

Recruiting new groups of students to teacher-training in science and mathematics – experiences from a new combined teacher-training and engineering programme

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This paper reports on experiences from a new combined engineering and teacher-training programme, run by The Royal Institute of Technology (KTH) and The Stockholm Institute of Education (LHS) in cooperation. We give a brief of description of the structure of the programme, where integration of subject matter, didactics and engineering skills is a key-concept. We describe the profile and the expectations of the student group; it seems that this programme to a very large extent has attracted students that do have a wish to work as teachers in science and mathematics, but would have gone for a traditional engineering education in the absence of this new opportunity.

In Sweden, as in many other countries, the falling interest for mathematics, science and technology among young people is a problem to the society, particularly to the educational sector. Recruitment to teacher-training programmes and university courses in these subjects as well as to engineering educations are weaker than one would wish. Within the next ten years large groups of today's teachers will have retired, and there is thus a need to increase recruitment to teacher-training.

In 2002 the Swedish government commissioned The Royal Institute of Technology (KTH) and The Stockholm Institute of Education (LHS) to jointly develop new ways to educate prospective teachers in mathematics, science and technology. As a result of this, a new combined engineering and teacher-training programme, the so-called CL-programme (from the Swedish name *Civilingenjör & Lärare*, Engineer & Teacher) opened the academic year 2002-2003. A main purpose of this programme is to recruit new groups of students to teacher-training in mathematics, science and technology.

Purpose of the Program

The programme finds its identity in the intersection of pedagogical and engineering competences. Here are a few key points:

- Mathematics is combined with one more subject: chemistry, physics or computer science.
- The programme is for five full years, leading to a double diploma, in engineering and teaching.
- The international name of the diploma is *Master of Science in Engineering and of Education, Degree Programme in Mathematics and Physics* (or *Mathematics and Chemistry* or *Mathematics and Computer Science and Information Technology*).
- Didactics, pedagogy and practical training are integrated in the programme from day one.
- The programme is designed as a whole, rather than as separate blocks of subject matter, pedagogy and didactics each moulded in a different department.
- Practical training involves training in upper secondary schools and also in science centres.

- A large part of the courses are developed especially for this programme; in particular this is true for the courses in mathematics and mathematics education.
- The students follow courses for other engineering programmes in physics, chemistry or computer science and information technology.
- The master thesis should be in the area Technology and Learning, combining science with technological and pedagogical issues. The thesis work should relate to practical experiences in some kind of a pedagogical environment, for example an upper secondary school or a science centre.
- As engineers the students should, after finishing their studies, have a solid and broad basic competence in their field with an edge in technology and learning, thus being particularly well trained for in-house education and technical customer support as well as development tasks in knowledge industry.
- As teachers in upper secondary school their special profile should be a broad understanding of the subject matter, special skills in problem solving and good knowledge of applied science, resulting in a good ability to make the subjects come alive. They should also be a good resource in course development. One important point is that they hopefully will come to play a prominent role in inspiring more students in upper secondary school to engage in academic studies in mathematics, technology and science, and to serve as link between upper secondary school and engineering studies.

It should be noted that, at least in Sweden, there has always been a flow back and forth between the engineer category and math/science-teacher category. The CL-programme wants to educate for this double identity right from the start.

A Short Description of the Programme

As mentioned above, the programme is for five full years. This is slightly more than for conventional engineering programmes or teacher-training programmes, which run for four and half year.

Table 1
Overview of the Curriculum in the CL-Program

Subjects	Credits
Pedagogy, psychology, sociology and general didactics	30
Mathematics (including 10 credits of subject didactics)	60
Physics/Chemistry/Computer Science and ICT (including 10 credits of subject didactics)	60
Interdisciplinary courses	20
Optional courses	10
Thesis	20

Note. The credits given are approximate, and refer to the Swedish credit point system where 40 credits correspond to one full academic year of studies.

We now give a short description of the programme. We will refer to Swedish credit point system, in which 40 credits correspond to one full year of studies. The CL-

programme thus consists of a total of 200 credits. In Table 1 we list approximate portions of the different subjects.

Please note the following.

- According to Swedish regulations, all teacher-training programmes should contain a common core of 30 credits corresponding to the first line in Table 1.
- A teacher-training programme should also contain 30 credits of interdisciplinary courses, in order to prepare the teachers for interdisciplinary cooperation. In the CL-programme there are 20 credits of courses in this category, for example *Science of Engineering* that looks at the engineering profession from different perspectives, and *Communication and Media*. The thesis, as described above, is also of an interdisciplinary nature. This makes up for 10 more credits in this category.
- A total of 20 credits of subject didactics are included in the subject matter.
- At least 30 credits should be directly related to studies and practical work in school. In the CL-programme this means a number of shorter periods of 1-2 weeks of field studies and initial practical teacher-training during the first four years of the program, and a longer period of approximately 8 weeks of practical training during the fifth year, which also should contain the thesis work with further field studies and/or practical training.

Teacher-training specific courses are integrated in the programme from day one. The first year is common to all students, with mathematics, pedagogy, interdisciplinary courses, programming and practical training in upper secondary school and on a science centre. Years 2 – 4 follow the same pattern, with the addition of the second main subject (physics, chemistry or computer science and ICT). The last year, as described above, is mainly devoted to practical training and thesis work.

There is a definite ambition to work across the department and institution lines. For example, during the first year there is collaboration on a task in the didactics of mathematics between the math department at KTH and a course given at LHS. Tasks in subject didactics may be integrated into courses in general pedagogy and didactics. We also support and encourage pedagogical enhancements of standard engineering course compulsory to the CL-students.

Mathematics courses

Mathematics is a common subject for all students on the program, and the courses in mathematics are developed especially for this programme. Compared to standard math courses on KTH, there is a greater emphasis on ability in written and oral communication and on the use of technology, and there are also didactic tasks integrated in the curriculum. Here follows a brief list of compulsory courses in mathematics.

- Mathematics 1. Precalculus, linear algebra and single variable calculus. (8 credits)
- Mathematics 2. Linear algebra and calculus in several variables. (8 credits)
- Differential Equations and Transforms. (4 credits)
- Programming. (4 credits)
- Numerical methods. (4 credits)
- Discrete mathematics. (5 credits)
- Probability and mathematical statistics. (4 credits)
- Mathematics for teachers. On different number systems and their properties. Concepts from real and complex analysis. Geometry. (5 credits)

- _ Mathematics for physics/chemistry/computer science. (4 credits)
- _ The history of mathematics. (5 credits)
- _ Didactics of mathematics. (10 credits)

In addition to this there is of course a fare amount of applied mathematics, problem solving and modelling in standard engineering courses in the programme.

The students and their background, expectations and motivations

Nominally there are 60 places in the programme each year. The first year attracted only approximately 35 students, but the second year 67 new students were accepted. This should be compared to the fact that recruitment to Swedish teacher-training programmes in science has been poor for the last years. (Math-teacher programmes usually do better.)

There is approximately the same number of male and female students. Most students are young, 86% of those who started their studies in 2003 were then under 25 years of age.

We have surveyed the student's background, expectations and motivations. The result can be summarized as follows.

- _ Most of the students would have chosen a traditional engineering education, in absence of the CL option. In a web survey 23 of the approximately 60 students who entered the programme 2003 answered questions on which other educations they had applied for. It turned out that 18 of them had a traditional engineering education as second alternative, while only 1 of them had a teacher-training programme as a second option. Results for student who entered 2002 are similar.
- _ Most of students express commitment to teaching. In the same survey, they answered the question of what was their main reason for applying to the programme. Out of 23 answers, 19 declared that they were motivated by the combination of an engineering- and a teacher-education, 3 of them were mainly motivated by the engineering aspect and 1 by the teacher-training aspect. Once again we found similar interests in the group who entered the programme in 2002.

Although the percentage of answers to this survey was low, it does seem to indicate that the CL-programme indeed have succeeded in recruiting new groups of students to engage in a math/science teacher-training and that most, or at least many, of them expect a professional life where teaching is a large component.

Similar initiatives

A similar combined education programme exists at NTNU, the technical university in Trondheim, Norway. Partly inspired by the work at KTH and LHS, their programme opened the academic year 2003-2004. There is already a cooperation developing between KTH-LHS in Stockholm and NTNU in Trondheim. Also at Mälardalen University in Sweden, it will be possible to combine engineering studies with a teacher-training programme for students starting the upcoming academic year.

At present we are not aware of any others similar programmes, neither in Sweden, nor abroad. Hopefully, ICME-10 will be a forum where we learn about similar initiatives outside Sweden.

Conclusion

A combined engineering and teacher-training programme in Stockholm, run jointly by The Royal Institute of Technology (KTH) and The Stockholm Institute of Education (LHS), has been briefly described. Experiences from the first two years point to that this programme does well in recruiting new groups of students to teacher-training. A positive side effect of this initiative has been the stimulating and challenging meeting between two academic worlds, the engineering culture at KTH and teacher-training culture at LHS.