Bringing Skills and General Competences Back into Technological Education

Gunnar Andersson[1], Tony Sahama[2], Graham Willett[3], Bjørn Gitle Hauge[1]

[1]Østfold University College, Faculty of Engineering, Fredrikstad, Norway
{gunnar.andersson@hiof.no, bjorn.g.hauge@hiof.no}

[2]Queensland University of Technology, Faculty of Science and Engineering, Brisbane, Australia
{t.sahama@qut.edu.au}

[3]Corporation Technologies Pty Ltd, Brisbane, Australia
{g.willett@corptech.com.au}

Abstract: In this paper we show that industry-based student training is not limited to work experience; work integrated learning, internship or extended vacation work. It is also about bringing back the lost parts of technological education. We experience the unilateral focus on theoretical knowledge at the expense of skills and general competences as one important challenge in technological education. The lacking facilitation and training of practical skills and general competences in the curricula and programs are identified, but many institutions have failed to address the problem. Today's curricula in many ways reduce technology to abstract concepts, calculations and models, and create a gap between the academic programs and the practical applications in the society. We explore two (Australia and Norway) initiatives on industry-based student training and discuss how these initiatives address and bridge the gap. We argue that these initiatives of industry-based student training contribute to bringing skills and general competences back into technological education, and that the effects are not limited to increased employability, but also include increased academic performance.

Keywords: *Industry-based student training, work integrated learning, employability, student performance, skills and competences, CEED, BTPIB.*

1. INTRODUCTION

We experience the unilateral focus on theoretical knowledge at the expense of skills and general competences as one important challenge in technological education. The lacking facilitation and training of practical skills and general competences in the curricula and the programs are identified [1], but the institutions have failed to address the problem. Today's curricula reduce technology to abstract concepts, calculations and models, and create a gap between the academic programs and the practical applications and society. We end up educating engineers and technologists with little understanding of context and society as embedded [2] elements of technology, and vice versa. They lack important knowledge, skills and general competences. These trends emphasize the importance of industry-based student training as one tool to bridge the gap and build the lacking knowledge, skills and competences.

In this paper we explore two geographically separate but similar initiatives on industry-based student training and reflect on how these initiatives address and bridge the gap as tools to make practical skills and general competences a part of technological education.

We begin with a short outline of research on industry-based student training before we describe the two initiatives in more detail. In the discussions we draw the positions back to our initial question on industry-based learning as tools for bringing skills and general competences back into technological education. We also discuss effects from using industry-placed student training on employability and student performances.

2. BACKGROUND

2.1. INDUSTRY-BASED STUDENT TRAINING

Recent research argues that a good partnership between academia, industry and learning communities is key to preparing students adequately for the industry and for exchanging knowledge between stakeholders of ever growing innovation in industrial systems [3]. In the Science and Engineering associated industries predominately, technological applications are changing rapidly and demand industry-ready work forces. Higher education institutions around the globe confront challenges when producing such industry-ready graduates within a short time frame.

Subsequently, universities worldwide begin to appreciate the value of authentic learning experiences and struggle with methods of assessing the outcomes from such experiences. The most important feature of assessing industry-based student training experiences is fitness for purpose, hence the learning objectives and assessment of outcomes must be explicitly aligned to this objective [4]

Little research though is done on industry-based student training as means of experience, skills and competence necessary in a complete science and engineering education.

2.2. Australian Initiative

Co-operative Education for Enterprise Development (CEED) [5], is an industry based learning model found in several States in Australia. In South-East Queensland the Program has been in operation over two decades. The CEED Program comprises educational and industrial missions. While the education mission is to '*produce distinguished graduates with skills enhanced through co-operative education experiences on a real-world project*', the industrial mission is '*promoting enterprise development through a university-industry partnership in training, expertise transfer, innovation and development*'.

The CEED Program Qld has evolved from the initial single faculty/university model and is well integrated to university curricula by academic standards and course requirements, with flexibility to accommodate industry requirements (e.g., project start and completion date in particular). It services multiple disciplines in four major universities in Queensland and New South Wales, Australia. CEED is near completion of its 1000 projects this year. Further details of this program in particular management, student support and benefits to the students, etc. are described in the CEED Program Qld web site [5], [6].

For the reporting purposes of this paper, we selected successfully completed projects (e.g., student placements) in the Science and Engineering industries around South-East Queensland (Table 1). In general, the relationship between project and students are one-to-one, while there were a small proportion of projects that were completed by more than one student.

2.3. Norwegian Initiative

Bachelor Thesis Project in Industry and Business (BTPIB) [7] focuses on solving concrete, real and interdisciplinary problems in cooperation with local industries and businesses, and has been in operation for almost two decades. The work is organized as a contract for the industry and business client. Students work under supervision from academic staff and support from a local industry mentor. It is expected that students work full time in the project period and present the project for the public in the end of semester conference (EXPO).

BTPIB is a compulsory part of every program at the Faculty of Engineering at Østfold University College. BTPIB has grown to an institution and hallmark of the faculty of engineering establishing industry-based student training as a cornerstone and competitive advantage for the faculty. BTPIB is integrated to the program curricula by academic standards and course requirements. Further details are described in the online course description [8].

For the reporting purposes of this paper, we selected successfully completed projects in regional, national and international industries and business (Table 2). The majority of projects are regional and in general there are projects with more than one student.

3. RESULTS AND ANALYSIS

Our analysis is based on results from the last 8 years (2005-2012), referred to as 'this period'. We focus our results along two perspectives; first related to industry and second related to academia.

3.1. Industry Perspective

BTPIB: 279 projects are completed in industry and business in this period with a total of 641 students contributing to local and regional industry. Many of these students have found BTPIB to be an important gateway to industry and business, either directly with their partner company or in using the experiences to document competences in employment applications and interviews.

The contribution of BTPIB to industry has been of the order of millions NKr in improved productivity and innovation both directly and indirectly. Industry also sees the benefit of being able to hire students who are familiar with their operations and have a proven track record. Corporate feedback is continuously positive and we have established a long time relationship with key companies in the region.

More detailed and quantitative data and statistics on students hired directly and indirectly and the value of the contributions to industry are missing.

CEED: 545 projects are completed in industry and business in this period with a total of 567 students contributing to the industries around South-East Queensland. Many of these students have found CEED to be an important gateway to industry and business, either directly with their partner company or in using the experiences to document competences in employment applications and interviews.

The contribution of CEED to industry has been of the order of tens of millions of dollars in improved productivity and innovation. Industry also sees the benefit of being able to hire students who are familiar with their operations and have a proven track record.

Indirectly, the links with the universities have proven invaluable in providing companies with a flow of information on current research relevant to their industry. A small number of ARC (Australian Research Council) linkage grants and higher degree enrolments of industry personnel have resulted directly from the activity of CEED.

3.2. Academic Perspective

Academic standards of participating students are stable and high over this period, with the current students achieving outstanding results as measured by the academic grades (66% receive High Distinctions).

Table 1: Awarded Grades of CEED Program

Year	HD	D	C	P	F
2005	33 (51%)	26 (40%)	5 (8%)	0 (0%)	1 (2%)
2006	32 (46%)	23 (33%)	14 (20%)	0 (0%)	0 (0%)
2007	42 (64%)	19 (29%)	5 (8%)	0 (0%)	0 (0%)
2008	47 (56%)	29 (35%)	7 (8%)	0 (0%)	1 (1%)
2009	46 (64%)	19 (26%)	6 (8%)	1 (1%)	0 (0%)
2010	29 (46%)	26 (41%)	5 (8%)	0 (0%)	3 (5%)
2011	42 (64%)	18 (27%)	3 (5%)	3 (5%)	0 (0%)
2012	34 (57%)	19 (32%)	2 (3%)	3 (5%)	2 (3%)
Total	305 (56%)	179 (33%)	47 (9%)	7 (1%)	7 (1%)

Table 2: Awarded Grades of BTPIB Program

Year	A + B	C	D	E	F
2005	70 (83%)	13 (15%)	0 (0%)	0 (0%)	1 (1%)
2006	68 (76%)	16 (18%)	4 (4%)	2 (2%)	0 (0%)
2007	48 (73%)	17 (26%)	1 (2%)	0 (0%)	0 (0%)
2008	50 (68%)	23 31%)	1 (1%)	0 (0%)	0 (0%)
2009	57 (59%)	33 (34%)	5 (5%)	1 (1%)	0 (0%)
2010	49 (65%)	25 (33%)	1 (1%)	0 (0%)	0 (0%)
2011	62 (72%)	22 (26%)	1 (1%)	1 (1%)	0 (0%)
2012	46 (66%)	21 (30%)	3 (4%)	0 (0%)	0 (0%)
Total	450 (70%)	170 (27%)	16 (2%)	4 (1%)	1 (0%)

Grades HD (Higher Distinction), D (Distinction), C (Credits), P (Pass), and F (Failed) are equivalent to the grades A+B, C, D, E and F (Failed).

Table 1 and 2 respectively represent two data samples that are from unrelated populations and where the samples do not impinge on each other. The performance profiles (Figure 1 and 2 respectively) show a constant distribution over time and student performances that are significant ($P<0.0007$) better than for other courses and units. The effects of the industry-based student training on student performances are clear. In these industry-based programs, the mean performance of the CEED program is 38.12 and the BTPIB is 56.25. The 95% confidence interval of the difference in mean CEED program is between 9.17 and 27.08 of BTPIB. While these education programs demonstrate contribution to the student's performances, there are indications, such development might enhance students employability factor. However, further research warrants the exploration of the mechanisms and processes explaining the differences.

4. DISCUSSION

First, the paper describes two initiatives on industry-based student training that contributes to bridging the gap between the academic programs and the practical applications in society. Table 3 shows an overview of the design and organization of the two programs.

The overview describes one agenda but two very different approaches on industry-based student training. They share a common date of birth and agenda but take two different routes from a common start. Results demonstrate that the basic generic model is robust (duration and success of programs) and transferable to institutions in different parts of the world.

Table 3: One Agenda and Two Approaches 2005-2012

	CEED	BTPIB
Manager/facilitator	Corporation Technologies Pty Ltd	Faculty of Engineering
Design	Mandatory	Compulsory
Level	State level (4 Univ.)	Faculty level
Fixed Credits	No	Yes
Revenue*	Yes appr. A$5 million	No*
Academic Support*	Yes appr. A$670 k	No*
Scholarships*	Yes appr. A$2 million	No*
Projects (2005-2012)	545	279
Students (2005-2012)	567	641

(*Revenue and Scholarships are organized by the programs but are not widespread or significant.)

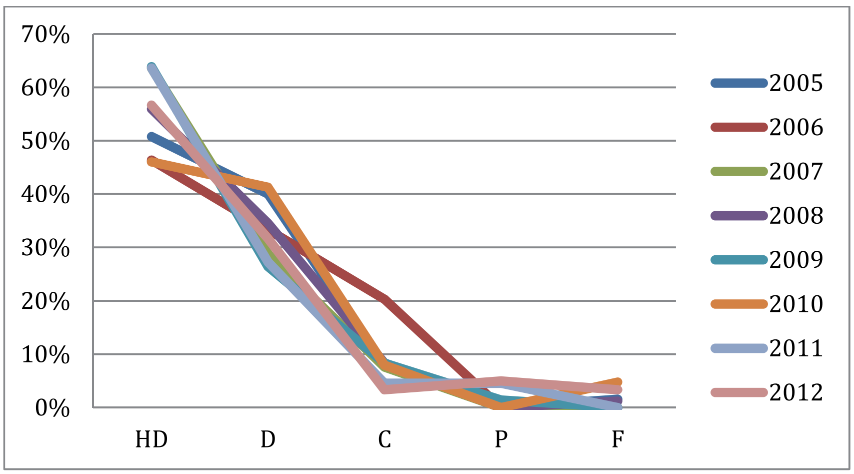

Figure 1: Performance Profile of CEED (Period: 2005-2012)

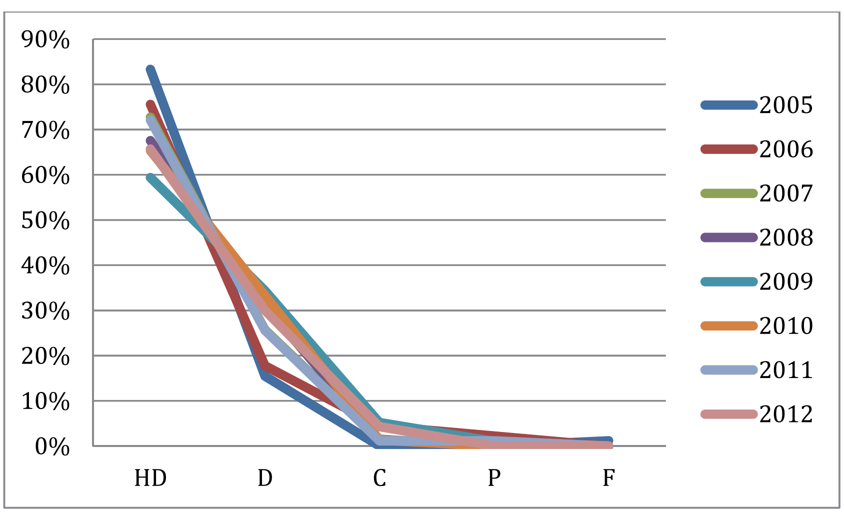

Figure 2: Performance Profile BTPIB (Period: 2005-2012)

The CEED Program advantages include specialized and dedicated operation and management (Corporation Technologies Pty Ltd) and how significant resources are made available as scholarships and revenue for the Universities. The BTPIB program advantages include impact on faculty of engineering where every student takes part in the program and the impact on the different engineering curricula and staff. One important note is that the CEED Program Qld has scaled successfully from a single university/faculty initiative to a multiple university, multi-discipline initiative with no compromise to the integrity of the academic results. We believe from this comparative study that shared experiences and collaboration will benefit both programs.

Second, the findings describe similar effects including increased employability and increased student performances in both programs. It seems like the organizational parameters have little to say for the overall results and effects on student employability and performance. This indicates how it is the arena and the contract for industry that is the important element.

Third, the results suggest that the industry-based student training contributes with important skills and competences that are not only relevant for the regional industry but also for the academic institutions. Results of student learning in this context clearly exceed those conventional university courses. We call it bringing back the missing parts of technological education as the increased time and focus on practical skills and competences increases rather than decreases the academic performances.

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