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Becoming a Chemist

First Year at University

Jonas Niemann

Kandidatspeciale

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Abstract

This thesis examines how it is to go from being a upper secondary school student to a student in the Department of Chemistry at the University of Copenhagen, in the cohort that started in 2015. It examines the expectations of the students to the education of life as universty students as a whole. It examines the expectations of teachers at the first years for their students. And it investigated how the students handle the transition from upper secondary

school to university. This is done with a focus on how the students' attitudes toward initiatives at the university; academic, social and cultural, how students change goals for the program over time and how their identity as chemists changed. The thesis is based theoretical on Vincent Tinto's work with academic and social integration as tools to explain retetion, and with Benson Snyder's theory of the hidden curriculum in mind. The thesis' data material consists of three questionnaires given to the students, one questionnaire for three first-year teacher and interview with the same 3 first-year teacher. The paper finds that chemistry students have very clear professional and academic goals, a strong professional identity, but lacks understanding of institutional identity and lacking skills in the hidden curriculum.

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UNIVERSITY OF COPENHAGEN
FACULTY OF SCIENCE

Master thesis

Jonas Niemann

Becoming a Chemist

First Year at University

Supervisor: Henriette Tolstrup Holmegaard

Handed in: 17-06-16

Table of content

Dictionary

Throughout this thesis a number of Danish word with specific meaning and important distinction from other related word, have been translated consequently to the following. Some of the translations come from the Ministry of Higher Educations Danish-English Terminology of Education("Dansk-Engelsk Uddannelsesterminologi," 2013).

Homework help	*Lektiecaféen*
SCIENCE	*Det Natur- og biovidenskablige Fakultet*
Upper secondary school	*Gymnasium*
General	*STX*
Technical	*HTX*
Galla Ball	*Galla på kemistudiet*
Chemistry Students Union	*Kemisk Fagråd*
Teaching plan	*Lærerplan*
Academic goals	*Faglige mål*
Core substance	*Kernestof*
Guidelines	*Vejledning – råd og vink*
Universities Denmark	*Danske Universiteter*
Progression Reform of Danish universities	*Fremdriftreformen*
Institute Counsel	*Institutråd*

1 Introduction

1.1 Abstract Danish

Denne afhandling undersøger hvordan det er at gå fra at være gymnasieelev til at studerende på Kemisk Institut på Købehavns Universitet for årgangen der startede i 2015. Det undersøges hvilke forventninger de studerende har til uddannelsen of livet som universitetsstuderende som helhed. Det undersøger hvilke forventninger underviserne på første år har til de studerede. Og det undersøges hvordan de studerende håndtere overgangen fra gymnasiet til universitet. Dette gøres med et fokus på hvordan de studerendes holdninger til initiativer på universitetet; både akademiske, sociale og kulturelle, hvordan de studerende ændre mål for uddannelsen undervejs og hvordan deres identitet som kemikere ændres. Afhandlingen baseres teoretisk på Vincent Tintos arbejde med akademisk og social integration som redskaber til at forklarer frafald, og med Benson Snyders teori om det skjulte pensum for øje. Afhandlingen datamateriale består af 3 spørgeskemaer givet til de studerende, 1 spørgeskema til 3 førsteårsunderviser og interview med samme 3 førsteårsunderviser. Afhandlingen finder at kemistuderende har meget klare faglige og akademiske mål, en stærk faglig identitet, men mangler forståelse for institutionel identitet og mangler evner inden for det skjulte pensum.

1.2 Abstract English

This thesis examines how it is to go from being a upper secondary school student to a student in the Department of Chemistry at the University of Copenhagen, in the cohort that started in 2015. It examines the expectations of the students to the education of life as universty students as a whole. It examines the expectations of teachers at the first years for their students. And it investigated how the students handle the transition from upper secondary school to university. This is done with a focus on how the students' attitudes toward initiatives at the university; academic, social and cultural, how students change goals for the program over time and how their identity as chemists changed. The thesis is based theoretical on Vincent Tinto's work with academic and social integration as tools to explain retetion, and with Benson Snyder's theory of the hidden curriculum in mind. The thesis' data material consists of three questionnaires given to the students, one questionnaire for three first-year teacher and interview with the same 3 first-year teacher. The paper finds that chemistry students have very clear professional and academic goals, a strong professional identity, but lacks understanding of institutional identity and lacking skills in the hidden curriculum.

2 Framing the study

2.1 Chemistry at UCPH

The bachelor of chemistry at University of Copenhagen is offered by The Department of Chemistry, a department under the Faculty of Science.

2.1.1 Physical location

The Department of Chemistry is physically located in a single building, the H. C. Ørsted-building, at a campus in Copenhagen. The H. C. Ørsted-building also houses parts of the departments of physics, mathematics and computer sciences and is used to host lectures, laboratory exercises and class room exercise in most of the STEM-educations, who are located at the campus. The H. C. Ørsted-building is the building primarily used to host the bachelor of chemistry and the master of chemistry, and the home of all offices of professors, PhD-students and technical personal of Department of Chemistry. the H. C. Ørsted-building also houses a room, NAKED (Nanokemisk delerum), shared by the chemistry and nanoscience students used for parties, meetings, and stay in general, and the cantina where chemistry students usually eat and host their Homework Help.
Apart from other buildings where classrooms and lecture halls are occasionally used by the chemistry students, the campus have a football field used in the football cup and a student bar, Caféen?, for all the students at campus.

2.1.2 Bachelor degree

The bachelor of chemistry is the only bachelor degree offered by the Department of Chemistry, who also offers the master of chemistry. However both the bachelor and master degree is highly specialized and the Department of Chemistry offers 5 different themed version of the degrees, so called specializations, that offers different courses after the first year of the bachelor. These specializations are very profiled by the Department of Chemistry and often used to show the diversity the degree offers. They are however not required to start any of the specialization on the master degree or in any other admissions. From time to time new specializations are made and other closed, but the specializations of the bachelor in 2015 ware:

- Environmental chemistry
- Medical chemistry
- Green and sustainable chemistry
- Chemistry for teaching in secondary schools
- And general chemistry, which is really not to choose a specialization.

2.1.3 Size of department

Chemistry, both as a department and a bachelor degree, are relatively small compared to the other departments and degrees at SCIENCE. They don't interact or collaborate much with others apart from nanoscience and all courses in the first year of the bachelor degree are offered solely to chemist, apart from the first mathematic course, Introduction to Mathematics, but here the chemist are grouped together in classes with one another and are taught by chemist. In past years chemist shared all of their courses with nanoscience and biochemistry students, but this was changed some years ago due to the different focuses of the students i.e. the chemist though the others were slow. The only remanence from this past is that the new chemistry and nanoscience students are told by their tutors to like one another.

The small size of the Department of Chemistry and the bachelor and chemistry degree, and its relative seclusion from the rest of SCIENCE however means that the students often gets familiar with all other students from their respective year and quite a big part of older students and professors as well. This is enhanced by initiatives like the Homework Help (older students helping, primarily first year students with their homework), the Galla Ball (dress-up-party for all students and professors in May), Nobel Crystal Ball (lectures trying to predict the upcoming Nobel Prize), the football cup and various theme parties arranged by the Chemistry Student Union. The fact that the students eat at the same spot in the cantina and that the professors keep open doors also helps to keep the whole department familiar with one another.

2.1.4 Admission requirements

The admission requirements for the bachelor program of chemistry are complex. In general they require that appliers must have completed a secondary education with a focus on science. This focus was originally on Physics and Chemistry, but with the two test courses in upper secondary school, Biotechnology and Geosciences, which can replace either Chemistry or Physics respectively the admission requirement, are now the following("Web Page of Bachelor in Chemistry,"):

A-level of Danish
B-level of English
A-level of Mathematics
And one of the following combinations:
A-level of Physics and B-level of Chemistry
A-level of Physics and A-level of Biotechnology
A-level of Chemistry and B-level of Physics
A-level of Chemistry and B-level of Geosciences

All of these courses exist in different varieties because they are offered both at the general upper secondary school and the technical upper secondary school . By comparing the teaching plans of the different levels and institutions a general minimum standard of the academic abilities in each category, mathematics, chemistry and physics, is constructed. This standard will along with examples from examination from secondary schools and early university be used to formulate questions for the university teachers about their expatiations of the students' academic abilities.

The teaching plans consist of multiple chapters concerning a variety of subjects from "Academic Identity" to "Evaluation and Examination" and the focus of this work will be on the academic goals and the core substance. This focus is chosen because the evaluation and examination of the students are based on them mastering the academic goals and because the core substance is the subjects that *must* be taught.

In general there is not a one-to-one line to be drawn between the academic goals and the core substance of the different teaching plans so sometimes this comparison includes passages from the core substance when comparing academic goals, and vice versa, and from the guidelines of each course.

2.1.4.1 Abilities in chemistry

The guideline of Biotechnology states that: *“A-level of Biotechnology equates both Chemistry and Biology at B-level”* hence in this comparison of abilities in chemistry, Biotechnology is included("Bioteknologi A Vejledning / Råd og vink," 2014).

The admission requirement shows that students can be accepted with just B-level of Chemistry or A-level of Biotechnology. The expected abilities regarding chemistry of the students must then be abilities mentioned in *both* the teaching plans for B-level of Chemistry at general upper secondary school, B-levels of Chemistry at technical upper secondary school and A-level of Biotechnology, who got the same teaching plan at both schools ("Bioteknologi A - Lærerplan," 2015; "Kemi B - STX Lærerplan," 2013; "Kemi B -HTX Lærerplan," 2013). The following lists are both the academic goals and core substances that the teaching plans have in common and list of selected non-common abilities e.g. abilities not mentioned in all teaching plans, or abilities from the A-levels of Chemistry("Kemi A - HTX Lærerplan," 2013; "Kemi A - STX Lærerplan," 2013). The following sentences are not citations since the phrasing differs in the three teaching plans.

Common academic goal

1. Relate observations, models and symbols to one another.
2. Account for connection between structure, and chemical and physical properties and functions of matter.
3. Perform simple calculations.
4. Prepare and perform simple experiment.
5. Handle chemicals and laboratory equipment in a safe and reflected way.
6. Collect, process, and evaluate experimental data.
7. Gather and use information about chemistry from different sources.

Common core substance

A. The composition and properties of matter in relation to binding types, state of matter, solubility and isomerism.
B. Simple chemical calculations, including pH-calculations and quantity calculations.
C. A selection of inorganic compounds.
D. A selection of organic compounds including carbon hydrides[1], alcohols, carboxylic acids, and esters.
E. Types of chemical reactions including acid-base reactions and redox reactions.
F. Chemical equilibrium, change in equilibrium and calculation of reaction constant.
G. Kinetics on a qualitative level, including rate of reaction and catalysis.
H. Qualitative and quantitative analysis in experimental work.
I. Chemicals and safety.
J. Bohr's model of the atom.

[1] Carbon hydrides are actually not mentioned in the teaching plan or guidelines for Biotechnology, but seams rather trivial considering the other compounds e.g. oxo compounds.

Non-common academic goals

1. Identify and outline simple problems related to chemistry from everyday life and trending debates (General B)…and from technology and production. (Technical B)
2. Analyse and debate biotechnological problems in the perspective of society, environment and ethics. (BioTech)
3. Demonstrate knowledge of Chemistry's/Biotechnology's identity and methodology. (General B / BioTech)
4. Collect, process and evaluate experimental data…

…including sources of error and uncertainty (BioTech)

…and communicate it both oral and in writings (General B)

…and document experimental work (Technical B)

5. Create and test hypothesis (Technical B)
6. Put knowledge of chemistry in relation to both other fields of chemistry and other academic disciplines into perspective (General B)
7. Analyse, evaluate and put into perspective biotechnological methods in selected areas as health and diseases, food technology, and chemical production on a sustainable basis (BioTech)
8. Demonstrate understanding of the relationship between different subareas of chemistry (General and Technical A)
9. Use knowledge of chemistry to understand and evaluate the significance of chemistry for human and the world in collaboration with the advance of society and technology (General A)

Non-common core substance

A. Amino acids, oxo compunds, carbohydrates, triglycerides… (BioTech, General A and Technical A)

…Peptides (General A)

…Proteins (BioTech and Technical A)

…Lipids (BioTech)

B. A selection of biological active compounds (General B)

C. Enzymes (Technical A and BioTech)

D. DNA and RNA (BioTech)

E. Chemical synthesis (General B and Technical B)

F. Separation methods (General B and BioTech)

G. Spectrophotometry (BioTech, General A and Technical A)

H. Spectroscopically identification with IR and H-NMR (General A)

I. Chemical understanding of photosynthesis("Biologi C - HTX Vejledning/Råd og vink," 2013; "Biologi C - STX Lærerplan," 2013) (BioTech)

J. Thermodynamic state functions: enthalpy, entropy and Gibbs energy in relations to chemical reactions (General A and Technical A)

K. Chromatography (BioTech, General A and Technical A)

L. Buffers and Bjerrum-diagrams (BioTech, General A, Technical A)

M. Types of chemical reactions including addition, substitution, elimination, condensation and hydrolysis (General A and Technical A)

N. The insufficiency of Bohr's model of the atom, but not other specific models (General A and Technical A)

2.1.5 Resent history of retention and admission

As mentioned earlier the bachelor degree in chemistry is a small one, relative to other degrees at SCIENCE. In the last decade Chemistry has however experienced an enormous boom in admissions tripling the amount of new students accepted in less than 10 years.

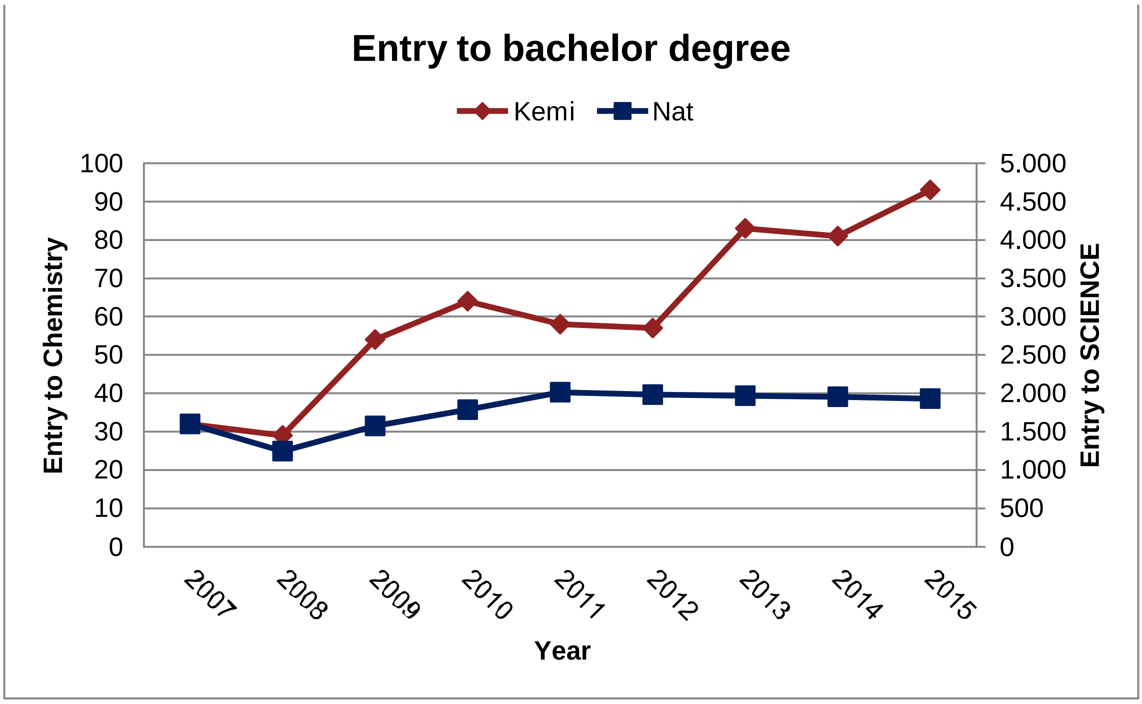


Figure 1 Entry to the bachelor degree in Chemistry (green) and all bachelor degrees on SCIENCE. In years there were multiple bachelor degrees in chemistry, these numbers have been multiplied. And in the years before SCIENCE were combined with the Faculty of Biosciences, their entry numbers were combined. Data from Copenhagen University's Statics of Students(University, 2016b).

As figure 1 implies this boom in students can be partly explained by a general increase in the number of accepted (and applying) students in SCIENCE, but only partly.

There have been many changes in the curriculum and education in general, like the before mentioned removal of nanoscientists and biochemist from first years courses, but none related to the increasing number of chemistry students.

As mentioned before, there is no definitive way to categorize students who drop out and a definitive retention rate is hence also not definable. This fact is illustrated very well by some of the retention data that the Copenhagen University, Universities Denmark and Associate Professor Solvejg Jørgensen has collected in the past years.

Copenhagen University every year reports how many graduation there are from each degree. The follow figure 2 is a plot of these data in recent years for the bachelor degree in chemistry and bachelor degrees from all of SCIENCE.

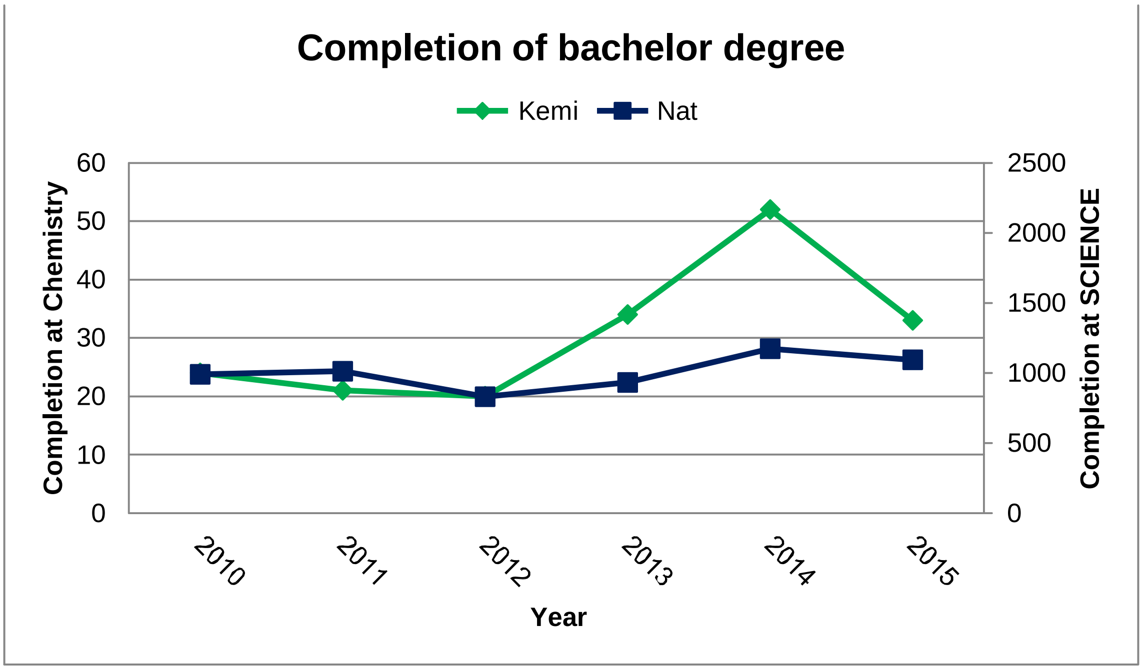


Figure 2 Completion of bachelor degree. In years there were multiple bachelor degrees in chemistry, these numbers have been multiplied. And in the years before SCIENCE were combined with the Faculty of Biosciences, their entry numbers were combined. Data from Copenhagen University's Statistic of Students(University, 2016a).

Even though there have recently been educational reforms in Denmark to reduce the completion time of degrees, these have not effected these numbers. Universities Denmark has also reported completion of degrees, but in a slightly different way. Below are the completions of students from the same year of acceptation, 4 years after acceptation e.g. column 2014 is data collected in 2014 from students who started in 2010.

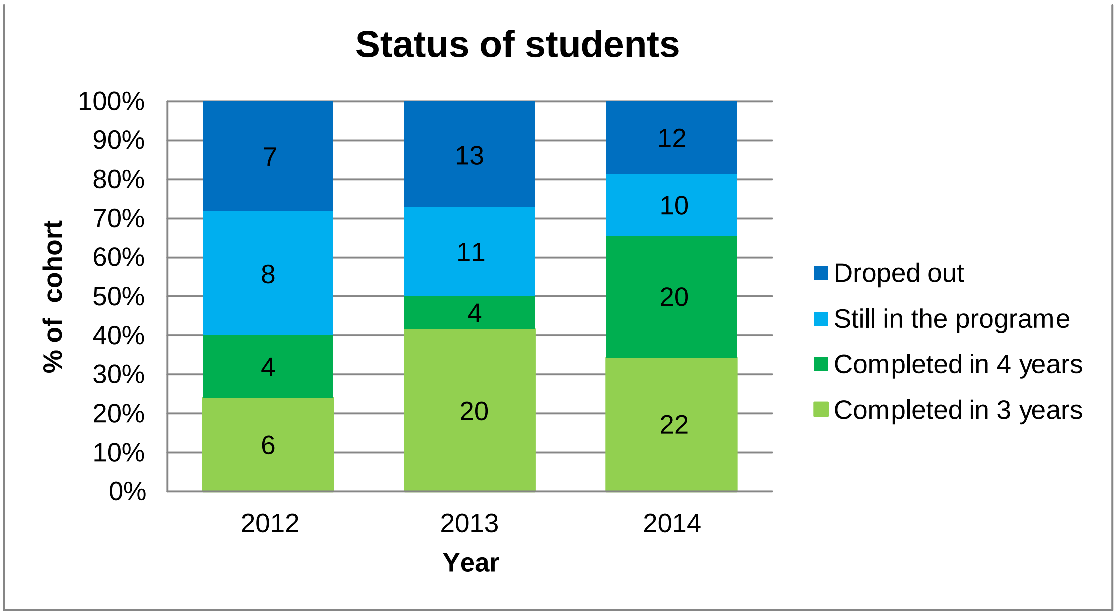


Figure 3 Status of students 4 years after beginning bachelor in chemistry from Copenhagen University. The year corresponds to the years the data was collected; i. e. 2014 corresponds to the cohort who stated in 2010. Data from Universities Denmark's statistic (Denmark, 2015).

These two ways of reporting dropout, as a measure of completion after 3-4 years after start, is useful in the sense that it actually measures the effect of the degree as a whole, not just the first year.

The two following tables focus on the amount of ECTS points each student have passed within their first year. Note that figure 4 included data from the examination in block 4 and that figure 4 excluded that.

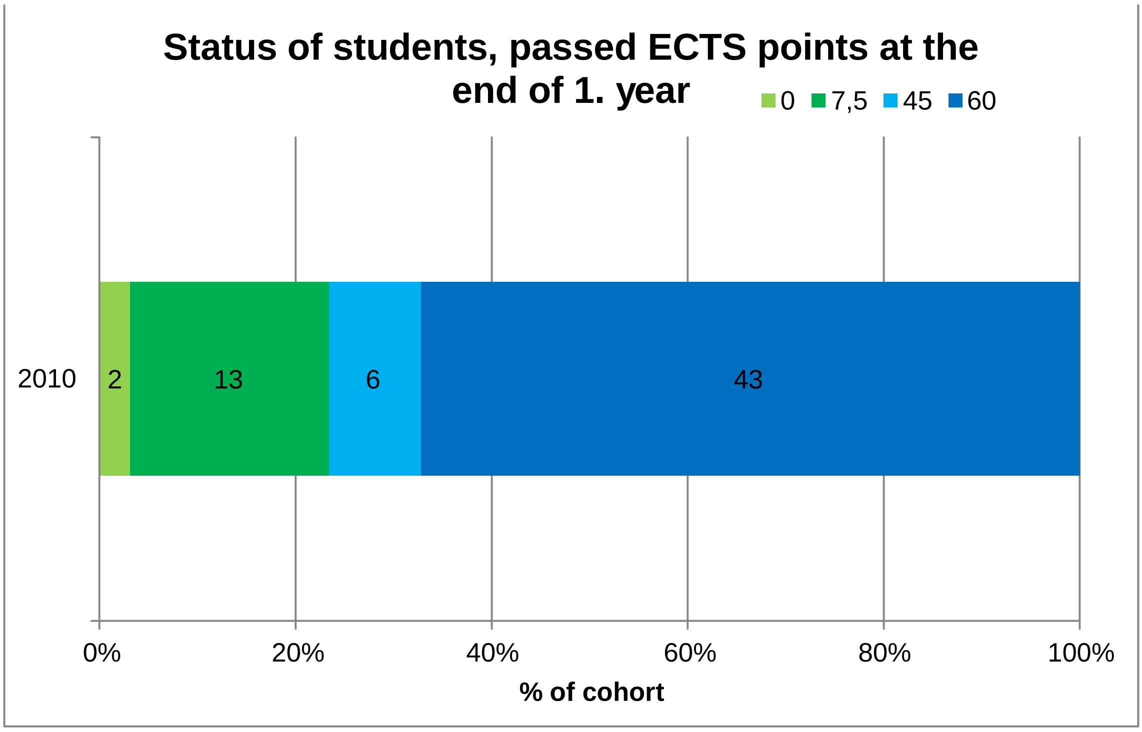


Figure 4 Numbers of passed ECTS points at the end of block 4, including possible points from passed reexamination from block 4, for students who started in September 2014. Data from SCIENCE´s report on Student Introduction 2012 ("Studieintroduktion Model 2012 Statistiske analyser III," 2012)

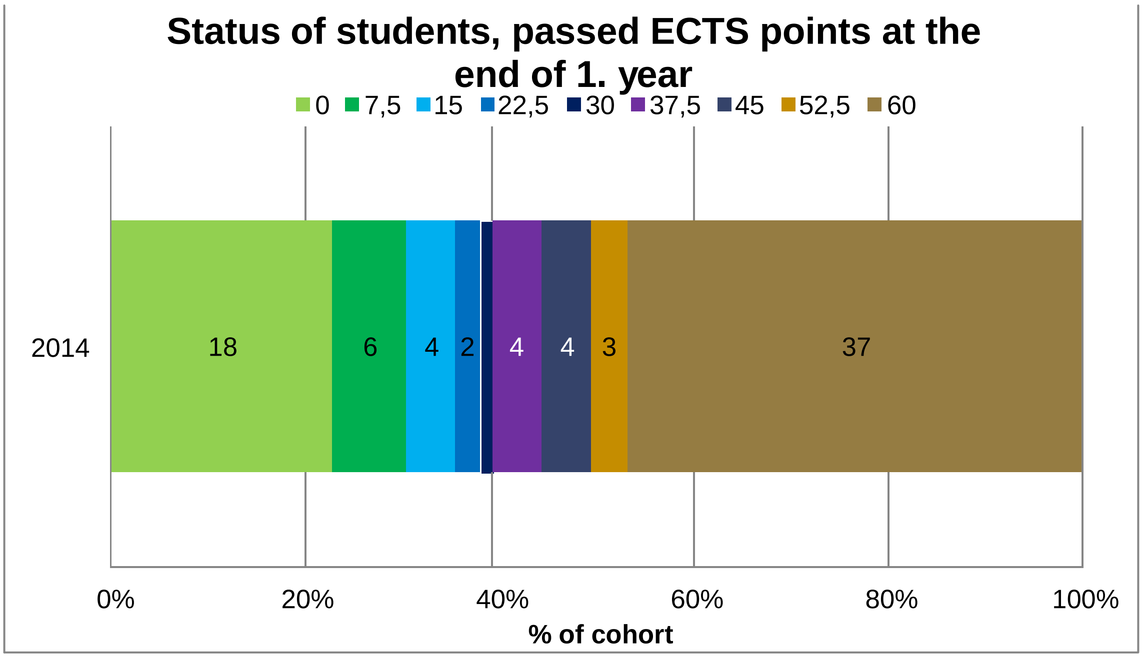


Figure 5 Numbers of passed ECTS points at the end of block 4, excluding possible points from passed reexamination from block 4, for students who started in September 2014. Data from Assoc. Prof. Solvejg Jørgensen.

Comparing all these figures some noteworthy observation can be highlighted:

- It is ambiguous whether or not the doubling of students entering Chemistry from 2007-2008 to 2010-2012 also leads to a doubling of the number of students completing a degree. With a 4-years completion rate this seems to be the fact in 2014, but the completion numbers drops dramatically in 2015.
- The number of students who doesn't complete 45 ECTS points the first years, and hence complete the first year test, and continue to second year increases from 23% of the cohort in 2010 to *at least* 38% in 2014.
- In the first year of cohort 2010 15 students doesn't continue to second year and the in 2014 12 students have dropped out. The reason the number of dropouts can be higher 1st year than 4th year is because some of the students might have reentered next year.
  I have not been able to find any data on how many students did this in 2010 cohort, but for comparison only one student from the cohort I have examined have reported that he reentered.
  In other words it seems extremely reasonable that a vast majority of the dropout occurs in the first year at Chemistry.

2.1.6 Retention of Chemistry in relation to other educations

When comparing the retention rates at Chemistry at Copenhagen University to other institutions it is obvious that the dropout the last past years have been high, especially in 2014. Figure 6 shows the dropout in the first year of the bachelor program of some comparable institutions bachelor programs, i. e. Copenhagen University, SCIENCE at Copenhagen University, Science on Danish universities, and Chemistry at Aarhus University (both Chemistry and Medical Chemistry). Notes that this data from the Ministry of Higher Education and Science (Science, 2016) uses a different way of calculating dropout, since students who change institution, but not subject are not included.
Even with this difference in measurement from the data in figure 4, 5 and 6 it is hard to make total sense of the difference. E.g. in 2010 the data from SCIENCE´s report on Student Introduction 2012 ("Studieintroduktion Model

2012 Statistiske analyser III," 2012) reports that 15 students didn't pass the first year test and the data from the Ministry of Higher Education and Science (Science, 2016) that only 4 students dropped out the first year. According to the difference in measurement this should be because 11 students either started at the program again in 2011 or changed to a different institution, but same subject (at this time Aarhus University was the only alternative, since the education at University of Southern Denmark, University of Aalborg and Roskilde University offered programs with a first year of basic science and was hence in another category by the ministry's account). So either there is underlying differences in the way dropout is understand and measured or a very high proportion of the students who drop out start again the next year.

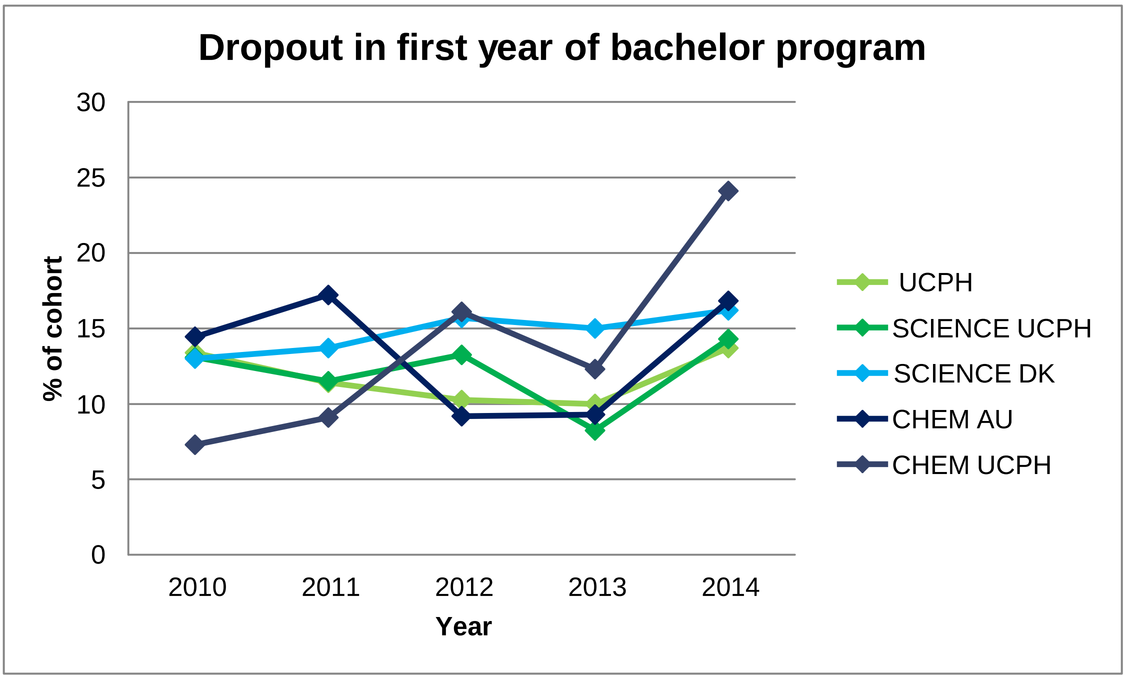


Figure 6 Percent of the cohort who dropped out before the end of first year. Students who changed institution, but not program are not included. Number for CHEM AU included both the bachelor program in Chemistry and in Medical Chemistry. Data from the Ministry of Higher Education and Science("Statistic and Analysis on Education ", 2016).

When comparing the dropout of the bachelor programs from Copenhagen University and Aarhus University with the absolute number of student who entered the education, it is noteworthy that there isn't a correlation between these numbers, so when a higher number of students are accepted is doesn't necessary follow that a higher dropout will follow. See table 1.

		Entry to program
Dropout after 1. year	Pearson Correlation	.343
	Sig. (2-tailed)	.332
	N	10

Table 1 Correlation between the number of students who entered a chemistry program and the number who dropped out after first year. Data from the Ministry of Higher Education and Science (Science, 2016)

Figure 7 show the entry to the bachelor program at Copenhagen University and Aarhus University over the years. On the same note as mentioned before concerning the difference in measurement of retention, the two institutions data on entry to their programs is not totally equivalent with the ministry's data in all. This difference on 0-3 students per year is however not significant to explain the difference in retention measurement.

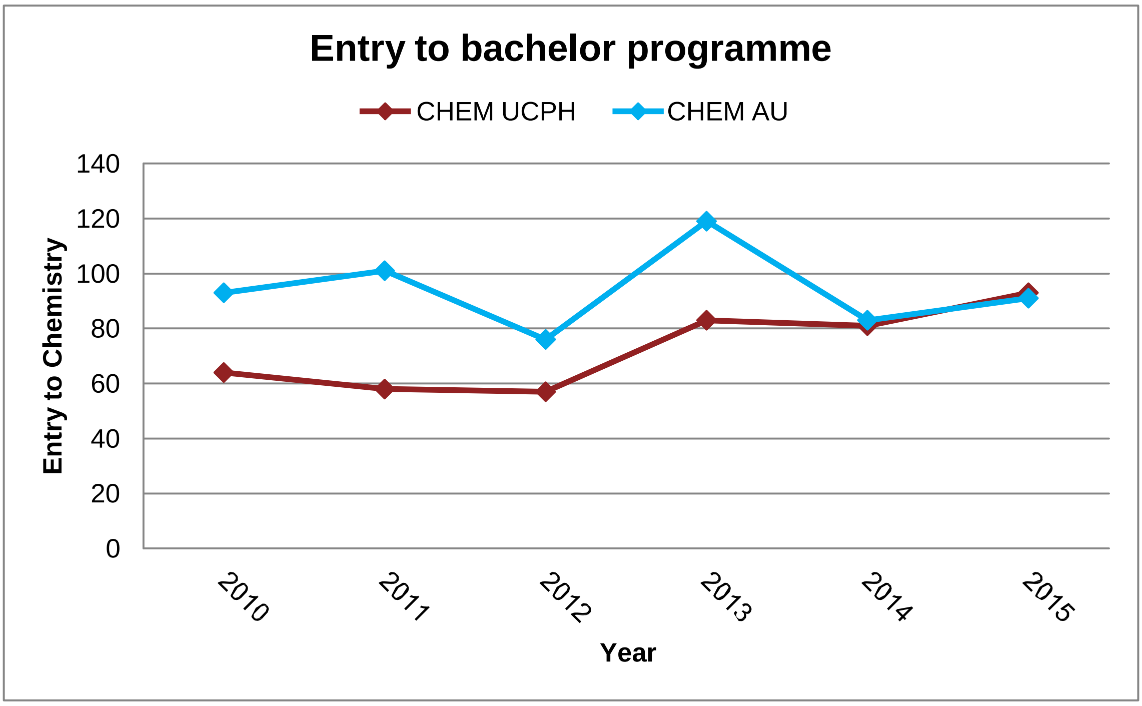


Figure 7 Entry to the bachelor degree in Chemistry at Copenhagen University (green) and Aarhus University (blue). Data from Copenhagen University's Statics of Students(University, 2016b) and Aarhus University's Key Number and Statistics ("Keynumber and statistics ", 2016).

On a final note when comparing Chemistry to Copenhagen University or SCIENCE cohort of 2010, Chemistry does resemble SCIENCE and

Copenhagen University overall, as figure 8 shows. Note that Chemistry's dropout-percentage is remarkably lower, which corresponds well to figure 6.

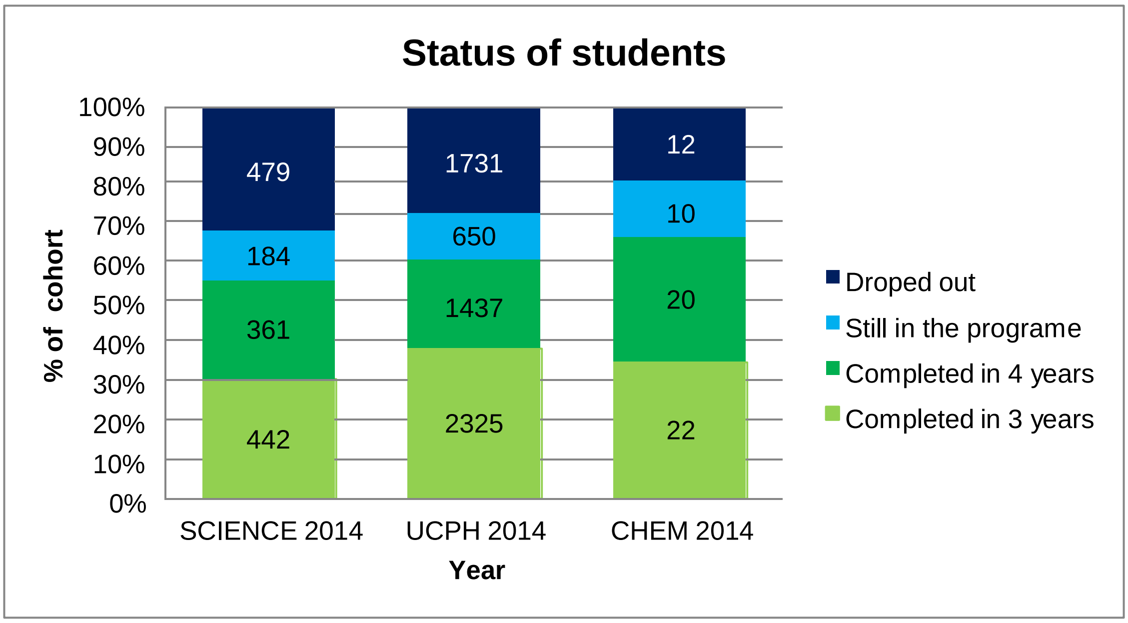


Figure 8 Status of students 4 years after beginning bachelor from SCIENCE, Chemistry or Copenhagen University in general. The year corresponds to the years the data was collected; i. e. 2014 corresponds to the cohort who stated in 2010. Data from Universities Denmark's statistic (Denmark, 2015).

To sum up:

- Chemistry at Copenhagen University has since 2012 had a notable higher dropout of first year students than Copenhagen University in general, SCIENCE at Copenhagen University and Chemistry at Aarhus University.
- The increase in the dropout cannot significantly be associated with the increase in the number of students who enter the education.
- It should be noted that the Progression Reform of Danish universities started to have effect from 2014. The dropout of all the examined programs goes up from 2013 to 2014, most notably the dropout for all programs at Copenhagen University that increase from 10.0% to 14.3%. But this general increase of ~40% does not explain why Chemistry experiences an increase at about 100%, or SCIENCE by 70%. The data in figure 8 does show that Chemistry and SCIENCE had a higher percent

of their students not completing their program in the normal 3 years (which the reform punish), which may explain part of why the reform hit Chemistry and SCIENCE harder than other programs, but certainly not all.

- The fact that the Ministry of Higher Education and Science and Copenhagen University doesn't use the same measurement to show dropout, and to some degree to show entry, is a very good example of the problem about measuring dropout; there doesn't exist a common way to measure dropout.

2.2 Research questions

When the work on this thesis began the following was formulated as research questions:

"A high number of students of the Department of Chemistry, UCPH, drop out or fail to complete a high number of their exams during their first year at the university.

The purpose of this thesis is to follow the 2015-year students during their first 6 months and examine why they drop out and fails examination. To examine this, the thesis will explore:

- What the students expects of the education before they start and how their identification of chemistry changes

- What academic skills the teachers expects students to have and how they incorporate academic integration in their teaching

- What students and teachers themselves think is the reasons for the high drop outs and test their hypothesis"

These questions have been the framework for this thesis and in the process it has not been found necessary to reformulate them.

3 Theoretical and literal framework

Dropout is in many ways a very well researched topic and other ways a very poorly researched topic. The intuitive manner of measuring the amount of students at the beginning and end of any time period, at an institution, can be reported as a number and easily correlated with background information of the students. Some of the referred articles in this study do this, and it present facts about retention that obviously are true, but facts that in many ways represent a simple, static and in some ways purely empirical view on retention.

In the scientific tradition the reporting of facts doesn't hold value without the accompanying of a supportive or dismissive theory, and this isn't always reported in retention literature. Maybe the basic theory that the world is deterministic and the difference in the student cohort must explain the difference in the retention of the cohort is so implicit that this is the framework to work from. It is of course not sufficient to describe retention in numbers and correlations, but a theory on the explanation of retention has to be applied.

3.1 Institutional departure

In 1975 Vincent Tinto published his paper *Dropout from Higher Education: A Theoretical Synthesis of Recent Research,* which is the rock on which this study is build(Tinto, 1975).

Dropout of educational institutions has to be view as the complex matter it is, and the first distinction is made between students who drop out: students who leave because of academic failure, e.g. not passing exams, and students who leave voluntarily.

Another important distinction is what happens to the students following the dropout; do they apply for other educational programmes or do they drop out of the educational system entirely. These distinctions can't be made simply by counting the students, and longitudinal models that combine the individuals and institutions effects on the students has to be formed in order to explain this.

Since this theory of retention recognizes that that the choice of leaving a programme isn't solely based on academic skills the social life of the student and the cultural environment of the institution have to be considered when constructing a model of retention. Tinto relate these effects in his model for dropout as depicted in figure 9 from his original paper.

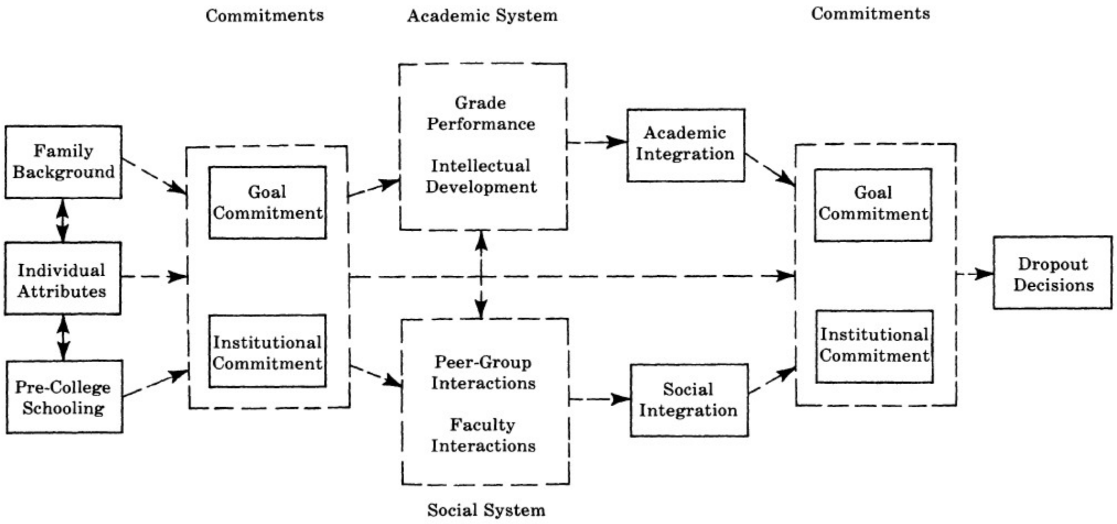


Figure 9 Tintos scheme for dropout from (Tinto, 1975).

The induvial background, which is not solely previous educational background, but also class and attributes in general creates different commitments for each students. Here Tinto creates a duality between sociocultural system and the academic system which are separate, but both important systems to be integrated in, in order to retain.

This duality serves as a tool to highlight some of different effect that forms students' decision of dropping out and how they can be categorized.

An inspiration of this way of interpreting dropout as something longitudinal was Spady's theory of dropout (Spady, 1970). Here Spady link Durkheim's theory of suicide to dropout. Here the likelihood of suicide in related to lacking of common values with your surroundings leading to insufficient social interaction and hence isolation. When students then lack common value with their cohort or the institution, they commit *social suicide* and dropout. Tinto refinement of this idea is that academia also constitutes a part of education with *academic suicide*.

The academic system and the integration into this, is the grades the student receive, which is both a measure of the students intellectual abilities and the students is able to present them in a faction as the institution deems "correct". It

is also a question of whether the students satisfy her own commitments of intellectual development in the right academic branch(es). And again, the students and institution might have different ideas of what sort of intellectual development should be rewarded. Examples of the latter is the curriculum (what abilities and knowledge is important to become a chemist).
Failure to integrate in the academic system could lead to academic dropout of the entire educational system, because of lack of abilities to pass exams. Or failure could lead to a transfer dropout to other institutions because the student finds the curriculum uninteresting.

The sociocultural system and the integration into this, is driven by the social interaction between students and the mixing of their backgrounds, value systems and interest. But it is also driven by the existing culture and social norms of the institutional system, which again have a set of norms which it reward students for following. The latter could by difficulties with attending extracurricular actives or understanding the relationship between professors and students.

In general the failure to integrate into the academic and sociocultural system leads to lower commitments of the students to achieve her goals, and in the end dropout from the current intuitions.
The model is great for putting a spotlight on the fact that several thing can be the cause of dropout, but isn't a total description of the process. Tinto himself point out that sufficiently high goals and commitment to these in either system might be enough to ignore the other system. Most universities does however not allow for failure in grades. Holmegaard et al. shows this in (Holmegaard, Madsen, & Ulriksen, 2014) where high commitments to social life outweigh the commitment to interest in the education

Another flaw of the model is the fact that commitment and goal achieving in on system might support commitment to the institutions as a whole, and improve commitment to the other half. In this perception the reevaluation of commitments doesn't just occur before dropout, but commitments are renegotiated several times, with possible changes, strengthening or weakening or the commitments.

An important addiction to Tinto's model is the repetitions of goal and commitment settings, and their continued effect on students' choice of dropout. To use the students narrative about themselves, and to see their adjustment of narrative in the connection with coping with success and failure of academic and sociocultural commitment, as in done in (Holmegaard et al., 2014), can be used to highlight reasons for dropout. This way of meaning making of identities is not just formed by what the students want with their education, but also what they in general think about the education. Does the narrative the student have of herself match the integration process of the institution, and if not what have to change? Either the student stick to her narrative of herself and reject the institutions "perception" of the narrative and drop out or she changes her narrative to be integrated. Note that the institution might also change its integration process because of an institution changed perception of the goal of the institution, e.g. changing curriculum or learning methods. This is of cause a very longitudinal process in relation to students changing mind.

In relation to the Spady's suicide theory (Spady, 1970), Lehrmann (Lehrmann, 2007), and Aries and Seider (Aries & Seider, 2005) investigate how students with working class parents don't get culturally integrated into university. Even though they don't see a big difference in the number of people who drop out, there is a clear difference in their reason. Students with non-working class parents mostly drop outs of university because of bad grades (academic leave), where most students with working class parents leaves because "*they don't fit in"* (voluntary leave). Since social class as background is not a strong cultural sub-class like race or sexuality, these students are either forced to exit university or commit a *cultural suicide* to their narrative where they reject their families' and friends' way of talking, dressing and way of living. The fact that the working-class students assert this means that it matters to them.

In (Tinto, 1988) Tinto specifies that the very first setting of commitment and integration in his scheme in figure 9 is of particular importance because of the change in institution. At this moment students doesn't just renegotiate their narrative in relation to previous narratives, but are forced by external forces to change some fundamental properties of their identities, as the go from upper secondary school to university. It is hence reasonable to predict that leaving in the year of an education isn't the same as leaving some years later, and that particular reasons for leaving are stronger represented at particular times.
Tinto builds his theory on Van Gennep's theory of *rite of passage* where individual's transition from being part of one group to another is explained. Tinto uses the same three phases, which Van Gennep describes, in his relation to university students:

- Separation
  This is the phase where the students experience major social and intellectual change, like moving to a new house, leaving family and friends and receive some of the first inputs (maybe just speaking with tutors about what's ahead of them) as university student.
  In this phase students are forced to abandon many of their previous norms and may in some cases be completely without any functioning norms (social, cultural, academic, economical). Especially students from working class families can be challenged by this. The opportunity not to commit any of these suicides like staying with parents, keep contact with old friends instead of making new or taking homework lightly can be tempting, and maybe a choice that ensures that some students advances to the next phases instead of leaving. But in the long run such choices, not to renegotiate narrative, might undermine a total integration, and just lengthen the dropout process. The change that some of the old friends or parents resist the separation actively is also possible.

- Transition

  After surviving the shock, the students now have to adjust their goals and commitments to the institution, since they probably have had expectation more or less changed by their first time at university. With the many external forced changes in the separation many might give this evaluation up. Tinto point out that:

  "*The point here is simply that the problems associated with both separation and transition are conditions that, though stressful, need not in themselves lead to departure. It is the individual's response to those conditions that finally determines staying or leaving."*

  In this phase the formation of peer groups are very important.

- Incorporation

  At some point the students will be associated as "part of the tribe" at the university. When this point is, is however often not very clear for the students. They should now possess the norms and behavioral patterns of the institution in general.

  Coming to this stage might be very hard since universities usually don't hold incorporations ceremonies and unofficial ceremonies like parties might not incorporate all students. Extracurricular activities might play a contributing role in this matter, but just like parties they very seldom match the interest of every student.

  It is a traditional thought at many universities that the students have "to learn the ropes" of how to behave by themselves.

In Tinto and Russo's paper from 1999 (Tinto, 1999) they emphasizes the special role of the classrooms in relation to integration and retention. The classroom possess the potential to both establish social, academic and cultural integration, since the involvement of students in learning forms a foundation for students to establish learning communities of peers. Tinto and Russo's specific programme, Coordinated Studies Programs, does prove to increase retention and positive view of the college environments, the students themselves, activity in all aspects.

3.2 Different students

For several decades, possibly forever, there has been a callout from companies, politicians and universities to educate more scientists. Chemistry now does this, or at least admits more students, as figure 1 and 2 shows. But to educate more chemist, twice and trice as many as 10 years ago, means that the kind of students entering the programme are other types of students or at least a more varied cohort. In 1990 Sheila Tobias published *They're Not Dumb they're Different (Tobias, 1994)* to address this fact; science education had to evaluate and adapt to these new kinds of students.

Tobias qualitatively studies some students who didn't choose STEM educations, but had the right grades and college courses to do so. These students are then put into STEM courses and asked to comment on them.

One of the first points is the fact that top scientist, who teach at universities, have very common reasons to study their subject: more than 80% of them decided their career in high school, 80% described the interest in their subject as the primary factor they studied science and less than a third mentioned their own teachers, prestige and salary as important factor for choosing their education.

Overall Tobias gives many and varied examples of the great turn-off in STEM educations the most common being:

- The lack of creativity, with the emphasis that problem solving doesn't teach students induction or deduction, but rather learn them analogical thinking, where all new problems are just variation of old problems.
- The lack of conceptual and *deep* learning, there instead the focus is on problem solving and learning a new chapter each week.
- The lack of goal(s). Is the point just that students are taught to solve problems and become lecturers?

3.3 Becoming a students

Both Tinto and Tobias circles around the explanation that integrating students aren't solely a question of curriculum, but that there are cultural, social academic norms at universities you can't find described in courses curricular. In 1970 Benson R. Snyder wrote the book *The Hidden Curriculum* (Snyder, 1973) on this matter. This undescribed second or hidden curriculum can be seen as the integrational aspects of Tinto's retention model, apart from the grading, which can be interpreted as the only part of institutional integration, that universities actively and straight forward learn students and evaluates on. Snyder examines all of these aspects of the hidden curriculum, but is of particular interest because of the characterization of academic aspects which the study is one of the few to examine in a broader perspective. One example of this quote from the book:

"*The question for the student is not only what he will learn but how he will learn, and when he will learn. These covert, inferred tasks, and the means to their mastery, are linked together in a hidden curriculum. They are rooted in the professors' assumptions and values, the students' expectations, and the social context in which both teacher and taught find themselves."*
- Benson R. Snyder, The Hidden Curriculum (Snyder, 1973)

This hidden curriculum is a useful analytical tool to identify norms, behavior, and skills that are required of students to study at university and to integrate well in institution.

3.4 Author as part of a system

This study is special in the fashion the author in some manner can be interpreted as investigating a system which the author is in some way part of. I have spent many considered where or not this is good or bad. On one hand provide the investigation a lot of cultural and contextual knowledge of the system; on the other hand the question of the study's reliability is at stake when I evaluate a system I have actively tried to change as an active chairman of the

Chemistry Students Union, vice chairman of Institute Counsel and founder of Homework Help. To help resort some of the biases that could arise I have looked to Adriansen and Madsen's article about researching a system you might be part of (Adriansen & Madsen, 2009).
They apply the logic that an insider is one who is considered an insider by the other members of the community or participate like other members of the community.
Concerning the latter I am obviously not a first year student or lecturer whom I collect data from, but do others perceive me as a chemist? In the beginning of the study I was still vice chairman of Institute Counsel, attended Chemistry Student Unions meetings and visited the campus bar. As one of the students, probably joking, answered in one of the questionnaire as a "Commentary on the questions in 'The Social Life' " one student said:

"We don't see you enough at the campus bar, Jonas."

First I thought this was very funny, but later realized this might prove a strong indicator of my relationship to the first year students; one the expected to meet in the bar, which some of them did. This might be good in the sense that some of them feel I am "on their team" and result in more trustworthy answers and greater support of my project. But it might also do the opposite, self-censor some answers because someone might feel their anonymity omitted.
My relationship with the students is however uneven in the sense that they all know my name and role, but I only remembers the name of two of them.

Beyond these considerations of my relationship to the students the following recommendations of working as an insider from Adriansen and Madsen's (Adriansen & Madsen, 2009) was applied.

- *Pursue 'you know' answers during interviews, otherwise the material may be of little use to a wider audience whose members 'do not know'.*

- *Be aware of one's own and others' role and shifting roles during the research process. Pay close attention to the issue of positionality as this has implications both for the interview situation (and thereby the material collected) and for the interpretation of the material.*
- *Acknowledge that some people may too close to one to establish an interviewer/interviewee relationship.*
- *Step back from the insider role in order to gain perspective, while being prepared that questioning taken-for-granted knowledge may change one's role from insider to outsider in relation to the research community under research.*

Apart from these recommendations they pose a valuable question:

"Is one an insider, when one starts questioning the hegemonic discourse, when one wants to study the tacit values and ideas?"

Assuming the answer is yes I would categorize myself in this fashion:
I have probably never been part of the community of lecturers, since I have questioned their discourse on teaching and planning long before I started this study.
Concerning my membership of the student community I have noted that some of the answers and evaluation I have got from questionnaires have changed my view or at least made my question my own opinion or students discourse on certain matters. A good example is one of the student's comments on the Chemistry Student Unions meetings:

"*The Chemistry Student Unions meeting are to lengthy, and the points on the agenda are often explained with way to many side stories. This could by one of the main reasons the attendance is so low, even though you would like keep up with what is happening."*

I have always considered the informal agenda of the meetings to be a strength, and thought it helped attract some students who wouldn't appreciate a more formal meeting style. In this fashion I think that instead of challenging my own discourse of the student life, I have invited new students who are still in the separational and transitional phases of their rite of passage, and hence not part of the discourse to challenge me. This should strengthen the analysis, but there still exist possible blind angles in my questions to the students and hence their might exist certain discourses that the students aren't asked to question.

To tie this to Tinto's model of retentions it is helpful to categorize myself as still (or at least in the beginning of the study) to be part of the enforcement of sociocultural system of the education while I never have been part of the enforcement of the institutional academic system.
A reading of the interviews with the lecturers also point to this direction; instead of falling in some of the pitfalls Adriansen and Madsen mentions, like acting collegial or skipping "trivial" facts, the lecturers answered the questions very professionally and clarifying, sometime so much that I skipped over some of the clarifying expiations, e.g.:

Lecturer: *…Well, a year's time ago, half a year, we had a meeting with the Educational Advisor. That is he who is the leader of the upper secondary school education. An upper secondary school teacher-*
Jonas: *Yes, Keld?*
Lecturer: *Yes…*

3.5 Literature overview

In Tinto's conclusion of (Tinto, 1988) he stresses a very fundamental point, also concerning this study:

"It would be a mistake, however, to conclude that our analysis can only be applied to issues of student retention. It can also be employed in a study of the process of student development. The issues of community that underlie successful retention programs also provide the foundations for student development."

Vice versa; the same can be said for students' development that also provides a foundation for successful retention. Hence this literature review will apart from research on retention also present some research on student development both social, cultural, and academic.

3.5.1 Working class and first generation university students

(Aries & Seider, 2005) shows that first generation students experiences intimidation, discomfort, inadequacy and deficiency in start of their college education, to a larger extent than other students because the lack cultural capital. This class-based discontinuity between pre-school identities and evolving identities worries many of these about being different than their friend and families at home.

Furthermore (Dalgety & Coll, 2006) shows that students with associates in sciences fields are 20% more likely to enroll to second university year in chemistry programme than students without.

Mastekaase and Hansen shows that Norwegian university students has approximately the same change of dropping out independently of their parents educational level (Mastekaasa & Hansen, 2005). If the dropouts however are categorized in transfer to other university programmes, transfer to university college programmes and dropping out of the educational system the picture is different. The amount of students leaving for another university programme increases with parent's education while the other two decreases, with students of parents with primary school having 18% change of dropping out of the system to students of parents with university education having only 9% change.

3.5.2 Experience versus reality

(Holmegaard et al., 2014) shows all their investigated, Danish STEM students to some degree experience a difference between their expectations of university and the reality, hence challenging their narrative identities. This expectation gap mostly manifest in their explanations of difficulties with courses and teaching. And a result most students renegotiate their narrative, and those who don't dismisses the need for certain goal, while emphasizing other.

3.5.3 Students commitment

(Hackman & Dysinger, 1970) shows that persisters shows greater commitment to studying in the beginning of college than transfer and dismissal dropouts, who again shows greater commitment than voluntary dropouts. (Shedlosky-Shoemake & Fautch, 2015) also shows that leavers' self-esteem is effected more by competition and academic competence than the other groups.
(Seery, 2009) shows that overall level of interest in courses are correlated with first year grades.

3.5.4 Grades and dropouts

(Shedlosky-Shoemake & Fautch, 2015) shows that the high school grades of transfers are higher than persisters', who's grades are higher than leavers. And after first year the difference between persisters and leavers grades have increased from 0.23 to 0.87 (on a 0-4 scale).

3.5.5 Lab work

(Bruehl, Pan, & Ferrer-Vinent, 2015) Show improvement satisfaction (no complains) with lab courses by introducing students-designed and inquiry-based experiments along literature search classes. (Laredo, 2013) also improve satisfaction with a lab course but designs problem based lab exercises instead.

3.5.6 Learning

(Ulriksen, Madsen, & Holmegaard, 2015) shows that high paced curriculum in first year Danish STEM programmes is a problem because students experience a recollection of information rather than deeper understanding, which they were committed to and gave their narrative meaning. To increase retention, universities should give first-year experience where students get a sense of different courses that contribute to their story of self.

(Lasry, Mazur, & Watkins, 2008) Introduces *peer instruction* in Harvard University and college physics classes, instead of traditional teaching. Students in peer instruction classes gets a higher final exam scores, scores better in conceptual learning gains and had 3-4 times lower dropout rate.

Furthermore (Crouch & Mazur, 2011) finds that peer instruction in introductory physics course improve students' conceptual learning gains over the course by 6-17 percent point more than traditional taught students and 6-19 percent point higher scores in problem solving.

And (Fagen, Crouch, & Mazur, 2002) tested peer instruction in physics classes asked 30 courses worldwide, average class gains in conceptual understanding were 39 percent point. 80% of 300 instructors consider peer instruction successful.

Hake introduces *interactive engagement* in introductory physics courses (Hake, 1998) and finds that it improve students' conceptual learning gains over the course twice as much as the traditional taught students and a correlation coefficient of 0.91 between the conceptual score and a problem solving score. In other words the students taught with interactive engagement also gains higher problem solving abilities.

The test for identifying gains in conceptual learning in (Crouch & Mazur, 2011), (Fagen et al., 2002) and (Hake, 1998) was the same, the Force Concept Inventory (E. Mazur, 1997), and their findings are listed in table 2.

The average normalized gain, g, is defined as:

$$g = \frac{S_f - S_i}{100 - S_i}$$

Where S is the score in the test (final and initial) in percent.

Class and study	Average normalized gains in conceptual learning
Calculus based peer instruction, 6 classes (Crouch & Mazur, 2011)	0.62
Algebra based peer instruction, 2 classes (Crouch & Mazur, 2011)	0.64
Peer instruction, 30 classes (Fagen et al., 2002)	0.39
Interactive engagement, 48 classes (Hake, 1998)	0.48
Calculus based traditional, 1 class (Crouch & Mazur, 2011)	0.25
Algebra based traditional, 1 class (Crouch & Mazur, 2011)	0.40
Traditional, 14 classes (Hake, 1998)	0.23

Table 2 Average normalized gains in conceptual learning in different classes and studies.

In (Felder, Felder, & Dietz, 1998) *cooperative learning* is tested in five chemistry courses for engineers over their two first years at university. After five years the retention rate was 85% for students who had been in test classes versus 68% for students in normal classes. Furthermore the students in test classes rated the student-friendliness of environment, peer support and quality of instruction in courses much higher than students from normal classes.
In the review of *What Matters in College* (Astin, 1994), Feldman shows that learning, academic performance and retention is all positively associated with students involvement(Feldman, 1994).

3.5.7 Institutional challenges

(Scott, Shah, Grebennikov, & Singh, 2008) Identifies students' reasons (which differ much whether national or institutional data is considered) for dropout and implement initiatives based on this the following year. The following year the receive 4.2% higher retention and 6.4% higher satisfaction and all significant satisfactorily changes were made in areas concerning administration.

3.5.8 Retention: extra courses

(Køller & Olufsen, 2013)Introduces optional extra classes running along introductory chemistry course, alongside with lecturers and help of a didactic chemist and obligational test. Students with low scores in a diagnostics test were asked to go to these extra classes. This resulted in higher average passing and grades in the course. Comparing the 5 years before these changes with 4 years after this the passing has increased with an average 15% point and improved grades.

In (Clifton, Baldwina, & Weia, 2012) a first year course in chemistry reorganized. Students with 70%+ score from upper secondary school and the rest had separate classes. The classes with poorer grades had fewer students in classes, more time and weekly testing and follow up. The student in special classes improved their chemistry grades from high school to this courses exam from 4.13 to 6.26, where regular student grades dropped from 7.25 to 7.00 (on a 3-10 scale).

(Hayes & Childs, 2015) introduced extra classes running alongside the normal chemistry course and 95% of those who usually fails are asked to take this. Students who participated in the extra classes got grades in course about grades 10 % point higher in average than those who didn't participate, and increased their self-efficacy related to chemistry.

(Zeegers & Martin, 2001) Introduces a *learning to learn program* in chemistry, running simulations with first-year course. There was a correlation between number of times students attended learning classes and their grades after 1st and 2nd semester, and is stronger correlating than pre math-test with their cumulative GPA.

Differences in percent between year with and without program.	Semester 1	Semester 2
Mean topic score	+3.5	+8.5
Passing rates	+11.5	+5.0
Dropout	-14.1	-8.0

Table 3 Data from Zeegers and Martin, page 44 (Zeegers & Martin, 2001)

3.5.9 Attendance

(Clifton et al., 2012) shows that attendance is correlated, with a coefficient of 0.465, with grade performance in first chemistry course.

3.5.10 Upper Secondary School grades

(Potgieter, Ackermann, & Fletcher, 2010) uses upper secondary school mathematics and science grades along with ability to predict students own

performance in a test to identity which students are at risk of failing first year chemistry course. Their test identifies 76% of the cohort correct, and 92% of students who fails.
(Wagner, Sasser, & DiBiase, 2002,) also creates a test for predicting students at risk of failing a general chemistry course. Combined mathematic and chemistry grades from high school, and demographic background questions. Their test identifies 76% of students correct, but only 41% of the students who fails.

(Seery, 2009) shows that chemistry grades from upper secondary school is the best predictor of first year chemistry grades, correlating with a coefficient of 0.569.
A clear negative correlation between dropout and A-levels score (O'Neill, Hartvigsen, Wallstedt, Korsholm, & Eika, 2011) Shows that an admission test is a better admission tool than average grade from upper secondary school. In 5 years students admitted to the medical school at the University of Southern Denmark had been admitted both with test and with average grade. The students admitted with a test had a dropout on 7,4% and grade-admitted 11.6%, even though the mean grade of test-admitted were 7.13 and grade-admitted were 9.65. Test was composed of interview, a knowledge test and an application.
The Danish Evaluation Institute released (Evalueringsinstitut, 2015) where a relationship between average grade from upper secondary schools and retention at STEM educations where predicted. Their predictive model is reprinted in figure 10.

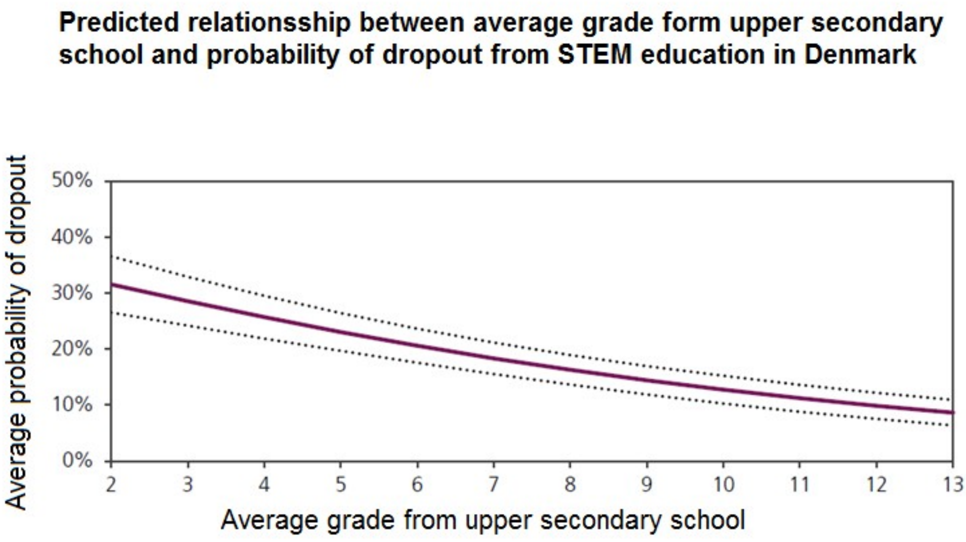


Figure 10 Relationship between upper secondary school grades and university dropout at STEM education in Denmark. Dotted line shows 95% confidence interval. Reprinted from (Evalueringsinstitut, 2015).

3.5.11 Social life

In Feldman's review(Feldman, 1994) of Alexander Astin's *What Matters in College* (Astin, 1994) he shows that:

"*The student's peer group is the single most potent source of influence on growth and development during undergraduate years"*
- Alexander Astin, (Astin, 1994), page 398.

Feldman also emphasis Astin's finds that learning, academic performance and retention is positively associated with students' social (and academic) involvement,

3.5.12 Maturity and time since upper secondary education In ("Studiekompetence - Pejlemærker efter 2. gennemløb af gymnasiereformen," 2011) from the Danish Evaluation Institute they note that *"…they students that starts directly [at tertiary education] after their upper secondary education, often don't possess the maturity and practical experience*

which is required to complete the education with the necessary competence of relation and ability to accommodate the other students."
- Danish Evaluation Institute, page 54 ("Studiekompetence - Pejlemærker efter 2. gennemløb af gymnasiereformen," 2011)
(Clifton et al., 2012) reports that grades from a first year chemistry course has a correlation coefficient of -0.09 with time since upper secondary school graduation.

3.5.13 Compatibility of literature

Not all findings in retention literature can necessary are generalizable and hence not all findings in the articles are reported, just like some articles I read for background information haven't been used at all.
Some of the most common reason not to include finding were their incomparability with the Danish educational system, often related to social and cultural practices, or with chemical education practice, often related to academic practices.

An example of incomparability with the Danish educational system is both Snyder (Snyder, 1973) and Tobias (Tobias, 1994) who characterizes the high amount of competition among students in science classes to be very damaging to the social integration of institutes. This is an important matter, but also a much localized matter. They both study in the United States of America and reflect specifically over the normalized grading system used in these universities and an overshadowing desire to score well.
Even though a race to the top concerning grades has been a hot topic in Denmark in recent years, this consideration is not part of this analysis. Mainly because the normalized grading isn't used at Chemistry, Chemistry doesn't have required minimum admission grade, and that the Danish grading race tends to focus more on upper secondary school.

Almost all of the studies referred in this work concerns STEM educations, mostly Chemistry and Physics, because they across the world share structures that distinguish them from other university educations; their large focus on problem solving, laboratory work and hieratical learning.

Another issue with some of the literature is the endogeneity problem, described by (Leiser & Wolter, 2015); using test for some changes in one year and comparing it with a year without, is in general not sufficient evidence to conclude anything on. For instance the universities can lower the standards form year to year or student might experience different degree of *Hawthorne effect* (Olsen, 2004)

3.6 Qualitative and quantitative methods

"For many scientists used to doing quantitative studies the whole concept of qualitative research is unclear, almost foreign, or 'airy fairy' - not 'real' research."
- Adri Labuschagne, biologist (Labuschagne, 2003)

A great deal of thought and guidance time with my supervisor have been spend on questioning the use of some of the qualitative methods used in this study, along with question of objectivity.
In short terms much of this comes down to the fact that going from doing chemistry and to doing somewhat sociological and didactic research is methodologically paradigm shift, and this disrupts my own narrative. I cleanly remember my lecturer in Chemistry's Philosophy of Science saying, on the matter of quantitatively: "*We are scientist. We deal with the truth."* and this "fact" forces me to severely question many of the methods used in this work, which is great from an academic point of view.

The questions of inner validity, to report data that reflect the phenomena in research (Østerud, 1998), have been very important to me. In some ways because the difficulties with qualitative data comes when they have to be analyzed. In this respect the analysis is quite subjective, and to ensure that analysis doesn't begin in the reporting of data increases the inner validity, even

though this means that data seam less focused. For this reason thematic analysis was chosen to both inductive and sematic (Braun, 2006).
Concerning outer validity, the generalizability of the study, I already mentioned some concerns with the generalizability of other studies in the previous chapter of comparability. These considerations are also valid for this study. A special concern with the outer validity is whether this is possible value greatly in this study; since the goal of this study is to examine a specific kind of students, at a specific education, at a specific university any conclusion drawn are quite specific. Especially considering that there were only 93 students in the total to be examined, it is a fair question to ask whether anything should be generalized with such a numerical small cohort? Specifically on the social and cultural integrational matter of Chemistry where data isn't collected in standalizied ways.

Another topic concerns the objectivity of reported emphasis in the analysis when using qualitative data. (Østerud, 1998) says the following on the matter:

"The objectivity requirement is often difficult to translate to a constructivist paradigm because it ignores the relationship that research activities are social in their nature and motivated by human assumptions."

This exact problem has been considered when the choice of analyzing open-answered question, who were qualitative, with thematic analysis and representing the analysis primary quantitatively. The choice of doing this instead of analyzing the data in a more latent way, results in a representation of results where the fact that more students has given a similar answers is of greater importance, than the fact that a single student has given an interesting answers. This means that analysis will yield results that are sematically focused, rather than latently varied.
This separation of qualitative and quantitative in the analysis is however not as black and white, since interesting, standalone answers are sometimes used. This, along with the whole transformation of qualitative data to quantitative data, which is describe in detail in chapter 5.2.3, can be seen as an example of

(Østerud, 1998) deconstruction of the classical dichotomy between the two, and a representative example of an analysis on the grayscale between quality and quantity.

4 Methodology

4.1 Background talks

Prior to beginning of the data collection in this study, and also while collecting data, I had a couple of background talks with some people of interest. Since this is the first study of the bachelor program in Chemistry at Copenhagen University the goal of most of these talks were get data and information about personal research made by some of these people, it was to identify what relevant data I should collect and it was used by me as academic sparring on some relevant topics.
These talks were not transcribed, and the following details on the interviews are from notes and mail correspondences, and are hence not part of the analysis. They are included here because they, however gives some reasons to some of the choices I made when the research was conducted.

Keld Nielsen – Educational Advisor for Chemistry in the Technical and General Upper Secondary School, Danish Ministry for Children, Education and Gender Equality

I met with Keld in August 2015. First and foremost we talked about the teaching plans and guidelines in the A- and B-levels Chemistry in technical and general upper secondary school, and how they had different content in their core substances and academic goal. These differences were important when I later created the test of academic levels for the professors. Keld also presented his own comparison of the different between the levels, which had a lot in common with my own comparison, even though we had made the comparison in two different ways.

Jes Andersen – Communication manager, Department of Chemistry

I met with Jes in July 2015. Jes had made questionnaires with new students before, primarily concerning the effectivity of the department's and faculty's recruiting. Jes shared some of his previous questionnaires with me, which helped me produce some of my own questions. Jes was also the person who held the session where the first round of my questionnaires was collected.

Solvejg Jørgensen – Head of Studies, Department of Chemistry

I have had several meetings with Solvejg, primarily because she is interested in this study. To this study she has provided some data on previous year's retention and data on the students' assignment status in Inorganic Chemistry, which Asoc. Prof. Anders Døssing has collected.

Jens-Christian Navarro Poulsen – Coordinator of First Year, Department of Chemistry

I have also had several meetings with Jens-Christian, because of interest. Jens-Christian has shared some previous year's questionnaires he had made that gave a lot of background information on the students and provided me with a lot of inspiration for my own questionnaires. Jens-Christian also established a connection to Andreas Wagner Tholl and Birte Volmer Larsen.

Andreas Wagner Tholl – Course Planer and Teacher, Brush-up Course

I met with Andreas in August 2015, a week before the brush-up course. He told about the concept of the brush-up course, which I also visited, and gave me the evaluations of the course in 2014 and 2015 along with the compendium he used in 2015.

Birte Volmer Larsen and Cecilie Bolø Østergaard – Special Educational and Dyslexia Adviser, and Audiologo Pedagogue and Dyslexia Teacher at Copenhagen Adult Education Centre

I met with Birte and Cecilie in March 2016 because they had made a study on same cohort of students who stated at Chemistry in 2015. They tested their reading skills in 4 different ways.

They explained some difficulties with their study that made the results more ambiguous, the primary that testing for reading skills is normally not done at university level. The highest standard test they had is from the beginning of upper secondary school. This meant that they lacked measures of comparison and that the reading test they used were either made up for this occasion, reading a lab instruction which they in hindsight thought wasn't a correct measure of day-to-day reading in chemistry, or made for lower levels.

4.2 Questionnaires – students

The primary collection of data has been through three questionnaires given to the students who started in 2015. In total 93 students started at Chemistry in 2015 ("Web Page of Bachelor in Chemistry,"). Of the 93 students 70 has participated in at least one questionnaire and 25 have participated in all 3.Questionnaires were given to students via Google Forms ("Google Forms," 2016) and data analyzed in Offices Excel 2010 ("Office Excel 2010," 2010) and in SPSS ("IBM SPSS Statistics for Windows," 2013). Table 2 shows all the participation combinations in this study.

	Questionnaire 1	Questionnaire 2	Questionnaire 3	Participation
	■			10
		■		11
			■	1
	■	■		14
	■		■	3
		■	■	6
	■	■	■	25
Sum	52	56	35	70

Table 4 Participation in questionnaires. The combination of participation is shown by the green boxes, green indicating participation, and the number of students who participated is given in the last column.

Questionnaire 1 was conducted just as the students started on their 2nd day in the introductory week. This collection was, as mentioned before, made by Jes Andersen, since I could not be present at that moment. The data was collected in a session were all the students (in theory) were together in an auditorium and asked to do 3 questionnaires in a row, mine being the third. One of the students told me some days later that he thought the session had been rather rushed and that many were tired of answering questionnaires. I however cannot see

that the answers in questionnaire 1 were more rushed in general than in the other questionnaires.
From one the questionnaires made before mine I noted that 70 students had answered, so better and more answers could probably had been achieved if my questionnaires. In comparison to the two other data collection, it is probable that the students would have benefitted from my presence, so that they might have had a better introduction to the questions and explanation of the reason the data was collected. This might also have increased the answer rate.
The focus of questionnaire 1 was on background information, information sources about Chemistry and expectations to the education in general.

Questionnaire 2 was conducted in December in the middle of block 2. I visited the students in the three teams they were divided in for Introduction to Mathematics, after agreement with the teachers.
I was present while they took the questionnaires and presented why I studied them, and answered questions they had (very few). The sessions took about 20 minutes in total.
While I was there I asked the teachers how many students normally participated in these class sessions and they agreed on ~20-25 students. In the last class I visited I got only about half the answers as I got in the first two. This is probably because I visited this class the day before the Christmas holidays.
The focus of questionnaire 2 was on evaluation of the teaching and social activities they had in block 1, and their identification as chemist.

Questionnaire 3 was conducted in March in the middle of block 3. I visited the students in the three teams they were divided in for Applied Mathematics for Chemist, after agreement with the teachers. While I was there I asked the teachers how many students normally participated in these class sessions and they agreed on ~10-15 students. Unlike the sessions in questionnaire 2, the teachers here thought that not all active students participated in the classes because he way the course was structured.

I was present while they took the questionnaires and presented why I studied them. The sessions took about 20 minutes in total and I got somewhat the same number of answers from each class.
The focus of questionnaire 3 was on evaluation of the teaching and social activities they had in block 2, their identification as chemist and why they thought students dropped out.

In all the questionnaires the students could answer either with a link they got send by their teacher or on some printed papers I brought. The majority used computers.
And for all the questionnaires it was possible to answer up to a week later with link the teacher send them, for all the students who did not participate in the classrooms. Only 5 answers in total were received this way.

The questions in the questionnaires were group in some appropriate themes and in the end of all themes the students could write comments to any of the question in the theme.

In questionnaire 1 the themes were:

- Personal background information
- Educational background
- Admission
- Choice of education
- Time spent
- Expectation to education
- Expectation to social life

In questionnaire 2 the themes were:

- Personal background information
- Organic Chemistry
- Inorganic Chemistry
- Follow-up on educational expectation
- The Social life
- Contact info

In questionnaire 3 the themes were:

- Personal background information
- Organic Chemistry
- Introduction to Mathematics
- Follow-up on educational expectation
- The Social life
- Contact info

When analysis their data this was used to categorize some of their answers in fashions the questionnaires went originally designed to handle. E. g. some students wrote in these comments that they had not participated in the Homework Help, and hence could not rank the learning output from this activity.

4.2.1 Different question types

In the questionnaires a variety of types of question were used. The reflections of why different types of questions are used on different topics are based on terminology and reflections in Hansen and Jørgensen from 2009 (Hansen, 2009). To most questions it was possible to give a free text as answer e.g.:

What would you like to do when you are done with your Chemistry degree?
"Properly development and production of medicine and preperates. I would like to do lab work."

Open answered questions were used most frequently because most question concerned matters of evaluation or attitude toward a matter. In relation to this type of questions open answers provides greater freedom to answerers in their choice of answers and hence more variation. Another advantages is, that open answers don't implant ideas of answers that the questioner poses into the minds the answerers. This might mean that certain answers are not given, because they are implied by the answerers (but maybe not the questioner) to be part of another answer.
The disadvantages of open answers to evaluation or attitude question are in some ways the opposite. Given some categories, questioners might give more variations in their answers if choosing more answers is a possibility or give more reflected answers, when comparing categories. Here open answers possibly gets the most impulsive, for the answerers, answer.
A great example of this can be found in the 1st questionnaire with the open question from above:

What would you like to do when you are done with your Chemistry degree?

As mentioned before the students were given some other questionnaires just before they were given mine. And in Jens-Christian Navarro Poulsen's questionnaire they were asked:

Chemist have long row of job possibilities. Mark the answers that have affected your choice of education.

Even though the questions aren't entirely the same, among other mine is prospective and Jens-Christian's is retrospective, the answers are so alike in the large picture, and then so different in some specific perspective, that they illustrate some differences in the construction of the questions. See figure 9 and 10.

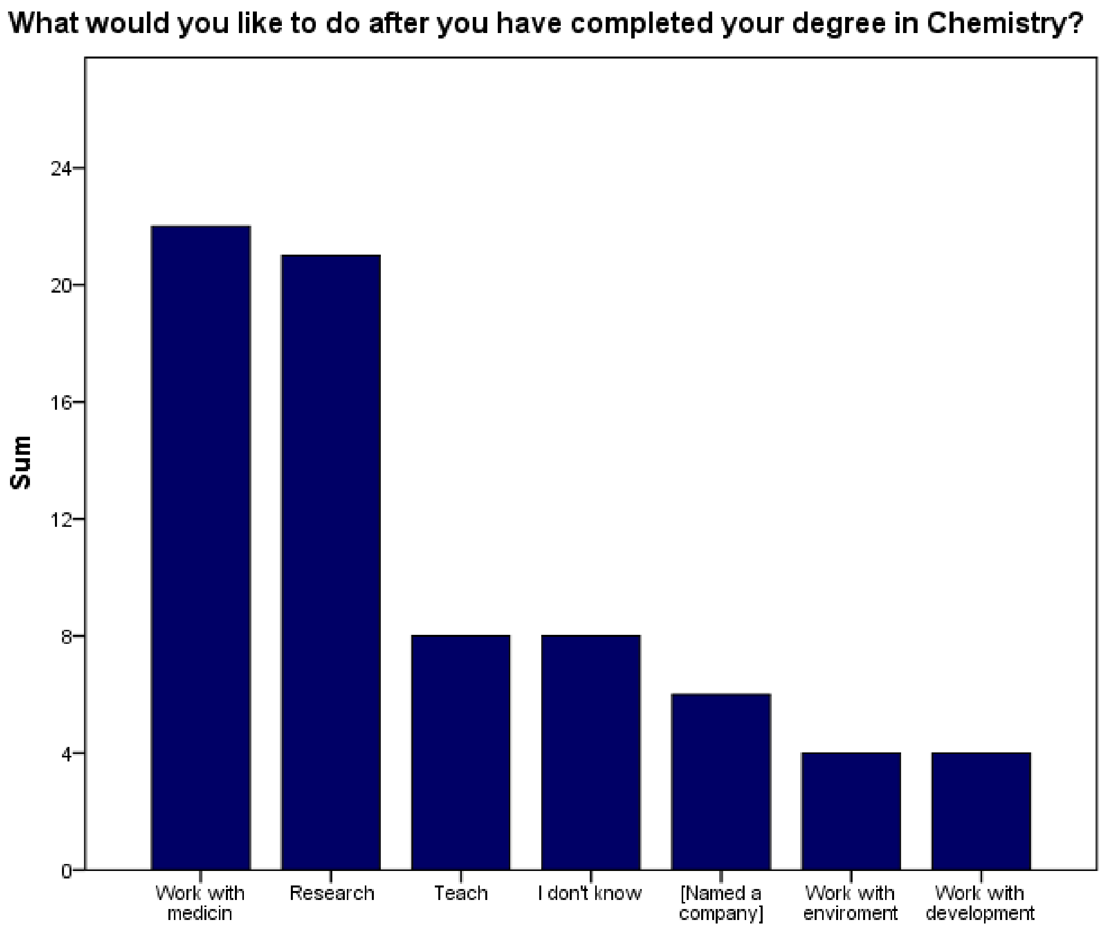


Figure 11 From my questionnaire 1.

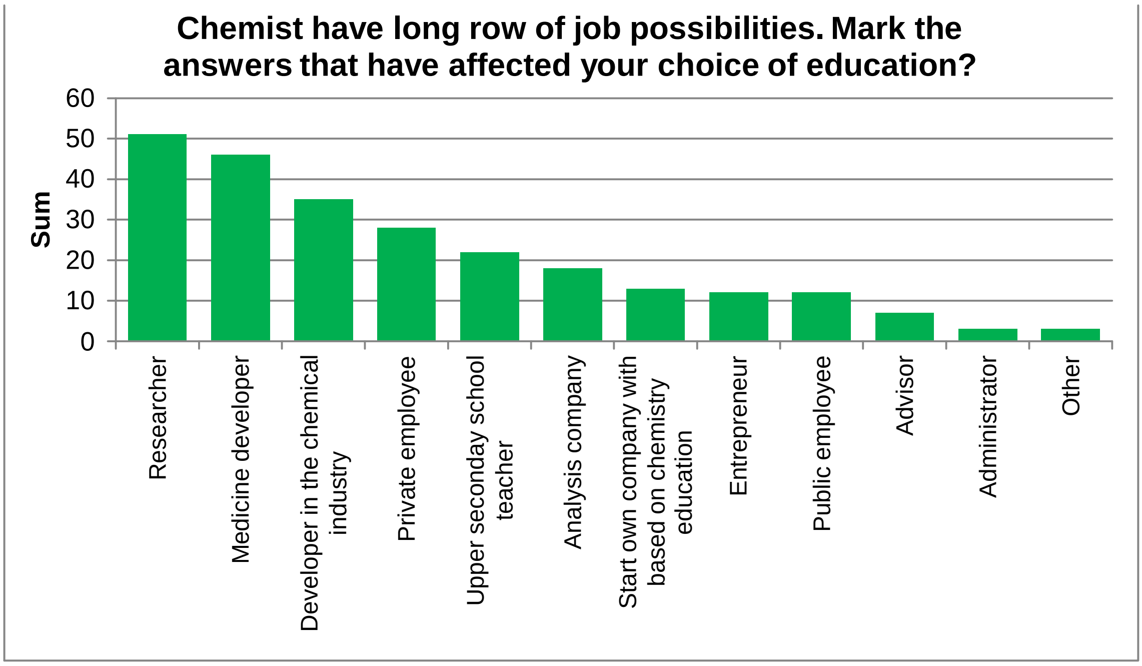


Figure 12 Data form Jens-Christians questionnaire.

So, researching, medicine, teaching and working in the private sector are representing in roughly the same proportions in both questions. But other chemistry-categories than medicinal chemistry in not possible to choose in Jens-Christians', and environmental chemistry was at least a category in mine. There is a change some students have thought some other categories includes this, but is not visible to us. From another point of view, development and entrepreneurship are quite popular in Jens-Christians', but not sufficiently intuitive enough to that the students mentioned the answers in mine.

Another types of question used a lot were question where the students were asked to scale something on a 1-5 scale. Quite often a description of the scale rather than actual numbers was used, just like in the following example. The scale was chosen to be uneven, and hence include a neutral passion. This was chosen because many of the questions by default had neutral positions and the intuitive choice of the answerers was valued higher than forced decisions learning toward two opposites. The latter can be handy if the question is actually between two choices, but this was not the case in these questions.

These questions were often given in groups were the students were asked scale more things, and mentally see these in comparison with one another, e.g.:

How high a learning output have you had from the following activity? [Problem solving in classes]

Very low	Low	Average	High	Very high
			“X”	

In some questions the students were asked to answer one of an already prepared list. This was first and foremost the case with factual questions where the answers should represent all possible answers. This type of questions was also used when answers could be given in intervals. This type of questions was chosen for the convenience of data analysis, and they could in principle have been asked as open questions. This would just take a longer time to analyze and would give the answerers the possibility to give ambiguous answers. In these factual questions a “Don’t know”-answers was given in some questions where the answers didn’t directly involve the answerer, e.g.:

What is your 1st parent’s longest education?

Primary and Lower Secondary School	Upper Secondary School	Vocational Education and Training	Academy Profession Degree	Bachelor's Degree (profession)	Bachelor's Degree (University)	Master's Degree	Ph.D.	Don’t know
			“X”					

And in some questions students were sked to check all answers that applied from an already prepared list. These questions were produced in the same way as those with only one possible answers, as mentioned above, and used in situations where one answers didn’t exclude another e.g.:

Which social activities have you participated in?

Homework Help	Chemistry Students Unions meetings	Science Dating	Starting-Uni-Camp	Campus bar	Autumn Party for Chemistry students	Football Cup
“X”			“X”	“X”		

When seeing the data analysis of different questions, it should be rather obvious which type of answers the students has given, but especially in the case the open answers and pre-categorized answers it will be emphasized which type is used.

In general questions were produced to give the answerers the possibility to answers what the like, like open answers, “don’t know” or to rate statements neutral rather, than to force them to decide on the given matter. This comes from a desire to produce reliable data, rather than getting higher answer rates in interesting categories. This will probably lower the possibility of drawing certain conclusion, but the conclusions made will be more reliable.

4.2.2 The order of questions

The order of the questions in the questionnaires was determined from a variety of reason.

The general order of the themes is ordered somewhat taxonomically with factual themes in the beginning followed be analytic and attitudinal themes. And a reason why the questions were themed was to force the students not to see upcoming questions in for instance attitudinal themes, when asked to analysis something. This possibility only exists in the digital questionnaires, which the majority used.

In each theme the order of the questions was chosen on the basis of a context analysis of the questions. Some questions were put immediately after one another because the questions and answers should be seen in context with one another in order to stress a difference, e.g.:

Describe in your own word why you chose Chemistry (the subject)?

And

Describe in your own word why you chose Copenhagen University (the place)?

Some questions were put immediately after other questions in order for the students mentally to think in same distinctions as mentioned in the first question. Note that this doesn't exclude the students from answering something not in the previous questions e.g.:

How high learning outcome have you had from the following activity in Organic Chemistry? [Very low (1)-Very high (5)]

Lectures	***Teacher explaining problems in class***	***Solving problems in class***	***Solving problem outside of class***	***Reading***	***Videos***	***Homework Help***

And

Are there any teaching activities you would like to have more of, and in that case which?

4.2.3 Open question to closed answers

In the data analysis almost all of the open-answered questions they have been transposed to categories or grouped in themes. This method of analysis was chosen because it gave an easy, quick and stable method of transposing qualitative data to something quantitative in a valid way. The process of categorizing is explained in this subchapter by following an example.
This way of categorizing loosely follows the instructions of Braun and Clarke's paper on how thematic analysis should be conducting (Braun, 2006). In their terminology this process is an inductive and sematic one, since the

categorizations is entirely based on the students' answers and reports their answers directly. It differs from Braun and Clarke's stepwise instruction in the sense that there wasn't conducted and written a separate analysis for each question and that the process itself wasn't as complex as their instruction suggest. This is mainly because the answers weren't that complex, and hence not deemed necessary.

To check for reliability in the categorization an intersubjective reclassification was conducted on the question below 4 months after the original categorization. Of the 76 categorizations in the final round 74 were the same. Checking which results were different, this showed that the difference appear in answers where I where in doubt, e.g.:

Should *"development of pharmaceuticals"* be categorized as "Medicine" when this is the only usage of the word "pharmaceutical" in the sample, and the other in this category uses the word "medicine" and "medicinal chemistry"?

This emphasizes that the reduction of qualitative data to quantitative data lacks depth if left standing alone, and the necessity of guiding readers though this process. On that note follows the example of this process:

First all answers was read and the keyword(s) of the answer was noted on a paper. When keyword appeared again a line was put next to the word and in this manner all key word were counted, e.g. from questionnaire 2.

What would you like to do when you are done with your Chemistry degree?

Answers	**Keywords**
Research in diseases	*Research, diseases*
I would like to work with development of medicine, and hopefully participate in research work.	*Development, medicine, research*
I am undecided. Possibilities: *- Teach (sec. school/uni)* *- Industry* *- Governmental* *Everything in open*	*Don't know, Teach, Industry, Governmental*
I would like to communicate science (or be a secondary school teacher)	*Communication, teach*
Forensic chemistry *Environmental chemistry*	*Forensic, environmental*

After all answers had been transposed to keywords some keywords that were very similar were combined, e.g. "green chemistry" and "environmental chemistry", and all keywords that had more than 3 persons mentioning them were made a category. Then all the answers were read again and marked in categorize were they fitted in:

Answers	**Categories**
Research in diseases	*Research*
I would like to work with development of medicine, and hopefully participate in research work.	*Development, medicine, research*
I am undecided. Possibilities: *- Teach (sec. school/uni)* *- Industry* *- Governmental* *Everything in open*	*Don't know, Teach, private company*
I would like to communicate science (or be a secondary school teacher)	*Teach*
Forensic chemistry *Environmental chemistry*	*Other specific type of chemistry, environmental*

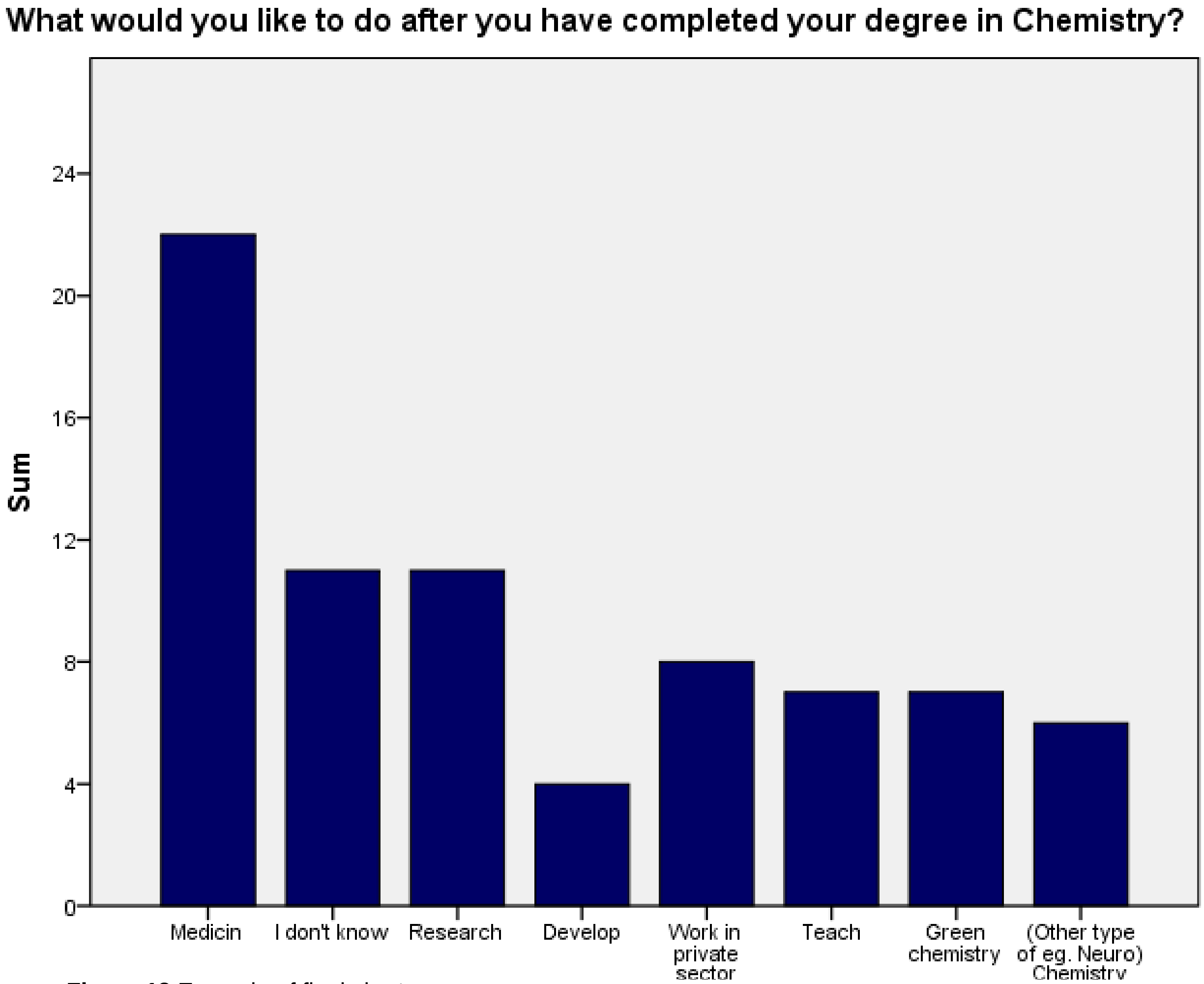


Figure 13 Example of final chart.

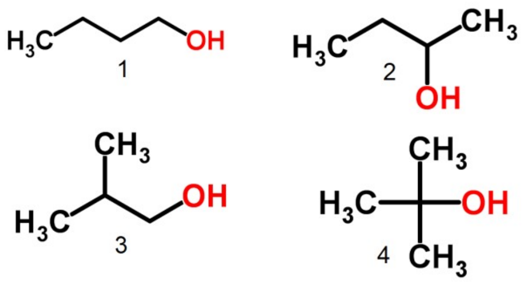
An in the end the number of students who fitted in to categories, with more than two answers, are displayed in the final chart, e.g. figure 9.

4.3 Questionnaire – lecturers

The questionnaire to the 3 lecturers, who were course responsible for Organic Chemistry and Inorganic Chemistry, were sent to them by mail in May 2016 and produced in Google Forms ("Google Forms," 2016) and analyzed with Office Excel ("Office Excel 2010," 2010).

The aim of questionnaire was to determine what academic level of chemistry lecturers expected students to have when they started at Chemistry. Instead of including this question in the interview, the form of a questionnaire was chosen because this evaluation would have taken long time live. The questions were produced to mimic typical chemistry problems that could be given as homework or exams in order to set the framing in a familiar form, both for myself and the lecturers. All the question were accompanied with and answers, and the question to the lecturers was whether or not they would expect new first years student to able to give the answer, in other word whether or not the teachers considered the question to be part of the minimum expected academic level. The lecturers were given 10 problems with a total of 36 questions. An example was:

Write all the possible alcohols with the empirical formula $C_4H_{10}O$ and name them.



1: butan-1-ol,
2: butan-2-ol,
3: 2-methylpronan-1-ol,
4: 2-methylpropan-2-ol

All three of the lecturers answered the questionnaire and two wrote the following answers to the mail, which reflect how they have given answers:

I have answered to the best of my ability – generally I think the questions are quite hard and it would be fantastic if all the students could that. In my field of teaching, I expect very little – when I have answered 'yes' it is often because I from experience know that the students can this.

And

I have answered.
I some questions they would probably be able to be partly right, but I have answered 'no' if I didn't think they could give the full correct answer.
My answers are based on that I observe in teaching. There is however large differences in the individual students' level at the beginning.
It is clear that that some are better than others and hence I my answers reflects whether I is of the opinion that at least 50% of the students could get the answer right when they start at UCPH.

4.3.1 Question production

The questions in the questionnaire were produced so that the test was comprised of material from C, B and A-levels of Chemistry from upper secondary school with few touches of material from university Chemistry and from B-levels of Physics and C-levels of Biology.
The concrete questions were produced with inspiration of the upper secondary school Chemistry books (Bruun & jensen, 2005; Mygind, Nielsen, & Axelsen, 2010).
To determine whether or not a question was considered to be expected knowledge the list of core substances and common goal produced in chapter 2.4 was used.
The amount of question produced was chosen so that all common goals and core substances were covered.

4.4 Interviews with lecturers

The interviews with the lecturers were done in November all with the author as interviewer.
All the interviews follow a semi structured form on the basis of some questions they were given before the interview with mail. One of the lecturers even answered the questions shortly, and his interview hence was also based on his answers.
In situations like this were the interviewed are expects on a given matter, and already culturally in a clear position of power over the interviewer the usual asymmetry of power is broken, as mentioned in (Kvale, 2009).

(Adriansen & Madsen, 2009) also point out that insider might experience the usual asymmetry of power shifted.
The symmetry breaking did however after my opinion not happen in the interviews, since the lecturer took the interviews very professionally and didn't question the premise of the questions or answers with internal vocabulary.

4.4.1 Transcription

The interviews were transcript by the author.
The transcription was done very semantic(Braun, 2006) however with (Poland, 1995) notion that the transcription is partial depiction of a much richer reality. This balance was challenged at certain incidences like when a lecture draw and referred to the drawing or when a lecture demonstrated a video he had made, and the conversation went from a two person conversation to a tree person conversation, where two of the person was the same person.
Throughout the transcriptions a specific nomenclature was used to indicate interruptions, pauses etc.

4.5 Assignments in Inorganic Chemistry

With the help of Asoc. Prof. Anders Døssing and Asoc. Prof. Solvejg Jørgensen, I received data of the students' completed assignments and lab reports in Inorganic Chemistry. The assignments were give weekly voluntary to hand in, and the lab reports needed to be passed in order to go to the exam. In the data set was alto noted if a student had *disappeared from the list* which usually only happens if students drop out.
Of the 85 registered, without credit transfer, to the course I at some point recorded a questionnaire from 65. Of the 85, 8 *disappeared* before the course was over, and 2 of these I have other data on.
Of the 8 who *disappeared* 5 never handed in their first lab report, in other words these students dropped out within some of the first weeks.

Another contribution of Døssing's data is that is questions whether the students examined in this study are an accurate representation of the students who started at Chemistry. If the 8 *disappeared* students is removed from the data set and the average number of assignments passed is calculated of the two groups, the students within my cohort have passed 5.7 assignments in average, where the students outside of my cohort have passed 2.9.

The rest of the data, corresponding to the cohort I had on data on, was very homogenous with a very high degree of students completing all assignments and lab reports, and hence this data didn’t contribute to other significant findings.

5 Results and discussion

5.1 Who are the students?

In this study there wasn't found significant correlation between the backgrounds variables; gender, commuting time to university, parents' educational background, average grade form upper secondary school or years since graduation from upper secondary school. This is important since these groups in other parts of the analysis correspond in similar ways, and it should be underline that they are independent.

5.1.1 Age and time since graduation

The median age of Chemistry students who started in 2015 was 21.1 years. For Copenhagen University in general the age was 21.2 years and for SCIENCE it was 21.3 years (Denmark, 2015). In other words, there was no significance in the students' age.

Looking at time since upper secondary school education the majority of students who starts have graduated within 1 year and a large minority, 11 students, have 4 or more years since graduation. Only one of these 11 students haven't attended other tertiary education, and this groups is hence almost all transfer dropouts from other educations.

How many years have passed since your graduation from secondary education?	Frequency	Percent	Cumulative Percent
0	16	30,8	30,8
1	18	34,6	65,4
2	6	11,5	76,9
3	1	1,9	78,8
4 and more	11	21,2	100,0
Total	52		

Table 5 Years since upper secondary school graduation. From September.

5.1.2 Gender

From the September data 27 students told they were male and 25 female. This gives a good impression of a data set consistent with whole new student mass at Chemistry from 2015, as figure 14 shows. As the figure also shows this ration is not significantly different from previous years at Chemistry or from SCIENCE this year. There is however a significant difference from Copenhagen University in general.

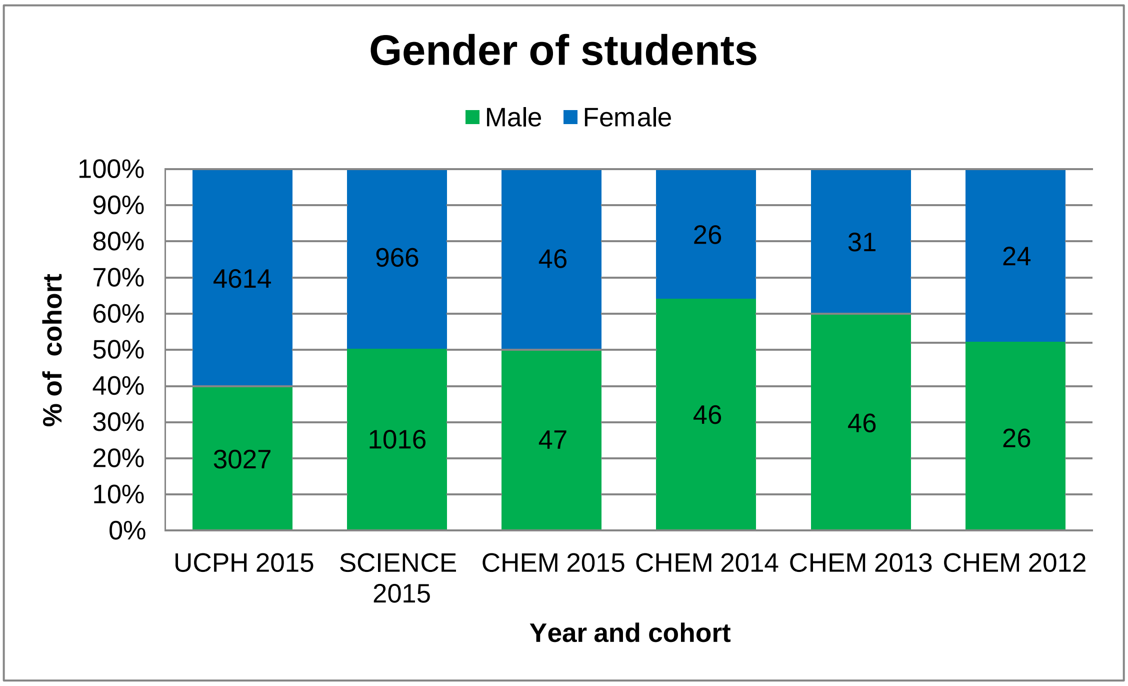


Figure 14 Copenhagen University's Statistic of Entry (University, 2016b)

5.1.3 Parents educational background

The total presentation the students' parents education background can be seen in figure 15. But this representation have mainly been used the more narrow representation in figure 16.

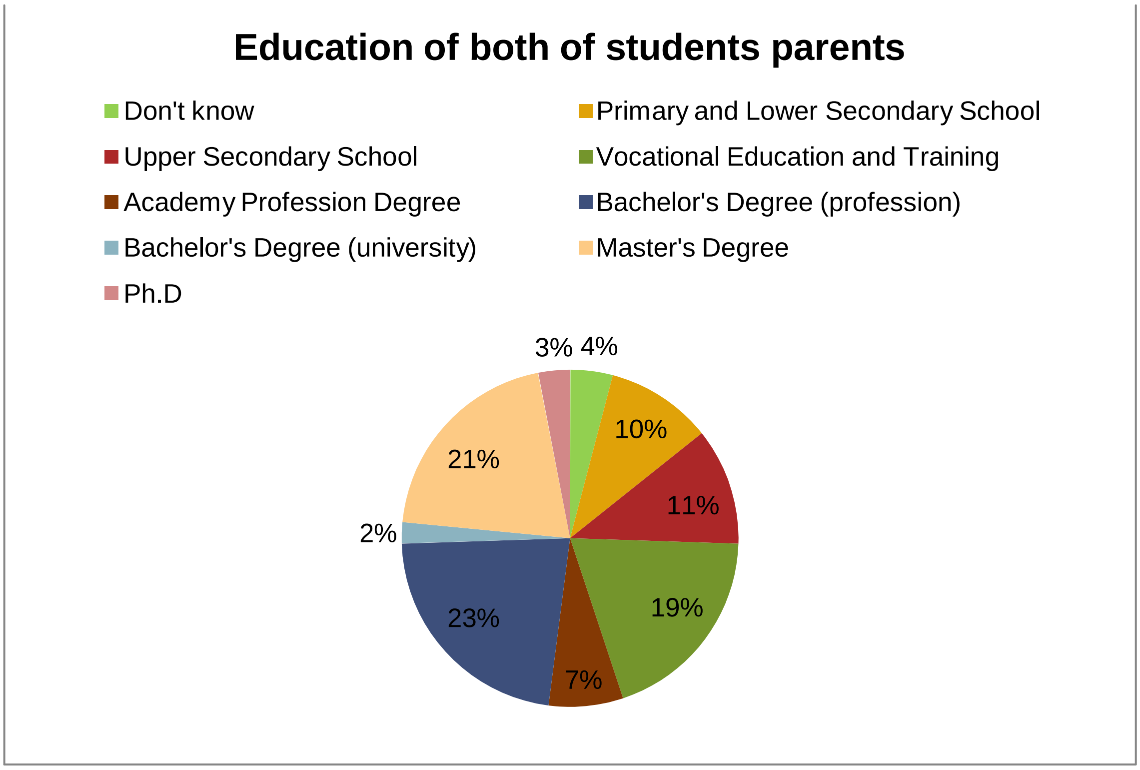


Figure 15 Education of both of students' parents. From September.

The reduction of educational background to academic (Ph.D, master degree and academic bachelor degree) and non-academic was chosen because this distinction reflects the presumed difference in cultural academic capital, and the interesting distinction of students having familiarity with university versus students who haven't.

It could be argued that the 3 academic educations reflect an ordinal scale, but for simplicity this is not introduced.

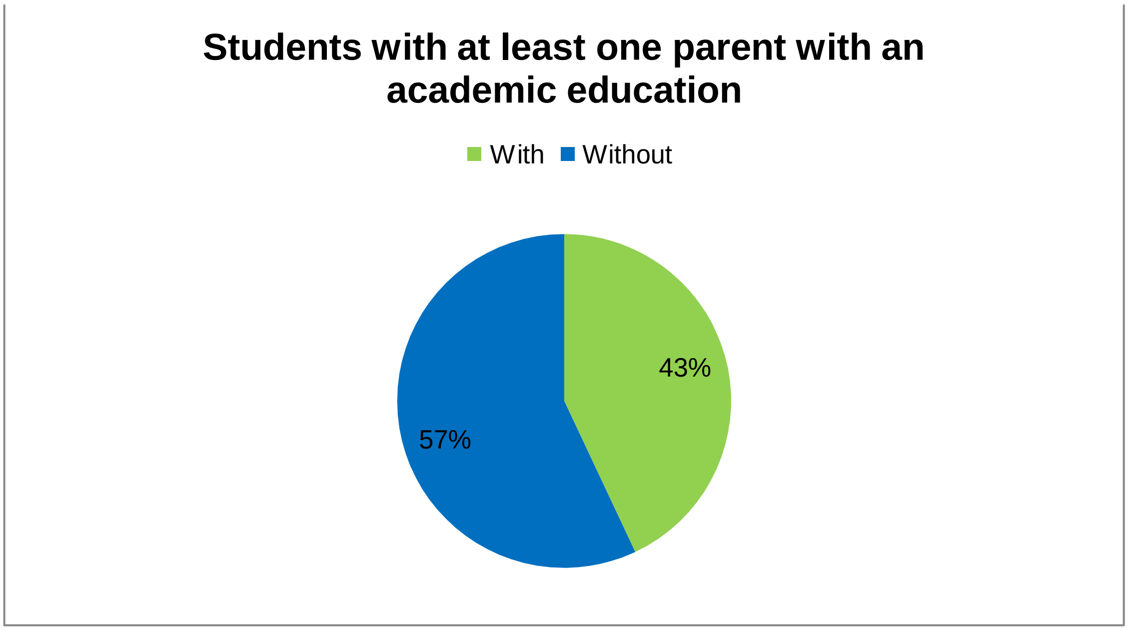


Figure 16 Amount of students with at least one parent with an academic education (academic bachelor degree, master degree or Ph.D). From September.

In comparison with figure 16 is figure 17, which shows the division of possible Danish parents with and without academic education. It is unsurprising that a higher amount of the parents of Chemistry students are academics, but it is worthwhile to keep in mind when considering educational policies and planning, what there exist a big potential of different students in the population.
Even if we a assume all Danish academics had children with nonacademic, the students with academic parents are at least twice and maximum 4 times as good represented at Chemistry, than they are in the general population.

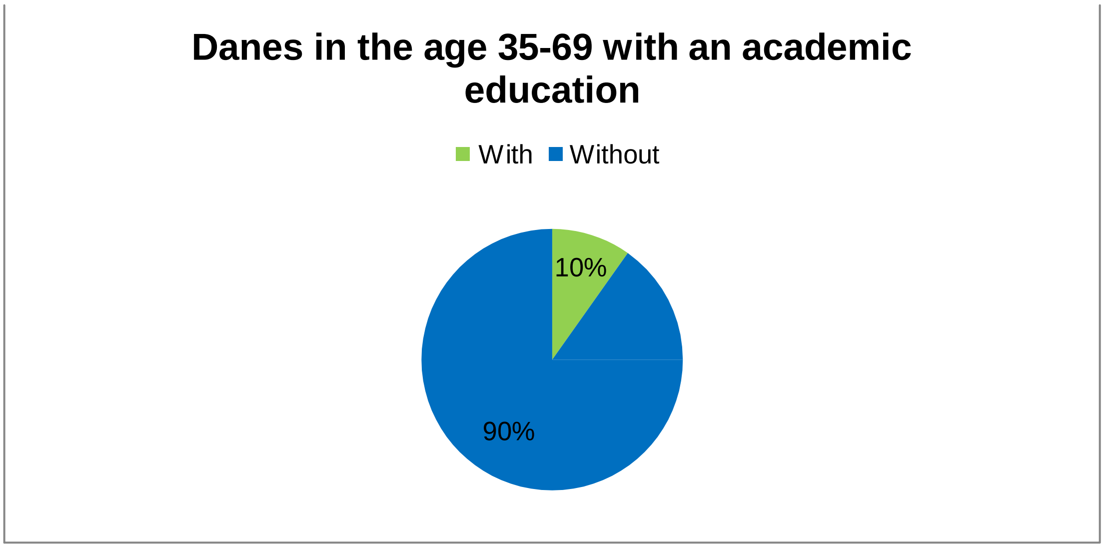


Figure 17 Data from Statistic Denmark, ("The populations highest completed education," 2015)

5.1.4 Students educational background

Students who started at Chemistry in general were different than the cohort of students who got their upper secondary exams in 2015. Chemistry got an overrepresentation of students with technical exams and international exams, and an underrepresentation of students with commercial and preparatory exams. See figure 18 and 19. This is unsurprising since commercial and preparatory students have to supplements their exams in order to the necessary combination of course to admit.

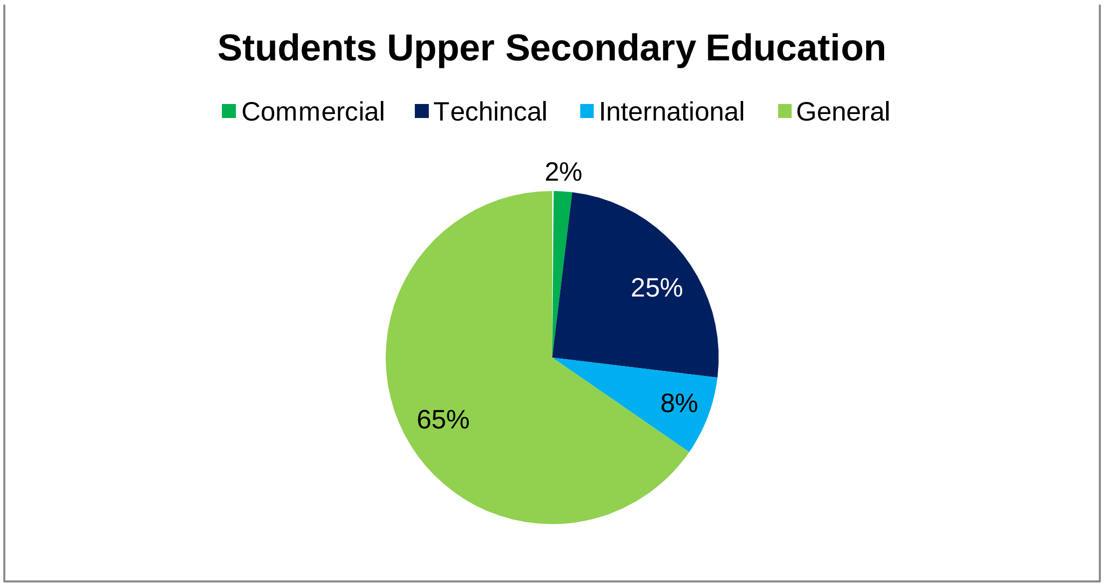


Figure 18 Upper secondary school of students. International exams both correspond to The International Baccalaureate and to upper secondary schools from foreign nations. From September.

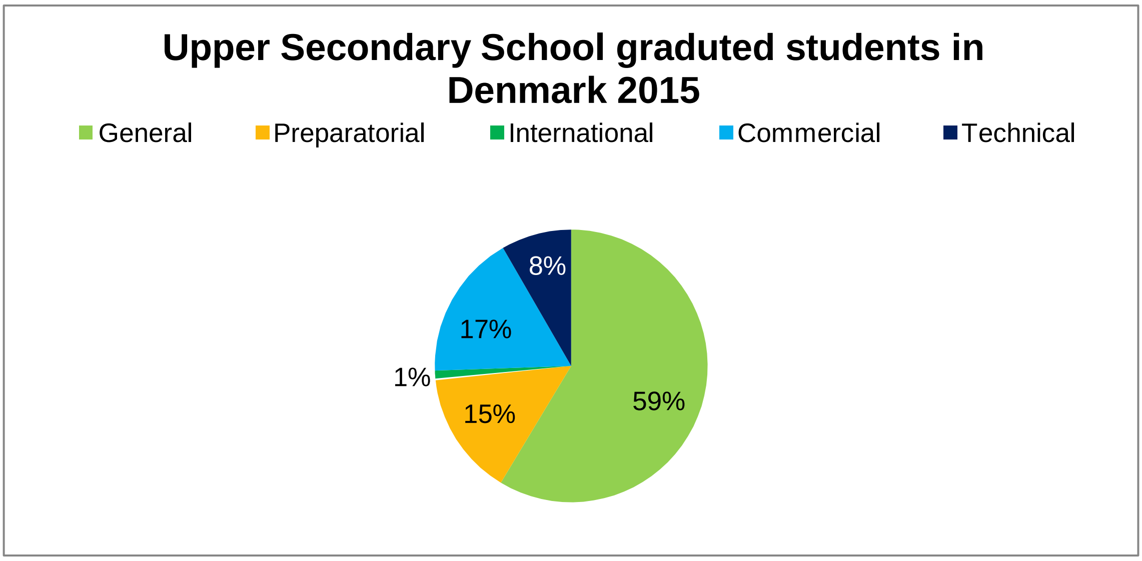


Figure 19 Division of graduated upper secondary students in 2015. International only covers international exams from Danish schools. Data from ("Upper Seconday School," 2016)

Of the 52 students who answered the September questionnaire only 8 didn't have A-levels in Chemistry and only 3 Biotechnology, but those 3 also had A-levels in Chemistry.

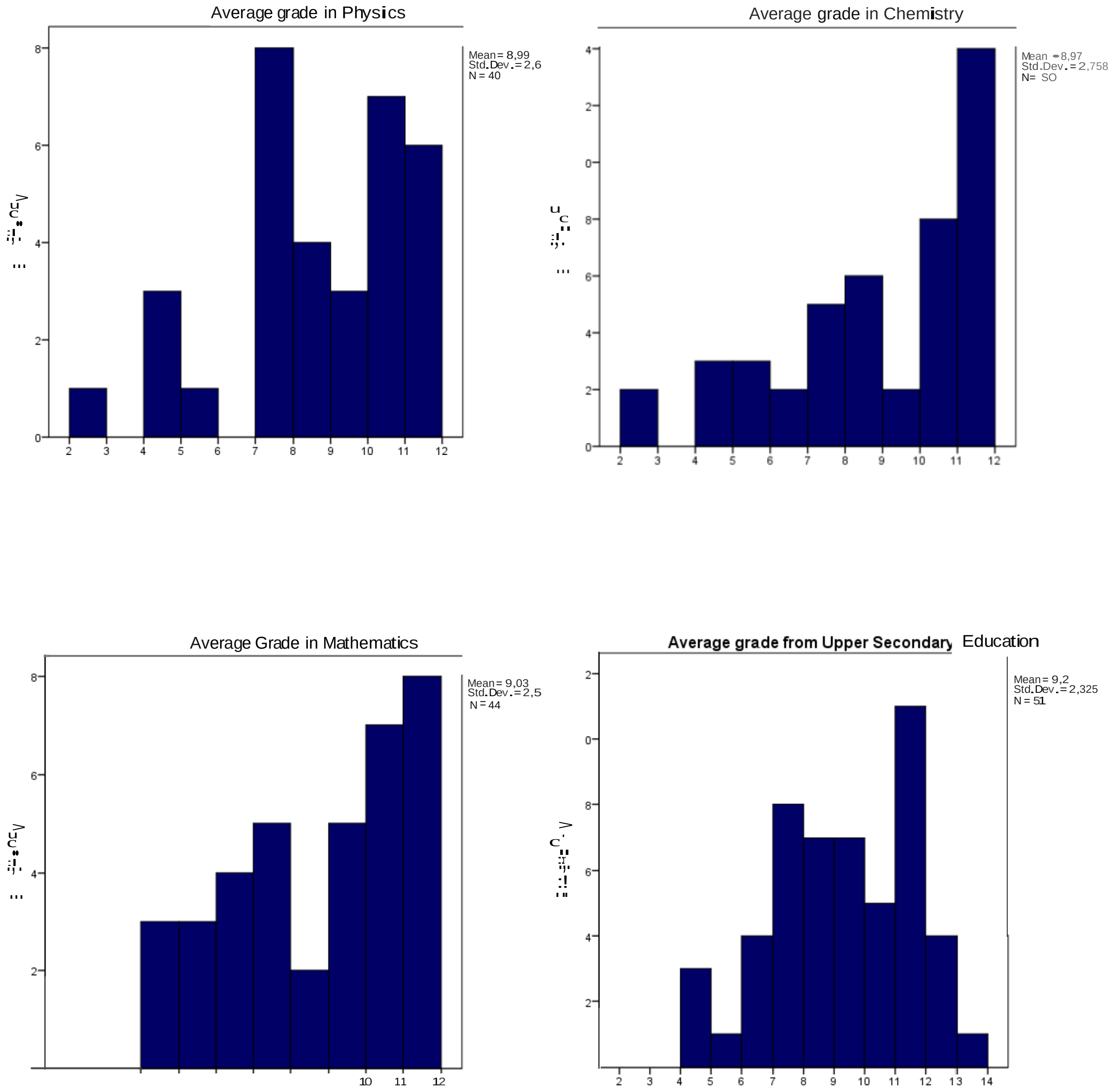


Figure 20 Histograms of students average grades from upper secondary school. The average was calculated on the basis of both exam grades and end of year marks, both oral and written. Note that the average grades from upper secondary school also include possible bonuses from extra A-levels and early start at tertiary education.

In general the students who were started at Chemistry had high grades in all three required courses and in general from upper secondary school. Hence there is no evidence that the programme attracts many students with low grades who only attends Chemistry because of the free intake.

Average grade from Upper Secondary School		Chemistry	Physics	Mathematics
Average	Pearson Correlation	,817**	,746**	,789**
	N	49	40	43
Chemistry	Pearson Correlation	1	,742**	,692**
	N	50	40	44
Physics	Pearson Correlation	,742**	1	,649**
	N	40	40	35
Mathematics	Pearson Correlation	,692**	,649**	1
	N	44	35	44

**. Correlation is significant at the 0.01 level (2-tailed).

Table 6 Correlation between average grades from upper secondary school. From September.

It is also noteworthy, but not surprising, that grades from the different upper secondary school course are highly correlated. (Potgieter et al., 2010) and (Seery, 2009) reports similar result.

5.1.5 Housing and commuting

Figure 21 shows the distribution of the housing situation of the students over time. Unsurprisingly over time fewer students live with their parents, in temporal places, or are without home.

When testing for negative correlations associated with living home or long commuting time none significant are found, apart from the two who are internally significantly negative correlated.

In correspondence to the theoretical work of Tinto (Tinto, 1975, 1988, 1999) where the theoretical social exclusion students living far away or with their parents experiences plays a significant role, especially in (Tinto, 1999), it is an unexpected finding that there is no such relationship. In (Seery, 2009) a negative correlation between commuting time and first year grades are also found, and even though this relation isn't tested in this study, this is supportive of Tinto.

One possible explanation is the difference in housing culture between the United States of America, Ireland, and Denmark where very few students live at campus in Denmark and hence the social culture isn't as related to housing. Even though this study doesn't back the theory of Tinto there exist a tendency in the data of leaning toward a negative correlation between social activity and commuting time. Considering the current critical lack of housing for students in major Danish cities, like Copenhagen this topic could be of interest for further investigation.

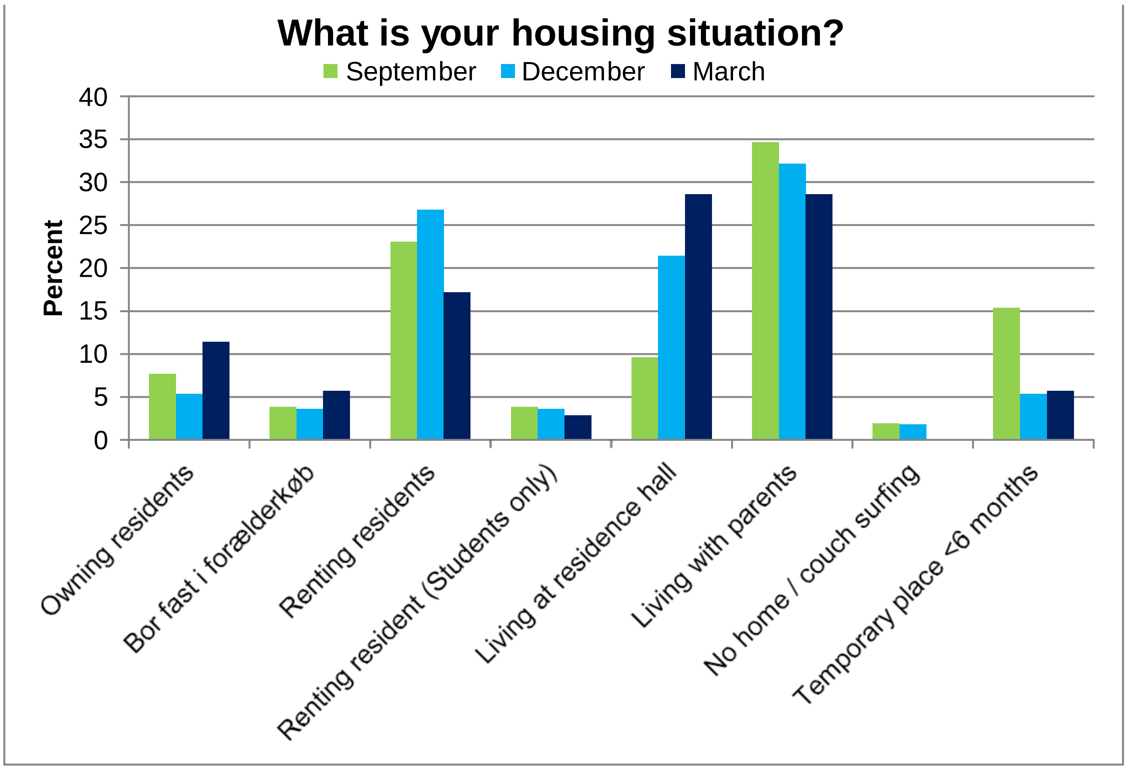


Figure 21 The housing situation of the students. Data from September, December and March.

An overall note on the findings on background variables is that

- Gender, commuting time to university, parents' educational background, average grade form upper secondary school and years since graduation from upper secondary school are independent background variables.
- There is an overrepresentation of students with parents with academic education in relation to the population in general.
- Housing situation and commuting time wasn't negatively correlated with social activity or academic preferences at Chemistry, which contradict previous findings and theory.

Otherwise the student's background information was rather insignificant.

5.2 Becoming a Chemist

"To me neither prestigious residence, distinguished position, renown nor health is as important to me as my preparates amongst the smoke of the oven and soot of the fiery coal ahead of the bellow. More persistent than Heracles in the stables of Augeas I work persevering, albeit almost blinded by the strong light of the fireplace and strangled by the vapors of mercury, like a Mithridates saturated with poison. Deprived of others companionship and esteem, like a beggar, I in the realm of the spirit however live as Croesus, despite of the afflictions so elated that I rather die than change position with the Persian king."
- Johann Joachim Becher about being a (al)chemist, Physica Subterranea (1667), also reprinted in successful computations in Gaussian(M. J. Frisch, 2009)

The above quotation is taught to chemistry students in their course on the philosophy of science on 3rd year. It is referred to as the Chemist´s Creed. Even though this depiction of chemist might not be up to date, chemist does have some strong, sometimes stereotypical, association in the public and maybe the strongest brand among scientist in general.
In this chapter the student's identification of chemists and chemistry is identified and analyzed. Both where they get their information from, what they hope to

work with and their expectations confrontation with the reality at the department is investigated.

5.2.1 Motivations for Starting at Chemistry

Both from a theoretical point of view students motivations for starting at any given education is important because it steers their first setting of commitments and goals for studying (Tinto, 1975, 1988).

The first indications of students motivation for attending Chemistry is how high a priority Chemistry was when they ranked their educational priorities in the summer of 2015. See figure 22.

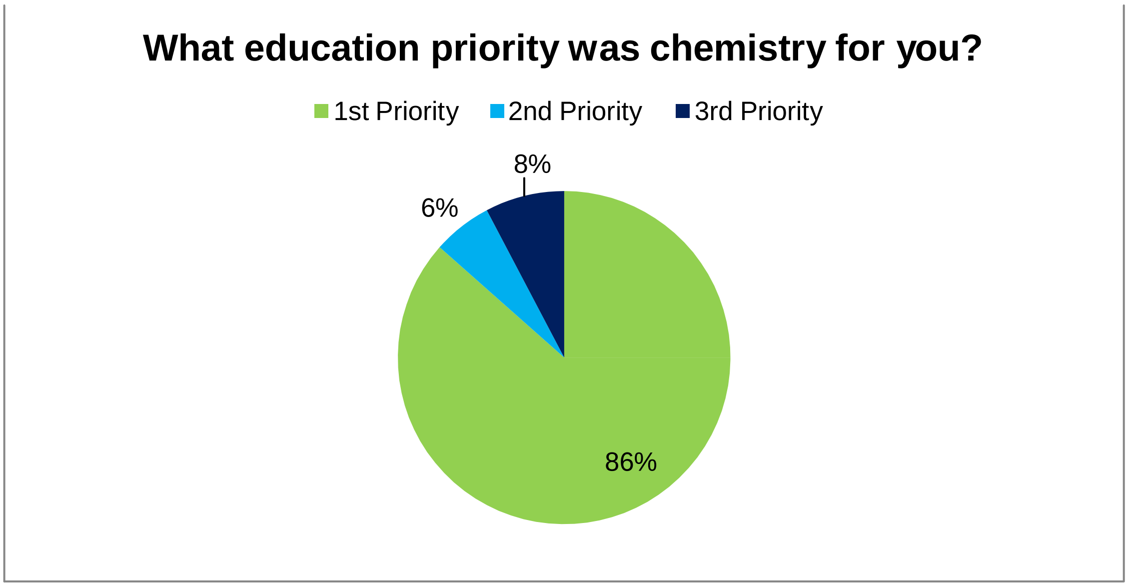


Figure 22 Priority given to the Chemistry programme when students prioritized educational preferences in the summer 2015. Data from September.

Of the students who didn't have Chemistry as their 1st priority 6 had other STEM educations, 2 had medicine and 1 had architecture as 1st priority.
From ("Copenhagen University's Statistic of Entry," 2016) it is relevant to point out that 77% of all students accepted into Chemistry in 2015 had the programme as their 1st priority, showing a slight overrepresentation in the examined cohort.

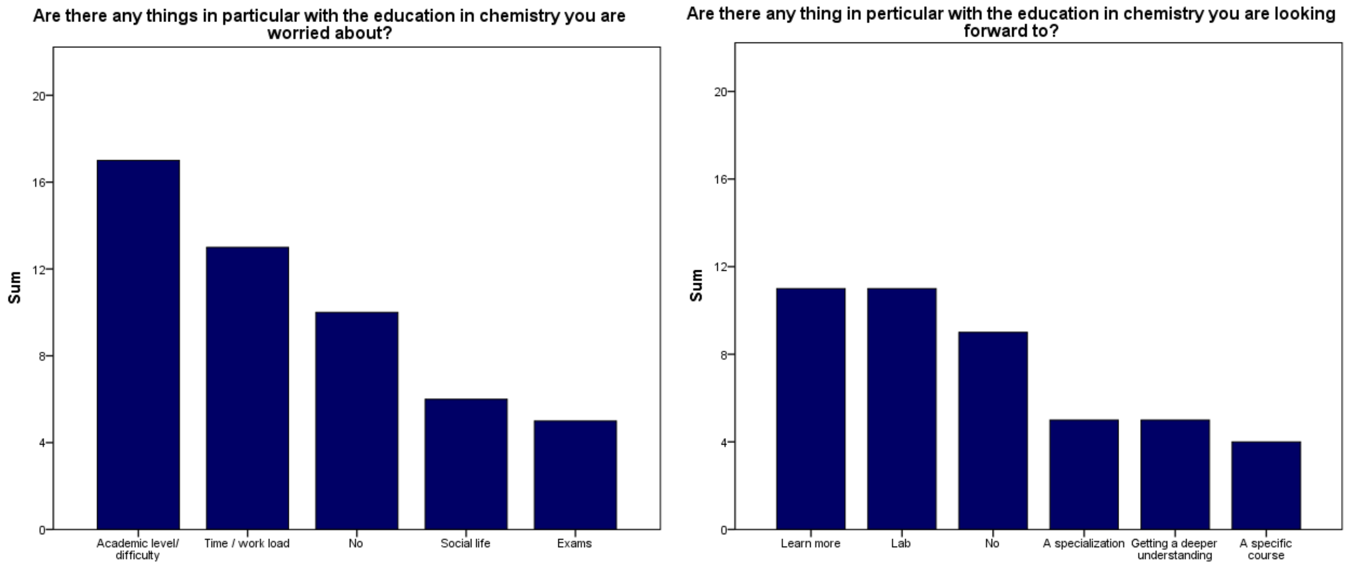


Figure 23 What students looked forward to and was worried about in relation to starting at Chemistry. Data from September.

When students were asked about what worried them about starting at Chemistry and what they look forward to a number of interesting things displays. It is noteworthy that all they are looking forward to is academic while their worries both concern academic subjects, social and external.
Another point is that none of their worries are specifically associated with chemistry, where most of the things they are looking forward to are associated specifically with chemistry. This might point to the fact that the choice of studying chemistry is a more active choice than just studying something and the pros about chemistry should have been superior to other programmes since the students have chosen chemistry. In this regard the students worries should also be optimized down to matters the students are willing to deal with in order to achieve their goal, and are in this fashion reduced to a background noise of typical worries about attending university. From this analysis the challenges for the students and university will be to satisfy expectations that are strongly associated with chemistry and dealing more broadly issues about going to university to minimize the disruption of the students narratives, which (Ulriksen et al., 2015) show concerning students expectations of *in debt learning*. On the other hand this might also prove that cons specifically associated with chemistry and pros associated with university in general might be some of the matter that surprises students most about starting at Chemistry.

5.2.1.1 Subject Vs University

In relation to the division mentioned in the chapter above, there could exist a division between the students' concept of university as an institution and as a study of a subject. When students were asked of the importance of these two aspects they gave quite similar answers. See figure 24.

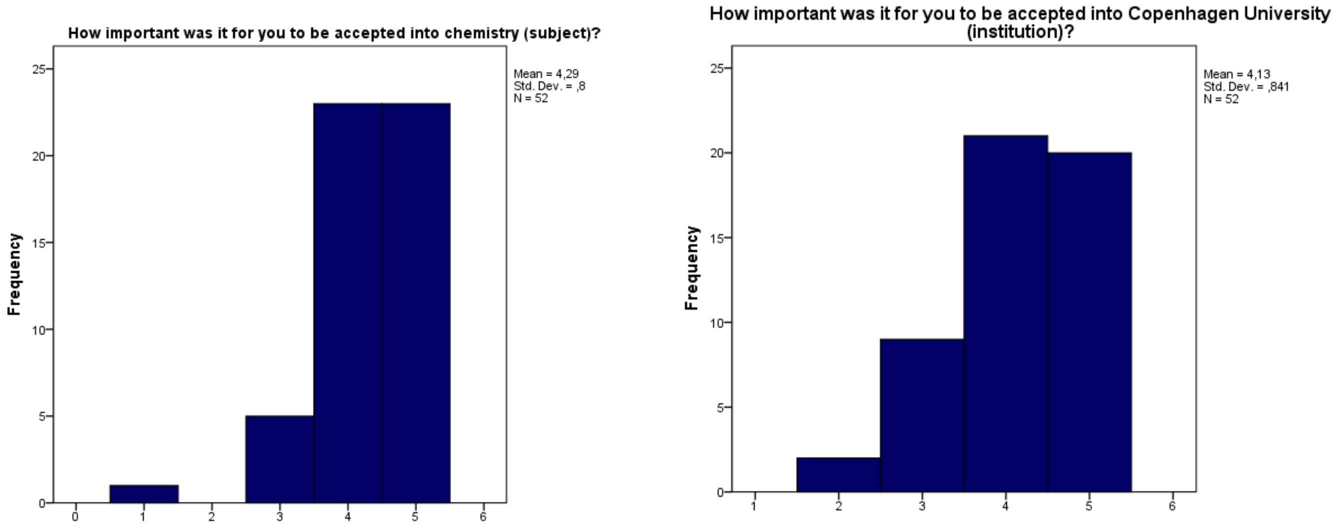


Figure 24 The importance of the subject and institution of the student's choice of education. Students were asked to answers on a 1-5 scale with 1 being "Doesn't matter" and 5 being "Paramount". From September

However when students are students are asked why they chose the institution and subject their answers mirror those given in figure 23. See figure 25 and 26.

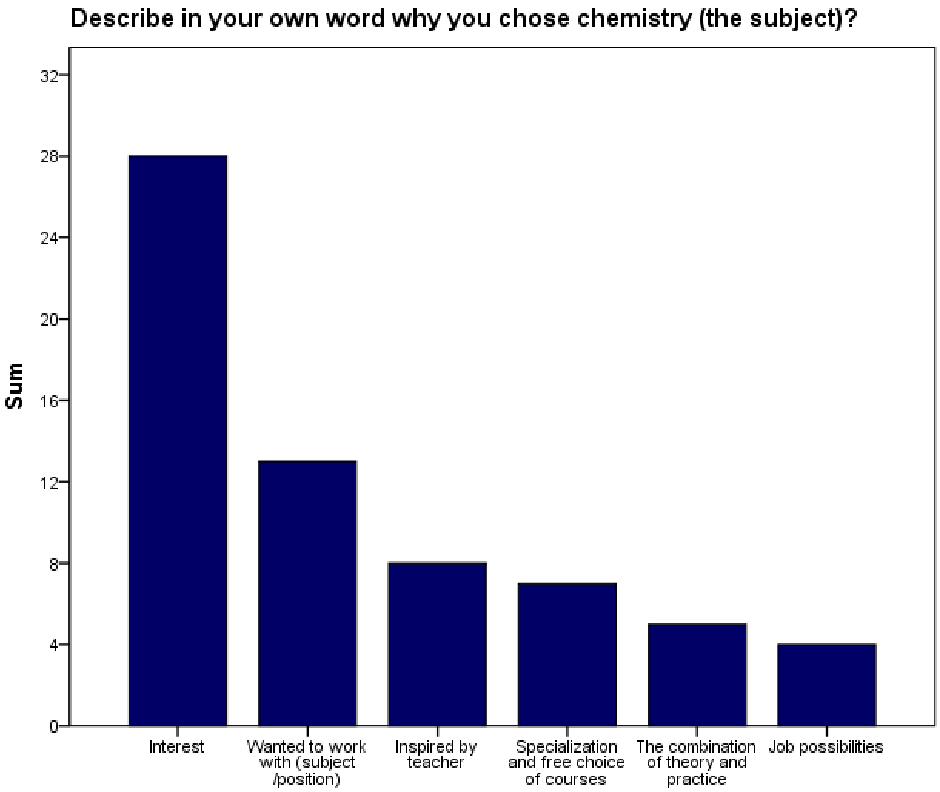


Figure 25 Students reasons for choosing to study chemistry. Data from September

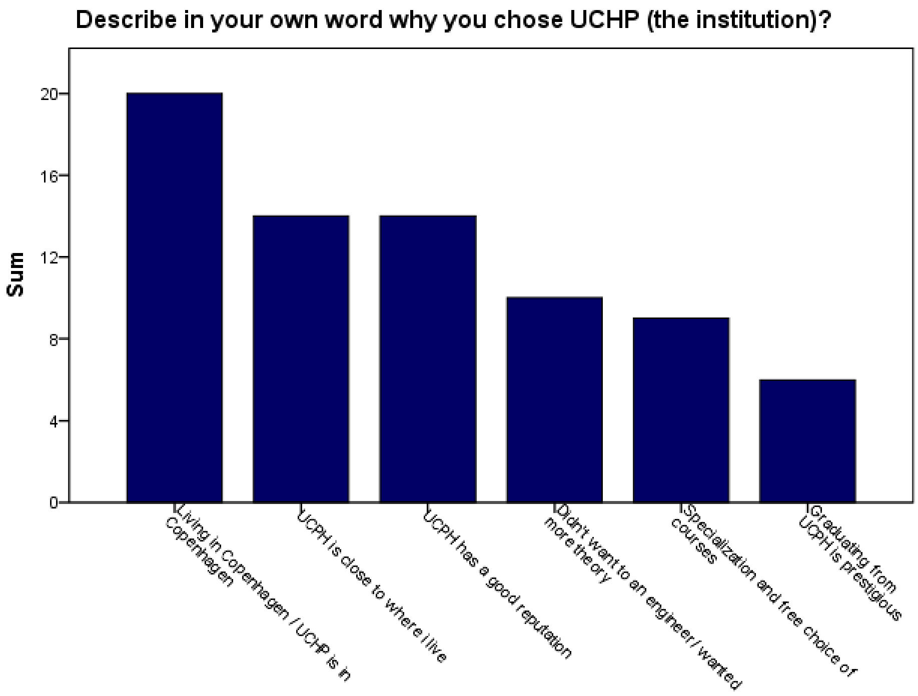


Figure 26 Students reasons for choosing to study at Copenhagen University. Data from September

Students' choice of subject is related to chemistry and the interest is by far the dominant answer, which according to (Seery, 2009) is also a mark for persistence and is consistent with (Hovdhaugen & Aamodt, 2005) results. But the reasons to choose Copenhagen University were either rather related to the subject (not wanting to be an engineer and have the possibility of free choice of courses), as one student say it:

"I don't become an engineer, but Cand. Chemistry. Get (I think) many more different choices when I have to work afterwards."

Or the students values the fact that Copenhagen University is in Copenhagen, which surely is important in social and cultural aspects, but not in an institutional matter. These finding are however consistent with (Hovdhaugen & Aamodt, 2005), where the choice of institute also is very depended on the fact that students just want to live in a particular city. The fact that the university is in Copenhagen isn't related to any of the social activities or academic practices, at least not in the matter of first year students, which none of them nor relates geography to. Like this students, all of them relate to the geography in terms of friends, family, and a desire to live in Copenhagen or to the fact that Copenhagen University is close to where they live:

"[I] have lived here the last 9 years in cph, and got associates, girl/boyfriend and some family over here."

On a final note it should be noted that some of the students describe an identity to the institution as being reputable and prestigious.

In general the lecturers don't mention their expectations regarding the student based on the students' motivation, but rather their performance. One exception is this, which corresponds very well with the students' answers:

“Yes, I do of cause have one [expectation], and it is of cause trivial, but I got the expectation that they are very interested in chemistry. And I think they are.”

5.2.1.2 Sources of Information

With the important first construction of commitment and goals, prior to the translational phase(Tinto, 1988), it is particular interesting to know what sources of information students create these from. In an very ironic way the construction of these, most important goals and commitments, the universities role is very secondary even though both Chemistry and the university in general offers many possibilities to see the “truth” about the education.

In the questionnaire in September students were asked first to tell their familiarity with a wide variety of information sources and then rate their eventual effect on their choice. See table 7.

The overall low scores of the initiatives reflect that many students give low scores to many initiatives, but a few. For instance does 2/3 students give at least on initiative 4 and all of the initiative had at least one student who gave them more than 4.

This shows that the students’ information sources are very varied, but that all of the initiatives the Department of Chemistry host are actually influential for some of their students. A special mention should be given to the department’s homepage and the videos they have produces which are some of the most valued sources of information.

It should be noted that this table doesn’t include influences that are more subtle or cultural and they can be influential, but maybe not always sources of information. An example of this could be teachers, another one could be the success of the series Breaking Bad with a chemist as a lead character (the rapid rise in admitted students to Chemistry from 2008-2010 was actually called the *Breaking Bad Effect*).

There are different ways to get information about the chemistry degree. Down below you should mark your familiarity with the initiatives and the degree the initiatives have affected your choice of education.	N=52 Valid	Mean	Std. Deviation	Variance
Student for one day at Chemistry	34	1,35	,734	,538
Student for 3 days at Chemistry	23	1,83	1,302	1,696
SRP-student at Chemistry	31	1,55	,995	,989
Chemistry Olympics at Chemistry	25	1,48	1,046	1,093
Secondary school class was visited and had lecture	19	1,84	1,015	1,029
Upper secondary school class visited Chemistry	21	2,10	1,261	1,590
Visited Open House at UCPH	39	2,05	1,376	1,892
Homepage of education guide (ug.dk)	47	2,81	1,313	1,723
Homepage of Chemistry	46	3,07	1,272	1,618
The films on the education at Chemistry's homepage	33	2,55	1,460	2,131
Familiar with one who study / have studied Chemistry	30	2,80	1,448	2,097

Table 7 Degree of effect different initiative have had on students choice of the Chemistry education. N shows the number of students who were familiar with the initiatives. Students rated the initiative on a 1-5 scale with 1 being “it had no influence on my choice of education” to 5 being “it had paramount influence on my choice of education”.

Another point about the information sources is that the amount of information versus the amount of commercial manipulation. With the current financial structure of educations, institutes and universities receive money based largely on the amount of students they got. This does for obvious reasons make the output of these sources of information balance on the edge of a knife; on one hand the short term strategy of institutes would be to make their programmes look as attractive as possible, on the long term strategy of the institutes would be to give a correct impression of their programmes, so that students can tune their goals and commitments correctly, an ease their integration.

Picture 1 To much?

Front page of brochure with presentation of SCIENCE programme ("Ta' hul på fremtiden," 2016). The author of this thesis on the left. I think that upper secondary school students know that you have to wear glasses in labs, so why not put them on. I why was the liquid colored with fruit coloring, when it could have just as good, and better story with cobber sulfate?

5.2.2 Work after University

A very concrete goal and a very strong narrative is the association of work after education. Even thou some students sees this as something in the far future, very denies to have any idea of what they want to do.

From a theoretical point of view the work after education can be seen as the ultimate goal, at least of the academic aspect of education, and inside this paradigm marks an end to negotiating narratives, commitments and goals in the social and academic integration of education(Tinto, 1975). In figure 27 the students wishes of work after completed degree is shown. Note that the questions were framed *like to do* instead of *work* in order to get a broader perspective on the students' wishes than just a professional one. Most of the students also answered without referring to professions.

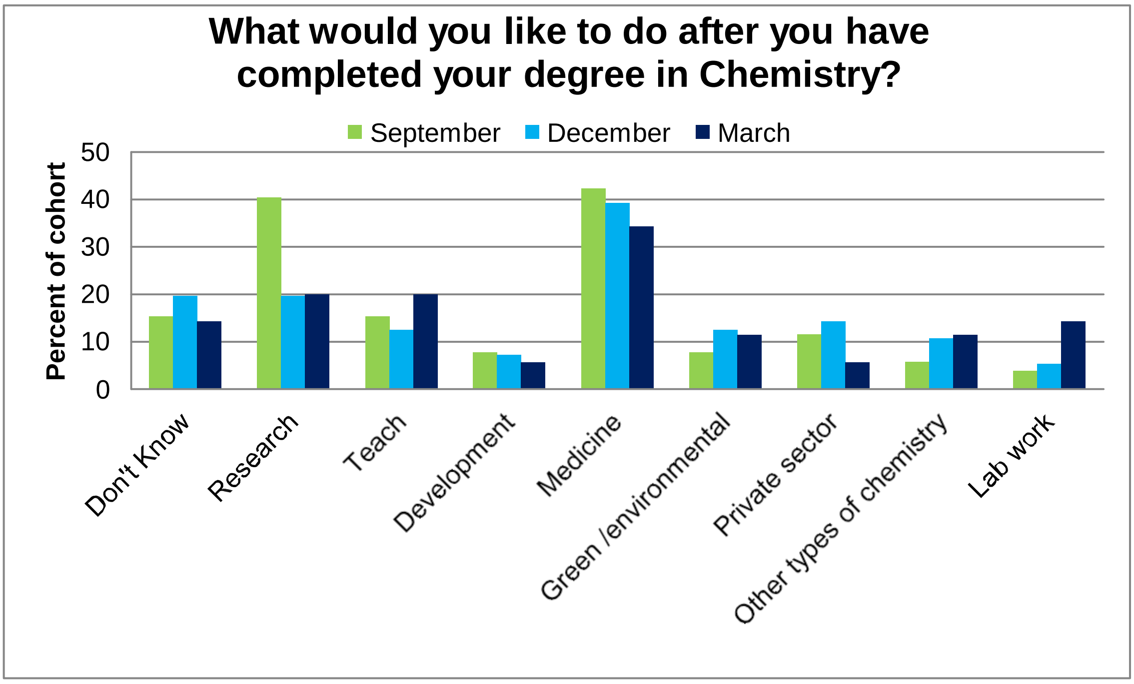


Figure 27 Students wishes of work after completed degree over time. Data from September, December and March.

The most remarkable result is the decrease in the amount of students who wants so research. Most of the students who answered *research* in the September questionnaire and didn't mention it in the December questionnaire had given answers that included research among other subjects, and just changed that specific part of their answers, e.g.:

From

"I would like to specialize in medicinal chemistry and would like to work with companies like The Danish Cancer Society or Novo. I would like to be chemical researcher and developer."

To

"I have decided to choose medicinal chemistry and after what work at Novo, or something similar. I will also work some years at The Danish Cancer Society."

But there is also a significant group of students who changed their minds, e.g:

From
”Research or teach.”

To
”I would like to be of communicator of scientific knowledge (or a upper secondary school teacher)”

Another measurement of commitment in this regard is the students’ working expectancy with these particular things.

How important to you is it to work with the previous?		September	December	March
N	Valid	52	56	35
Mean		3,58	3,46	3,17
Median		4,00	3,50	3,00
Std. Deviation		1,319	,972	1,175
Variance		1,739	,944	1,382

Table 8

When checking for correlation with background variables very few show any significant correlation and none are consistent over time in regard of the students’ working expectancy. And there is neither no significance nor consistency with their correlation with the importance of their work expectancy. There is however some negative trends in correlation between this expectancy and females and students with lower grades from upper secondary school. These trends are also seen in (Hackman & Dysinger, 1970) regarding gender and long term academic planning as commitment.

5.2.3 What is a Chemist?

As a tool to measure how students saw their narrative as chemist they were asked to describe a chemist. This question was by far the one with the highest variations of answers and hence the categories are more ambiguous than in other questions. See table

A confirmation of the importance of work regarding narrative is that most of the high scoring categories in the students' work expectancy are also present here; medicine, research, teach and development.

But the high scores in this question are characterized by instead of describing a work they describe a way of thinking; knowledge and understanding of certain things:

"A chemist work with chemistry, both to understand things that's surrounds us and to improve these. Everything from catalyst, to medicine and environment."

"One who can create new knowledge of the already existing knowledge."

"One with knowledge of different compounds and their effect/reaction."

Or describe as a person with an ability to perceive things and connection ordinary people cannot:

"A chemist is one who is interested in the chemical world that lies in the background of everyday life. One who has dedicated their time to find answers on the great mysteries among the atoms."

"A chemist got a fundamental understanding for the smallest details."

"A chemist is a person that specializes in research of the world's or universe's smallest building block. One who participate in developing and deciding the future, while pulling the future into the light. A chemist is a person who is interested in the smallest things, even though they are invisible."

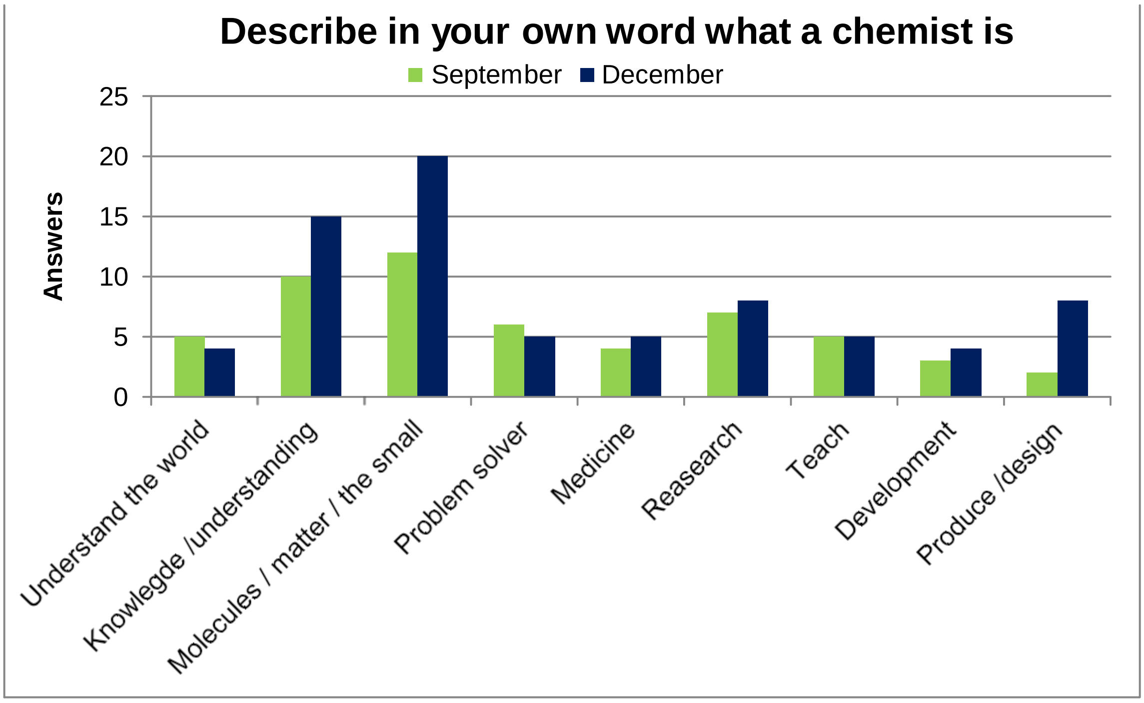


Figure 28 Student's descriptions of chemist. Data from September and December.

This view, that chemists are characterized by the knowledge and perception, is only strengthened as time passes which indicate that this narrative is a successful mean to longitudinal institutional integration.

Two of the letcturers also describe chemist (as an identity, not the students):

"It was Novo and Novozymes said it [we want some nerds]. That's because this specialized knowledge you have as a scientist - chemist – you don't just get it anywhere. Project management is the more a universal human competence. "

And

***“Jonas:** How do you try to catch their [students’] interests?*
***Lecturer:** I think there are two things that are catchy. One thing is of course, they expect to have a career, but it's very early in the first year to use that. The second thing is the identity as a chemist and the existentialist vision of the entire life because everything is chemistry, after all. So if you can catch this ‘I understand more of my life, of all of life, if I understand this chemistry and I can use it in all other scientific disciplines and also in my attitude to things.’ If you can catch them that it's really, really good, and try and give them the insight that in actually it is really simple to understand chemistry just from the periodic table.”*

It is interesting that the letcturers and students have such agreement on what the identity of chemist is, and this only strengthen that this identity is a “correct”, long-lasting interpretation of the narrative, and a good strategy to adopt to integrate.

To summarize this chapter:

- Comparing data collected for this study with official data from the university shows that there is a difference between the numbers of students who had Chemistry as their 1st priority for programme. This questions the representativeness of the cohort of the students who answered this study of the whole education. Specifically in differences associated with students’ commitment.
- In general students expectations to their study of Chemistry is positive regarding the academic content of Chemistry, and negative regarding the social and cultural academic frame, that more generally can be associated with attending university.
- Students’ choice of programme, chemistry, is a matter of interest and regard of selected disciplinary matters along with Chemistry’s possibilities of individually selected courses and specializations.

- Students’ choice of university, Copenhagen, is by large determined by externals factor, most commonly the wish to live in Copenhagen. In smaller regards Copenhagen University is considered a reputable and prestigious university.
- Student’s choice of studying cannot be narrowed down to a selected few sources of influence, and is very varied. Of the institutional offers the Department of Chemistry give, their own home page and videos about the education are the highest appreciated by the students, but only marching external sources like ug.dk and student’s own associated who have studied Chemistry.
- Students’ work expectancies are very coherent over the first year, with only *research* experiencing a significant decline. The most popular expected works are research, medicinal chemistry and teaching along with smaller, but consistent categories.
- In relation to student’s work expectancies, the students and letcturers share a strong narrative image of a chemist, first and foremost a person with attributes of knowledge and perception of connections in nature what allows the chemist to solve theoretical and practical problems in a varied field of work, especially regarding the working expectancies; research, medicine and teaching.

5.3 Learning

5.3.1 The Academic Level

“The academic level” is properly one of the most consistent used phrases in relation to education, especially universities. The academic level obviously plays a large role in university education, it is however important not to fall back to the academic level as a reason for explain everything.

In the matter of this research it is a pity this study haven’t been able to collect the grades of the examined students, since this is probably the strongest indicator of academic level.

About the academic level the lecturers took the test explained earlier. The results of this test are shown in figure 29.

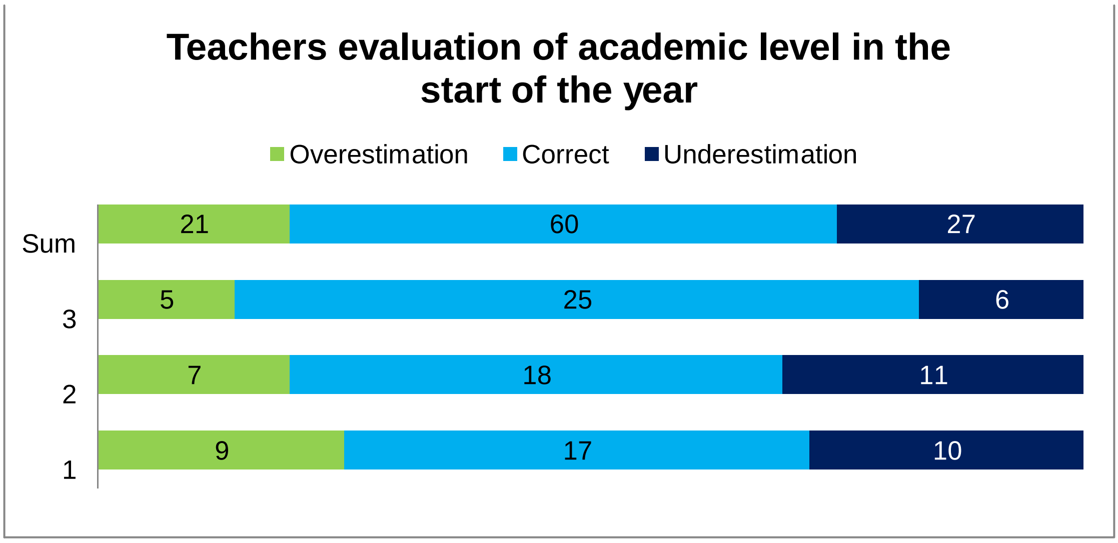


Figure 29 Lecturers' ability to predict academic level at the start of university. Data from test of lecturers.

In general lecturers don't show a tendency to overestimate or underestimate the students, and part of their underestimations of students can be seen as structural flaws in the test, since many of these questions were questions with descriptive answers rather than numeral, where they were all wrong.

Specific the lecturers said the following regarding the academic level:

- Abilities in calculus are low, which they think is a problem:

"So when they have Mathematics at A level, it's the highest you can have in mathematics. So I expect they have strong abilities in calculus."

"…calculations where you have to manipulate around with some symbols, isolate one on one side of the equal sign and then eventually end up putting some numbers into an equation. And that's difficult for many of them. They don't seem experienced in them, so I think of what the heck have they done in physics and chemistry? Do they have not been sitting and solving problem?"

- The academic level in chemistry is low, but increase very rapidly:

“We have to start from the lowest; we cannot lose them, those who have chemistry at B level. Accordingly, we almost start from zero when we begin. Then we do go rapid in the beginning, but we are starting with zero, the atomic structure, stoichiometric calculations…”

“Generally speaking the expectation have is that they can what has been learned in high school to some extent. But obvious, I am also well aware there are many things some has forgotten. And things have to be repeated. But I also think it is important that teaching in the first-year teaching is based on upper secondary material, but goes one step further. Also relatively quickly, so it is not just a repetition of upper secondary school.”

“The vision is that they should have a soft approach to chemistry, and they are told that they should not learn too many different things by heart. They get a very ... mechanistic insight into how atomic orbitals and electrons behave. And they have actually had that in upper secondary school, they have had all the things we teach in the first course in upper secondary school, but they can’t do any of it – at all. And then they become really, really good.”

- There is a big difference in academic level among students

“It is a big challenge. There really is someone who is knowledgeable. Oh boy. ... You can be a little worried about whether they have enough challenges. And then there are some completely at the opposite end which have difficulty just typing someone into a calculator.”

This specific statement is however opposed by one of the students:

“The majority sees to start at the same level, [this is a positive surprise] as I was worried that some would already far ahead of one. But everyone has seemed to work at the same level, and the content has started on a level all could follow. It was truly a delightful experience that the content did not seem completely unknown to begin with.

5.3.2 A Light Appetizer…

A rather new pheromone at chemistry is the brushup course the week before the actual beginning in September. 2015 was the second this was held.
From the internal evaluations of the course it is clear that students are satisfied with the course, and thinks it helps them.

Looking at this study, see figure 30, many students would like to participate in the course, but can’t for perfectly good reason. A group of students do however also attend the course for social reason, but in accordance with (Tinto, 1999) this is also a good strategy.

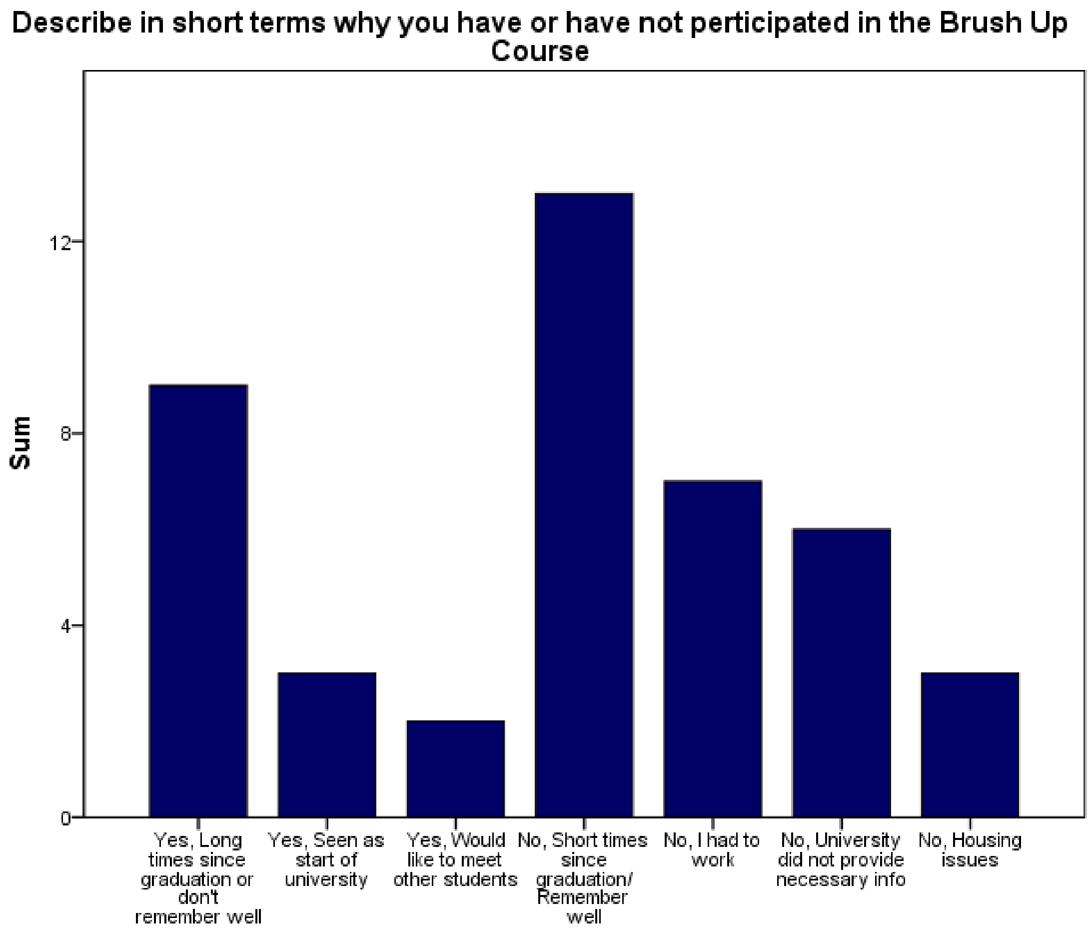


Figure 30 Whether or not students participated in the brushup course and why they did or did not. Data from September.

Table 9 does however show that the brushup course didn't correlate significantly background variable that might reflect the particular need for the brushup course.

	Did you participate in the Brushup course?	
	Pearson Correlation	N
Chemistry level	0,123	52
Persons age	-0,029	52
Persons gender	0,111	52
Parents Education	-0,146	51
Average grade from Secondary Education	0,055	51
Average grade in Chemistry	-0,05	50
Average grade in Physics	-0,072	40
Average Grade in Mathematics	-0,054	44
Years past since your graduation from secondary education	0,053	52

Table 9 Correlation of background information with participation in the Brushup course. None of the correlations are significant at the 0.05 level.

Another issue with the brushup course is that the lecturers don't know its content and hence don't use it, e.g:

*"**Jonas:** There's starting to be this brushup course at the beginning of the year. Is it something that you base your teaching on?*
Lecturer: *No.*
Jonas: *No. It is allowed to run its own race?*
Lecturer*: Yes. I am not involved, I do not even know what it contains, other than it must be something some pretty elementary chemistry."*

These observations combined show a fundamental problem with the brushup course; it works separately and it doesn't help those who it intends to help. The course itself runs fine and the students are satisfied with it, but the research (Clifton et al., 2012; Hayes & Childs, 2015; Køller & Olufsen, 2013; Zeegers & Martin, 2001)that underlines that courses like the brushup course are excellent tool for academic integration is so overwhelming that more could be expected.

5.3.3 … and a Menu of Three Courses

After the brushup course and the introductory week, normal life at university started. In the first half year the students had three course, which were investigated in this study; Organic Chemistry in block 1 and 2, Inorganic Chemistry in block 1 and Introduction to Mathematics in block 2.

It should be noted that in both Organic Chemistry and Inorganic Chemistry the lecturers have tried new learning activities and some of the data might be effected by the fact that these methods are not as refined as others.

5.3.3.1 Organic Chemistry

Organic Chemistry consisted of weekly lectures, problem solving classes and lab work when block 2 started. The lectures were accompanied by videos and reading and every week the homework help offered help in problem solving. The videos were a new activity as they accompanied the lectures in a manner of clipped classroom where the lectures was now taught in a variety of peer instruction.

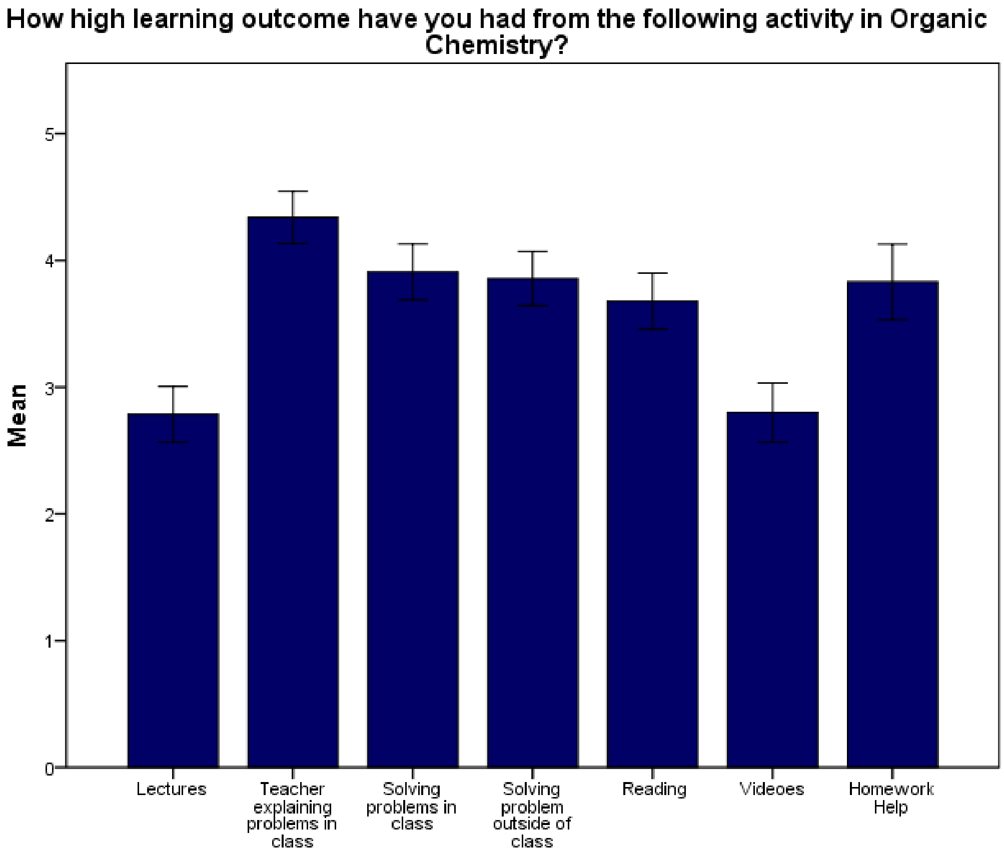


Figure 31 Learning outcome of activities in Organic Chemistry. Data from December. Error bars shows 95% confidence

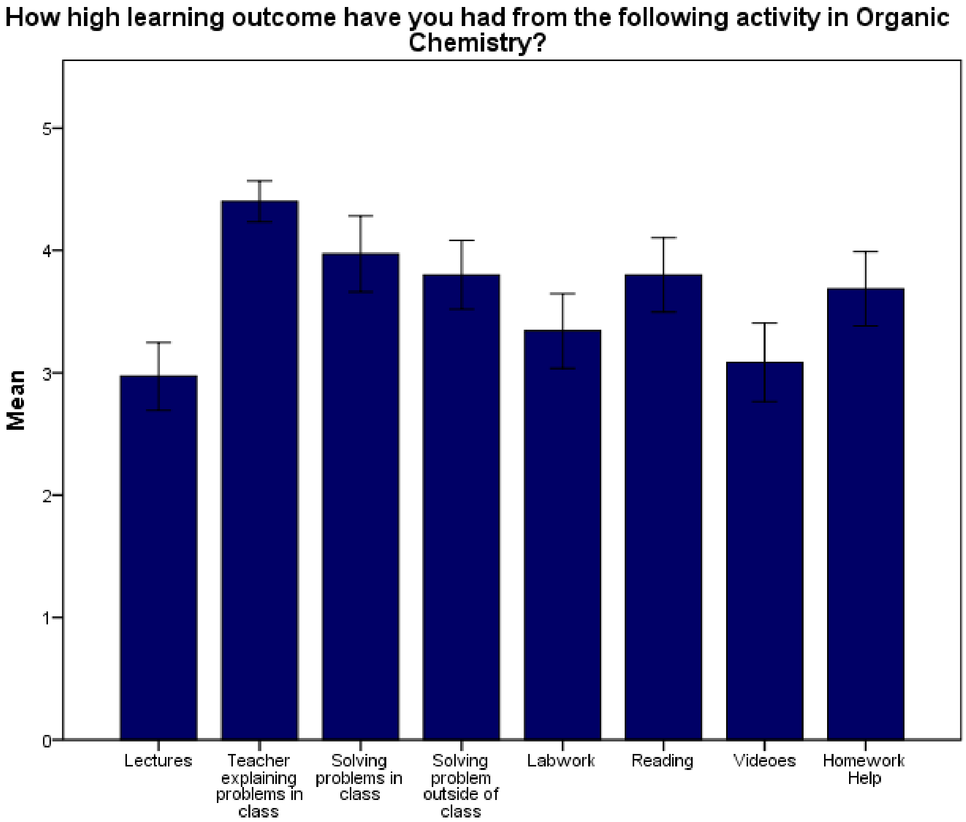


Figure 32 Learning outcome of activities in Organic Chemistry. Data from March. Error bars shows 95% confidence

Many students commented that would like to have more problem solving classes and fewer, or at least different, lectures that cover topics not covered other places. The latter comment is much alike some of the comment in (Eric Mazur, 2009); *lecturing straight from his lecture notes* and emphasis one of the problems of covering the same topic at multiple platforms.

There were also many comments on the videos, in general that they should be shorter and less intense, but no one wanted to remove them. One of the students even suggests go the lecturer in Inorganic Chemistry for help with this:

"Shorter videos, or optimize them so they are less monotonous. See also Anders Døssing's videos. The audio equipment is also poor in many of the videos."

5.3.3.2 Inorganic Chemistry

Inorganic Chemistry consisted of weekly problem solving classes and lab work. To the classes videos and reading where sources of homework, and every week the homework help offered help in problem solving. The videos were a new activity as they completely replaced lectures, and the teaching was now total clipped classroom.

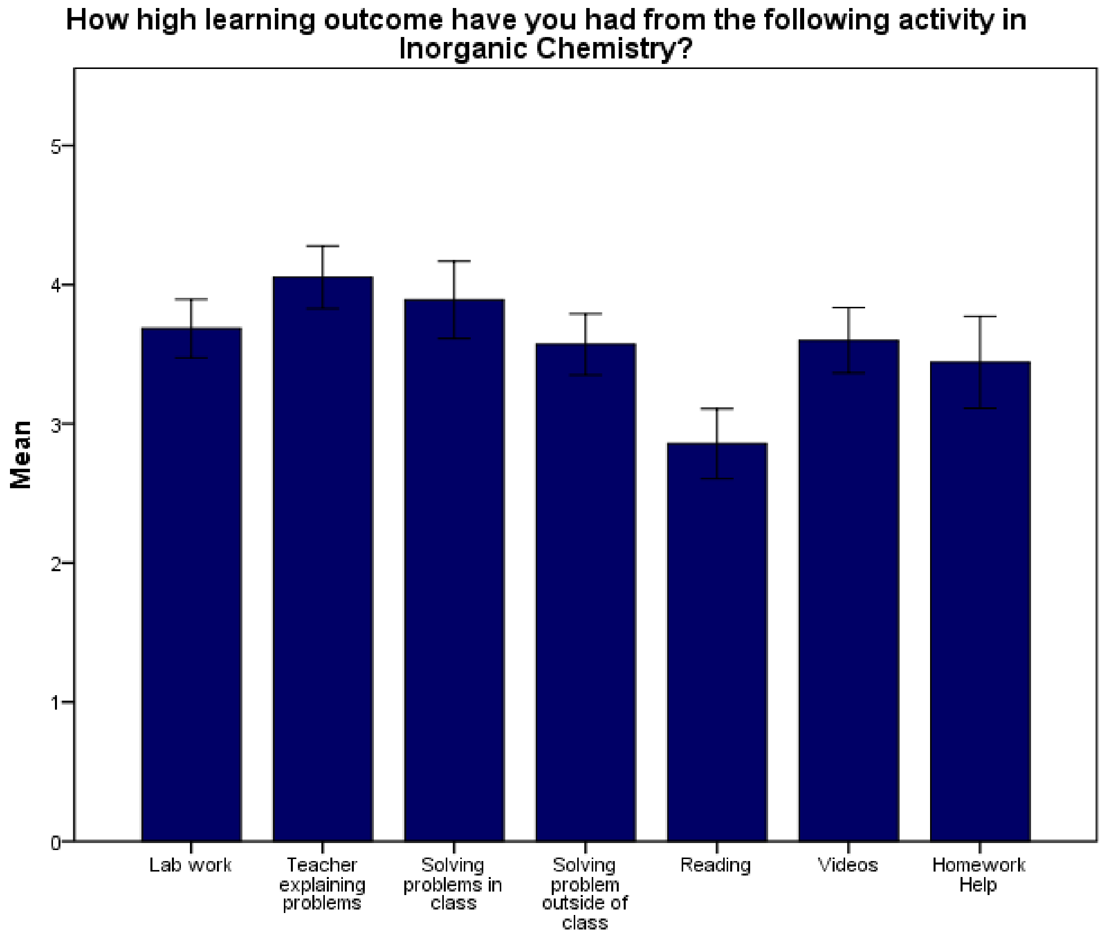


Figure 33 Learning outcome from activities in Inorganic Chemistry. Data from December. Error bars shows 95% confidence

Some of the students commented that they would like to have more problem solving classes. Some also comment on the videos and book used in the course, with the connection that they thought the videos were so superior to the book that they didn't use it, both because the videos were good and the book bad.

5.3.3.3 Introduction to Mathematics

Introduction to Mathematics consisted of weekly lectures, problem solving classes and Maple help classes. Every week the Homework Help was also ready to help with problem solving. The source of homework was the book. In figure 34 the problem solving classes and Maple classes are considered in one category, since I was not aware of their distinction before the questionnaire was given.

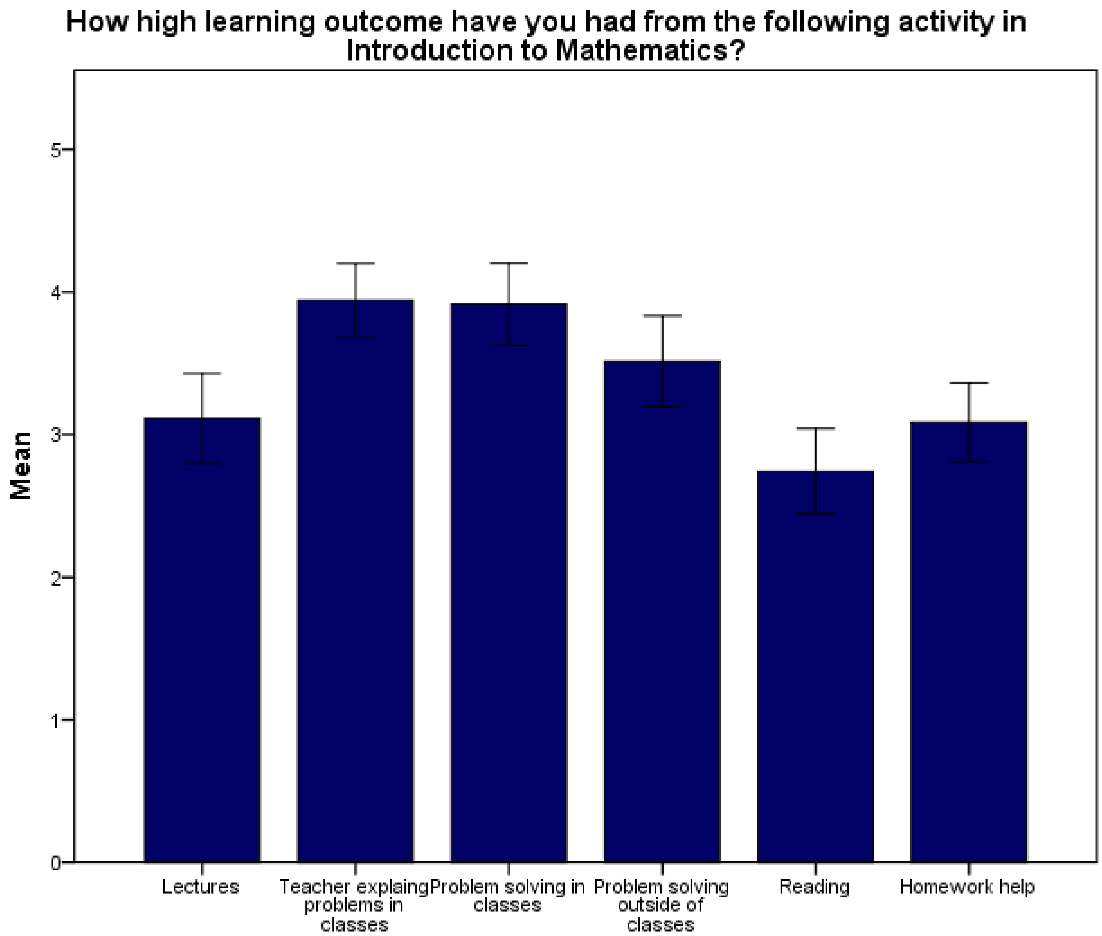


Figure 34 Learning outcome of activities in Introduction to Mathematics. Data from March. Error bars shows 95% confidence

When students were asked to comment on if there were any activities they would like more or less of a large cohort of students asked for more class hours.

Many students emphasis that there exists both a need for more problem solving and to a restructuring of the maple courses, where students who need help can get it, and students who don't can work on something else. Along with this a handful of students who finds the lectures boring and useless, and wishes they were replaced with videos and classes.

Overall there are some consistencies with learning outcome of the same activities across courses. In the special case of reading it is worth to consider some of the comment in Inorganic Chemistry that connected this to, what they considered a poorly written book, not necessary as much the process of reading.
Apart from this it is clear that classroom activities yields the best learning and that more of this is requested in all courses. The difference in outcome by more than one point between teachers explaining in classroom versus lectures is so significant that it is hard to plead a good case for lectures. Note that lectures are not asked for in the course where they aren't and are asked, by a smaller group of students, to be removed in the course that has lectures without peer instruction. It is also noteworthy that lecturing is the only activity below the average score of 3, meaning that students in general consider their learning outcome above average, which should be considered a success. This point has been made in many studies, especially those pleading for peer instructions uses, see chapter 3.5. One example is:

"The practice of 'lecturing' in universities derives from medieval times and dates back to the founding of Europe's earliest universities. The German word for lecture, 'Vorlesung', literally means reading a book in front of others.
This method of teaching was not, of course, chosen on grounds of pedagogy."
- Eilks and Byers, 2010 (Eilks & Byers, 2010).

Lecturing is also significantly bias against student's years since upper secondary school graduation with a correlation coefficient of -0.407 and the same is true for problem solving in class with a correlation coefficient of -.392.

It is also noteworthy, but not significant, that the homework help correlate positive with all examined background variables; young students, female, students without parents from academic education and students with lower grades from upper secondary school. This could be an interesting topic for more research.

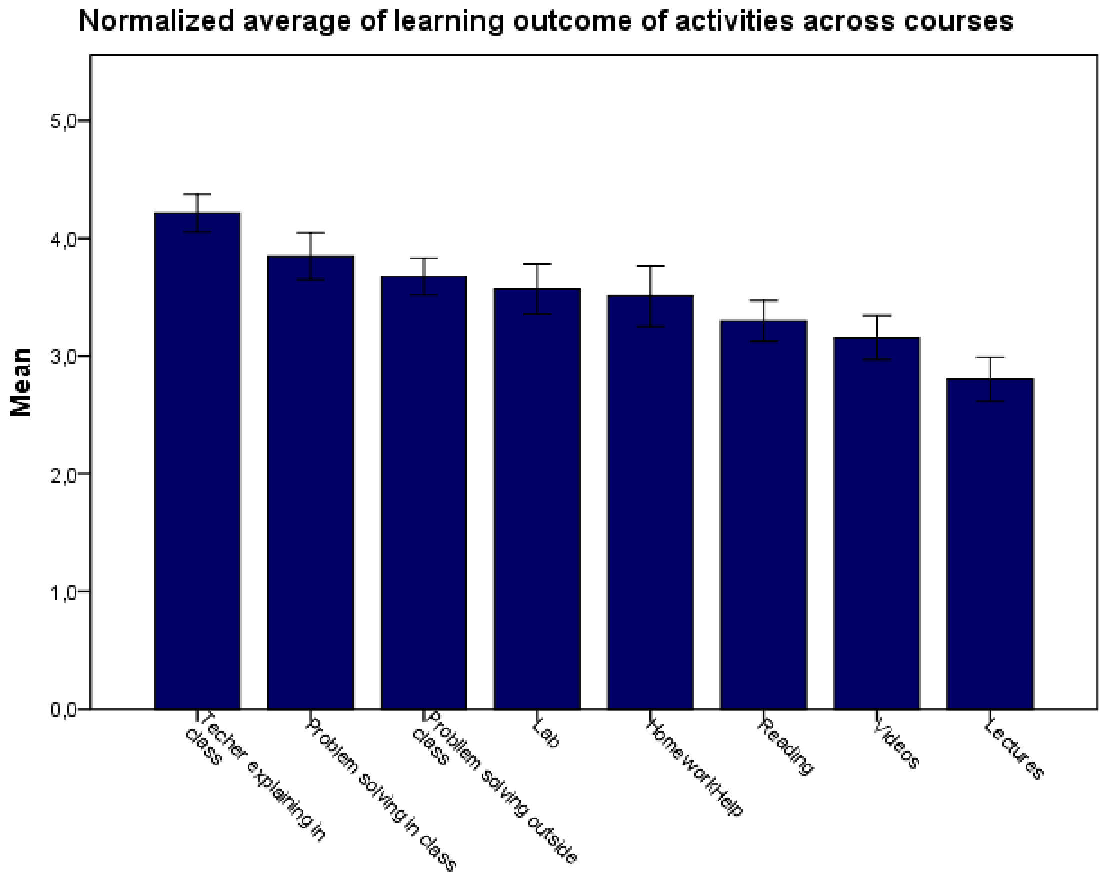


Figure 35 The normalized average of learning outcome of activities across courses. Data from September, December and March. Error bars shows 95% confidence.

So, evidence is mounting that readjusting the focus of education from information transfer to helping students assimilate material is paying off. My only regret is that I love to lecture.
- Professor Eric Mazur, Harvard University (Eric Mazur, 2009)

5.4 The Hidden Curriculum

To be fully integrated to university life need not only to understand the curriculum, but also the hidden curriculum. In this chapter some of the hidden exam results are brought to light.

As already mentioned the aspects that students worried about in their first questionnaire were parts of the hidden curriculum; social life, exams and workload/ time.
When students were asked in to scale these issues alongside other possible worries the following resulted:

Down below are some worries some of you had when you started. How do you view these?		It has been hard that most of the literature is English	It has been hard to follow the academic level	It has been hard to find enough time to study	It has been hard to get through the exams	It has been hard to hand in all assignments in proper time	It has been hard to work this much alone
N	Valid	35	35	35	35	35	35
Mean		2,03	2,54	2,80	2,14	2,77	2,11
Std. Deviation		1,175	,886	1,431	,879	1,262	1,157
Variance		1,382	,785	2,047	,773	1,593	1,339

Table 10 Mean scores on worries student had. Data from March

It has been hard to find enough time to study		Frequency	Valid Percent	Cumulative Percent	It has been hard to hand in all assignments in proper time	Frequency	Percent	Cumulative Percent
Valid	1	7	20,0	20,0	1	7	20,0	20,0
	2	11	31,4	51,4	2	10	28,6	48,6
	3	6	17,1	68,6	3	3	8,6	57,1
	4	4	11,4	80,0	4	14	40,0	97,1
	5	7	20,0	100,0	5	1	2,9	100,0
Total		35			Total	35		

Table 11 Students' scores in worries about finding time to study and hardness of handing in assignments. Data from March.

As table 10 and 11 shows students in general rank all worries below average. But with *studying time* and *hardness of handing in assignments* scores were closer to average scores and with large variances. When these answers are examined in table 11 it is clear that these averages are not a result of a normal distribution but rather the opposite; a large amount of students worries and a large amount don't.

Another concern with students' worries can be seen in table 12, where students' worries have been correlated with backgrounds variables.

Down below are some worries some of you had when you started. How do you view these?		Persons gender	Patents education	Average grade from upper secondary school	Years since graduation from secondary school?
It has been hard that most of the literature is English	Pearson Correlation	-,289	-,285	-,460**	,032
	N	39	38	38	39
It has been hard to follow the academic level	Pearson Correlation	-,526**	-,271	-,420**	,231
	N	39	38	38	39
It has been hard to find enough time to study	Pearson Correlation	-,368*	-,395*	-,191	,403*
	N	39	38	38	39
It has been hard to get through the exams	Pearson Correlation	-,442**	-,370*	-,567**	,061
	N	39	38	38	39
It has been hard to hand in all assignments in proper time	Pearson Correlation	-,188	-,389*	-,610**	,337*
	N	39	38	38	39
It has been hard to work this much alone	Pearson Correlation	-,157	-,291	-,453**	,048
	N	39	38	38	39

Correlation is significant at the 0.01 level (2-tailed).**

Correlation is significant at the 0.05 level (2-tailed).*

Table 12 Correlation between background variables and worries about the study.

An almost identical table can be made when the questions are asked again in March; women, students from the working class, students with low grade from upper secondary school and student who graduated from upper secondary school longer time ago are significantly more worried than their peers, and really worried about most issues.

On this concern with time management one of the lecturers remarks:

"*In fact, Jonas, I think really that our times students isn't so different from us. I also thought it was difficult to read the 60 pages, and didn't always get it done, depending on what kind of a subject. Just as all other students."*

This point is brilliant since it precisely shows what the hidden curriculum is; there isn't enough time to read the 60 pages, and either you worries about it and let it disturb your institutional integration or understand that you can work around this and develop a strategy for coping with this. Another lecturers also talks about learning strategies:

"The idea is for students to become aware of where they stand in relation to the teaching they receive. 'How much time should I spend on problem solving? Is problem solving that which gives me the most? ' There we provide the tricks for how they use the time when they are most suited to learn and then they party when they are not so suitable for learning."

And

"So I think many have been able to cope with their good head in upper secondary school; they have not had to do their homework. They have simply managed with their good heads and just follow lessons. They have could survive on it and it is not possible [now], it is completely unrealistic. And it is a habituation process for many of them."

When students were asked about the biggest positive and negative surprises about starting at Chemistry they gave the following answers, see

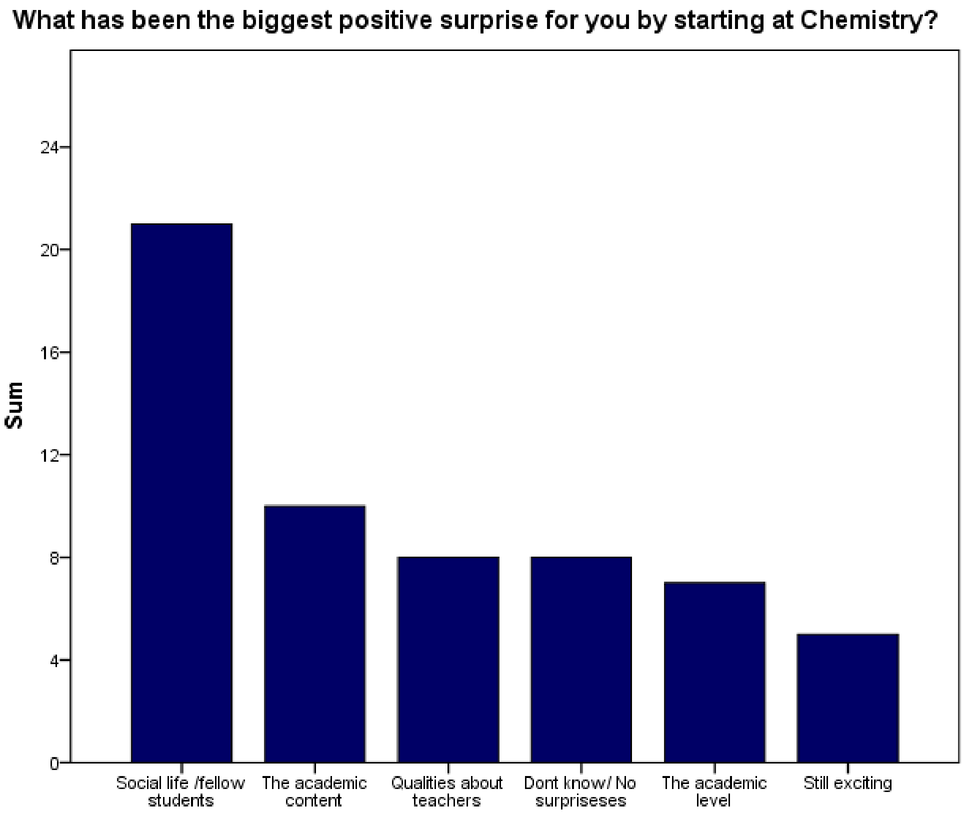


Figure 36 Positive surprises of starting at Chemistry. Data from December.

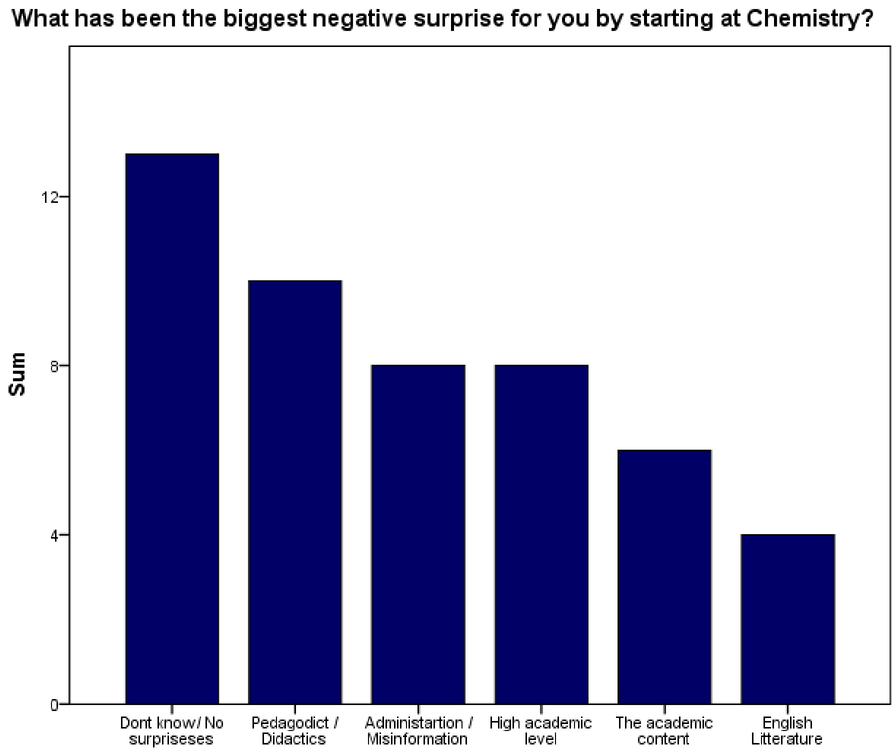


Figure 37 Negative surprises of starting at Chemistry. Data from December.

Just like the analysis in 5.2.1 predict some of the highest scoring positive surprises are related to the hidden curriculum, like *social life* and *excitement,* while some of the highest scoring negative surprises are related to academic life; *academic level, academic content* and *English literature*. The fact that English literature is seen as a negative surprise should be seen in the light of reading test that was conducted with the first year students, which showed that a high portion of them doesn't read very well, and that his concept is widely recognized as one of the first major differences from upper secondary school.

The fact that *didactics* and *lecturers abilities* are both recorded as positive and negative surprises should be seen with the distinction that the positive is the people, the negative is the structures, like two students say it:

"*Al the people I have met [have been the biggest positive surprise about starting], especially the fact that lecturers give themselves time to talk with people before and after the lecturers."*

And

"I haven't been made familiar with working in study groups even though it was mentioned in the beginning that it was a good idea."

It is also noteworthy that a significant part of the negative surprise is propelled at the specific dislike of lecturers.

Concerning the social life on Chemistry it is highly appreciated by the students, and as figure 38 shows the participation rate in the social activities is extremely high especially the weekly offer of Homework Help and the daily offer of the campus bar, but standalone events like the autumn party has a participation rate over 50%.

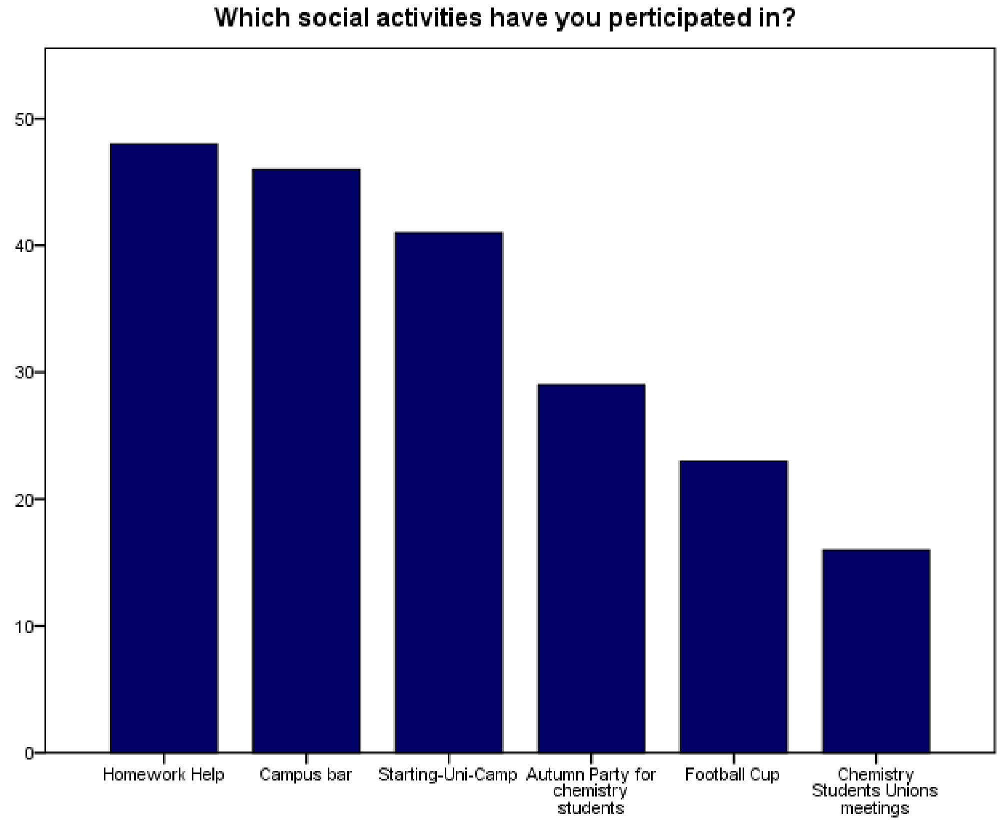


Figure 38 Students participation in social activities in block 1. The total number of students answering these questions was 52. Data from December.

One of the students give very short , but descriptive answer why the success of the social life is important and how this can bridge the expectancy gap of the academic integration, just like (Holmegaard et al., 2014) describes:

"[The biggest positive surprise], that has surely been that people have been so nice and helpful regarding work and assignments. There doesn't exist the same kind of internal competition that you hear of on other studies".

This statement also back up the point that (Snyder, 1973) and (Tobias, 1994) strong emphasis against the competitive environment of universities isn't useful at Chemistry.

It is hard to make a case against the social life. A single point however is that there should exist a social environment were a are given the same options. The following two examples show that might not always be the case:

“There is also starting to appear small clubs up at Chemistry on the student's own initiative, such as card games clubs, dinning clubs etc., Which I think is positive.”

5.5 Dropout

This final chapter doesn’t give the ultimate solution to fix the world’s universities dropout nor does give a clear picture of dropout from Chemistry.
It should be clear by now that dropout from education is not matter is not a simple one, and the complete description of retention is founds throughout this thesis in all aspects of social, cultural, and academic integration.

This chapter does however give a picture of the perception about dropout at Chemistry. In figure 39 the students’ answer of why they think people dropped out of Chemistry is shown.

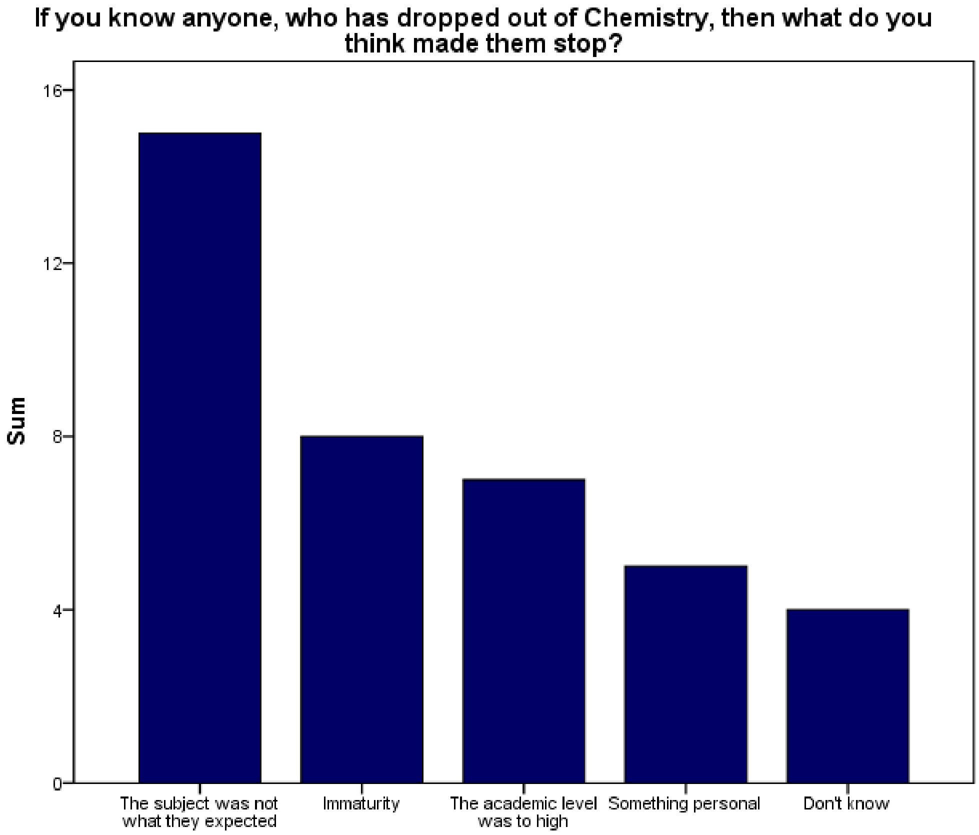


Figure 39 Why students think people left Chemistry. Data from March.

The lecturers, like the students, gives a varied answer, that recognizes the different reasons for dropping out, both because of lack of academic abilities and the wrong choice. And especially the latter is given much responsibility, but on the same time the lecturers think the department do a lot to inform the students and that it can't be done better.

On the possibility of limiting the number of people admitted to Chemistry with a minimum grade on lecturer says:

" I don't think we should do it, in the fashion that there still are some students with low grades that actually do really well. So, as long as we got room for the students I think it would be stupid that students who do well should be dropped for this reason."

This quote doesn't specify what ability determines students integration into university, but is dismisses the thought that grading is a sufficient measure to determine this with.

One last note is that most students associate the dropout with personal internal matters, institution matters. Only one of the students gives an external cultural reason for dropout:

"I think it has something to do with that many feels compelled to take a tertiary education on basis of some social norms. But in reality they don't want, resulting in that they don't learn curriculum, and quietly drop out."

This seems to be a legitimate reason, but such macro cultural matters is not covered in this thesis or the theory used in this thesis.

These findings first and foremost proves that students and lecturers alike are able to characterize all the different failed integrational processes that Tinto suggest(Tinto, 1975), apart from the social, without knowing his theory (presumably).

6 Conclusions

“The biggest and most long-lasting reforms of undergraduate education will come when the individual faculty or small groups of instructors adopt the view of themselves as reformers within their immediate sphere of influence, the classes they teach in every day”
-Professor Kathryn Patricia Cross, University of California, Berkeley (Tobias, 1994).

This thesis has been built in part around the research questions, in part about finding concerning retention that would come up in the process of answering the questions.

What the students expects of the education before they start and how their identification of chemistry changes.
Students’ expectations about Chemistry can be divided in two categories; the professional and the institution.
Professionally students have positive expectancies regarding the academic content of Chemistry and emphasis that their choice of chemistry is by large based on interest, the many free choices in the programme or a specific wish for certain job. A stressed point in this matter is the fact that Chemistry offers both theory and practice (offend mentioned as an option the engineering).
Institutionally students lack a consistent, institutionally internal, reason to study at Copenhagen University, apart from a minority who views the university as reputable and prestigious. Most students associate Copenhagen University with the fact that is physically in Copenhagen where they would like to live. In relation to the lacking image of the institution most negative expectancies are associated with overall institutional university culture, like work load, high academic level and exams, but social life is also a concern for the students.

The students have a very clear working expectancies and a very clear image of the narrative the chemist possess. These are also very consistent over time, with working expectancies being centered on research, teaching, medical

chemistry along with a handful of smaller niece areas that however also are very consistent over time. The only significant change in the students working expectancies is a rapid reduction in the desire to research after block 1, research however remaining as one of the numerous answers.
Students' identification of chemist are characterized by first and foremost a very varied view, but centers around certain aspects. Chemists are persons that are first characterized by a knowledge and perception of the hidden connections in nature, what allows chemist solve and describe problems in the areas the students described as working expectancies; research, teaching and medical chemistry. This is narrative is only strengthened as time passes which indicate that this narrative is a successful mean to longitudinal institutional integration. Even so long that the lecturers' narrative of a chemist is the same.

What academic skills the teachers expects students to have and how they incorporate academic integration in their teaching

Generally the lecturers expect very low academic skills from the student in the beginning of the first year, but very rapidly increase the pace at which subjects are taught. This view is also presented by the students that however express a division on their view of the general high academic level, part of the cohort find it worrisome, part the cohort are happy about it.
The view that student have very varied academic abilities is also backed by the lecturers.
A test taken by the lecturers also shows that they possess a high amount of knowledge about that accurately can be expected from students when they start. The lecturers also note that the academic level in calculus is very low and a problem.

The matter of skills from the hidden curriculum is however different. Most lecturers show awareness about the matter that there are certain skills and knowledges, not directly associated with chemistry, that are needed in order to succeed and strategies that need to be made. The both recognize the larger

amount of reading, the lecturers form in contrast to classes, time management and development of personal learning strategies.
They do however not seem to integrate much of this in their classes, apart from telling the students about it and specifically they have stated to change their lecturers.

This concern with the hidden curriculum is possibly the most important finding in this study. For many reasons because there is good evidence that the social life works almost perfect, and that the academic integration at least is mostly successful.
Since a lot of literature exist on how teaching can be change to handle much of the hidden curriculum and bridge the gab between the academic and social integration process further research, and action, in this field would be very interesting. See for instance (Katz, 1996),(Byers, 2006),(Tucker, 2012),(Novak) and especially (Eilks & Byers, 2010), who argues for the need for innovation in university chemistry teaching in Europe and Give 10 potential areas of innovation.
Some of their key reflections are:

1. *A need to modify the objectives of higher level chemistry teaching and learning to promote relevance to both everyday life and the world of work.*
2. *A need to consider and evaluate evidence obtained from school science teaching when considering modifications in higher education.*
3. *And most importantly, a need to recognize that chemistry teaching is a developing evidence-based profession.*

- What students and teachers themselves think is the reasons for the high drop outs.

In general students and lecturer gives an impression of dropout from chemistry that is almost completely consistent with Tinto's theory of retention (Tinto, 1975): Students drop out because they made wrong choices when selecting chemistry (transfers), they drop out because of the academic level (dismissal

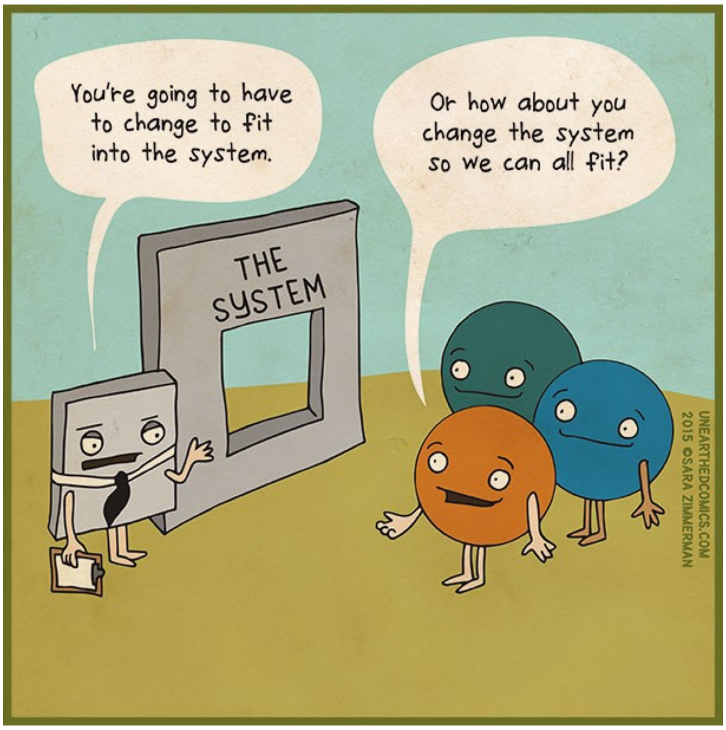
dropout) or they do it because of personal reasons (voluntary leave) and this choice is made over time.
As mentioned before the students and lecturers don't consider social life as a strong indicator for dropout, mainly because they don't considerer it at all, because of its success. On the other hand neither of them are especially good at emphasizing the matter of the hidden curriculum in general and here lies a big potential.

Some general flaws concerning this study have been alluded to with Asoc. Prof. Anders Døssing's attendance list and with the ambiguous picture of 1st priority students at Chemistry when comparing this data with data from the Universty. In general these finding emphasis that the cohort of students examined is representative of total cohort of students, learning toward that students not in this study had lower attendance and lower commitments to the education, and with the theory used in this chapter this would result in finding that in general should effect retentions badly.

Another problem, a fundamental one in retention research, is that the interesting students are those who leave. It is also the case in this study that the students who have been examined have been the students who were in classes at the given time of the questionnaire survey. This is implicitly a theoretical assumption that implies that that the students who leave in many ways are like the students who stay, and that they at least experience the same kind of challenges in education.

The last words in this thesis will be given to one of the lecturers and be accompanied by a fitting drawing:

“You might take the starting point in the students' academic level, what they can and what they will it they can and will...”



Picture 2 Sara Zimmerman’s “Time to Change the System”(Zimmerman, 2016).

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