Teaching sabbatical – Final report

A semester at University of California, Berkeley

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Cover: *Photo of UC Berkeley (Bonnie Azab Powell)*

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Introduction

I have for a number of years looked at STINT and the possibility to have a full semester at another University to focus on teaching at different levels. However, my background in chemical engineering is applied science and has previously not been the suitable for the scholarship. It was therefore with great pleasure I saw that a number of new partner universities with a strong engineering education recently have been included and that the focus is no longer only on undergraduate education but also on graduate education. Among those was UC Berkeley, which year after year are ranked high for their research and education in chemical engineering research and education.

Already from the beginning in the application process, I was clear about that I should not only concentrate on the actual teaching but also on the surrounding structures to support teaching and quality control. The reason was to find out if these parts differed from those from my previous experience and if so, what implications that might follow.

I had the possibility to do co-teaching, which is highly recommended. It gives you a fast introduction to the teachers and what is expected. It also gives you someone to discuss with in matters regarding teaching. In my case, the other teachers were relieved from a part of their duty in the course (the parts I was responsible for) and they had therefore time for the discussions.

I'm really grateful for the opportunity to visit UC Berkeley and stay there for a full semester. The time went really fast and it would have been easy to stay for another semester. I have learnt many things about teaching and education as well as how structures could differ between universities and countries.

Preparation and planning

On December 17, 2013, I got the happy news with the notice of the decision. Shorty after that, I sent e-mail to my contact persons (one at the global engagement office and one at the department of chemical engineering). Both of them were administrative persons. From the global engagement office (which is the central unit for foreign collaborations and exchange at UC Berkeley), I got some information regarding practical issues such as how to sign up for finding housing etc. I also got in contact with the chair of the department department who assisted me from that on.

I did a planning trip on March 10-15. During this week, I had a rather full schedule of activities with a number of core courses to follow (as audience) in order to see how teaching was performed (this included both actual lectures, labs and discussion sessions). This was very helpful and not only it gave a sense of how the lectures were structured and the pace and content that should be covered but it also gave a good sense of the students within the area (chemical engineering). Some of these courses were given twice per year (a course is a full semester) and thus gave me an opportunity to explicitly see details about a course I would teach in the fall. In the end of the week, I had a meeting with the chair and discussed about different possibilities regarding the teaching and what would be best for me and for the department.

Housing is important and could be difficult to find. The planning trip is a perfect opportunity to see different areas in the city and look for transportation systems. Berkeley has a bus system and also the BART (train system) that both works well and has stops close the campus area.

Task and responsibilities

I taught one course (4 credit course) during the semester together with two lecturers. The course was project based and included traditional lectures, home works, introduction of new computer software (SuperPro), and, of course, the project itself. In total we had 39 students, which were divided into groups of 3 (13 groups).

I was in charge for a couple of the lectures, one home work, and then together with the other lecturers grading the oral presentations and the reports (at three occasions during the semester) and then I together with one of the other lecturers were responsible to make the written exam and all of us decided the grades. We all attended to the others lectures.

Activities during the semester

Apart from the actual teaching, there were a number of other activities related to teaching and education at the department and at the University. It started already before the semester with something called a faculty retreat, which meant that the whole faculty had a full afternoon to discuss the coming courses and also what development projects that were on-going or to be started. Several times during the fall we had faculty meetings (at lunch from 12-13) where different topics were discussed. Quite often this was related to teaching activities, either on undergraduate or on graduate level. Every week, the department had a seminar during 1 hour. Most often, it was PhD students who presented their work (it was mandatory to do a presentation a few months before submitting the final thesis) but it could be invited speakers as well.

At UC Berkeley, they had recently started a Teaching colloquium, where different important topics were discussed during an afternoon. This involved teachers from the whole campus and I had the chance of attending two such meetings; one with the flipped classroom and one focused on teaching in large classes (above 300 students).

I managed to arrange separate meeting with the chair on a monthly basis where we discussed different aspects of teaching and how the supporting structure looked like. In the end, I also had discussions with a few of the PhD students (both new and senior) to get their view on the system and how it was to do graduate studies at UC Berkeley.

During my visit, I also wrote about the experiences in a blogg (tobiasrichards.blogspot.com) where more details are found.

Comparison between the foreign and the home institutions

UC Berkeley

The University of California was certified in 1868 and its major campus was situated in Berkeley and envisioned as a "City of Learning". In Berkeley there are about 36,000 students (36,204 in fall 2013) of which 26,000 are undergraduates and 10,000 pursuing a graduate degree (including both master and PhD). There are roughly an equal amount of both sexes (slightly more women in the undergraduate and slightly more men in the graduate studies). There are 350 programs that end with a degree. Today, there are 1,620 fulltime and 616 part-time faculty members at the university. The

university has had 22 Nobel laureates of which 8 are current faculty. The revenues were $2.16 billion in 2012-13 and received $730 million in research funding.

The department of Chemical and Biomolecular Engineering runs one undergraduate program in chemical engineering[1] (there is also one 1-year master program called Professional development program, PDP). All courses given by the department are connected to the program. Some courses are mandatory (9 courses of the bachelor program are mandatory within chemical engineering and additional 9 are mandatory within chemistry, physics and mathematics) and some are electives. Normal pace is to take courses corresponding to 30 units every year; given that the courses are mostly between 3 and 4 units this means 4 courses in parallel each semester. The system is very flexible and the student has a high degree of freedom to choose among the broad spectrum of courses offered at UC Berkeley but each course has a set of course requirements that must be fulfilled before entering. There are additional constraints, making 19 units to be breadth electives (especially emphasis is made on American history and culture) and the student has to manage the right amount of units within engineering, chemistry and chemical engineering in the end to get the degree (apart from the mandatory courses).

Roughly, there are 140 students pursuing a major in chemical engineering. It is possible to choose the major in the second year but regarding chemistry related majors there are some requirements already in the first year.

University of Borås

The University of Borås was founded in 1977 within the Swedish Higher Education Reform. There are 13,299 registered students (corresponding to 5896 full time students) of which 13% is on the advanced (master) level. The students are either taken one of the 94 programs that end with a degree or separate courses. In 2013, the proportions of all students were 73% female and 27% male. At the university, there are 395 members of the teaching faculty (of which about 200 are adjunct teachers with special trade and industrial knowledge). Of the faculty, 49 are full professors. Total revenues in 2013 were 586 million SEK ($ 82.1 million) and the research funding were the same year 117 million SEK ($16.3 million).

At university of Borås, a bachelor program in Chemical engineering with specialization in applied biotechnology[2] is offered. It is a three-year program and all courses are compulsory. The reason for the mandatory courses is partly that this program is rather small (with a maximum intake of about 30 students) and this is the only program at the university, which is related to chemistry and partly that the bachelor degree is given in three years and a number of requirements must be fulfilled. The idea is that the program is niched and therefore there is no need for further electives. Typically, the courses are 7.5 credits and each semester is divided in two quarters where the total amount of credits for a semester is 30. This means that two courses are taken in parallel. The program is finalized with a 15 credit independently work (bachelor thesis). One of the courses is given as a breadth course; products, processes and the sustainable society. The university strives to include sustainable development integrated into the regular courses. Two master programs in Resource recovery, one directed towards industrial biotechnology and one directed towards sustainable engineering are offered and can be an extension of the bachelor program.

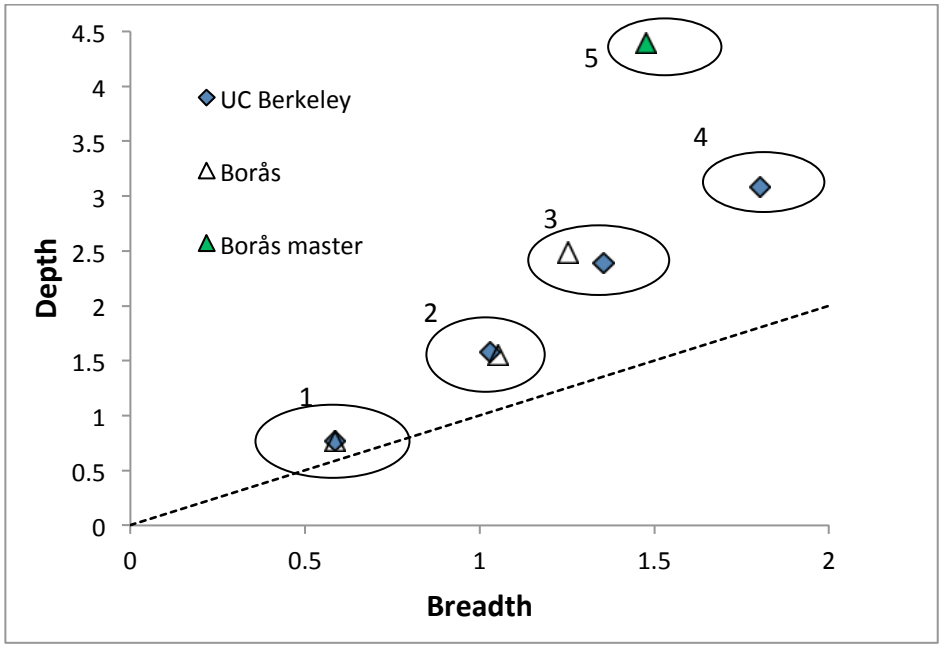
[1] http://chemistry.berkeley.edu/student_info/undergrad_info/degree_programs/cheme_major/index.php
[2] http://www.hb.se/Vill-studera/Program-och-kurser/Program-HT-2014/Kemiingenjor---tillampad-bioteknik/

Comparisons between the systems

It is clear, that the universities have different approaches to the structure of programs. This is a reflection of how fast the specialization should be made, what kind of free choices there are for the students, other constraints (such as national constraints) and also about student availability (that is how many students that the university can handle and what kind of educational assignment agreed upon and how many students that are applying and registered at the programs). The system at UC Berkeley involves the largest degree of freedom for the student at the cost of one extra year. However, if the students are to undertake graduate studies as PhD, this is the common starting level. In Sweden, it is mainly desired that you have a master's degree before starting research in engineering. It is important to stress, that learning is not something you only do at the university. This is something you can do all the time but what the educational system provides is a methodology and structure how to do this and also to provide a sounds basis as starting point for further explorations.

Flexibility vs specialization

Who benefits the most from education? Is that the student, the coming employer, the university or the country as a whole and should they be considered equally important. The answer of the question set the boundary conditions of the educational system and the orientation of the content. A system with high flexibility will primarily benefit the student due to a larger variety of choices and a possibility of exploring areas of different interests. Specialization, on the other hand, means that the student is more attractive by a specific employer (it is easier to know what to expect from the newly graduated) but with the drawback of becoming narrower and will therefore not match with random employers. The following figure represents schematically how the depth and breadth are progressing in each of the chemical engineering programs. In the graph the following weight factors have been used for each subject; science course 1.4:1.4, breadth course 2:0, Engineering course 0.9:1.8 and, finally, Chemical Engineering course 0:2 where the numbers represent breadth:depth and the course credits are divided by the total number of course credits each year. The numbers are chosen to give the same length of the produced vector and to emphasize the content in courses. The line represents equal emphasis on breadth and depth and is only there for visual aid. To simplify the comparison, the proposed program plan for UC Berkeley has been used even though the students may choose courses in a different order.



As can be seen in the figure, the educations are rather similar in this respect in the two first years. It is noteworthy that the smaller university with fewer choices shows the highest amount of specialization (even though the difference is rather small). Looking at UC Berkeley, it is clear that the extra year gives the student a more depth as well as a better breadth. As a comparison, the master program in Borås is also listed. It is obvious that the amount of specialization is higher in the master program (higher slope) but also that the ending position is quite different. These numbers only reflect the relation between breath and specialization (as stated in the program and course curriculums) and should not be taken as a measure of how much content there is in each course/program.

3 or 4 year program

Four years program provides longer time to educate the student and to foster him or her into critical thinking and judgment and also to show ability to understand new concepts. The benefit with the shorter program is that the student doesn't have to spend longer time than necessary before he or she will be available for the work market and thus become productive. The crucial point is to have enough time to let critical thinking appear because this can be implemented in almost all occasions and areas. It is not what particular parts you remember that counts; it is what you have knowledge in and how you handle knowledge that is important.

It is also a matter of choice and when to make the choice. Is the choice made before the university studies or are they made after you have started? Students, who are clear about in what field they want to work, are more focused on the actual core subjects than students that have not made up their mind. It is therefore likely that the system which allows for a later choice can benefit students who have not decided their career path early but do so at the expense of an extra year at the university.

Teaching at undergraduate level

Often the student is in focus in all discussion regarding teaching at undergraduate level. This is fine in the sense of that the student is the product but it has also to be taken at a higher level. The focus above all should be "Why do we educate the students?" and "What purpose should they fulfil?". We have to make sure that every student that comes in will get the best possible education. This education is multipurpose in the sense that we need to cover many needs; it is the need of trade and industry; it is the need for research to develop the coming products/processes; it is the need for universities to teach new students and to perform research; it is the need for the society to have people who can contribute (e.g. to tax, to welfare, to industry, to university, to joy and to development); and it is the need for the student who want to get a good future (interesting job, well paid or whatever reason they have).

Each of these purposes has their own list of things the student should be able to do after graduation and it is not possible to meet them all at once. What we can do is to make sure that the student who is graduating can assimilate necessary knowledge and then become productive. However, the more of the specific knowledge needed for a particular branch that is incorporated in the product (i.e. the student) the better it is for those receivers in that area. However, it is not the role of the university to target each and every industry but we have to make sure that the time needed before the new employed is useful is as short as possible and that they are attractive on the market.

Following this strategy it is possible to set up a couple of rules for the undergraduate teaching (this is by no means a full coverage but serves its purpose in the following discussion):

1) Students should have a necessary base knowledge in matters important to society (solved by breadth courses on a general level)
2) Students should have base knowledge in matters important to industry (core courses in each major)
3) Students should have base knowledge in matters important to research (core and elective courses)
4) Students should have knowledge in matters important for their own growth (all courses)
5) Students should know how to get new information
6) Students should know how to be critical and how to judge information (only possible when the other rules are fulfilled)

UC Berkeley

The courses have several key moments: lecturing, homework, quizzes, reports, presentations and final exam. The professor (teacher) usually has the lectures and prepare for the homework and quizzes but the GSI's (graduate student instructor, i.e. PhD students) are the main working force for evaluate and correcting the different assignments (sometimes even undergraduate students that have passed the course with honours can be used). By this construction, it will, in theory, not be much more work for the professor regardless if the class consists of 15 or 150 students. In reality, there is always a difference, which is for example seen on the office hours (the time where students can meet their lecturers and ask questions).

In the system, the students do not register for the courses in the spring until the end of the fall semester. For chemistry and chemical engineering a first selection is done already in the first year when the student chose the chemistry course but there is no determination of which program they

will chose among these two (the student might reconsider and not pursue a major in these subject as well but it is not possible without this course). As an extra check (preliminary consideration) there is a course within chemical engineering already in the first year (not mandatory but recommended) that will give an indication of number of students in the following years.

In general each course has the same amount of lecturing hours as the amount of credits, i.e. a course for 3 credits has 3 lecture hours every week. In addition to these lecturers there might be lab work and office hours. The number of office hours is generally taken as 2 times the number of lecture hours. Each professor (including research faculty) are supposed to have one course every semester and the courses changes by time so that the teachers are involved in more than one subject (the idea is that they should manage all teaching at the undergraduate level in their field of chemical engineering).

University of Borås

There are several categories of employees at the university. Some of them are full time lecturer (both those with a PhD degree and those without, referring to lecturers and adjuncts). Beside of these there are also those who pursue research and that are involved in teaching. Normally, a full professor has up to 50% of teaching in the contract but that include undergraduate, and graduate teaching (including master thesis supervision which is student research).

It is up to each lecturer to decide their own teaching and this gives a broad variety of techniques. Most courses in the undergraduate level have the traditional structure with lectures and exercises. Because University of Borås is not an old research university, very few GSIs are present and the exercises are therefore taken care of by the teacher him or herself.

A full course load is 60 credits for one year and the courses are mainly 7.5 credits each. The year is divided in quarters which mean that there are two courses in parallel each quarter. The number of lectures varies between the different subjects but are somewhat reflecting the credits (roughly 5-6 hours or lecturing every week for each course and then in addition an extra 3-5 hours of exercise or lab work). In many of the courses, there is an open door policy meaning that the teacher is available (if present) for the students to ask at any time. However, for some courses (especially those with many students office hours are used).

Experiences

To attend other lectures is seldom something that we do as teachers/lecturers/professors within academia. It is however, important in order to get new ideas and to see how other deal with the same kind of difficulties in separate subjects. At UC Berkeley, they have something called open classroom, where you can attend a lecture from one of the distinguished teacher award professors. This gives a great opportunity for the rest of the colleagues to easily listen and watch and to get inspired. It gives also a chance for the awardee to spread his or hers technique in a natural environment.

I have had the opportunity to attend several other lectures at UC Berkeley within different courses belonging to the major in chemical engineering. Generally, the teachers are really good at trying to engage the whole class even if the number of students is high. It is done by quizzes and small examples where the students have to be active. Also there are questions being asked to the students. All of this is monitored and added to their total score of the course (often the whole course

is made up of credits from home work, quizzes, mid-term exam and final exam). The quizzes are given unannounced and on lecture time (if the student is not present there is no second chance to answer the questions). This system is easy for the teacher (especially if there is a GSI helping with the correction or if they use the clicker system) and encourages the students to be present at the lectures. The actual learning outcome is questionable because the question must be rather simple to be done in such a short time but it will anyway give the students something to think about if they didn't understood the questions or make them understand that they have to read the material and go through the lecture notes again (all the quizzes I have seen were on material from previous lectures). The level of technical aids is rather good. Many of the teachers use computers with either a presentation or in combination with a touch sensitive screen so they could make notes that were directly shown with the projector (in addition almost all lecture halls had one or several black boards for those who preferred this).

I was curious about the level of the courses and on the lectures. It was clear that the classes are not on a different level compared to what we have in Sweden. On the contrary, in many classes there is an emphasis of basic understanding rather than to go too deep into the subjects. By this way they really build a foundation to start new courses from or wherever they find new information to judge. Especially, this progression is seen within the courses but also on a program level there is a good referral between the different courses. For example: "If this is not fully clear for you, I suggest you look up the material in course xx". This seems obvious but it is difficult to manage.

It is clear that the teachers at UC Berkeley know about the high selectivity of students and their assumed potential because they expect the students to perform at high level and achieve high grades on the course. Thus it will encourage students to help each other and work together but also is strengthen their own image of understanding the subject.

Graduate education (PhD level)

University of California, Berkeley

To apply to graduate (PhD) studies at UC Berkeley, the student must provide grades from their undergraduate education, GRI score and recommendation letters. The GRI is a test that is taken before the senior year in the undergraduate education and is supposed to cover everything necessary to manage graduate studies (the student who aim for master's degree should also take this test). The application is done in the late fall or early winter. Due to the fact that the full undergraduate education (bachelor's degree) is not achieved at the time of the application deadline, the GRI score and the recommendation letters are very important. In the beginning of May, the acceptance letters are sent out from the universities and the student will have two weeks before accepting the offer.

In August, the courses and information of the PhD program starts. Normally, the time until graduation should be around 5 years until graduation but the funding will be provided for at least 6 years without any cutbacks. The graduate students take courses the first semester and may also do GSI. In principle, all students should do 3 semesters of GSI during their studies but exemption is if they have funding from other sources such as NSF or similar, then they are excused from the first period of GSI and can focus more on the initial courses. The students are not paid extra with their GSI

but it will provide money for the tuition fees (students don't pay tuition fees themselves but the departments/research groups have to do it). The courses taken in the first semester are courses in chemistry, transport processes and statistical mechanics, which is the foundation for the different topics studied in chemical and biomolecular engineering. There is also a course in teaching that is taken in parallel with the other courses.

At Berkeley the PhD students have to decide their research project by November 1st. This gives an opportunity for the student to go around in the different research group to find a topic and also to find a group and supervisor that match their interest. It should be noted, that the supervisors also make a selection of the students, which means that there has to be a mutual agreement before the assignment. If the student chooses to have their work outside the CBE department (which is possible) then there should be a co-supervisor within the CBE faculty otherwise a co-supervisor is not needed.

In the beginning of the second semester is the first qualifying exam. This covers any material related to the three courses but also to the undergraduate education. Focus is to make sure that the students are able to think and analyse different problems. This exam is graded and if the grade is too low (grade C), then the student must first complete a master's degree before taking the test again. Otherwise, the student has passed but it could come together with some warnings and suggestions of courses to be taken etc. to make sure that the student understands his or hers situation.

In the third semester, it is time for GSI again. The last GSI is done in the fifth or sixth semester and this is also the time for the second qualifying exam. It is almost like a defence of the thesis where the student should present his or hers work together with a plan for the remaining time. They have to show that they understand what they have done and how problems are addressed.

8th to 10th semester: this is the time where the thesis is ready. There is no open discussion about the thesis but the thesis has to be approved by a committee of research faculty. At Chemical and biomolecular engineering, the student should present their work at an open research seminar for their peers and the faculty in the end of their studies.

University of Borås

Admission is anytime of the year and is officially decided by the board of research studies (there is a separate board in each subject, such as Resource recovery for my students, to ensure a correct judgment of the student's abilities and credentials). There are general rules of prerequisites that must be fulfilled in order to meet the demand as a PhD student and this involves, for example, number of credits in the undergraduate exam and that the previous exam is in the right subject (major). It is the local funding that sets the limit of the number of students. Each student is assigned a supervisor, a co-supervisor and an examiner. They are also enrolled in the research school where the administrative issues are taken care of. The director of studies of the research school is responsible to follow up on all students every year that they are making the expected progress and if there are any problems regarding supervision. There is no tuition fee for the PhD students regardless if they are from Sweden, the EU or anywhere else.

PhD students can be enrolled in several different ways; one is as graduate students (doktorander) in which they are employed by the university during their studies which means that they will get a salary, parental benefits, retirement benefits (pension) etc. as in any other job. Depending on need from the department, the students can participate in teaching activities. This is highly encouraged

and could be up to 20% of the time. The nominal time to reach a PhD is 4 years full time but with a 20% teaching load (or administrative tasks) the actual time is 5 years.

Other options are that the students are enrolled on a scholarship or as industrial PhD students. Enrolment with a scholarship can only be done with external funding from private companies, foundations or foreign institutions and will only be applied to foreign students. The conditions are mainly the same for the student as the studies are concerned but there are less social benefits. The university makes sure that there is a health insurance in place for all their employees and students. The industrial PhD students have their employment in an industry (usually at a company) and at least 50% of their time should be devoted for research.

Together with the actual research, you have to pass a number of courses (corresponding to 60 credits which equal the credits for 1 academic year). Each of the courses is examined separately and the examiner for each individual PhD student eventually decides if the course is passed or not.

Half way through the studies, the student are either performing a Licentiate degree or taking a half-way seminar.

The final thesis can either be a monograph or a compilation thesis depending on area. In engineering, the most common is a compilation thesis, which consists of a cover essay and the published, accepted and prepared papers as attachments in the end. 3-5 months before the defence, a final seminar is held where the thesis is discussed. It should include: the student, the supervisor, the examiner and an external reviewer.

On the day of the defence, the students present their work in an open forum and there is an opponent who is appointed to have a discussion with the defendant. Present in the room are also the evaluation committee. It consists of at least 3 persons, which are not involved in the PhD work but are highly skilled in the area or part of the area. They have all read the thesis and will judge the students presentation and ability to answer questions. After the open discussion, the evaluation together with the examiner and opponent continue with a closed discussion where eventually the evaluation committee decided whether the student should pass or not.

Comparison

Admission and enrollment with focus on the University

At UC Berkeley, the university dictates the number of PhD students each department can accept. This is based upon previous years, number of faculty and funding history and probably other factors as well. It seems to me as an inefficient process but serves as a cushion in case applications are not approved because the department is, in that case, obliged to come up with the funding for the scholarship for the student (equals to salary). It is, in general, more PhD projects available than incoming students. This situation must be frustrating for the faculty with funding but that might end up with no student. What is attractive is this cohort of PhD students that are starting at the same time and can push and support each other during their research. This will form strong bonds and at the same time give a good network. It also simplifies the initial courses because all students need to take the same courses the first semester and this gives a good baseline for further discussion.

Another attraction with this system is that there is a possibility for both the student and the supervisor to get acquainted before the commitment of a mutual research journey is about to start.

This goes far beyond the possibility of having an on-line meeting (by video or by voice) or an interview at one specific time as the only compliment to the grades and eventual recommendation letters.

A hire-by-available funds system is more flexible; you can only hire a student if there is funding available and this can be done at any specific time. However, it puts higher demands on a follow-up system (like the research schools and the director of studies). The flexible system can sometimes be less in favour for the student when it comes to courses because the courses are only given at specific times (often once a year for common courses or every second or third year for more specific courses) and it could be difficult to match them perfectly with the demand from the research. This system may also give larger fluctuations in the number of students depending on the success with applications.

Admission and enrollment with focus on the student

Apart from the number of students available for the faculty and the selection of project, there are more components that are different between the systems. One such system is the qualifying exams. As mentioned earlier, the students need to take a test before they have completed their undergraduate education (GRI) which is something similar to the SAT but for college students. In order for the student to start research in the research group, they must also pass an individual qualifying exam. This gives the department some extra room for correcting an admission to the PhD program of a person who might not be suitable for research or at least is not suitable within the present research context.

I might seems hard for the students to have this exam coming up so early on in their studies but I think the underlying concept is good from both sides; neither the student nor the research group is benefitted from a student that eventually end up taking a long time for their studies and produce a weak thesis. To have this early on means that there is still time for the research group to find a post-doc for their project and for the student to re-evaluate their choice. I like the idea of having a back door in the sense that if the qualifying exam is failed, the student is directed towards one of the master's program and it will still be possible to have a graduate degree. It is also possible to go back to research after the master's degree and retake the qualifying exam.

In the Swedish system, it is very difficult to remove a PhD student after the enrolment is done. Thus, the enrolment process is much more delicate (especially if there is a governmental funded project with a time limitation where the enrolment must be done through an application open process).

Examination

Personally I'd like to have a mix of the two described systems. It seems to me odd to only defend the thesis work after about half the time; research made in the more senior years is better represented by the student and thus this is the research that should be evaluated. An evaluation in-between will mainly evaluate if the student have understood the topic and the procedures together with a plan for future work. Each of these parts is very important but I miss the component of evaluating the student's ability to react upon difficulties based on their own formulated ideas. This becomes more apparent now since the trends are that funding a student means defining projects and this leaves only a small amount of time available for own suggestions. However, the system with a final presentation and discussion that determines the outcome of the whole study is a source of anxiety

and insecurity for the student. One suggestion would be to involve the evaluation committee earlier in the process and make them preapprove the thesis before the presentation.

Important lessons

Educational structure

Both universities have its advantages and disadvantages regarding the students and the outcome of the education. One of the key elements in the educational system at UC Berkeley is the wish of educating the whole human which would lead to a broader wisdom and better problem solving skills. This focus cannot be seen at my Swedish University, which is more devoted to education aiming directly to the profession. There is a delicate balance of the overall education for more knowledge and the usefulness of the student after graduation and also the amount of time needed for the education.

It is important to stress that the university programs are not intended to be the end of learning but rather should be seen as the formation of a sound base from with further insights in various areas can be gained and incorporated. We want to make sure that the student has such ability after the graduation and the educational systems are made to educate and evaluate this ability. At the same time, it is the duty of the university to provide the different sectors (academia, community and trade and industry in this particular case) with the necessary skills.

Regardless of system, it is crucial for the universities to motivate and engage the students for their coming challenges. They represent a huge asset not only today but mainly for the future.

Teaching

The actual teaching on undergraduate level within chemical engineering is not so much different on a course basis between the different universities. There is a strong emphasis in continuous evaluation with scores from different part that makes up the total score for the course (collecting points for quizzes, home works etc.). This does not only test the students in the different parts of the course but also collect a total score for the final grade. Often, we have different part that must be passed (different examinations) with reports and home works for example. The final grade of the course is heavily dependent by the score of the final written exam. However, the amounts of credits given for the courses are somewhat more generous at University of Borås. The course in Process design to take a specific example is worth almost twice as many credits (recalculated on a common yearly basis) compared to the course at UC Berkeley. The course content is not exactly similar and we have some extra parts included in the course to make up for the fact that the students do not have the same background. This is mainly due to the fact that we see a more heterogeneous student population regarding the pre-knowledge (partly depending on number of applicants to the program and the selection process).

Action plan – topics to address and if possible introduce in Sweden

Personally

A clear task for me as I went to UC Berkeley was to see how they handled the project course with individual grading even though the work was performed in groups. This is something we have discussed even before I got the scholarship, regarding a similar course I have in Borås.

For the department

I'm responsible for three courses in the master´s programme (Resource recovery – Sustainable Engineering) and we have regular meetings to improve the course and program curriculum. The experience I have from the course work at UC Berkeley will be of great help for in the future discussions. On a general level it will be questions regarding course contents; how much that should be included in each course and the way how the courses are examined. Traditionally, we have the grade of the course given by the written exam even though there might be parts within the course that are examined separately (reports, home works, projects etc.). What I noticed at UC Berkeley was that the courses used a more continuous evaluation where home works, project reports, presentations, quizzes and the final written exam all added up to the final grade.

*Benefits: not only one specific time for the grade,

*Negatives: more difficult to say that each specific goal within the course is passed (the higher the grade, the more likely that all goals are fulfilled.

For the faculty/University

University of Borås has been participating in exchange programs for teachers for a long time, which includes the Teaching Sabbatical and its predecessor programs at the STINT foundation but also other programs such as Linnaeus Palme and Erasmus to name a few. It is important to continue this exchange and expand it to invite other teachers for shorter or extended periods. By the participation in the teaching sabbatical, there are links formed between the universities, which make it easier for future exchange.

One thing I'd like to proceed with is the implementation of something similar to a qualifying exam for the PhD students. This will not be so easy based on our current system where the students in most cases have a signed agreement for the full period and I anticipate that it has to be introduced soft where for example the exam initially gives recommendation to courses that must be taken. It is difficult to see how well the student will perform as a researcher by just looking at the grades and have short interviews. A qualifying exam will make it easier to judge and this will in turn also help the student (if the student don't pass the exam there is a strong indication that something is not ok; one suggestion would be to let the student perform a minor research project up to a semester and then take the test again). At UC Berkeley, they also had a second qualifying exam after 2.5-3 years where the student should present and motivate their research (this is what we see partly in the midway seminars where we have an external reviewer).

For the undergraduate education, it is important to include parts in the courses that really emphasize on the growth of the student as a person and its ability to achieve critical judgement. I envisage that this is easiest by integration in existing courses. This is well in line with the demands in the Higher education ordinance where the three parts knowledge and understanding, ability and proficiency,

and judgement and approach should be included in the programs and distinguished down on course level. To some extent this is already happening with e.g. integration of sustainable development at the university (inclusion of critical thinking and ethical aspects) where all programs eventually should have at least one course, which is certified from the sustainable development perspective, but it could be expanded with a clear context to also focus on the student development.

In the Swedish research and education system

Regarding the research system, there are some things that could be noticed and would be good for a general discussion.

Within the undergraduate education it would be interesting be to have a discussion about the re-examinations we have and the rules about re-examinations. The risk with a system we (and several other universities) apply is to have three occasions every year where the course is examined is that there is an increasing number of failing students. In one way this is good for the students who don't have to wait very long until the next opportunity to take the exam again. Unfortunately, there are courses where almost half of the class (in sometimes even more) fails the course. What we have to ask our self is why this is the case. Is it because of the course material is not adapted to the pre-knowledge of the students? Are the students performing less than expected (other interest and don't spent enough time on the course)? Are the examinations to difficult?

For the graduate education, something, that I think is important is that after the second qualifying exam at UC Berkeley the only thing left before getting the PhD degree is to have a report approved by the examination committee (at chemical engineering they demanded that the students should present on the weekly seminar in the end but this is not an examination but more information). This relieves a lot of pressure on the student for the final day. One suggestion would be to more commonly introduce a pre-approval of the report from the examiners (this is done in some places already today) and thus have the final presentation more as a way of promoting the research and as a last task to perform but it is more on the national level to discuss whether the actual performance on the day of defence have an impact on the outcome for the student.