Curriculum building and student progression in two LTH engineering study programmes

Marie Wahlgren, Food Technology, LTH

Anders Ahlberg, Genombrottet, LTH

***Abstract*—Engineering education is organised as programmes consisting of chains of courses. Formal programme objectives integrate skills, scientific attitudes and engineering knowledge. However, assessment of learning and educational quality mainly focuses individual course units. It is our concern that study programme quality and student progression are hard to evaluate and stimulate in the prevailing modularised system. We have therefore investigated progression directions and stages and designed activities that will evaluate and stimulate integrated engineering capacities and evaluate progression in 1st to 4th year students of chemical- and biotechnology engineering programmes. To make the aim of progression explicit we interviewed students, alumni, teaching staff and senior industrial staff, thus elucidating core educational and professional values. Students develop a sense of becoming engineers late in their training (typically around the 7th semester). They all emphasized problem-solving abilities as the most prominent competence. Teachers focussed more on subject discipline content than other interviewed groups. Students and industry go beyond subject discipline and request professional social skills. In the session we will report on the use of case methodology to stimulate engineering programme progression.**

I. The LTH Chemical Engineering and Biotechnology Study Programmes

THESE two related study programmes have been up and running since the early 2000´s. Both programmes share a considerable number of courses and social activities, aside those that are programme specific. The Biotechnology Programme provides specialisation in molecular biochemistry and biotechnological processes whereas the Chemical Engineering Programme is characterised by inorganic and polymer chemistry, mechanics along with further specialisation in chemical engineering. The students of the two study programmes show some differences in terms of gender, admission merits and study results (Table 1).

II. Evaluating Study Programmes

Quality assurance commonly serves multiple needs as it informs future students as well as detailed educational planning and resource allocation. It can also be deliberately designed for quality enhancement [1]. At LTH course modules are analysed and used for educational planning (annual course reports and the Course Experience Questionnaire evaluation system), e.g. the parts that form study programmes. However there are currently few attempts to monitor student progression and overall study programme qualities. Such ambitions typically monitor curriculum (for example CDIO [2, 3], *core curriculum* [4] , or fulfilment of formal course objectives and learning outcomes such as the current focus on masters theses by the Swedish National Agency for Higher Education (HSV [5]).

Internationally and particular in medical training (now also in Sweden), annual *progress tests* are used [6]. These are sets of core competence questions repeatedly monitored at different stages of the study programme that monitor progression and stimulate progression through student meta-cognition.

III. Curriculum at the Chemical Engineering and Biotechnology Study Programmes

We have compared curricula from course and programme documents with actually used curriculum, partly based on previous LTH work by Reistad [7]. Further we have investigated in which course modules different learning outcomes are treated. In short, formal documents, students and teachers do not always agree, and some learning objectives are tacitly taken for granted within the academic community.

Table 1: Student cohort facts

	Biotechnology	*Chemical Engineering*
Female students	60 %	40 %
Number of freshmen	75	55
First choice admissions 2008/09	103	43
Median admission merits 2006-2009	Ca 18	Ca 17
Achieved >40 hp merits 1st study yr (2008/09)	80 %	70 %
Programme drop outs	ca 30 %	Ca 35-40%

IV. Focus group interviews with programme students

Semi-structured interview were conducted with groups of 6-8 3rd-4th year students from each of the two study programmes. Questions revolved around expectations of the professional engineering role and competences and views on future progress test focus. Students from both programmes consider problem solving abilities as the most prominent engineering asset, e.g.; "*to solve problems that emerge at work; to form new questions, to contribute with widely usable disciplinary width; clear presentation of results; deliver on time"* (4rth year student of chemical engineering).

Whereas the discussion of the chemical engineering students remained within the technical realm, the biotechnology students widened their expectations to include project management and leadership. Both groups agreed (but were not worried by) that they internalised the "becoming an engineer"-perspective rather late, in the 7th semester of studies. Prior to this the "coping of next course" remained in the foreground. They claim that the maturity and confidence to solve complex problems emanates from working with open-ended industrial projects in project-based courses, with no obvious correct answer (but they didn´t think this was possible in the early part of their training due to lack of basic knowledge). Both student groups preferred any future progress tests to revolve around problem-solving strategies rather than detailed knowledge, and claimed that both work process and work result/product have to be included in the task.

V. Focus group interviews with teaching staff

The academics teaching courses of the two programmes were asked questions in analogy to those discussed by the students. These teachers are much more focussed on disciplinary content (f. ex. molecular understanding being in the foreground for biotechnology students and mass balance and calculus being in the foreground for chemical engineering students). The teachers refer the students´ pronounced focus on problem-solving a consequence of project oriented teaching design in the latter part of their training, and agree with students that this late maturation cannot be achieved in earlier semesters of the study programmes; *"..they need the tools first*". Students from newer, smaller study programmes have, according to teachers, a more developed meta-perspective on their educational journey at university.

VI. Views of industrial employers and alumni

To further triangulate the relevance of study programme outcomes mid-level employers of chemical and biotechnology engineers were interviewed. To be attractive among employers these informants claim aspects of engineer businessmindedness (being able to drop pet projects and favour those with more potential); realistic expectations on the first engineering job; being willing to stay in the company for some time before moving on; adding specialist competence to the group; project management capacities; professional social skills. We will add views of alumni informants to get an even more complete picture.

VII. Conclusions and ongoing work

Our interviews (and other investigations [8]), have provided a basis to re-negotiate study programme objectives with the interviewed steak-holders and to update formal programme objectives accordingly.

Further, inspired by the interviewed students position on progress test and complex problem-solving strategies we have developed a multi-stage real-world case (based on the Kemira incident in Helsingborg industrial harbour 2005), to be used as a progress test by a pilot group of programme students this winter, and in full-scale 2011. Student groups at different stages of their study programmes will get into character and react to the evolving scenario. Observers (engineering teachers) will follow and document student group performance, e.g. with respect to integrated chemistry-technique aspects, professional conduct and leadership, and risk/ethics. The case will be played/discussed stage by stage in typical case methodology manner, and it is our ambitions to be able to report back to the students on the differences between less and more experienced/student groups, and to use the outcome as an evaluation of professional engineering development of the students.

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