Industry/college cooperation on undergraduate project work as a college revenue source

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ABSTRACT: Since 1994, the Norwegian Ministry for Education and Research has required government supported universities and colleges to find additional sources of income. For Telemark University College (TUC) in Porsgrunn, senior year students' project works, which count for $^{1}/_{6}$ of the student workload for that year, could represent such an opportunity. In this paper, the authors tabulate and examine some of the causes and effects of six off-campus senior year projects, with three of them having produced college revenues while the other three did not. The causes include the teacher's role, students' competences and the *human factor*. The effects listed cover the technical outcomes, the college/partner relationship and college income. The study reveals that all projects tended to confirm former industry leader signals regarding a willingness to support the College economically if project work results were found to be useful for the company.

NATIONAL AND INTERNATIONAL BACKGROUND

Around 1990, the Norwegian National Assembly accepted a plan to modernise most of the publicly financed institutions. As a result of this decision, in 1994, the Ministry of Education and Research cut the budgets of universities and colleges by 10%. Simultaneously, these institutions were encouraged to find or develop additional sources of income. The Ministry continued to follow this policy in subsequent years.

Traditional sources for extra income have mostly been graduate student work at the doctorate level. However, additional income sources have to be found to run the college efficiently at *all levels*.

The Bologna Declaration was signed in Italy in 1999 by European Ministers of Education [1]. It is of a particular interest to note that the Declaration stresses the need for undergraduate study level development in particular. Undergraduate learning programmes should focus on two goals, namely: to prepare students for advancement to graduate studies and, simultaneously, qualify them for the European labour market.

In 2000, the Government launched the Competence Reform [2]. This targeted better university college outreach to cover the educational needs of *all* citizens, regardless of workplace, age, gender, etc. *Opening up* universities and colleges was the key phrase to understand the intentions of this reform.

Stimulated by the Bologna Declaration and a will to improve the quality of higher education, the National Assembly, in 2002, accepted the necessary legislative changes to launch the Quality Reform [3]. The New Funding Formula for institutions introduced a more results-oriented funding approach than previous methods. Even this reform may thereby represent a positive attitude to college experiments in finding alternative sources of income.

REGIONAL AND LOCAL BACKGROUND

In 1996, the engineering faculty at Telemark University College (TUC) in Porsgrunn undertook a survey of 21 regional leaders of small and medium-sized businesses [4]. An indication that about 70% of these leaders were willing to pay for undergraduate student work was *one* result of this investigation.

A BEGINNING

In 1998, a local industry company paid the TUC NOK 24,500 (about USD 3,600) for an electrical engineering student project that resulted in significant annual energy and money savings. Later, mostly at the electrical engineering department's power section, a few, merely random attempts have been made to check the validity of the signals mentioned above.

In 1976-1978, experiments with undergraduate student group project work were conducted within the TUC's power engineering section. The timing and setting was not accidental. At that time, most power engineering students were recruited from the engineering technology (ET) schools, following a special, industry-approved learning programme. Since a trade certificate was an ET school admission requirement, all students had at least one relevant certificate plus some hands-on experience already before entering the college.

Simultaneously, the power engineering section was directly involved in a national programme to enhance electrical engineering education. This was cosponsored by the Ministry for Church and Education, and the industry confederations for mechanical industries (MVL) and electro-technical industries (LEI). In 1982, project work in groups was adopted as a pedagogical hallmark of the TUC.

ONE STEP FURTHER

It is *not* the TUC's policy to seek income from undergraduate project work. However, as some projects have brought in college revenue, it could now feel right to put this issue on the TUC's agenda. Therefore, six recent projects have been selected for comparison, with three having resulted in college income while the other three did not. Factors that are described and discussed include the teacher's role, student qualifications, interpersonal relationships and project outcomes.

PROJECT SELECTION AND FORMULATION

The projects are listed chronologically in Table 1 and sorted into two categories: projects 1-3 represent industry, while projects 4-6 cover power transmission problems.

Problems 1 and 3 were presented to the TUC by the factory's technical leader. For problem 1, it was believed that *something* caused unreasonably high annual electricity bills of about NOK 4,000,000 or USD 600,000 – and that the solution to the problem could be rather simple to solve. Problem 3 represented an environmental, as well as a technical and an economical, problem. Both problem formulations were carried out by the teacher. Problem 2 was detected and formulated by the teacher after an invited factory site inspection.

The three power supply problems were very different, and were all defined and formulated by the external partners at the TUC's request. The projects' common denominator was usefulness to the energy company itself.

SOME CAUSES FOR PROJECT OUTCOMES

It can be seen that the teacher played an active role in maintaining extramural contacts, as well as problem description and formulation. In addition, student qualifications may also be important for achieving good results. For these reasons, both the *project teacher* and the actual TUC student groups are briefly described below.

THE TEACHER: AN IMPORTANT PREREQUISITE FOR PROJECT WORK SUCCESS

It has been mentioned that the project work learning form practised by the TUC is based on student collaboration in groups. The success of the learning process depends upon how well the group members cooperate – and on the teacher's qualifications.

The successful teacher, who serves as a leader of learning processes, may be described as: *the real challenge in college teaching is not covering the material for the students; it's uncovering the material with the students.*

Accordingly, the teacher needs neither be the expert of the topic chosen by the group, nor be in command of the group process. Instead, the teacher – often referred to as a *facilitator* – should be the insightful *leader* letting things happen and provide an evaluation of the process itself, as well at its outcomes. *Ideally*, this teacher, like all business leaders, should already have developed and continuously expanded a broad extramural network. It is unnecessary to say that this teacher should be broadly trained at a high academic level in addition to having wide experience from different businesses and/or organisational work.

ABOUT TUC GROUPS

The TUC's final project group size is ideally 3-4 persons. For all groups, all students have been well trained in 3-4 preceding internal projects in their first and second years of study.

Table 1: Six selected projects.

Number/Theme	Year	Partner	Short Problem Description
1. Removal of power spikes	1997	Porsgrunds Porselænsfabrik, a porcelain manufacturer	Reduce power spikes and costs by controlling the overlap of large electric motors' power intensive periods. The cost of electricity was directly related to power consumption (*power spikes*) over a few minutes on icy winter days. All large electric motors, some having a start-up time of up to 40 minutes, were started simultaneously at 7:00 am
3. Energy saving by large compressor speed control	2003	Kjættingfabrikken, a steel chain manufacturer	A compressor was constantly operating at a high speed and noise level. This motor drive was considered an obvious speed control candidate
2. Energy saving by a frequency converter	2005	Porsgrunds Porselænsfabrik	Cost reduction by simultaneous fan and heating element control. A 75 kW motor ran continuously at full speed and power 24 hours a day. The air flow had to pass a 300 kW heating element to make the production hall tolerable on cold winter days
4. Technical analysis of the power supply to the city of Skien	2005	Skagerak Nett, the regional energy company	An increased private demand for electricity was expected to overload the underground main cable system. Based on calculations, the group should advise Skagerak Nett how to reinforce parts of Skien's power grid
6. Grounding and short circuit calculations for a 400 kV transformer station	2005	Statnett, the national operator of the main power transmission network and main transformer stations	A major transformer station needed upgrading from 132 kV to 400 kV. Making new short-circuit calculations and designing a new grounding plan were parts of the job
5. A more reliable power supply to an industry park	2006	Kragerø Energi, a small local energy company	How could an unstable net, subject to thunderstorm outfalls, be made reliable? The industry park (and the power company) suffered from network breakdown caused by thunderstorms. A medical company had recently reported a loss of nearly USD 160,000 related to such an incident and something had to be done immediately

In addition, *all students* participating in the projects selected for this report possessed at least one relevant trade certificate. Their average workplace experience was about four years.

GROUP PROCESSES AND CUSTOMER CONTACT

It has already been underlined that the teacher, as a non-member of the group, serves merely as a business leader and advisor. In addition to setting up an acceptable mode of internal collaboration, the group was also fully responsible for arranging and running meetings with partners and other external businesses, such as suppliers of different kinds, public institutions and agencies, etc.

Thus, external projects are not only interdisciplinary; they are truly multidisciplinary, as they may include every aspect of human behaviour from handling human conflicts and technical problems to the use of advanced measurement instruments and computer tools.

The selected projects are listed with short descriptions in Table 1. Interpersonal *climate* and outcomes for each group are listed in Table 2. Note that USD has been used in making the amounts of pay meaningful to international readers.

COLLEGE OUTCOMES

The factors that are related directly to *college* outcomes are listed in Table 2. The reasons for the parameter selection are elaborated on below.

Was the project's technical result realised by the external partner? When external project partners are involved and the TUC offers technical assistance given by experienced personnel, both parties should have high expectations. As seen by the external partners, groups consisting of nearly graduated engineers holding different but related trade certificates are attractive: it is a fact that all electrical power engineering graduates are hired before leaving the College. Also, their average starting salary clearly exceeds the pay offered to graduates holding a Master's degree in engineering. From the TUC's point of view, having the Bologna vision of qualifying students for a European labour market in mind, it is essential to document that the learning programme really works.

Were mutual agreements signed after project completion? Today, it is assumed that there is a need to establish industry/college partnerships to ease collaborative processes. The TUC's partners were asked if they found it necessary to formalise future collaboration.

Table 2: Some project characteristics.

Number/Theme	Interpersonal Relationships	Was the Project's Technical Result Realised by the External Partner?	Level of Industry/College Cooperation Formalities	Economy
1. Removal of power spikes	Excellent and skilful student communication	Yes, two years later, using new technology	No formal agreements were signed, but signals were given that more project cooperation was wanted	Company investment was USD 13,000; annual savings USD 150,000. The TUC was paid USD 3,600
2. Energy saving by frequency converter	Poor student/teacher communication	They will be used in the planning of a new and compact production hall	No formal agreements were signed, but future collaboration is wanted in the informal way it commenced in 1996	An investment of USD 9,000 was expected to produce annual company savings of USD 55,000
3. Energy saving by large compressor speed control	Foremen and other staff members were not properly prepared, plus teacher exchanges may have caused an uneasy social climate	Indirectly. Kjættingfabriken has used the insight in the planning of their new production plant	No formal agreements were signed. There has been no contact after the company moved into new and modern production halls	Not discussed because the student group met early and insurmountable social problems
4. Technical analysis of power supply to the city of Skien	Excellent communication	Yes, partly	No formal agreements were signed. It was agreed that the long-time collaboration continues	Not involved but ought to have been discussed
5. A more reliable power supply to an industry park	Excellent communication	Yes	No formal agreements were signed, but the company wants continued collaboration	The technical solution produced large economic results. Kragerø Energy paid the TUC a honorarium of USD 3,000
6. Grounding and short circuit calculations for a 400 kV transformer station	Excellent communication	Yes, partly	No formal agreements were signed but Statnett welcomes new TUC initiatives for collaborative student projects	Statnett found the student work useful, and paid the TUC a honorarium in excess of USD 3,000

Economy. It has already been stated that the Ministry expects State-supported universities and colleges to find new income sources. From this point of view, all six projects could be interesting. However, as the TUC could not guarantee a useful outcome already by the project's start, the economic aspect was usually put on the agenda after some weeks – if encouraged by the group's progress. It should be noted that this column does not list college benefits like the value of expensive equipment and professional computer programs supported by external partners. Finally, the value of the knowledge and best practice way of solving daily problems transfer can hardly be overestimated.

Interpersonal relationship. Through the years, it has been observed that technical challenges seldom have caused serious problems for student project groups. On the other hand, in earlier years, social problems – *even inside the partner's organisation* – had to be solved by student groups before the technical issues could be effectively addressed.

DISCUSSION

First, it should be mentioned that all problems could be treated independently of other partner projects. Even projects numbers 4 and 6 were independent with respect to other parts of much larger network projects.

Also, all projects were of the type: *the job is important to us - but presently we do not have the resources (personnel) to get it done; other problems must be handled first ...*

All projects were *multidisciplinary*. For instance, projects 1-3 included electrical and mechanical engineering theory applications including the use of measurement instruments. Also required was an economical analysis combined with high demands on reporting and documentation. With the exception of economics, similar demands were put on groups 4-6.

Then what can be read from Table 2?

Was the project's technical result realised by the external partner? The answer must be a *yes*. For those projects producing a TUC income, another answer would be meaningless since the external partners paid for useful results only. So what about the remaining three projects; were they selected by purpose or rather randomly? Actually, as external projects have almost always produced useful partner results, they were randomly chosen.

Were mutual agreements signed after project completion? This column shows that neither the external partners nor the TUC at the time felt any need for formalisation. However, this mutual confidence may depend on personal attitudes and may change over time.

Economy. It can be seen that partner support for a useful project is typically about NOK 20,000 or USD 3,000. The TUC's upper limit is NOK 30,000, an amount which has never been obtained. Then why did projects 2, 3 and 4 not result in TUC income?

From a formal engineering point of view, group 2 made some essential and painful miscalculations. However, as indicated in column 2, their faulty calculations were considered useful suggestions for the porcelain factory's future planning. As indicated in the table, group 3 met a difficult social climate at Kjættingfabriken. Such behaviour may have occurred because the College had to replace its prime contact professor early in the process because he was suddenly hospitalised for almost three months. And, finally, in project 4, the teacher was at fault. The TUC's cooperation with Skagerak Nett on student projects had lasted for about 30 years without the involvement of money. Apparently, established habits may be hard to break.

Interpersonal relationships. Except for projects 2 and 3, excellent written and oral communication abilities have been observed from all groups. For group 2, the internal culture was the problem. They were dominated by an experienced electrician who had worked with electric motors for more than 20 years. The group neither accepted the teacher's advice, nor did they consider questions to be constructive teacher feedback. They eventually succeeded in writing a report, but the technical content was partly disastrous.

FINAL REMARKS

This small sampling of final semester student projects hardly provides support for firm conclusions. However, it appears that the teacher's attitudes, students' experiences, human feelings and behaviour all may affect a project's technical and economic outcomes. Also, it may be noted that all projects were of limited size and could be handled independently of other and possibly parallel partner projects.

In particular, the partial failure of groups 2 and 3 signals the importance of good personal interrelationship within the group, and between the group and the external partner. It should also be noted that mutual trust between the group and external actors, such as industry employees – even the professor, is important for obtaining good results.

In 1992, it was strongly recommended that in making higher education competitive in a global market, there was a need for substantial increase of resources for undergraduate education development [5]. A similar recommendation was given in the Bologna Declaration.

In this context, the TUC electrical engineering department project sampling indicates that industry/college collaboration may also include methods to increase college incomes. Such means could resemble those applied for the Master and PhD levels, but more limited in scope and economy.

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