelor studies from both first and final year measurements. First a model with all scales measuring students approaches to learning, their experiences of the teaching-learning environment from both measurements and study success from the final year. The model fitted to the data fairly well, but the scales measuring students' experiences of the teaching-learning environment had very little effect on study success except of the Interest and Relevance scale. Also, the number of parameters in the model was too big in relation to the sample size. Thus, the scales measuring Peer support, Alignment and Teaching for understanding were excluded from the final model. The final model fitted the data well ($\chi^2 = 11.06$, df = 9, p = 0.27, RMSEA = 0.047, CFI = 0.972, RMR = 0.036). In the model, both Organised studying and Interest and relevance predicted study success in the final year. In addition, the Deep approach in the first year predicted study success positively in the final year even though the effect of the Deep approach in the final year was very low. The model is shown in Figure 5.

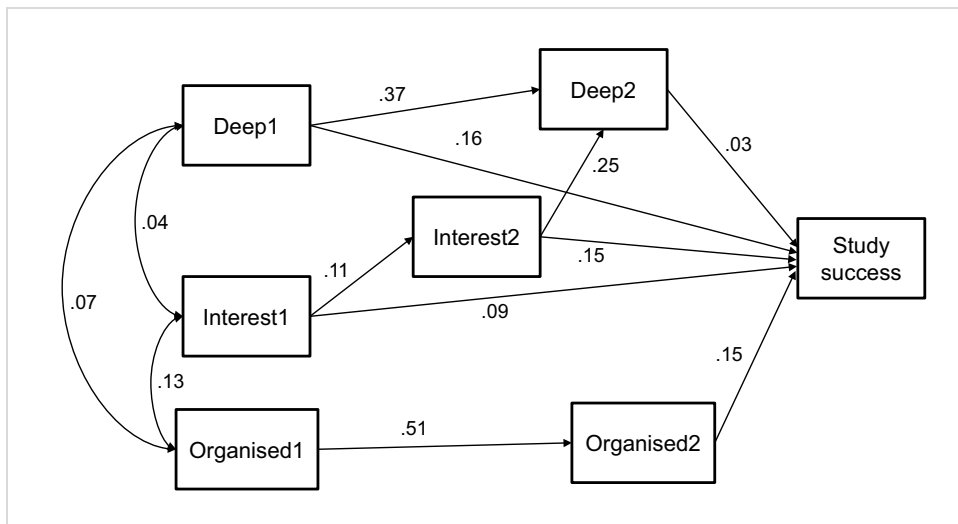


Figure 5. The relationship between approaches to learning, perceptions of the teaching-learning environment and study success in the final year of bachelor studies with standardised estimates

5.4 The development of approaches to learning and perceptions of the teaching-learning environment during bachelor studies and their relation to each other (Study II)

A statistically significant increase in the deep approach ($t = -2.96, p = 0.004$) from the first year to the final year of bachelor studies was found at the group level. No statistically significant changes were found in Organised studying. Furthermore, a decline in all the scales describing students' perceptions of the teaching-learning environment was found during bachelor studies, but the decrease in Teaching for understanding ($t=2.43, p=0.017$) was statistically significant. The results of the paired sample t-test appear in Table 7.

Table 7. The change in approaches to learning and the teaching-learning environment by paired sample t-test

	mean 1	mean2	SD	t	p
Organised	3.28	3.21	0.77	0.83	0.410
Deep	3.00	3.22	0.74	-2.96	0.004
TFU	3.75	3.62	0.76	2.43	0.017
Alignment	3.62	3.57	0.64	0.79	0.429
Relevance & Interest	3.88	3.77	0.90	1.23	0.222
Support	4.14	4.23	0.76	-1.21	0.228

The analysis on the change variables correlations showed that the changes in students' perceptions of the teaching-learning environment correlated positively with each other. The change in the Deep approach was positively related to a change in Teaching for understanding. In addition, a change in Organised studying correlated statistically significantly with Interest and relevance. No other relationships between the changes in students' approaches to learning and their perceptions of the teaching-learning environment were found.

In order to understand better the relationship between the changes in students' approaches to learning and their perceptions of the teaching-learning environment stepwise regression analyses were conducted. These analyses were conducted on the basis of the correlational analyses of the change variables. The purpose was to analyse how much variance in students' approaches to learning can be explained by the initial score on approaches to learning in the first year and by changes in students' perception of their teaching-learning environment. The analyses showed that 16% of the variance of deep approach can be explained by the initial deep approach at the start of studies. In addition, changes in

students' perceptions of Teaching for understanding influenced changes in the deep approach: Teaching for understanding in both measurements together with the deep approach at the start of the studies together explain 33% of the variance. Based on this, it can be concluded that changes in the students' perceptions of the teaching for understanding are related to changes in the students' scores on the deep approach. Furthermore, Organised studying in the first year explained 26% of the variance in Organised studying in the final year of bachelor studies. The students' perceptions of alignment were not a significant predictors of organised studying. The analyses appear in Table 8.

Table 8. Regression analyses

Change in deep approach	Beta	t	p
Change in Deep approach Deep approach first measurement R = 0.40, R ² = 0.16, F = 19.78, p < 0.001	0.40	4.45	< 0.001
Deep approach + Teaching for understanding R = 0.594, R ² = 0.352, Adjusted R ² = 0.333, F = 18.50, p < 0.001	0.45	5.34	< 0.001
Change in organised studying Organised studying first measurement R = 0.513, R ² = 0.263, F = 37.11, p < 0.001	0.53	6.10	< 0.001

5.5 Students' study profiles comprising their descriptions of their approaches to learning, motivation and learning outcomes in two bioscience courses (Study III)

Next, students study processes were explored at course level in order to understand more deeply the relationship between the study processes and success in studies. In study III, we identified five different study profiles: A) Deep approach to learning; B) Deep approach to learning, but poor time management; C) Fact-based learning and repetition before understanding; D) Change from understanding to memorisation in the course and E) Surface approach to learning. These categories reflect the students' combinations of approaches to learning, study motivation and self-reported learning outcomes.

A Deep approach to learning: This profile represents students whose aim in the course was to develop their own understanding of the subject matter and the students reported being intrinsically motivated. Students belonging to this profile also reported developing their own summary structures of the knowledge and linking what they learned in the course to their prior knowledge. These students

felt that the exam was easy and had good learning outcomes. The following quotation from such a student describes this profile:

Well, the subject matter was very interesting to me. And then I had prior knowledge about these matters and, at the same time or before the lectures, I attended the lab class, and it was nice to combine the theory and practice, thinking this was the thing we did in the lab that I did not quite understand then, but now I understand how it really works. I think I learned well in the course. I know I will forget some difficult terms for the methods, but I have understood the important matters. (Student, Course 2)

B Deep approach to learning, but poor time management: This profile describes students who reported being intrinsically motivated in the course and reported studying in the course by relating ideas and constructing their own summary structures. The difference between this and the previous profile is that these students reported poor time-management skills; they felt that they did not have enough time to fully understand the subject matters during the course. These students' learning outcomes were considered to be weak due to their poor organisation and time management skills. That is to say, these students learned poorly, or rather, learned well, but too slowly. The following extract exemplifies this profile:

My aim is to study this course with the other course so as not to manage them as separate courses but to read them as a whole. And I will invest in these [courses] so everything about these courses should be clear because they are very important in this field that I am studying. I am sure that I will run into these matters later and will need this information then. It's just that you understand the structure of these, how they are developed, what the affects are, how they function and, well, even the structure and its parts.

I did some laboratory work and wrote some reports in computer science, and they took a surprisingly long time, and had no time left for these things. I have studied the other course a bit more and in this course, I have had time to just re-enact my prior knowledge, and I have drawn the structures for myself in a certain way, kind of more explained, but in a way that all the parts and connections are formed there. (Student, Course 1)

C Fact-based learning and repetition before understanding: The students representing this profile reported that they understood the subject matter, but did so by reading the learning material over and over again until they understood it. These students also reported being motivated to learn in the course. Thus, their objective was the same as for the first two categories, but the learning process was different. Although the students reproduced the learning material, the students felt that they understood and learned the subject matter well in the end. The following example represents this profile:

I read – I had the book – but usually I just read the slides from the lecture. There were a little less than ten lectures, and I had printed out the slides and then just read them. I read them though four or five times properly, and then I looked through some things. The day before the exam I went through some of the difficult matters. It is not enough for me to read the text just once: I definitely need to read it several times. Usually I don't understand anything the first time; it happens later.

*I learned a lot from the course. I think the course was very good. These matters were quite new to me, and this course was quite easy, and there were these basic methods that I learned. I am very happy that I completed the course; it gave me very much. The exam was a very nice experience; when you felt that you could answer, it was nice to write them down.
(Student, Course 2)*

D Change from understanding to memorisation in the course: This profile consisted of only one student who had difficulties in self-regulation. This student aimed to understand the subject matter in the course, but reported having difficulties understanding the lectures. The student also reported insufficient self-regulation and studying skills. Consequently, this student reported losing motivation and resorted to rote learning and memorisation of the material due to the difficulties in studying. In the end, the student felt that he or she had learned poorly. The following example describes this profile:

I had no idea what the lecturer was talking about. I attended the lectures, but I just could not follow. I had no particular aims other than to just learn the basics and get a general idea. I had great difficulty forming a general picture.

I did not attain my goals, I did not learn the things that I wanted to learn. I felt that I cannot learn, which, of course reduces, motivation, and then

you feel like it does not matter. So yes, it affects your learning competency.

It was an interesting experience, because many students who had passed the course earlier told me that the same questions are always asked in the exam. Then I thought that if the same questions have been always asked, it would be different this time. But then, when I became desperate, I could not learn everything, I thought that I would just read these topics that everyone said were being asked every year. And precisely the same questions were asked. So the course went quite well, but I kind of feel like: What was really the point overall? (Student, Course 1)

E Surface approach to learning: The students representing this profile reported having little or no interest in the course and their sole aim in the course was to pass it with minimum requirements. These students' intention was to memorise facts without understanding, and they reported using learning processes such as rote learning in their studying. These students were also disorganised in their studying, and that the quality of their learning was rather poor. The following example describes this profile:

I had no idea what the lecturer was talking about. I attended the lectures, but I just could not follow. I had no particular aims other than to just learn the basics and get a general idea. I had great difficulty forming a general picture.

I did not attain my goals, I did not learn the things that I wanted to learn. I felt that I cannot learn, which, of course reduces, motivation, and then you feel like it does not matter. So yes, it affects your learning competency.

It was an interesting experience, because many students who had passed the course earlier told me that the same questions are always asked in the exam. Then I thought that if the same questions have been always asked, it would be different this time. But then, when I became desperate, I could not learn everything, I thought that I would just read these topics that everyone said were being asked every year. And precisely the same questions were asked. So the course went quite well, but I kind of feel like: What was really the point overall? (Student, Course 2)

5.6 High and low achievers study profiles in two biosciences courses with different exams (Study III)

Based on their achievement in the course, the students were divided into three groups: low achievers, average achievers and high achievers. The high achievers ($n = 10$) performed very well on the course exam (earning a grade of 4 or 5), while the low achievers ($n = 5$) failed the test or passed it with the lowest grade (grade 1) on a scale from 0 to 5. Those students who received a *grade of 2 or 3 formed the average group ($n = 9$)*, they were excluded from the analysis of student achievement to see the differences between the high and low achieving students more clearly. Among the participants in Study IV, three high achievers and three low achievers participated in Course 1 and in Course 2, there were eight high achievers and two low achievers.

In Course 1, all three high achievers aimed to understand and had good self-reported learning outcomes. Two of them represented the profile *Deep approach to learning*, and one represented the category *Fact-based learning and repetition before understanding*. In Course 2, the high achievers differed from each other more and represented all the profiles except *Deep approach to learning*, but *poor time management*. Some high achieving students in Course 2 were unmotivated and reported learning little, whereas other students used the deep approach to learning and had good learning outcomes. Furthermore, the low achievers in the two courses were more similar to each other. For instance, two of the low achievers in Course 1 represented the profile *Surface approach to learning*. One student in Course 1 and low achievers in Course 2 represented the profile *Deep approach to learning*, but *poor time management*. The distribution of the high and low achievers, according to the study profiles in the two courses, appears in Table 9.

Table 9. Distribution of the high and low achievers study profiles in two courses

Study profile	Self-evaluated learning outcome	High achievers		Low achievers	
		Course1	Course2	Course1	Course2
		(N)	(N)	(N)	(N)
Deep approach to learning	learned well	2	3		
Deep approach to learning, but poor time management	did not learn well			1	2
Change from understanding to memorising in the course	did not learn well		1		
Fact-based learning and repetition before understanding	learned well	1	1		
Surface approach to learning	did not learn well		3	2	

5.7 Variation on students' conceptions of learning (Study IV)

In order to understand the bioscience students' learning more profoundly, the students' conceptions of learning were next explored. In Study IV, five different categories of descriptions describing students' conceptions of learning emerged from the data: 1) Reproducing knowledge, 2) Using knowledge in practice, 3) Integrating new knowledge with prior knowledge, 4) Evaluating different views, and 5) Creating one's own worldview.

Category 1: Reproducing knowledge

Students' conceptions of learning in this category emphasised learning as the ability to recall something learnt before. Learning was seen as an accumulation of facts which can be recalled. Students in this category explained their conceptions of learning very briefly despite the clarifying questions by the interviewer. Thus, these students had difficulty discussing their learning. The learners con-

sidered themselves as a receivers of knowledge. In this category, students considered learning as discerning the learning material as a whole, but they tried to perceive the learning material on the basis of the goal set by the teacher and to remember it as it was assigned. The primary focus was on remembering things, not on understanding.

The following quotations represent this category:

[Learning makes] new engrams in your brains. So, if something has been taught you can remember it afterwards. (Student 1)

I try to learn as well as possible the content provided by the teacher. However, teachers are very different, and of course I must work myself, too, to understand (Student 2)

Category 2: Using knowledge in practice

In this category, students emphasised the use of knowledge in practice as the most important part of learning. The emphasis was on reproduction of knowledge, as in the former category, but here the emphasis was also on the use of given facts. In Category 2, learning is seen as the ability to use the given knowledge or facts in the future or in the working life.

The following example reflects category 2:

Learning is when you can process information for use in working life and in practical situations. [Learning is] when you use the information you have gained from the teaching or learnt at home. It is not only something you can remember, but also something you have internalised and can use. (Student 3)

Category 3: Integrating new knowledge with prior knowledge

This category describes students' conceptions of learning as integrating a coherent picture of knowledge. Students emphasised their own active role in aiming to understand and finding connections and building a coherent whole between separate facts of knowledge by actively integrated new knowledge with prior knowledge. Thus, their understanding of knowledge, instead of just acquiring knowledge, differentiates the two previous categories. An example of this category appears below:

[Learning is] creating networks of different themes and topics, linking new and old knowledge and understanding relationships between them. More precisely, firstly you need basic knowledge, and then you either collect knowledge or enrich it with further details. Or you can integrate old and new knowledge. (Student 4)

Category 4: Evaluating different views

In this category, students emphasised the importance of expertise in their own field. The emphasis was on the understanding of different aspects of various phenomena. The difference between this category and the three previous ones lies in the relative nature of knowledge. Where students in the previous category wanted to understand the whole picture, students' descriptions of learning in this category emphasise a deeper understanding of this wholeness by also including different and critical viewpoints and dimensions of knowledge into learning and assessing these different viewpoints.

In practice, [learning is] mapping new knowledge for the future. It has always been about reaching a new stage, getting out of school, getting into the high school you want to and, now it is about building a desired career. Could it [learning] be about becoming an expert in your own field, so you can show your expertise in discussions, write public opinions... Well, it for sure can't be one-sided information; it must be comprehensive. (Student 5)

Category 5: Creating one's own worldview

In this category, students stressed meta-understanding about the subject matter. In addition, students emphasised learning as building one's own conception of knowledge and also as creating new knowledge. The difference between the previous and the present category is that, in the present category, the students stress the active process of forming one's own opinion and creating a new perspective, whereas in the former category, the focus is not on the creation of something new but on understanding different viewpoints. In this category, students also emphasise their own development as learners. The next example represents this category:

Learning is at best is when you - how can I put it - learn to apply your prior knowledge for real, and through that, you learn to find new things, because that's the way to practise science in one sense: you find new knowledge, you become. Searching for new things is a part of learning. When you come to a situation in which nobody has the right answer or there are only educated guesses, then learning something new means that, according to your own hypothesis, you begin searching for new findings in order to explain the observation. The world of ideas develops and becomes more dynamic when you learn and make "clicks" between the knowledge that you have learned and your observation and reasoning skills. They give you the possibility for deep learning. And when you understand the principles of a picture, you also know how it differs from

reality, which comes from just thinking those things over and learning something new. (Student 6)

The relationship between the categories

The critical aspects of the different conceptions of learning indicate the structural and hierarchical relationships between the conceptions. Focusing on the structure of the outcome space provides an opportunity to see the variation as a whole (Åkerlind, 2005a). In Study IV, five categories of description were formed with the three key elements that differentiated the conceptions of learning from each other. The critical aspects are seen in Table 8.

Nature of knowledge: The most evident difference between students' conceptions was on whether they saw the nature of knowledge as dualistic or relative. The first four categories describe knowledge as something that could be transferred and acquired. They focus on memorising or understanding something preset or true. On the other hand, the students in the latter two categories see knowledge as relational. There are no right and wrong answers, but only different points of views.

Student's role: Another difference between the categories of conceptions of learning was the different roles that the students gave to themselves as learners or learners in general. In the first category the student is seen as a passive receiver of knowledge who memorises information. In the second category, the student is seen as using his or her knowledge in practice, not just passively receiving. In the third category, the student's role is more active. The emphasis is on building a coherent picture by integrating knowledge. In the last two categories, students are seen as actively constructing knowledge themselves. In the last category, students are seen as creating new knowledge.

Understanding: The clarifying question used in the interviews usually asked what the students meant when they talked about understanding something. The way they talked about understanding varied among the students. Conceptions of learning and the nature of understanding are naturally strongly related to each other. In the first category, understanding is seen to develop as more knowledge is acquired and remembered. In the second category, knowledge is understood when the students are able to use the knowledge in practice. In the third category understanding something is described as understanding the context around the matter being learnt. In the fourth category, understanding is understood as taking into account different point of views. Students in the fifth category emphasise understanding as creating one's own view of something and of the world. Table 10 presents the critical aspects between the conceptions of learning.

Table 10. Critical aspects that differentiate between the learning conceptions

	Re-productive knowledge	Using knowledge in practice	Integrating knowledge	Evaluating different views	Creating ones own worldview
Nature of knowledge	dualistic	dualistic	dualistic	relative	relative
Under-standing	knowing/memorising	use of knowledge	understanding the context	different perspectives	own perspective, problem-solving
Students' role	passive, knowledge receiver	use of knowledge	actively integrating knowledge	constructing knowledge	constructing / creating knowledge

Most of the students emphasised learning as integrating knowledge (N = 10). Seven students saw learning as evaluating different views and four as creating one's own worldview. Two students saw learning as the reproduction of knowledge, and one saw learning as the application of knowledge. The occurrence of each category is seen in Table 11.

Table 11. Distribution of students representing different conceptions of learning

Reproducing knowledge	Using knowledge in practice	Integrating new knowledge to prior knowledge	Evaluating different views	Creating one's own worldview
2	1	10	7	4

5.8 Combinations of high and low achieving students conceptions of learning, approaches to learning, motivation and self-reported learning outcomes (Studies III & IV)

The same students participated in Studies III and IV. The original purpose was to combine students' conceptions of learning and their study profiles together and see how they are related to study success. This was done in the earlier version (Rytkönen, Virtanen, Parpala, & Lindblom-Ylänne, 2011). However, in the final articles, the variation in students' conceptions of learning was explored separately from the study profiles. In order to see how students' conceptions of learning and the study profiles of high and low achievers are related, the results are brought together in this doctoral thesis.

The conceptions of learning of high achievers in both courses are relatively sophisticated. High achievers conceptions of learning comprised Constructing

one's own worldview (3), Evaluating different views (2) and Integrating new knowledge with prior knowledge. In Course 1, students applying a surface approach to learning or changing from understanding to memorising in the course saw learning as either Constructing one's own worldview or Evaluating different views. Table 12 shows the high achievers' conceptions of learning, study profiles and self-evaluated learning outcomes.

The conceptions of learning of low achievers are more variable. It seems that there are two kinds of low achievers in these courses: 1) students whose conception of learning emphasises reproduction in learning, they apply the surface approach to learning in the course and do not learn very well and 2) students who have a sophisticated conception of learning, apply a deep approach to learning in the course but have poor time management skills and do not learn well. Table 13 shows the low achievers' conceptions of learning, study profiles and self-evaluated learning outcomes.

Table 12. High achievers' conceptions of learning, study profiles and self-evaluated learning outcomes

High Achievers			
	Learning conception	Study profile	Self-evaluated learning outcome
Course 1	Constructing one's own worldview	Deep approach to learning	Learned well
	Constructing one's own worldview	Change from understanding to memorising in the course	Did not learn well
	Evaluating different views	Surface approach to learning	Did not learn well
	Integrating new knowledge to prior knowledge	Deep approach to learning	Learned well
	Integrating new knowledge to prior knowledge	Deep approach to learning	Learned well
	Integrating new knowledge to prior knowledge	Fact-based learning and repetition before understanding	Learned well
	Integrating new knowledge to prior knowledge	Surface approach to learning	Did not learn well
Course 2	Constructing one's own worldview	Deep approach to learning	Learned well
	Evaluating different views	Deep approach to learning	Learned well
	Integrating new knowledge to prior knowledge	Fact-based learning and repetition before understanding	Learned well

Table 13. Low achievers' conceptions of learning, study profiles and self-evaluated learning outcomes

Low achievers			
	Learning conception	Study profile	Self-reported learning outcome
Course 1	Integrating new knowledge to prior knowledge	Deep approach to learning, but poor time management	Did not learn well
	Reproducing knowledge	Surface approach to learning	Did not learn well
Course 2	Creating one's own worldview	Deep approach to learning, but poor time management	Did not learn well
	Integrating new knowledge to prior knowledge	Deep approach to learning, but poor time management	Did not learn well
	Reproducing knowledge	Surface approach to learning	Did not learn well

6 DISCUSSION

The purpose of this dissertation was to explore successful learning and studying in the biosciences at two levels: at the general level, the aim was to explore the relationship between students' approaches to learning, their perceptions of the teaching-learning environment and academic achievement during their bachelor studies. At the course level, the aim was to examine high and low achieving students' combinations of approaches to learning, motivation and self-reported learning outcomes in two bioscience courses. To understand learning in biosciences more deeply, the aim was also to explore the variation of students' conceptions of learning. One purpose of this doctoral thesis was also to combine the results of Studies III and IV to explore more profoundly successful studying at the course level: the aim was to analyse high and low achieving students' conceptions of learning, combinations of their approaches to learning, motivation and self-reported learning outcomes. In this next section the results of this doctoral thesis are discussed further.

6.1 Approaches to learning, perceptions of the teaching-learning environment and study success

Study I showed that higher scores on Organised studying was related to both better study success and faster academic progression in the first year of studies. That is to say, if students organise their studies, manage their time well and put effort into their studying they also receive higher grades and proceed better in their studies. These results are partly in line with previous studies which report a relation between strategic approach and study success (Diseth & Martinsen, 2003; Diseth, 2003; Diseth, 2007a; Diseth, 2007b), but Diseth (2003; 2007a; 2007b) also found a relationship between the deep approach and study success. Kamphorst et al. (2013) explored the relationship between the deep approach to learning and the amount of earned credits and found no relationship between them. In Study I, no relationship between the deep approach and academic progression was found. In addition, a relationship between peer support and study success was found.

The relationship between the deep approach and study success was not so straightforward. The deep approach in the final year of studies was not related to study success. According to the Pearson's correlation deep approach in the final year was positively related to study success, but the relation was not significant ($r = 0.177$, $p = 0.069$). Study I showed that in the first year of studies the deep approach was not related to study success either. However, in the SEM model,

the deep approach in the first year predicted study success in the third year. These results suggest that a deep approach to learning is important already at the beginning of studies. One explanation of this result could be the changing curriculum in bioscience studies. Parpala et al. (2010) suggested that the most common group of students in the Faculty of Biological and Environmental Sciences are unorganised students applying a deep approach. In the first year studies, students do not necessarily need to be that organised, because they study according to a pre-set schedule and thus they might succeed without organising skills. But in the third year, students need to be more organised in their studying because of the responsibility they themselves have to make in planning their studies. Thus, in their third year, there could be a lot of students applying a deep approach to learning but not organising their studying well enough and not succeeding well in their studies. Another reason for the relation between study success in the final year and the deep approach in the first year could be that in the first year the standard deviation of the deep approach was larger ($SD = 0.73$) than in the final year ($SD = 0.67$). Thus, as the scores for the deep approach increased and the standard deviation decreased, the relation between the deep approach and study success in the final year was no longer significant. In addition, one explanation for the unclear relationship between the deep approach and study success could be that grade point average is only one way of measuring students' study success and it does not necessarily measure the quality of the learning outcomes (Räsänen et al., 2012). Lindblom-Ylänne, Lonka and Leskinen (1999) found that higher grades on an entrance examination which measured deep level learning and critical thinking predicted study success in the master's level of medical studies, but not in the bachelor level. In this study, however, study success was not measured in the beginning of studies.

The result concerning students' experiences of the enhancing and impeding factors in studying support the preceding results. Especially the impeding factors were related to difficulties in time management and organising skills: Most of the students felt that difficulties in time management impeded their studying. However, those students who experienced difficulties with time management scored lower on organised studying than those students who did not select it. Previous results are in line with these results by suggesting that law students who earned the most credits organised their studies well, and that students who earned the fewest credits experienced problems in time management (Haarala-Muhonen et al., 2011). In addition, two thirds of the students selected peer support as enhancing their studying which was also found with statistical analyses. Students also felt that pre-set schedules and interesting teaching enhanced their studying. These can be regarded as parallel with the components of the teaching-learning environment measured in this study. Interesting teaching can be related to interest and relevance and pre-set schedules relate to teaching for

understanding. Furthermore, in the third year of studies, organised studying was also related to study success in addition to interest in the subject and perceptions of relevance. This suggests that students, who find the learning materials interesting, enjoy studying and see the relevance of the subject, succeed in their studies. This is in line with previous results that suggest that interest and enthusiasm are related to a better course grade (Ketonen & Lonka, 2012).

6.2 Development of approaches to learning and perceptions of the teaching-learning environment

In Study II, students' scores on the deep approach to learning increased from the first year to the third year. Thus, students scored higher when looking at evidence to reach conclusions, coming across long chains of thought triggered by academic reading, thinking over how well they got their point across when communicating ideas and trying a different approach if understanding things seem difficult during studying. These results mainly differ from earlier studies which have reported a decrease in deep approach during university studies (Biggs, 1987; Lietz & Matthews, 2010; Watkins & Hattie, 1985; Wilding & Andrews, 2006; Zeegers, 2004) or reported no change in deep approach during tertiary education (Zeegers, 2004). Rodrigues and Cano (2007) found a positive development of deep approach to learning from the first year to the third year of studies, however it was not statistically significant ($p = 0.07$). The development of the deep approach is a result that is expected and hoped for because one aim of the university studies and the bioscience curriculum is to promote deep-level learning. Bioscience studies in the first year introduce different subjects to students, whereas in the third year the studies aim to deepen students' understanding in specific major subjects. Thus, it can be assumed that the deep approach to learning is supported more during the third year of studies. Furthermore, students' organised studying, more precisely their time management and effort in studying, seems to stay constant. Earlier studies have reported a decline in the achieving approach during studies (Lietz & Matthews, 2010; Wilding & Andrews, 2006). However, Organised studying does not emphasise achieving motivation like the achieving approach rather in emphasises the organising and time management skills and effort in studying. A positive change in organised studying could have been expected because the nature of the studies changes during bachelor studies: the first year is pre-scheduled but the in the third year the curriculum has a lot of optionality and students need to plan their own study schedules.

Students' experiences of Teaching for understanding decreased during their bachelor studies. This suggests that students experience teaching less positively at the end of their bachelor studies. Our earlier study showed no significant

changes in science students' perceptions of their teaching-learning environment during bachelor studies (Rytkönen & Parpala, 2010). One reason for this decrease in students' experiences of teaching for understanding during bachelor studies could be the changing curriculum. In the third year, students are given the responsibility to create their own study paths and the subject they specialise in. In addition, the lack of pre-set scheduled requires the students' skills to plan and schedule their own studying. This change in the curriculum may make students feel that the teaching does not support them so much after the first year.

Although students' experiences of Teaching for understanding decreased during their bachelor studies at a group level, changes in the students' Deep approach were positively related to changes in Teaching for understanding. This suggests that changes in students' experiences of teaching are positively related to changes in the deep approach. Earlier studies have found a positive relationship between students' perceptions of teaching and the deep approach (Entwistle et al., 2003; Parpala et al., 2010; Rytkönen, Parpala, Lindblom-Ylänne, Virtanen, & Postareff, 2012). This relationship between changes in the deep approach and teaching for understanding and, on the other hand, the significant decrease in teaching for understanding suggest that there are also students whose score for both the Deep approach and Teaching for understanding decrease. This suggests that the changes are individual in nature and there are different study paths among different students (Lindblom-Ylänne et al., 2014). Although, the changes in students' experiences of teaching and the deep approach are related to each other, the direction of the relationship cannot be defined (Richardson, 2006). The relationship between approaches to learning and experiences of the teaching-learning environment is bidirectional. Nevertheless, the results of the present study suggest that change to a more positive perception of teaching are related to a positive change in the deep approach to learning.

6.3 High and low achieving students' study profiles

In Study III, the study processes of high and low achievers in the two courses differed substantially. In Course 1, all high achievers reported good learning outcomes in the course, whereas in Course 2, some of the high achieving students reported poor learning outcomes, lack of motivation and resorting to memorising the answers to the exam. One reason for this diversity appears to be the nature of the exam in Course 2 comprising simple questions requiring only reproduction of knowledge. In addition, the exam questions were often exactly the same every year so the students were aware of them. Thus, some of the students memorised the answers to the questions without actually understanding the phenomena. In another study, the teacher of this course was interviewed about the assessment practices in this course and the some of exam answers were

discussed with the teacher (Tuononen, 2011). The results showed that the teacher realised that he had not always assessed students' understanding in the exam but rather the quantity of facts in the answers. Furthermore, the low achieving students were more alike in the two courses. Two of the low achieving students reported lack of motivation and poor learning outcomes, but three of them, interestingly, belonged to the profile *Deep approach to learning, but poor time management*. These students were motivated and applied study processes in their studying that supported understanding, but the problem was that these students had no time to learn properly. It has been suggested that the combination of a deep approach and unorganised studying may result in a heavy workload which threatens student wellbeing (Ruohoniemi et al., 2010). This suggests that the deep approach to learning may be insufficient, but that to perform well in one's studies requires organised studying. Parpala et al. (2010) demonstrated that *Unorganised students applying a deep approach* are a major student group represented in the Faculty of Biological and Environmental Sciences. This raises the question about the number of poorly achieving students due to poor organisation and time management skills.

Study III suggests that exam grades do not necessarily reflect the quality of students' learning outcomes. In Course 1, how students succeeded in the courses matched their self-reported learning outcomes. However, in Course 2, the mismatch between the students' own self-reported learning outcomes and the exam grades was evident. One reason for this can be the nature of the assessment. A further study regarding the reliability of the assessment of this same course supported this view: the teacher and the students were interviewed with stimulated recall about their experiences of the formulation of the grades and the fairness of the assessment (Räisänen et al., 2012). The study suggested that both the teacher and the students experienced the assessment as quite unfair and measuring just reproduction of knowledge. The exam did not measure what it was intended to measure and assessment criteria were not always taken into account. This result raises the question about other courses with similar assessment practices. In an interview study conducted at the Faculty of Biological and Environmental Sciences, most of the teachers perceived assessment as a method for grading students and saw it as a "a method for determining whether the students had succeeded in assimilating the teacher's words." (Halinen et al., 2013). Studies have also showed that even good teachers may not comprehend the effect that assessment can have on learning. Rather, they may regard assessment as something separate from teaching (Parpala & Lindblom-Ylänne, 2007; Ramsden, 2003). Pedagogical training could enhance their awareness of supporting student learning, but either of the teachers of these two courses had received any pedagogical training, which may have influenced the assessment practices

they used. This, in turn, suggests that teacher awareness of assessment practices should be promoted.

The mismatch between students' study processes and their learning outcomes in Course 2 brings evidence of the fact that inappropriate assessment can promote poor learning outcomes and still lead to good success in studies. Blooms' taxonomy refers to different levels of thinking that can help to define educational goal for learning (Bloom, 1957). Bloom defined these levels as knowledge, comprehension, application, analysis, synthesis, and evaluation. Blooms' taxonomy is one way to assess the levels of thinking better and has been found to be very useful tool for assessment in biological studies (Crowe, Dirks, & Wenderoth, 2008). The exam in Course 1 required different levels of understanding from high achieving students namely understanding, applying of knowledge and analysing instead of just remembering. In the exam in Course 2, memorising was enough to succeed in the course. The results of Study IV agree that assessing different levels of understanding in an exam is more appropriate for evaluating students' learning outcomes.

6.4 Conceptions of learning

In Study IV, the purpose was to explore the variation in students' conceptions of learning. The results were partly in line with previous results concerning phenomenographic studies on students' conceptions of learning. The first two conceptions were similar to those in previous studies (Marton et al., 1993; Säljö, 1979; Van Rossum & Schenk, 1984; Van Rossum & Hamer, 2010). The category *memorising* (Marshall et al., 1999; Marton et al., 1993; Säljö, 1979) resembles the category *reproducing knowledge* in the present study, and the categories *acquisition of facts* (Säljö, 1979) and *applying* (Marton et al., 1993) are similar to the category *use of knowledge* in the present study. One difference in the present study was the absence of a similar conception to the first conceptions, *increasing of knowledge* (Marton et al., 1993; Säljö, 1979; Van Rossum & Schenk, 1984; Virtanen & Lindblom-Ylänne, 2010). In Study III, students mentioned an increase in knowledge as a part of their conceptions, but none of the students' comments represented this level alone unlike in the study by Marton et al. (1993) 12 of the 29 participants represented only the level: *increasing of knowledge*. The absence of the first conception has also occurred in previous studies (Eklund-Myrskog, 1998; Marshall et al., 1999).

The way students were distributed in different categories in the present study was interesting. Most of the students' conceptions of learning emphasised integrating knowledge in their learning. Only four students emphasised only the reproduction of knowledge or applying knowledge as it was received. Earlier research has shown that bioscience students' conceptions of learning emphasise

reproducing knowledge more than understanding the meaning (Virtanen & Lindblom-Ylänne, 2010). The results of Study IV offer insights about the learning in biosciences by suggesting that the variation in the present study differs from those of earlier studies (Eklund-Myrskog, 1998; Marton et al., 1993; Virtanen & Lindblom-Ylänne, 2010). In the present study, the strong emphasis was on integrating knowledge into prior knowledge. This result can reflect the cumulative nature of the biosciences. According to Biglan (1973) the hard sciences are considered as hierarchical in nature and building upon theoretical knowledge. It can be suggested that understanding the development and functioning of different phenomena and building a coherent whole cumulatively are crucial to understanding biological phenomena. Furthermore, when students also assess different viewpoints, the understanding of the general picture is qualitatively different. This can also be considered characteristic of the hard sciences. Relativity and uncertainty in knowledge is not a big part of studies until the later stages; one's early studies are based on factual knowledge (Neumann, Parry, & Becher, 2002).

6.5 Methodological issues

This doctoral thesis was conducted by using a mixed method approach. The purpose of the mixed method research is to use both qualitative and quantitative approaches in order to get a deeper and better understanding of the phenomenon being studied than either of the approaches would provide alone (Creswell & Plano Clark, 2007). However, the mixed method approach has been criticised for mixing different research paradigms together when using different methods (Smith, 1983). Howe (1988) has argued that qualitative and quantitative studies have different conceptions of reality and truth and the role of the researcher and the objectives of both methods are different. In mixed method research the purpose, however, is not to mix these different paradigms, but to approach research problems with a pragmatic approach which emphasises a practical method to conduct research (Creswell & Plano Clark, 2007). Mixed method research has established its status as a third paradigm in addition to quantitative and qualitative paradigms over the years and it relies on the contingency theory which suggests that there is no one right way to do research; all paradigms are best suited for situations and it is the responsibility of the researcher decide which approach to use (Johnson, 2004). In this doctoral thesis the results of the qualitative research clearly complemented results of the quantitative studies by, for example, giving explanations of the weak relationship between deep approach and study success.

The questionnaire used in this doctoral thesis is based on *The Experiences of teaching and learning questionnaire* (ETLQ) created at the University of Edin-

burgh (Entwistle et al., 2003). The ETLQ has been modified to a Learn questionnaire in the Finnish context (Parpala & Lindblom-Ylänne, 2012). The modification process of the ETLQ to Learn questionnaire has been a long process which started in 2005. The ETLQ used in a Finnish context with 18 items measuring approaches to learning and 40 items measuring students' perceptions of the teaching-learning environment was found to be a robust tool for measuring approaches to learning and students' perceptions of the teaching-learning environment (Parpala et al., 2013). The first shortened version consisted of 11 items concerning approaches to learning and 21 items concerning perceptions of the teaching-learning environment and it was based on factor loadings, communalities and skewedness of the items. In this version, both Intention to understand and Surface approach scales had only two items. After this the questionnaire was further developed and shortened to a questionnaire comprising 16 items concerning approaches to learning and 21 items concerning the components of the teaching-learning environment (Parpala & Lindblom-Ylänne, 2012). The development of the Learn questionnaire was taking place when Study I was conducted and confirmation and transformation analyses with longitudinal data suggested that those factors were acceptable, although two scales, Surface approach and Intention to understand, had only two items. Thus, all the four factors were included in the first study, including the ones with two items. Further analyses revealed the difficulties in these scales. In Study II, approaches to learning were measured with the 16 item version, but only the 11 items were used in order to compare the scales for Study I and Study II. The purpose of the follow up Study II was to examine how students develop during their bachelor studies. Both organised studying and deep approach to learning can be considered as desirable approaches to learning. Thus, the exploration of these two approaches can be regarded as justifiable. Confirmatory factor analyses conducted in Study II supported the exploration of the development of the deep approach and organised studying not including the Surface approach and Intention to understand scales.

Exploring changes in students' approach to learning and their perceptions of their teaching-learning environment can be challenging. The paired sample t-test was used to see how the scales have changed in the students' final year of bachelor studies. With only two measurement points the development or growth is hard to estimate and sophisticated analysing methods, such as multilevel and multi-indicator latent growth analyses cannot be used. However, it has been suggested that similar results can be obtained with simpler methods such as repeated measure ANOVA as with multilevel and multi-indicator latent growth analyses (Coertjens et al., 2013). One of the problems in longitudinal design studies is the Regression to the mean (RTM) problem which means that the scores in the second measurements tend to be closer to the mean (Barnett, Van

der Pols, & Dobson, 2005). This problem is especially evident when change variables (2nd measurement – 1.st measurement) are used. The change scores tend to be unreliable and correlate negatively with the first measurement and thus, scores tend to be closer to the mean in the second measurement (Allison, 1990). In the present study change variables were used on the basis of the regression analyses and to show the direction of the growth because it cannot be defined on the basis of the regression analyses. Thus, the use of change variables in this doctoral thesis can be considered to be reasonable.

Another reason for the difficulty in exploring approaches to learning longitudinally is that the changes in students' approaches to learning can be regarded as individual. Analyses made at the group level may not reveal the variation in individual changes (Lindblom-Ylänne et al., 2014). Changes in the whole group level do not necessarily mean that there are no changes at the sub group level (Vanthournout et al., 2013). Lindblom-Ylänne et al. (2014) have demonstrated that although changes in approaches to learning at group level seem insignificant, a closer exploration shows individual variation in the changes: when exploring university students' changes in their deep approach to learning during bachelor studies some students' deep approach to learning stayed constant, some students' showed a decrease and some students' showed an increase in their deep approach to learning. The purpose of this doctoral thesis was, however, to see how students develop in their approaches to learning at the general level during their bachelor's as a consequence of the aims of university studies to develop students deep-level learning and to explore how changes in students' perceptions of the teaching-learning environment are related to the changes in approaches to learning. Thus, group level analyses were applied to achieve this goal.

On purpose of this doctoral thesis was to explore the variation in students' conceptions of learning. A phenomenographic-inspired approach was applied to achieve this aim. According to the variation theory, which defines the assumptions in phenomenographical research, learning always depends on variation and is considered as a change in a person's discernment according to critical aspects of the phenomenon (Marton & Tsui, 2004). In traditional phenomenography, different ways of experiencing a particular phenomenon constitute an outcome space, which includes the categories of description and the relationships between them (Marton & Booth, 1997). The structure of the outcome space is constructed logically; usually the different categories of description form a hierarchical relationship with each other (Åkerlind, 2005b). In this doctoral thesis, a hierarchical relationship between different categories of descriptions was formed based on critical aspects according to the principles of phenomenographic research.

Traditional phenomenographic research is not interested in individual students' conceptions of learning but the variation of the different categories of descriptions (Åkerlind, 2005b). For example, in the study by Marshall (1999), distribution of students conceptions of learning were not included in the study but the focus was solely on the variation of students conceptions of learning. Nevertheless, phenomenographical analyses have been conducted in various different ways. Similar phenomenographical analyses focusing on individual students have been conducted by Eklund-Myrskog (1998) and Tsai (2004). In these studies the categories of descriptions were similarly categorised: individual conceptions were categorised so that one student represents one category of description. Even in the widely cited studies on students' conceptions of learning conducted by Marton et al. (1993) and Säljö (1982), the focus was not solely on the variation of the different conceptions but students were distributed so that the conception of one student could feature several categories of descriptions. Van Rossum and Hamer (2010) use and refer to a pragmatic phenomenography in which phenomenography is used more as a method of analysis rather than a philosophy or ideology. The focus in this doctoral thesis was on individual students' conceptions of learning and how they are distributed among the students. In addition, the aim was to combine the results with Study IV and see, how students' conceptions of learning are related to their study success. Thus, analyses were conducted focusing on individual students' conceptions of learning. In mixed method research, data is often analysed in a manner that focuses on answering the research questions without underlining the principles or philosophical assumptions of the method (Creswell & Plano Clark, 2007).

7 GENERAL DISCUSSION

The purpose of this doctoral thesis was to explore successful learning and studying in biosciences. The aim was to examine the relationship between students' conceptions and approaches to learning, their perceptions of the teaching-learning environment and study success. The central findings of this doctoral thesis were as follows:

1. At the general level, Organised studying was related to study success in the first year and in the final year of bachelor studies. Organised studying was also related to academic progression in the first- year studies in addition to peer support. In addition, the deep approach in the first year as well as interest and relevance were related to study success in the final year.
2. At the course level, two groups of students had poor self-reported learning outcomes and succeeded poorly in the exam: students applying a surface approach and students applying a deep approach but poor time management.
3. Students developed in their deep approach during their bachelor studies and the development in students' perceptions of teaching for understanding was positively related to the development in the deep approach. However, at the general level, students' experiences of teaching for understanding decreased. This suggests that development is individual in nature.
4. A variation in high-achieving students' study profiles were found. Thus, it was found that the assessment does not necessarily support the deep approach to learning, and that the course grades do not always reflect the quality of learning outcomes.
5. A wide variation of students' conceptions of learning was found in the context of the biosciences. The emphasis on the conceptions was on integrating new knowledge to prior knowledge and evaluating different views.

The results of this doctoral thesis demonstrated that organised studying can be regarded as crucial for successful studying for bachelor level university studies. This doctoral thesis showed that the deep approach to learning can be insufficient on its own, because to perform well in one's studies requires organised studying. In Study I and Study II, organised studying was most evidently related

to study success and academic progression in first year studies. In addition, the relation between organised studying and study success was evident in the final year of studies in the bachelor programme. That is to say, students who manage their time well, plan their studying and put effort into studying receive good grades during bachelor level studies and also make progress in the beginning of their studies.

The results of the qualitative studies in this doctoral thesis supported evidence of the importance of organised studying: it was found to be the only element which was systematically related to qualitatively better learning outcomes. The lack of organising skills was also the reason why students applying a deep approach to learning did not always succeed. In Study III and Study IV, students who had sophisticated conceptions of learning, applied deep approach to learning in the course and were organised received good learning outcomes unlike students, who had sophisticated conceptions of learning, applied deep approach to learning in the course and had trouble with organising and time management. This finding is supported by the fact that the deep approach to learning combined with organised studying has been found to be related to better learning outcomes (Entwistle & Ramsden, 1983).

This doctoral thesis demonstrates that at general level the deep approach to learning is not so strongly related to successful studying in the biosciences. Only the deep approach in the first year of studies predicted study success in the third year of studies. The qualitative approach brought insight to why the relationship between the deep approach to learning and study success is not so strong in the biosciences. First, the nature of the assessment in the Faculty of Biological and Environmental Sciences does not always support the deep approach to learning. A closer exploration of two bioscience courses showed that the deep approach to learning is not always required to succeed in studies: In one of the two courses in Study III, the quality of learning outcomes was not supported by the assessment and students memorising without understanding received high grades from the course exam. In this case, the course grades did not always reflect students own self-reported learning outcomes. Earlier studies in the same context have revealed that a large amount of bioscience teachers conceptions of assessment do not encourage deep processes in learning and studying (Halinen et al., 2013). In addition, assessment methods are not always perceived to be appropriate and fair by the students (Räisänen et al., 2012). Second, students who apply deep approach to learning but are not organised can succeed poorly in university courses. In Study III, students who applied the deep approach to learning and had poor organising skills succeeded poorly in two bioscience courses. Parpala et al. (2010) identified a cluster *Unorganised students applying a deep approach* at the university of Helsinki. In this cluster students scored high on a scale measuring the deep approach but low on a scale measuring organised studying.

In the Faculty of Biosciences, a third of the participants in the study by Parpala et al. (2010) represented this category. According to this result, there is a considerable number of bioscience students who aim at understanding and apply deep-level processes in their studying but do not organise their studying well. It has been shown that unorganised students applying a deep approach feel that the studies proceed too fast and they do not have enough time to fully understand everything (Ruohoniemi et al., 2010). In addition, it has been shown that students' own evaluations of their development in critical thinking during university studies is negatively related to their accumulation of credits (Tuononen, Parpala, Asikainen, & Hailikari, 2013). Thus, it can be suggested that students who apply a deep approach and are unorganised really want to understand everything and develop in their thinking and for that reason progress slower in their studies. This is also supported by the results of Study I which suggests a relationship between organised studying and academic progression.

Despite the not so explicit relationship between the deep approach and study success, this doctoral thesis suggests that the development of the deep approach to learning in bachelor level studies is supported. In addition, the development of the deep approach to learning is related to the development of students' perceptions of the teaching-learning environment. According to Study II, students' scores on the deep approach increased during their bachelor studies. Based on these results it can be suggested that students develop in critical thinking and relating ideas during their bachelor studies. Especially positive changes in students' perception of teaching for understanding were related to increase in the deep approach. The variation and distribution of students' conceptions of learning in Study III support the finding that in the context of biosciences deep-level learning is supported by demonstrating that in the context of biosciences students' understanding of learning is centred on building a coherent whole of knowledge and critically evaluating different viewpoint. Only a few of the students' conceptions only emphasised the reproducing of knowledge.

Study II also suggested that students' perceptions of teaching for understanding decreased during their bachelor studies. One explanation for this can be that students who develop in their studying can become more critical towards the teaching-learning environment. However, changes in the deep approach were related to changes in perceptions of teaching for understanding. Thus, it can be concluded that there are some students whose deep approach to learning decrease during bachelor studies together with their perceptions of teaching for understanding. The way students experienced teaching was not the focus at the course level in this doctoral thesis, but Study IV demonstrated that the assessment in bioscience courses does not necessarily support students' understanding. Study IV brought evidence of the relationship between methods of assessment and student learning: one student tried to understand the course matters but

changed her way of studying to just memorising the exam questions by heart due to the assessment. In other words, the nature of the assessment affected the way the student studied for the exam. Thus, it can be concluded that the development of the deep approach is not always supported in this context.

On the basis of this doctoral thesis, it can be argued that students' conceptions of learning do not necessarily reflect successful studying in the biosciences. Some students have relatively sophisticated conceptions of learning but still apply surface approach to learning and do not learn well in a particular course. In these cases, a lack of motivation was evident. This suggests that study motivation has an important role in successful studying. In addition, sophisticated conceptions of learning and applying a deep approach to learning does not always reflect qualitatively better learning outcomes. There were students with sophisticated learning outcomes and who applied deep approach to learning, but did not learn well because of their poor organising skills. This suggests that the poor self-evaluated learning outcome derives from a lack of motivation, interest or organising skills rather than unsophisticated conceptions of learning. Furthermore, some students with sophisticated learning conceptions applied the deep approach to learning in the course, were organised and learned well. In addition, these students were not affected by the assessment of the courses but tried to learn for themselves. McCune and Entwistle (2011) introduced the concept of *disposition to understand* meaning that some students have a continuous will to learn and they seem to have a tendency to apply the deep approach to learning continuously in different learning contexts.

Students who were categorized in *Fact-based learning and repetition before understanding* reported studying by memorising the subject matter and repeating it until they understood it. These students reported aiming to understanding the subject matter but they used repetition and rote-learning to achieve their aim. This profile is similar to 'the paradox of the Asian students' which means that Asian students have been found to have a tendency to both understand and memorise when studying (Kember & Gow, 1991; Kember, 1996; Marton et al., 1997). Different combinations of memorisation and understanding have also been found in Western countries (Entwistle & Entwistle, 2003; Meyer, 2000). For example, the subscale *Memorizing before understanding* which is a part of The Reflections on Learning Inventory (RoLI) is similar to the *Fact-based learning and repetition before understanding* found in the present study. These findings suggest that memorising and understanding are not separate processes, and that memorising can also be combined with understanding in Western cultures. One reason for this could be the nature of biology as a science where one should first acquire extensive factual knowledge, and only then begin to transfer that knowledge into practice and work. Furthermore, students applying *Surface approach to learning* reported having little motivation to study in the

course. These students studied by memorising and did not learn well. The lack of motivation was the aspect that all the students reported to share. This relationship between a surface approach to learning and poor learning outcomes has been demonstrated in many previous studies (Diseth & Martinsen, 2003; Entwistle & Ramsden, 1983; Marton & Säljö, 1976a).

7.1 Practical implications

The purpose of this doctoral thesis was to bring insight about the relationship between learning and studying, the teaching-learning environment and study success. The results of this doctoral thesis stress the importance of organising skills and time management as well as effort put into studying as part of successful studying. Universities should focus not only to support deep-level learning but to support students by making sure that organised studying is also supported in bachelor level studies at all points. It has been shown that time management practices predict students study success in their studies (Britton & Tesser, 1991). Some practices have been implemented to support students organising skills and deep approach. In the Faculty of Biosciences, the first-year students receive a pre-scheduled study plan for their first year studies. In their first year, students are required to make a plan for their studies and reflect on their own study skills. The University of Helsinki is also in the process of implementing a feedback system which gives students detailed feedback of their approaches to learning based on their scores in the Learn-questionnaire developed further from the questionnaire used in this doctoral thesis (Parpala & Lindblom-Ylänne, 2012). Students receive feedback about how they score on scales measuring deep approach, surface approach and organised studying compared to other students studying at the same level and get written feedback based on their score on which aspects they could concentrate on (Parpala & Lindblom-Ylänne, 2012). However, in the Faculty of Biosciences students in their first year do not necessarily know how to plan their studies yet, because they choose their main subject only in their second year of studying. This doctoral thesis showed that some students have difficulties in time management also at the course level. It can be assumed that some students cannot evaluate how much work courses require of them. Encouraging students to evaluate their time spend in studying and supporting students to schedule and plan their studying at the course level could also support the development of students' time management and organising skills in a more concrete way.

This doctoral thesis also showed that in first year studies, students' experiences of peer support in studies was related to better academic progression. In addition, it was suggested that the deep approach to learning at the beginning of studies predicts study success in the final year of studies. Based on these results

it can be suggested that teaching practices in first-year studies should support students' critical thinking and relating ideas as well as co-operative learning with fellow students. However, in the first-year studies all the students study the same courses and, thus, the number of students in the courses is really high. Nevertheless, different teaching methods such as active learning together with fellow students can be implemented in big lecture courses and it supports students' construction of their own knowledge and learning together with other students (Biggs, 2003).

This doctoral thesis brought more evidence of the inappropriate assessment methods used. It is clear that the assessment practises in the Faculty of Biological and Environmental Sciences should be developed. It has been shown that the emphasis on assessment in bioscience courses has been in evaluating lower levels of knowledge (Halinen et al., 2013). Pedagogical training which increases lecturers' knowledge about student-centred learning and the impact of assessment on students learning should be held. In the University of Helsinki, pedagogical training is offered to university teachers in all faculties, but it is not compulsory to teachers. Some attempts have been made in the Faculty of Biological and Sciences to improve the assessment practices. A peer assessment has been implemented in a bachelor level course and a study has shown that most of the students experienced it very positively and experienced it as supporting their learning (Virtanen, Asikainen, Postareff, & Heino, 2013).

7.2 Limitations of the study

In this doctoral thesis small sample size can be regarded as a limitation in all of the studies. In Study I, the sample size of the first-year bioscience students was 188 participants comprising 93 first-year students who began their studies in 2008 and 95 students who began their studies in the study in 2009, which can be regarded as fairly small sample for the analyses. However, the sample can be regarded as being very representative of first-year students because overall 74 per cent of the first-year students participated in this study. In addition, only 54.8 per cent of the participants in the first year participated in the follow up study. There is always the problem of loss of participants in longitudinal studies in the social sciences (Bijleveld, 1998). The exploration of the reasons why some students did not participate in the second wave is necessary, because participants only in the first wave can differ from the students who provide complete data in a way which affects the interpretation of the results. Students who are representative in all measurements may differ in their study processes from those who do not participate in all measurements (Richardson, 2013). However, in Study II all the important factors under exploration were compared between these students who participated in one measurement and students who participated in

both measurements and no statistically significant differences was found. Based on this it can be concluded that the sample received in the third year of studies can be concluded to generalise the students who participated in the study in their first year of studies. Furthermore, the small sample size also made the analyses of the relationship between students' study success, approaches to learning and experiences of the teaching-learning environment more challenging. The final model was done with limited amount of parameters. The final model was conducted mainly based on the statistical indicators by conducting the model only with scales with a significant relationship to study success. Nevertheless, the final model brings important information about the relationship.

In Study III, only 24 students participated in the analyses. The relationship between the nature of assessment and study profile in Study III was only analysed with high and low achieving students so the number of participants in the final analyses was even smaller. Even though Study III gives information about a small group of students, the purpose in the present study was to closely explore how students study in these particular courses with different kinds of exams. The purpose was not to generalise the results to all bioscience students but to have qualitative evidence of the relationship between different study profiles and the assessment of the course. In addition, these 24 students also participated in Study IV exploring conceptions of learning. In phenomenographic studies a proper sample size is not an unambiguous matter because the purpose is to explore qualitatively the variation among participants in a specific context. Optimally, the categories of descriptions in phenomenographic analyses represent the full range of possible ways of experiencing the phenomenon in question for the population represented by the participants at a particular time (Åkerlind, 2005b). The variation in Study IV can be considered as giving information about a wide variety in students' conceptions and the differences between them. In addition, although the participants in the present study participated in the present study voluntarily from two biosciences courses, it can be regarded as representing students from different levels of study.

In this doctoral thesis, success in studies is measured with grade point average, course grades and accumulation of credits. The qualitative measurement of students' learning outcomes is based only on students' self-reports in two courses which are based on student interviews. Self-reports are students' own experiences of their learning outcomes and they can be unreliable in the sense that they are affected by a number of things such as students' emotional state, the context or the fact that the students give answer they feel could be appropriate and desirable (Cohen, Manion, & Morrison, 2007). In addition, students' conceptions of learning vary a lot in this context as Study IV showed. It can be, thus, questioned if these self-reports give us valid information about the quality of students learning outcomes. In addition, the argument of the inappropriate

assessment is based on the fact that students' own self-reported learning outcomes do not match their grades received from the course. Students could also evaluate their performance and understanding of the subject matter incorrectly.

7.3 Conclusions

Based on the studies of this doctoral thesis it can be argued, firstly, that three components are important for successful studying in the biosciences: organised studying and effort management, understanding of the subject matter and motivation for studying. To succeed in bioscience studies, the deep approach to learning is not enough: organised studying and effort management is an important element regarding students' studying and should be taken into account when exploring student learning and studying. This doctoral thesis showed that exploring student approaches to learning only using the deep-surface dichotomy can disregard important information about the ways students study and also about the relationship between approaches to learning and the quality of students' learning outcomes. Thus, it can be concluded that in order to succeed in studies, students need to apply a deep approach to learning, organise their studies and put effort into their studying. In addition, this argument is supported by the fact that there were two groups of students who did not succeed in their studying: students who applied a deep approach to learning and had poor time management skills and students who applied a surface approach to learning. The role of motivation in studies was also important. The students applying a surface approach had a sophisticated conception of learning but their lack of study motivation was the key element why they did not study according to their conception of learning.

Secondly, this doctoral thesis brings evidence of a lack of constructive alignment in bioscience studies and argues that this can result in successful studying which includes memorising and poor learning outcomes: Study III showed that poor assessment methods in courses can result in undesired ways of studying such as learning by heart, and brought evidence of this by demonstrating that students resorted to memorising due to the foreseeable and reproduction oriented nature of the exam. In addition, it can be argued that these inappropriate assessment methods can reward poor learning outcomes with high grades. Study III clearly showed that students who applied a surface approach in the course and did not understand the subject matter received high grades. In addition, Study I and II showed that students' experiences of the constructive alignment were positively related to the Deep approach and Organised studying and negatively related to the Surface approach. These results suggest that the alignment in course objectives, methods and assessment play an important role in affecting

the way students study and what kinds of quality of learning outcomes is rewarded.

Thirdly, based on the results of this doctoral thesis it can be argued that changes in students' perceptions of teaching are related to the development of the deep approach to learning during studies. Study II showed an increase in the deep approach to learning during bachelor studies, and that positive changes in students' experiences of teaching for understanding were related to positive changes in the deep approach to learning. Thus, it can be concluded that if students' perceptions of the teaching as supporting their understanding increases they are more likely to apply a deep approach to learning. In the context of the biosciences the teaching-learning environment changes from a prescheduled curriculum to a learning environment which required students to plan and organise their studies themselves. Furthermore, as students' perceptions of the teaching-for understanding decreased during their bachelor studies, it can be argued that there are individual changes in students' deep approach to learning and their perceptions of the teaching for understanding.

Fourthly, it can be argued that students' conceptions of learning in the context of biosciences are relatively sophisticated in the 21st century. The exploration of the variation of students' conceptions of learning in Study IV showed that students in the context of biosciences emphasise integration of new knowledge to prior knowledge and evaluating different viewpoints in their conceptions of learning. There were no students who understand learning solely an increase in knowledge. In earlier studies, students have emphasised more the increase or reproduction of knowledge to a large degree (Eklund-Myrskog, 1998; Marton et al., 1993).

7.4 Future research

This doctoral thesis gave an overview of how students' approaches to learning and their perceptions of the teaching-learning environment develop during their bachelor studies. In Finland, in the biosciences, students rarely end their studies with a bachelors' degree. Almost every one of the students continues their studies to complete the masters' degree. In the Faculty of Biological and Environmental Sciences, a large amount of students also continue their studying after the master's degree to doctoral studies. For future research, it would be important to see how students' approaches to learning and perceptions of the teaching-learning environment develop at the masters' degree level and how these factors are related to study success. In addition, the connection between university studies and working life should be studied more closely. This doctoral thesis raises the question of whether successful students at the university are also the ones who succeed in working life. It has been suggested that the way stu-

dents study at university is related to the way they approach their work (McManus, Keeling, & Paice, 2004), however, research combining the information about how students' study at the university and their achievement in working life have been scarce.

This doctoral thesis showed that students differ a lot according to their learning and study practices. In Study IV, different study profiles were identified which suggests that students have individual study profiles in their ways of studying. In this doctoral thesis, the development of approaches to learning has been explored on scale level. Vanthournout et al. (2013) suggested that changes in the whole group level do not necessarily mean that there are no changes at the sub group level. The development of these different students' study profiles should be explored in order to understand more precisely, how students develop during university studies. In addition, Study IV identified the study profile Deep approach but poor time management. It was also shown that these students performed poorly in courses and had poor learning outcomes. Parpala et al. (2010) found a similar cluster *Unorganised students applying a deep approach* in the University of Helsinki which was the most common cluster in the Faculty of Biological and Environmental Sciences. These students with the intention to understand but inability to organise their studies should be more closely examined in order to understand how these students cope in university studies.

Learning and studying are complex phenomena and are affected by number of factors such as the learning environment, students' conceptions of learning, motivation and study skills. Because of the complex interaction between the learner, the teacher and the learning environment, it would be best if successful studying were also be explored from different perspectives. Although this doctoral thesis stresses the importance of organised studying, it could be that some important factors of successful learning and studying are missing from this doctoral thesis. For example, it has been suggested that students' self-efficacy beliefs are related to their approaches to learning and the way they experience impeding factors in their studying (Hailikari & Parpala). Thus, students' self-efficacy beliefs are important in successful studying and it is possible that the beliefs students have about themselves as learners are crucial in determining how they go about learning. In addition, recent studies have emphasised the importance of the relationship between students' academic emotions and success in studying (Hailikari & Postareff, 2013; Triggwell, Ellis & Han, 2012). Although emotions are a crucial part of the learning experience, they have not been studied much in the university context. Future research should focus on other aspects, such as the emotional aspects, of the learning experience in order to understand successful studying at the university level more profoundly.

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