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HIGHER EDUCATION DEVELOPMENT WITH THE CDIO INITIATIVE

Juha Kontio

INTRODUCTION

The strategy of Turku University of Applied Sciences (TUAS) defines innovation pedagogy as the base of its operations. Innovation pedagogy reflects many challenges that higher education is facing today. It is a pedagogical approach developed for the universities of applied sciences. Innovation pedagogy has five underlying elements: multi-field operation, applied research and development, flexible curricula, entrepreneurship and internationalisation. Innovation pedagogy emphasises efficient learning and the external impact of the institution on regional development. The Faculty of Telecommunication and e-Business uses the CDIO approach to put innovation pedagogy into action. The CDIO approach has been the guiding principle of education development for the faculty since 2006.

CDIO APPROACH

A small group of engineering educators identified a gap between the working life expectations and engineering education in the late 90's. Based on different discussions the CDIO initiative was started in 2000. The CDIO initiative is an innovative educational framework for producing the next generation of engineers. The CDIO Initiative is developed with input from academics, industry, engineers and students. It is universally adaptable to all engineering schools. It provides students with an education stressing engineering fundamentals, set in the context of **C**onceiving – **D**esigning – **I**mplementing – **O**perating real-world systems and products. The overall idea of the Conceive-Design-Implement-Operate (CDIO) approach is to support engineering education development and educate students who are able to:

- master a deeper working knowledge of technical fundamentals
- lead in the creation and operation of new products, processes and systems
- understand the importance and strategic impact of research and technical development on society.

Although the CDIO initiative primarily focuses on engineering education, it can be applied to other field of education as well. Our multi-disciplinary faculty is using the CDIO initiative to develop higher education in all our fields.

One of the key elements in the CDIO initiative is the 12 standards that define a framework for good education (Figure 1). These 12 standards provide support and offer guidance to target the development actions of the universities. The 12 CDIO Standards address program philosophy (Standard 1), curriculum development (Standards 2, 3 and 4), design-implement experiences and workspaces (Standards 5 and 6), methods of teaching and learning (Standards 7 and 8), faculty development (Standards 9 and 10), and assessment and evaluation (Standards 11 and 12). For each of the 12 standards there is a description that explains the meaning of the standard, a rationale that highlights reasons for setting the standard, and evidence that gives examples of documentation and events that demonstrate compliance with the standard. The standards aim at improved learning results, students learning more and students having a better experience at their Higher Education Institutions (HEIs).

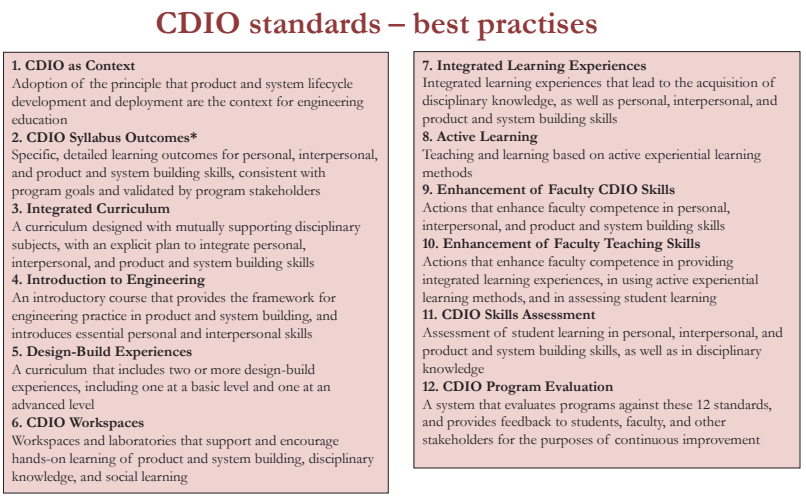

FIGURE 1. *CDIO standards.*

Another key element of the CDIO initiative is the CDIO Syllabus. The syllabus offers rational, complete, universal and generalisable goals for undergraduate engineering education. The key value of the syllabus is that it can be a generalised model for engineering programmes to derive specific learning outcomes.

STRATEGIC STEPS WITH CDIO

The Faculty of Telecommunication and e-Business learned about CDIO in the summer of 2006 in the Engineering Education conference. During autumn 2006, the faculty's management team had several discussions about the CDIO initiative. It soon became obvious that the initiative is good continuum for the development activities that had been carried out earlier. The initiative emphasised working life related education, increase of active and hands-on learning, and the emphasis on problem formulation and solution among others. In addition, the worldwide network for sharing successes and challenges was another motivation for the faculty's decision of starting to implement CDIO in our programmes.

The selection of the CDIO approach as the guiding principle in our strategic development of the degree programmes has given us a systematic and useful framework. The CDIO adoption process as well as our strategic steps can be divided in different phases. The first phase is to learn the CDIO approach and agree to commit to start the change. In our case, the first year focused on this – creating better understanding about the CDIO. The second phase is to understand the situation in your degree programmes at the moment. Mainly four broad areas should be invented: curriculum, use of workspaces, approaches in teaching and learning, and practices in assessment. The activities defined in the second phase of the CDIO adoption process are distributed in years 2 and 3 in our case. The third phase in the CDIO adoption process focuses on the areas of improvement and designing the programmes to meet the goals. We started our continuous improvement process based on the CDIO approach right from the beginning together with the other adoption process activities. The first development activity was the design of introductory courses. After that we have continued the development with design-implement projects, learning objectives and assessment and recently we have introduced capstone projects. Along the CDIO adoption process a key question is the personnel's

capability and skills to actually carry out the change and development process. As our strategic path describes, ensuring personnel competence has been in focus all the time. Several actions and training have been carried out – teachers' industry periods, active learning training, competence definitions training and assessment trainings. Furthermore, additional plans to continue this support for our personnel are in place. The whole CDIO journey of our faculty is described in Figure 2.

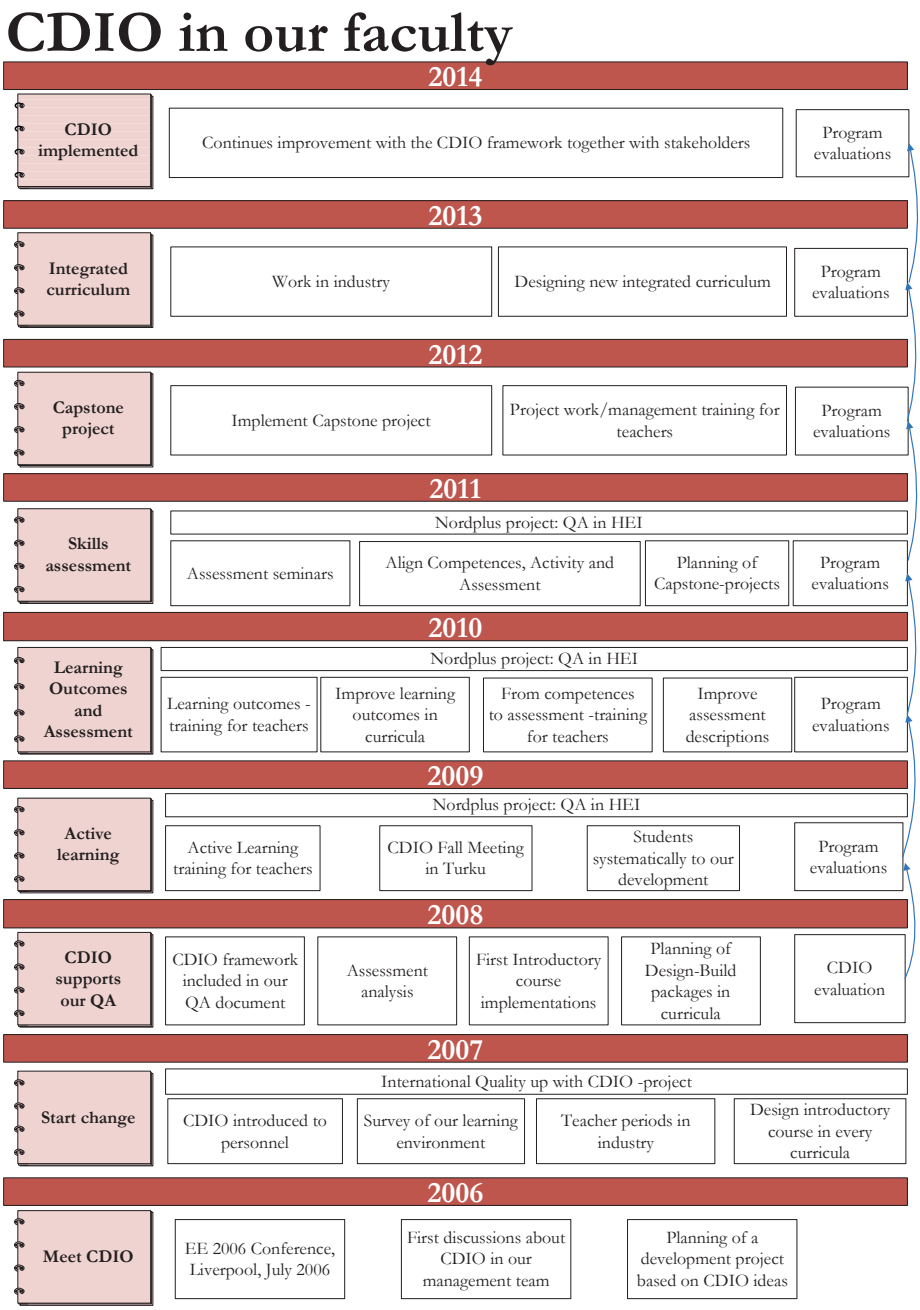

FIGURE 2. *CDIO in our faculty.*

APPLIED ICT PROGRAMME: THE KNOWLEDGE TRIANGLE IN THE MIRROR – REFLECTIONS FROM THE INTERNATIONAL EVALUATION OF RDI ACTIVITIES

Aulikki Holma

Applied ICT Programme, the principles of innovation pedagogy, and the CDIO framework integrate RDI (Research, Development & Innovation) activities with education and business in the Faculty of Telecommunication and e-Business at Turku University of Applied Sciences. The new report of international evaluation offers useful indications for the strategies to develop the complex functions in its entirety. The purpose of this article is to reflect the observations of the report in the light of functions and experiences of the Faculty of Telecommunication and e-Business at TUAS.

Research, education and innovation are three central and strongly interdependent drivers of the knowledge-based society, as it is stated in the European Institution of Innovation and Technology's Annual Programme for 2012 (EIT 2012). Together they are referred to as the "knowledge triangle" where innovation means an idea implemented in use and benefit, most preferably in business.

To strengthen European and national competitiveness, research needs to develop strong links with education and business innovation activities. This means that there should be a strong connection with the practice in market and industry. The work environment has moved from academic laboratories to business environments where user-driven development and fast feedback can be taken account continuously during the development, testing and piloting phases. It has been estimated that only 4–5% of new ideas and innovations applied in practice emerge in the academic research environments. The more complex the organisations and working environments and their problems

become, the more quickly experimental research and development activities are needed, which are more experimental in character and rather fast to implement. (Harmaakorpi 2009; Snowden 2010).

The practice-oriented universities of applied sciences still have to emphasise the mission to facilitate the following transitions more: from idea to product, from lab to market, and from student to entrepreneur. An important tool here is the interplay of education, RDI activities and business.

The importance of RDI activities at universities of applied sciences (UAS) will still become more emphasised in the next act for UAS, according to the strategies of the Ministry of Education and Culture (Ammattikorkeakoulujen toimilupien uudistaminen. Sivistyspoliittinen ministeriryhmä 24.2.2012). There are three statutory tasks for: 1) higher education, 2) applied research and development (R&D); and 3) regional development[1]. At the early stage, the Finnish universities of applied sciences (UAS) sector was initially a 'pure' education sector, but since 2003 it is formally also expected to develop R&D activities, to which in 2010 an innovation function has been added by the Ministry of Education and Culture.

What will be the strategy, purposes and directions in practice to renew and develop RDI strategies and functions in the nearest future, is shown in the recently published international evaluation report "From the Bottom Up – Evaluation of RDI activities of Finnish Universities of Applied Sciences" (Maassen et al., 2012). The report analyses and gives recommendations at the national, regional and institutional level.

This point in time offers a fruitful moment to examine further how to develop RDI activities to face the challenges of the future. The period 2012–2014 will be a turning point from many aspects, both from the regional, national and global points of view. The funding and management of UAS will be changed by the government's legislative reform. The responsibility for UAS' funding as a whole will be transferred to the government, and the UAS will be made independent legal persons. The licences to provide UAS education will be revised, with strong emphasis on quality and impact. UAS financing will be overhauled to better support current objectives, such as speedy knowledge and expertise transfer to the labour market. The UAS reform aims at a university,

1. Polytechnics Act, 351/2003.

which is an internationally recognised, independent and responsible educator of professionals, builder of regional competitiveness, labour reformer and innovator by the year 2020. (Koulutus ja tutkimus 2011–2016). This means also that at Turku University of Applied Sciences (TUAS) changes will take place at the organisational level.

In addition to the new legislation and the Ministry of Education and Culture's strategy[2] for UAS coming into force, the next framework programme for research and innovation in the EU area, Horizon 2020, will start in 2014. Horizon 2020 will provide more support for innovation and activities close to the market, leading to a direct economic stimulus. A major objective will be to provide SMEs with adequate support in order to help them grow into world-leading companies.

Thus, it is really time to examine the RDI functions of our university and at the Faculty of Telecommunication and e-Business in light of these changes and challenges.

EVALUATION REPORT: THE VALUABLE FEEDBACK

The international evaluation group says that from the international perspective, Finland is one of leading countries in Europe in developing a formal RDI role for the UAS sector. The progress made since 2003, when the RDI functions were stated in the act and started has been remarkable, and the commitment and enthusiasm with which all the actors involved in the UAS work on the further development of the sector's RDI functions is promising for the future. The environment and partners of the UAS also seem to be positively dedicated to the further development of the UAS sector's RDI functions. The coming years will show whether the UAS sector can profit from this advantage or will be bypassed by many other countries.

However, according to the report, UAS face important challenges in their efforts to institutionalise a sector-specific RDI profile. The development demands actions both on the national and institutional level. There is a checklist of problematic questions to be answered in the near future. To summarise the report, these problems concern, for example, the lack of a generally accepted

2. Koulutus ja tutkimus 2011–2016.

concept, an RDI definition (considering the responsibilities of UAS) (Hyrkkänen 2007). The other serious questions are the relatively small basic funding basis for RDI, the fragmented external funding context, the education dominated academic culture in the UAS sector, the weak international dimension in the sector's RDI projects, the relatively weak institutional links to public and private organisations in the UAS' environments, especially the SME sector, that are in need of RDI services, and the absence of an effective, sector-specific set of RDI indicators that can be used for funding and policy purposes. RDI work today is dependent on the small amount of committed staff, researchers, lecturers and project management experts, but it is not widely integrated in the main functions and education.

The purpose of this paper is to demonstrate the main conclusions and reflections of the report, and reflect them in the light of the functions and experiences of the Faculty of Telecommunication and e-Business at TUAS. The situation and decisions made in our university will be described, considering what we in our faculty have already done and what we should still do in the nearest future.

FROM FRAGMENTED PROJECTS TO EDUCATION INTEGRATED RDI STRATEGIES – FINAL REFLECTIONS

The overall steering, legal and funding framework of the RDI role and task in the UAS sector are currently too fragmented and weak for allowing the UAS sector to perform its RDI task at its full potential, as it is stated in the report.

On the national level there is a need to develop a fitting governance and funding framework for the UAS' RDI role. The new UAS act should offer a framework for the improvements at the national level.

There are important needs also at the institutional level. Strategic institutional choices and investments are needed with respect to RDI activities, by changing from an education dominated university to comprehensive HEIs with strong RDI emphasis in education and work and the expertise of staff. In order to become an effective and respected partner the UAS needs to develop institutional RDI profiles based on institutional RDI strengths and regional RDI needs recognised in collaboration with the industry.

THE RDI RESEARCH PROGRAMMES AS TOOLS FOR INTEGRATION OF THE NEEDS OF EDUCATION AND INDUSTRY

On behalf of TUAS, the RDI programmes acting since 2007 aspire to response to the strategic and industry challenges and give opportunities to strengthen and focus RDI functions in the region in a strategic way, taking into account the policies and aims of regional economic and cultural development. TUAS has seven applied research and development programmes which are linked with the regional innovation system in a future-oriented way. The themes of the programmes cover various expertise areas while acknowledging the multi-disciplinary approach, as follows:

- Applied ICT
- Biocompetence & Business Know-How
- Expertise in Health Care and Medication
- Future Work and HEI (Higher Education Institution) Development
- Lifelong Well-Being Services
- Marine Environment & Construction Expertise
- Working Life Based Approaches to Creative Arts.

The programmes are run by the research and development managers in the faculties and they shape the directions and research areas on which the more specific research topics shall focus.

The RDI programme includes several thematic research groups where the expertise, knowledge and experience of the staff will meet the development needs of the external partners and of regional industry clusters, and the learning interests of the students. The members of the research groups consist of lecturers, researchers, project managers, technical and administrative staff for project management, laboratory experts, students as assistants and project managers in smaller projects etc. The research group is managed by an expert lecturer or researcher on the research topic.

The RDI activities, i.e. every single project, will be planned and performed in research groups in collaboration with the clients and other partners. The groups are formed in order to fasten, cumulate and transfer achieved experience, knowledge and valuable network more efficiently and also horizontally between the projects, staff, students and local and international partners. The advantages of the group are also mutual learning and the opportunity to deepen competences and experience in the collaborative project work.

In the Faculty of Telecommunication and e-Business, there are four research groups which have a coordinator and several members in each (Figure 1).

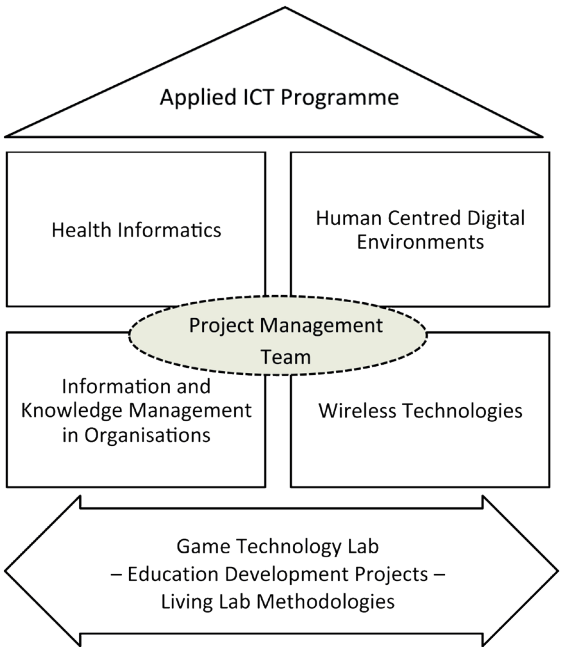

FIGURE 1. *RDI in the Faculty of Telecommunication and e-Business.*

All the research groups are tightly involved with the education in the degree programmes of the faculty. For instance, the students in the Degree Programme in Information Technology will work in the projects of the group Health Informatics, in order to design an innovative tool, e.g. a digital game for mobile phones to encourage children to take care of their teeth. In this case, experts from the faculties of Health Care and Well-being Services would be needed to join the project.

Tasks of the coordinator of the research group are e.g. as follows:

- to lead the research group
- to integrate RDI projects with the education and curriculum together with the lecturers and other staff in practice
- to build up and maintain networks, serve the regional industry and strengthen the links with it together with the members of the research group

- to set up new projects and deliver information about the achievements and results of the projects
- to network and act internationally with the partners working in the projects.

INNOVATION PEDAGOGY AND THE CDIO FRAMEWORK AS TOOLS IN INTEGRATION

According to the evaluation report, RDI is not integrated effectively in education today. The recommendations for improvements are stated in four actions**:**

1. put stronger emphasis on RDI activities for Bachelor level students
2. increase direct participation of senior academic staff in RDI activities
3. benefit the potential of master programmes and master students more in the further development of the RDI function
4. to strengthen basic RDI competences and project skills, they shall be acquired at the Bachelor level and they need to be implemented systematically within the curricula. (Maassen et al., 2012).

TUAS has already established a comprehensive strategy to meet these RDI development challenges. As an answer to develop the culture of the academic community and to integrate RDI creativity and innovativeness in the education, TUAS has produced in its strategic and pedagogic development work a new systematic approach, innovation pedagogy. It is defined as a learning approach that defines in a new way how knowledge is assimilated, produced and used in a manner that opens opportunities to create innovations (Kairisto-Mertanen 2012, 269).

Innovation pedagogy has five underlying elements: multi-field operation, applied research and development, flexible curricula, entrepreneurship and internationalisation (Kettunen 2011; Kontio 2012, 250). Innovation pedagogy promotes group-based and communal, collaborative and participatory learning, project learning as one of those.

However, the general guidelines and elements of innovation pedagogy have to become true at the operational level at the university. The aims and procedures of innovation pedagogy have to be implemented to act and work in students' and staff's everyday practice. The Faculty of Telecommunication and e-Business has answered to these challenges by implementing the CDIO approach[3] as a fundamental guiding structure and framework to develop curricula and education continuously at the concrete grass roots level.

The central idea of the CDIO framework is to bring students closer to a work-life orientation by means of active teaching methods and learning by doing processes. Established in 2000, the CDIO initiative has given a structure and tools to meet the needs for innovative higher education and creative engineering expertise in the economic globalisation. The practical approach of learning by doing, with the tools of development standards, offers a strategy for education reform and implementation. The CDIO framework has demonstrated good achievements in improving study results, obtained popularity among students and been highly appreciated by the employers and industry circles (Crawley 2007).

The degree programmes are developed with the help of the comprehensive practical standards of CDIO, which are really concrete tools. Thus, the RDI activities are linked continuously in the work of students and lecturers in all of our degree programmes (e.g. Capstone projects as a part of the curriculum).

The CDIO approach emphasises the importance of education's relevance to the labour market and professional working life, similarly to the strategic innovation pedagogy principle that is leading the education strategy at the institutional university level. (Kontio 2012, 257.)

CHALLENGES IN STAFF DEVELOPMENT

According to the feedback in the evaluation report, the institutional RDI culture in the UAS in Finland is rather weakly developed. It is clear that when RDI is one of the core tasks of the UAS sector, a change in the academic culture is needed as well as changes in formal industry contracts for the academic staff. RDI skills and competence development should be also prioritised and emphasised in staff training.

3. www.cdio.org; CDIO comes from the words Conceiving – Designing –Implementing – Operating; since it started in 2000, the CDIO model has been implemented in tens of universities in the world with MIT taking the lead.

The structural changes in the traditional working culture are not easy and fast to achieve. The Faculty of Telecommunication and e-Business has since 2007 encouraged and supported lecturers to participate in trainee periods to work in regional enterprises in order to get up-to-date professional practice and knowledge and brush up their networking and partnerships (Holma et al., 2008). Improvements in the university lecturers' work practices, rules and methods are challenging to achieve. The development of higher education is bound to be faced with incongruity at the system level of the university due to the complexity of the structures. Meeting these challenges will call for participatory planning of the staff, students and the regional industry.

In our faculty we have carried out a mutual development and changing process within a group of lecturers as a preparatory phase to recognise and solve the main problems and barriers in renewing the work towards an RDI emphasised direction. This process was carried out by using the Changing Laboratory (CL) methodology, which is a participating development method based on examination, problem solving and new concept creation of the people who the development and changing needs concern. As the result we have identified the bottlenecks of the cooperation with the external partners and created concrete proposals to increase RDI work in the lecturers' annual plans and labour contracts. (Holma & Hyrkkänen 2009.)

Project management itself is a unique competence. It is clear that just few lecturers have got it as a part of their degrees. There is a high need to offer effective project training, as a part of the lecturers' work. The Faculty of Telecommunication and e-Business is offering in the year 2012 a training programme in RDI which will be completed by the end of the year. There will be a demand for training also in the future and the experiences of this course will be utilised in further planning.

STRATEGIC CONSORTIA STRENGTHEN THE INTERNATIONAL DIMENSION OF RDI

RDI projects and activities depend on international funding and cooperation. According to the evaluation group, the UAS sector should set up more specific internationalisation strategies. We shall intensify the RDI cooperation with

international consortia too. Special attention should be given to increasing the participation of UAS in the EU's RDI funding programmes, especially FP7 and Horizon 2020.

At TUAS, we have established a strategic consortium of five European partner universities, CARPE, which has provided a networking opportunity since 2008.[4] The CARPE network aims at joint applied research projects and curriculum development. This network will offer partnership and shared knowledge and expertise in the international competition on EU funding. As the first UAS in Finland, TUAS has established this type of strategic consortium, and already now we have promising experiences on the cooperation. The consortium CARPE is seen as valuable resource for the staff and students. At its best the network's synergic collaborative work will guarantee the quality of the proposals, funding and successful project performance.

The Faculty of Telecommunication and e-Business has been a contractor or participated as a partner in 15 international RDI projects since 2004. This has given not just expertise in international projects but offered ways to build up a valuable international network for the faculty and its staff – not restricted just to Europe – for collaborative RDI actions in the future, too.

The educational challenge of today is to develop learning environments towards that their operational culture supports interaction between people, learning, and sharing and creating new knowledge between external partners. This will call for new structures at the operative level in people's work procedures. However, it will also require more flexible structures and rules, to increase mutual and continuing interplay between a much bigger amount of lecturers and external partners as what we now have. Finally, this will demand the formation of a new strategic concept for learning, education and RDI activities at the university of applied sciences.

4 http://carpenetwork.org/

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QUALITY ASSURANCE

Juha Kontio

FROM STRATEGY TO ACTIONS

The strategy of Turku University of Applied Sciences and the annual Action Plan are the guiding principles of the faculty operations. The strategy of the University defines long-term goals and aims. The action plan concretises the development actions and goals based on the university strategy and on our own quality assurance tools and procedures. The annual action plan defines development actions for the following calendar year. It shows how we plan to reach our goals and how we plan to focus our operations. On the strategic level, the quality assurance and continuous improvement follow the Plan-Do-Check-Act cycle as Figure 1 shows below.

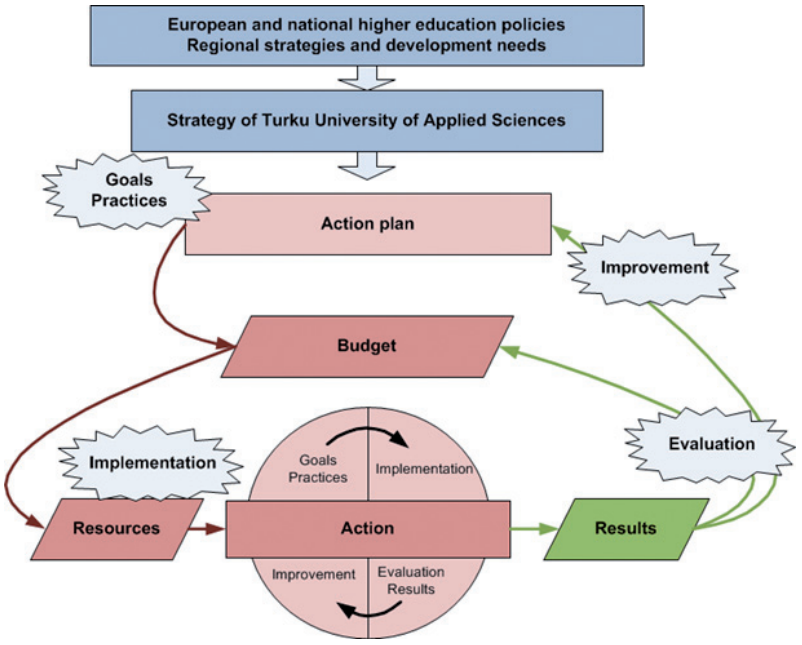

FIGURE 1. *Plan-Do-Check-Act cycle.*

QUALITY ASSURANCE WITH CDIO

The Finnish Higher Evaluation Council defines quality assurance as all the procedures, processes and systems used by the HEI to manage and improve the quality of its education and other activities (Finnish Higher Education Evaluation Council, 2008). On the European level, the quality assurance policy is coordinated by the European Association for Quality Assurance in Higher Education (ENQA). Furthermore, in each European country there are a number of organisations and agencies that take responsibility for the external auditing of higher education (European Association for Quality Assurance in Higher Education, 2008). Actually, in many countries and in many institutions the role of external quality assurance is dominant (Kristensen, 2010). In Finland the quality assurance systems of the HEIs are evaluated by the Finnish Higher Education Evaluation Council, but the HEI is responsible for their internal quality assurance and the success of their education (Finnish Higher Education Evaluation Council, 2011). The quality of education is highlighted as the key area of development in education and the quality must also be assessed on a regular basis (Confederation of Finnish Industries, 2010). Self-evaluation is one part of the internal quality system and culture. In self-evaluation, an institute systematically reviews and reflects on the quality of the instruction and education services provided and on the outcomes produced by the HEIs. (OECD, 2011). In our faculty, the CDIO approach plays an important part of the quality assurance process. It provides tools for self-evaluating the programmes against the CDIO standards and their criteria (CDIO, 2011).

Our planning and quality assurance work is based on the CDIO approach. Although CDIO is not a quality assurance tool it certainly provides elements that support comprehensive development of education. The CDIO approach – more precisely Standard 12 – helps to identify the areas of education that should be invested in. Standard 12 (CDIO Program Evaluation) defines a system that evaluates programmes against all twelve CDIO standards, and provides feedback to the students, faculty, and other stakeholders for the purposes of continuous improvement. The programme evaluation is a self-reported process where the programme gathers its own evidence and uses standard specific rubrics to rate its status with respect to each of the 12 CDIO Standards. While the rubrics are customised to each CDIO Standard, they follow the pattern of the following general rubric (Table 1).

TABLE 1. *General rubrics.*

Scale	Criteria
5	Evidence related to the standard is regularly reviewed and used to make improvements.
4	There is documented evidence of the full implementation and impact of the standard across programme components and constituents.
3	Implementation of the plan to address the standard is underway across the programme components and constituents.
2	There is a plan in place to address the standard.
1	There is an awareness of need to adopt the standard and a process is in place to address it.
0	There is no documented plan or activity related to the standard.

The programme evaluation is done before the planning of next year's action plan begins. The evaluation can thus create input and be benefited in the new plans. As the standard name suggests the evaluation is done at the programme level and the whole staff joins the evaluation process. In addition, student representatives are free to join the evaluation process too. Furthermore, the evaluation reports are discussed in our advisory boards. At the time of writing this article, four evaluation rounds had been completed, the fifth taking place in autumn 2012. The combined result of the programme evaluations is shown in Figure 2. During the evaluation process

- programmes rate their status in relation to the standards
- provide rationale for the ratings
- define initial plans for improvement.

Our four evaluations have shown us the next areas of improvement or areas we need to focus. Based on the evaluations we have started several activities to be better in education and in working life relevance. Some of the activities that are based on the analysis of evaluations are listed below:

- Introduction to – cources
- Survey on workspaces
- Active learning and teaching training for our staff
- Focus on competence definitions in the curricula

- Improving assessment criteria
- Connecting students to our development activities
- Capstone projects.

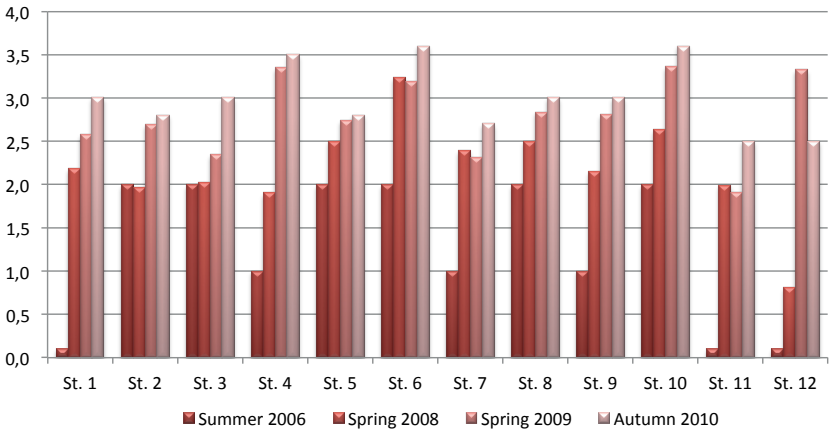

FIGURE 2. *Combined evaluation results.*

The self-evaluation idea in CDIO is a good tool for improving quality assurance in higher education. CDIO provides detailed guidelines and criteria for self-evaluation. However, it is up to the programme how well it documents the evaluations and thus how good footprints the evaluation process leaves. In our faculty the programme evaluation is nowadays natural part of our work – it is a central tool for quality assurance and continuous improvement.

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As one of the first steps towards CDIO adaptation, a first-year introduction to engineering courses was included in the curriculums. The motivator of the course development was derived from the CDIO standards aiming at providing a framework for the practice of engineering to the students, as well as strengthening their motivation for the field and relevant core disciplines already in the beginning of the studies.

The planning of the new courses first faced several curricular and practical challenges. How to define the learning objectives and contents of the courses? What to remove from the existing curriculums? What type of a design-build project can be successfully implemented with new students? All these questions were discussed by the faculty utilising our earlier experiences on problem based learning, and the best practices and encouragement provided by the CDIO community.

The process led to a set of novel courses in our curriculums. For example, a course in Product Development was introduced into the B.Eng. Degree Programme in Information Technology. The course contains topics in Computer Design, Software Development, Mechanics and general Product Development; not to forget development of personal and interpersonal skills via team-based learning activities. This course, together with other examples, is described in more detail in the following articles.

Within the faculty there is also a group of international students with different cultural backgrounds. For these students the introductory course mainly focuses on introducing them to the ICT industry in the region and familiarising them with the Finnish working life.

Currently, a series of "Introduction to Engineering" courses have already been implemented. The results have been very encouraging and the courses have earned their place as important elements in the curriculum. Project-oriented activities in the very beginning of the studies guide the students efficiently to the rich flavours of the engineering profession and, furthermore, facilitate the development of social competences, and support the new students' networking with their fellow students and the staff members, too.

Janne Roslöf & Patric Granholm

FACILITATING LEARNING THROUGH INTRODUCTION TO ENGINEERING COURSES

LEGO MINDSTORMS® AS PART OF THE COMPUTER SCIENCE EDUCATION

Teppo Saarenpää

First year computer science students start their studies with a Product Development course (6 ECTS). The aim is that students familiarise themselves with practical engineering work. The main goal of the course is to learn the product development cycle and tasks, as well as to get to know the general project management and control. Within the projects also engineering disciplines (computer design, software development) and problem solving skills develop. The central theme is to emphasise the nature of the engineering profession, i.e. to conceive, design, implement and operate complex devices and systems. Students receive a real world problem which they must solve, in theory and in practice. The platform for the course is the Lego Mindstorms® environment that students will use to realise their tasks. The course is implemented in project format and students work in small 6–10 person groups, so not only hard skills but also communication and teamwork abilities are enhanced. The framework of the project is formed by a series of problem-based learning assignments, supported by lectures and group work instructed by tutor teachers. See Table 1 for details.

TABLE 1. *The framework of the project.*

Computer Science, Turku					
PBL AUTUMN 2010					
Yesr 1 / AUTUMN 2010					
Week	**Problem number**	**Topic**	**Course**	**Lecture**	**Assesment**
Period S1					
35	1	OPTIMA	*Computer skills*	Tapani Ojanperä	Tapani Ojanperä
36	2	What does a computer science engineer do? Time and self management	*Study skills*	Leena Mattila	Leena Mattila, PBL-tutors
37	3	Assignment	*Product Development*	Teppo Saarenpää	Teppo Saarenpää
38	4	Project planning and quality assurance	*Product Development*	Heikki Rajala	Heikki Rajala
39	5	Crawler vehicle (NXT intro, mechanics and development environment)	*Product Development*	Taisto Suominen	Taisto Suominen
40	6	Voice and touch sensors (logic and programming basics)	*Product Development*	Tapani Ojanperä	Tapani Ojanperä
41	7	Light and UV sensors (advanced programming and parallel constructs)	*Product Development*	Tapani Ojanperä	Tapani Ojanperä
42	***Holiday week***				
Period S2					
43	8	Working on development task	*Product Development*	Taisto Suominen	Taisto Suominen
44	9	Marketing	*Product Development*	Reetta Raitoharju	Reetta Raitoharju
45	10	System testing (crosschecking between groups)	*Product Development*	Heikki Rajala	Heikki Rajala
46	11	Job application	*Study skills*	Osmo Eerola	PBL-tutors
47	12	Personal study plan and International Exchange	*Study skills*	Raija Tuohi, Anne Uuttu	PBL-tutors
48	13	Productization	*Product Development*	Janne Roslöf	-
49	-	Final competition and showcase	*Product Development*		Teppo Saarenpää, PBL-tutors

The table shows topics for each week and persons responsible for lectures and assessment. The main idea is that in the beginning of the course, student groups form their own product concept to tackle the assignment given to them on week 36. In 2010, the assignment was to develop a robot to help with a problem encountered in routine tasks at home. Students could define the task and problem by themselves and then come up with an idea how to solve it. On the second week of the course, students get an introductory lecture to project planning and they must figure out how they will accomplish the task they set themselves a week ago. The outcome of this week's work is a project plan that will be evaluated by the responsible teacher. The course will continue in this fashion the whole autumn term, and students groups will eventually go through each product development stage that exists in each R&D project, ranging from documentation and testing to competitor analysis and marketing material. Finally the course will culminate in an exhibition event where all groups present their work to the public, and an external board will evaluate all robots and reward the most innovative and promising group. So far the course has proven to be a success for both students and staff, and we have seen robots doing everything from household cleaning to scratching a dog.

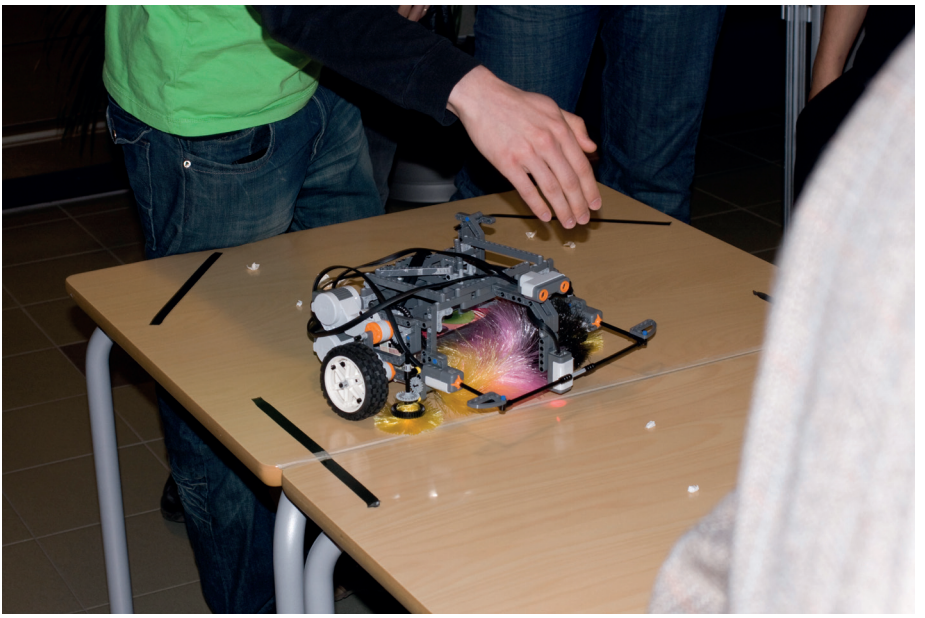

FIGURE 1. *Lego robot in action.*

FIRST YEAR PROJECT IN ELECTRONICS USING CDIO

Markku Karhunen, Henry Gylen & Mauri Suhonen

A first year student does not usually have much knowledge of what an electronics engineer does, and why subjects like mathematics and physics are studied to such a great extent. Specific to electronics is that building even the simplest device requires a relatively great deal of theoretical knowledge. A design-build based CDIO project using many disciplines, distinct from one another, has therefore been established. Since electronics is developing very fast, lifelong learning skills are important. Also working in groups is essential because problems in electronics are usually complicated and a multidisciplinary and a cooperative learning method like PBL (problem-based learning) is required.

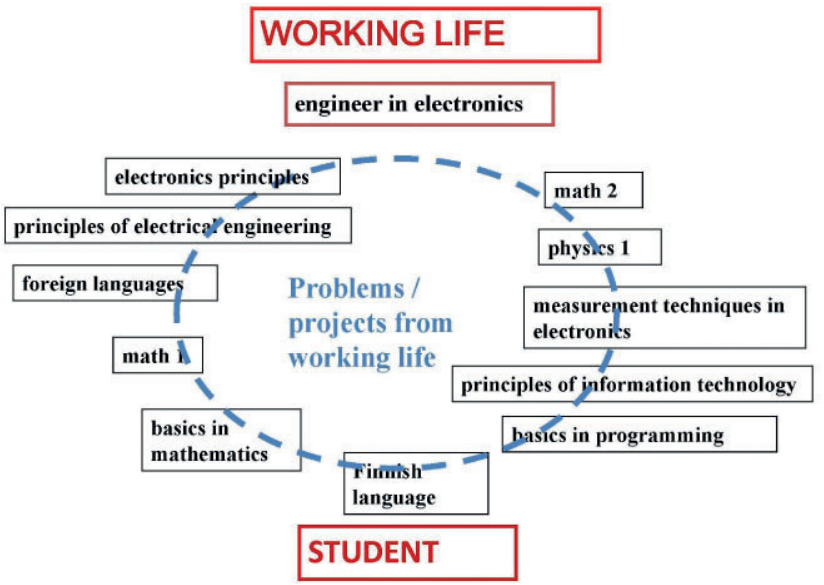

FIGURE 1. *With a design-build project it is easier for a student to understand the connections of different study modules if they are all needed in the project.*

At present, students need more knowledge about working life and why so many different subjects have to be learned. The connections between distinct subjects in the curriculum are blurry for students, and the learning results are not as good as they should be (see Figure 1). In the first year a student does not usually have much knowledge about electronics and working as an engineer, so it is difficult for him/her to understand why a subject like mathematics or physics has to be studied as much as they are directed in the curriculum. Therefore learning how separate subjects are tied together and how these subjects are all needed to build an electronic device, is important. Consequently a design-build experience is unquestioned.

According to the CDIO principle the target for a first-year student is to build a working electronic instrument. One particular difficulty in electronics is that to design even the simplest circuit a rather large amount of theory has to be studied. This is the important difference from other technical fields. Depending on the circuit or device, many special facts in mathematics and physics have to be learned. The theory and skills needed are quite often not included in conventional courses at least to an adequate extent. Extra lessons and laboratory work have to be arranged and they cannot quite often be part of an existing content of the course. At the same time, working with PBL students will provide life-long learning and group working skills which are particularly important for an electronic engineer in the very fast developing field.

The project begins with dividing the students into eight small groups so that in every group there are about eight students. In the beginning a PBL method is learned and as an application, a couple of exercises about an engineer's work will generally be produced. After about two months from the beginning of the studies a CDIO initiative is introduced and a first electronics project is established. The purpose of the project is to design and build a working electronic device which can be e.g. a light bulb reacting to sound with requisite controlling circuits and sensors (see Figure 2) or a magnetic field meter (see Figure 3). In addition, a product document of the device is required. The document should describe the design process and the building process of the project. For many students this project is the first opportunity to work with an electronics circuit or arrange components in the printed circuit board and solder them. If the purpose is, for instance, to use sound as a driver for some action, it is necessary to teach the physical properties of sound and the decibel scale and the logarithmic scale in mathematics at this point. For this purpose

a PBL problem and a tutorial is arranged for the physics of sound and for the mathematics of logarithms advised by the teachers in question. These parts of the task will affect the evaluation of the subject at issue.

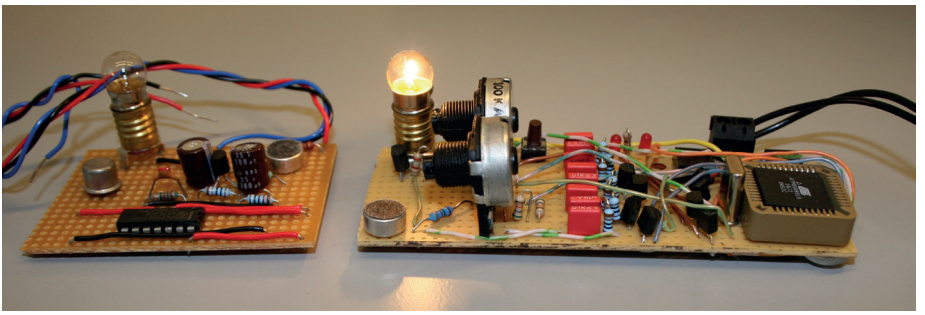

FIGURE 2. *Two electronic devices switch on the light with a signal. The circuit on the left is made of conventional electronic components and a more complex circuit with a processor is on the right.*

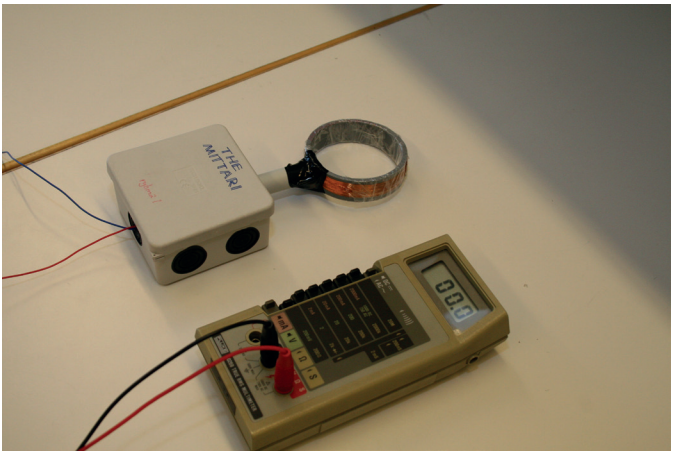

FIGURE 3. *Magnetic field meter.*

EMBEDDED ENTREPRENEURSHIP STUDIES IN OUR FACULTY

PRACTISE ENTERPRISE

Ville Kalijärvi

DESCRIPTION

Practice Enterprise (PE) project is a faculty-wide study module with an objective to develop students' basic knowledge of entrepreneurship and business operations. Every year approximately 200 students from several disciplines, curriculums and cultures participates in the Practice Enterprise project in the Faculty of Telecommunications and e-Business. Practice Enterprise is a simulated start-up company formed by the students from different disciplines and with different cultural backgrounds. There is a real enterprise working in the background of the simulated practice enterprise to support business planning and to provide real-life information for start-up. The actions, products and services of the practice enterprise are similar to the real business. Practice enterprises do business with each other in a global network of practice enterprises. The project lasts 30 weeks and is divided into five phases: (1) Orientation, (2) Planning and Founding, (3) Start-Up, (4) Business Operations, and (5) Closing the books and Evaluation.

HISTORY

The Practice Enterprise project was started in 2000 in the Faculty of Telecommunication and e-Business in Salo with one pilot student group. In 2002 the Practice Enterprise project was expanded to cover all first year students in Business Administration and Computer Science degree programmes, with a total number of 8 practice enterprises. In 2003, the Faculties of Well-being Services and Health Care joined the Practice Enterprise project and the number of practice enterprises increased to 16. In 2004, the Faculty of Telecommunication and e-Business' degree programmes in Turku joined the project. During the implementation in 2010–2011, the Practice Enterprise project was integrated into study counselling and the curriculum of first year students in Salo as a learning environment.

FIGURE 1. *History of the Practice Enterprise project.*

The continuous development of the Practice Enterprise project has been in an important role since the beginning of the project. After each implementation, the project is evaluated and further developed based on student feedback and development ideas, as well as evaluation and analysis made by staff members participating the project. As a result of this work, the Practice Enterprise project was selected in 2008 for the European Union report "Best Practices in Entrepreneurship Education".

METHODOLOGY

The Practice Enterprise project is based on applied problem-based learning and learning-by-doing approaches. Student groups are given problems and tasks with initial information and sources for additional information to solve the task related to given problems. Learning in the Practice Enterprise is based on self-directedness of individual students and interaction in student groups. The role of the tutor in Practice Enterprise is to act as a mentor and consultant for the group. The assessment is based on interactive methods; self-assessments, group assessments, peer assessments and process assessments.

RESULTS

The main results of the Practice Enterprise project are the learning outcomes of the students about real-life basic business operation and functions, and entrepreneurship. Students can practise founding a company and starting-up as entrepreneurs in safe learning environment and learn basic business

skills and get know-how in business field. Also, attitudes of the student towards entrepreneurship are more positive after the project. Working in multi-cultural teams and with students from different fields of study gives student understanding and important skills needed in contemporary business environment. The project gives students skills and knowledge in managing and coordinating work, using information technology, communicating in foreign language and with people from different cultures, and adapting to changing situations and environment.

ELEMENT OF SURPRISE AND NEW INNOVATIVE LEARNING ENVIRONMENTS

Jaana Kallio-Gerlander & Jussi Puhakainen

The aim of this article is to present a novel learning environment: Salo BusinessAcademy (BisnesAkatemia in Finnish). BusinessAcademy (BA) is based on student-owned cooperatives where from the 2nd year most learning takes place. BA is an extension of the innovation pedagogy approach of Turku University of Applied Sciences, where active learning standards in the form of problem-based learning, real-life projects and the changing role of the teacher meet. In this article we also present the key challenges and possibilities of this environment for students and teachers and illustrate key activities related to this kind of learning. From the CDIO perspective, the article and the BA concept are strongly related to standards 3, 7 and 8; Integrated Curriculum, Integrated Learning Experiences and Active Learning, respectively.

FOREWORD AND TWO PRINCIPLES

"I never try to teach my students anything. I only try to create an environment in which they can learn." (Albert Einstein)

Two principles:

- Principles of old education, disciplinary theory and so-called "problem solving". Problems are defined and led by lecturers or professors. This is necessary but not sufficient.
- Principles of new education, theory and judgment applied to real problems which cross disciplinary boundaries, are complex and ill-defined and contain tensions. This is necessary and sufficient.

PICTURE 1. *Brainstorming and training room at Salo BusinessAcademy. Spot the teacher!*

INTRODUCTION

The social environment and general view of the relationship between education and working life has changed almost completely during the past ten/twenty years, from total isolation to close co-operation. The working life of today is demanding. New skills and competencies are needed in the traditional fields of business and engineering and substance information is taken for granted. The new business and engineering generation is facing a different kind of world with constantly changing demands for their skillset and mindset.

About a half of the graduates from the field of business and engineering are working in a position of expert or specialist. Every fifth graduate worked in a clerical position and every fourth had a management position. In these positions both soft and hard skills are equally important to master. (Finnish Labour Statistics 2009.)

MINDSET AND SKILLSET

This means that both soft and hard skills (Dewey 1938, Hofstede et al. 1994) must be taken into consideration. The definition of soft skills underlines both personal values, skills and attitudes like self-confidence, self-discipline, self-marketing and stress resistance, and interpersonal abilities like co-operation, diversity of tolerance, willingness for teamwork, conflict handling and decision making skills. Thus, being an entrepreneur is more than gathering and using substance elements of information, in this context the so-called hard skills. It is a holistic view about oneself and one's relations to other people and, of course, possessing the facts and figures concerning one's own field of discipline. The latter is taken for granted in education, but not the first two (Gibb 2005).

CO-OPERATIVE WORK AS A SOLUTION OF COMBINING STUDYING IN REAL LIFE PROJECTS IN THE EARLY STAGE OF THE CURRICULUM: CASE SALO BUSINESSACADEMY

In this context, a cooperative form of studying is nowadays an essential part of HEIs. In the faculty of Telecommunications and eBusiness, all students have the possibility to join or establish a co-operative during their third semester of studying. These co-operatives are student-owned and conducted companies in which real-life projects are done with local SMEs (Small and Medium Enterprises), bigger companies and other organisations. Especially local SMEs are favoured partners for student-owned cooperatives for multiple reasons. For example their needs are typically smaller and thus manageable.

The students organise their own workday in various ways: selected reading materials are handled, discussion and evaluation groups are held, projects provided by local companies are implemented and project meetings with other stakeholders are arranged, seminars, workshops and lecturers are visited etc. Each student builds his/her own personal and tailored study plan with his/her personal coach concerning the goals and skills which he/she wants to study and learn.

The study plan consists mainly of reading materials, discussion groups, and real-life projects targeted at the curriculum competencies of a certain level as well as personal objectives of the student. Traditional lecturing can be taken as a part of the study plan but is not, however, its most important sector.

Identifying, recognising the learning in various situations, also outside the school, is a crucial part of co-operative work and studying. Reflection and evaluation is done by the coach, but also by the students themselves, by clients in projects as well as by fellow students. When comparing this study form to the CDIO principles, in order to *reach* the learning outcomes, the relevant question is what the students should do to demonstrate that they *fulfil* the learning outcomes.

One demonstration possibility is the personal portfolio. Students gather "evidence" from all projects and actions and thus create their own portfolios. The evidence may include written material, videos, newspapers, web pages and so on.

This form of studying sets a number of challenges (but also opportunities) for teaching staff and students. Challenge number one is the element of surprise. If what-is-to-be-learned is defined by actual projects from actual companies, one cannot really fully plan when and where learning takes place. The teacher cannot plan very far ahead what is to be learned and must be adaptable. This applies naturally to the students as well. The student also learns not to fear the unexpected. We consider this as a major issue.

Another major issue is the role of innovations and how they are "made". Modern innovation literature (see Christensen 2003, von Hippel 2001, Ramaswamy and Gouillart 2010) focuses on openness and co-creation as viable solutions to facilitate innovations. Environments such as BA are open both internally and externally. Thus students learn modern innovation skills while tackling the problems of real-life projects.

The role of the teacher is interesting in this environment. It changes quite radically from traditional lecturer to facilitator and coach. In BA there are three kinds of teachers: coaches (each cooperative has a coach), specialty-area teachers (who give specialised knowledge, for example coding skills, when needed) and students-as-teachers (also known as sub-coaches, older students who act as student mentors). This kind of transformation of a teacher's profession is not for everybody – it is quite demanding initially and includes many other roles than lecturing. These roles are coach, mentor, facilitator, tutor and thesis supervisor just to name the most important.

CONCLUSION

In this short article we have presented an innovative, novel learning environment; Salo BusinessAcademy. We have shown how it is connected to CDIO thinking and the innovation pedagogy of Turku University of Applied Sciences. We have also pinpointed the key possibilities and challenges of this environment to both students and teachers.

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THE EDUCATION SUPPORT CENTRE AS A COMPANY-LIKE LEARNING ENVIRONMENT

Maria Leivo & Patric Granholm

INTRODUCTION

The Education Support Centre Finland (ESCfi) is a student run, company-like learning environment providing software support that implements projects for schools, other educational institutes and non-profit organisations in Finland. ESCfi aims to provide a learning environment that is very close to working life and guides students towards entrepreneurial behaviour. Customer support requests and projects are authentic and the operational principles promote initiativeness, independent work and entrepreneurial attitude. The operation of ESCfi is organised so that it resembles an authentic company as much as possible.

OPERATION OF ESCFI

Students who want to work at ESCfi apply for a position as they would apply for any job on the normal labour market. The management of ESCfi is arranged in a very light way. The overall activity is supervised by a lecturer who also is responsible for pedagogical aspects of the activity. Led by a student manager, the students are responsible for all practical operations within ESCfi. The students do not have financial responsibility, but they have the major responsibility of customer satisfaction, cooperation with companies and different organisations, organising the work, resourcing and most importantly, learning.

ESCfi LEARNING PROCESS

Typically students start working in ESCfi during the second year of their studies and they finish when they graduate. The learning process contains participation in everyday support centre work, solving customer problems, taking part in different projects or making technical certification exams to prove their skills. The technical certification process also has an important role in the provided service's quality assurance from the customer's point of view.

Figure 1 illustrates ESCfi learning from students' perspective. Altogether it is possible for a student to achieve 102 ECTS by working in ESCfi. It is possible for a student to choose some of the ESCfi learning modules and for example do the work placement period somewhere else.

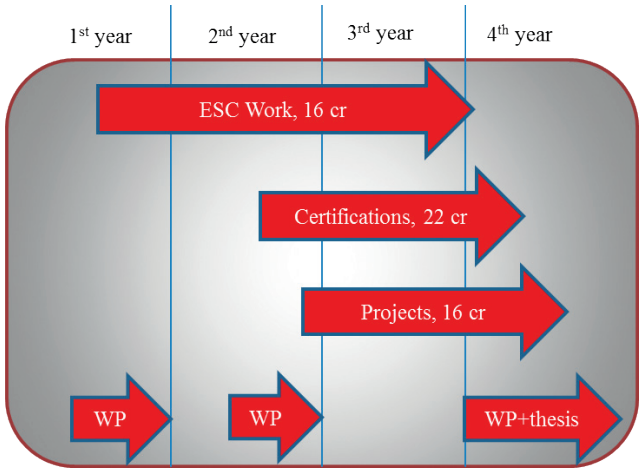

FIGURE 1. *Engineering studies and ESCfi learning. Work placement periods 3 x 10 cts are marked with WP. The thesis is 18 cts.*

LEARNING IN PRACTICE

When a new student starts at ESCfi, a senior student is assigned as tutor for him/her. The tutor helps the new student to get started and solve customer requests and problems in the beginning. When a student is able to take the responsibility and work independently, he/she is assigned to more challenging tasks.

The ESCfi teacher conducts appraisal interviews at least once in a semester. In these interviews the following issues are discussed: student's learning objectives, schedule for certification, amount of working hours, tasks and responsibilities and follow-up of previous semester. This interview is documented and updated if necessary.

ESCfi has a software based system for following up students' working hours and their tasks. There are no strict working hours in ESCfi, and students come to work when it is possible according to their curriculum and other courses. The objective is that ESCfi is a flexible learning environment so that working in ESCfi does not take over students' other studies. The weekly working hours vary between 5 to 30 hours. Every other week all students make a plan where they define their learning objectives for the next two weeks. They report their learning activities in a learning diary. They must also evaluate their operation in respect to other students and customers. Also all possible changes in their plans are reported here. Credits are given based on the learning diary and for passed certification exams.

DESIGN/BUILD PROJECTS

GAME TECH & ARTS LAB – GAME DEVELOPMENT LABORATORY

Taisto Suominen, Tatu Laine & Mika Luimula

FINNISH GAMES INDUSTRY

As the games industry is one of the most rapidly growing fields, game development is the hottest topic in software development and digital arts. Especially the Finnish games industry is at the top as Rovio's top selling Angry Birds is played worldwide and the critics and players have also acknowledged Remedy's Alan Wake. These latest successes have given a tremendous boost to the Finnish game industry. However, also the new ways to distribute digitally and play the games with hand held devices have set an easy path to start up a small game development company. The growing Finnish games industry requires more employers with an education on game development than what is available. This has resulted in that game development has found its way to curriculums in many Finnish universities.

In 2008 the Finnish games industry was mainly located in Helsinki, some companies were located in Oulu and Tampere, but there was only one registered game development company in Turku by the records of the Neogames, Finnish National Centre of Game Business Research and Education. In 2012 the amount of game companies in Turku is about 10 and in addition there are several smaller entrepreneurs and student start-ups.

GAME TECH & ARTS LAB

The University of Turku (UTU) and Turku University of Applied Sciences (TUAS) had some success with game development courses in co-operation and decided to apply for funding in co-operation from the Federation of Finnish Technology Industries to start a game laboratory. The goal for this laboratory

was to provide education for students from different curriculums in game development, but also a facility with an infrastructure for game development and a community where people interested in game development could get together.

The challenge in working life is communication difficulties between the artists and the programmers, as they meet for the first time on projects and teamwork after the school. We wanted to get students from different curriculums; digital arts, media technology and computer science, to work together on game projects so they would learn new skills in working as a team member. A goal was also to boost the game industry in Turku region, as we would assist the future game developers in starting up an own company or work as an employee.

PICTURE 1. *Summer Game Jam 2011 in the GTAL with representatives from Rovio.*

The funding for three years was granted and it started in 2009. We started to build our Game Tech & Arts Lab (GTAL) with hardware and software for game development. The first course started in autumn 2009 with a series of guest lectures from the Finnish game industry and we were stunned by the

popularity as the 200-seated auditorium was not big enough for the audience and the floor was also occupied. In addition, a course titled Introduction for Game Development Tools started in autumn 2009 and it was also very popular.

PICTURE 2. *Guest lecture by Joonas Laakso, Bugbear.*

After a local newspaper article about the Game Tech & Arts Lab, Supercell, a Finnish game development company contacted us and we started a co-operation with their upcoming game Gunshine for usability tests and closed beta testing with over 50 students involved with the testing. After the test period, Supercell was pleased with the results and also employed one student as level designer for the same game. He still works at Supercell and has been promoted to game designer. Supercell was our first Living Lab case to provide services for the game industry and after that we have made several projects in co-operation with the games industry.

By the end of 2011 the students have made over 100 games during the courses, over 10 games have been published and over 10 students have been employed in the game industry. Furthermore, several students have done professional training in local companies. As game development is software and digital art design, others have been employed in more traditional programming or digital arts.

One remarkable success story is a student who made success with developing a plugin for the game development software Unity 3D with a revenue of over $30 000 in 8 months. The skill of this student was acknowledged by Unity and he started as their full time employee in May 2012.

We managed to found a working co-operation laboratory in game development with good results with the amount of student made games, but also as credits for students, the community with monthly meetings with students, teachers, graduates and the games industry in Turku and most importantly, both universities have integrated game development officially in their curriculums.

A STUDENT'S PERSPECTIVE ON GAME TECH & ARTS LAB AND CDIO

The traditional perception of universities is that they are a place of individual work and lectures. The Game Tech & Arts Lab challenged this perception when I was first introduced to it. The lab is a classroom filled with game development software and hardware – a place for students to get together and work together on projects that are often conceived by themselves.

Students in the game lab are encouraged to work together with students from other curriculums and fields of interest to learn project management and communication skills. Typical projects are ambitious games that challenge the genre and aim to be highly innovative. Students see little point in copying game mechanics from existing games and thrive to challenge themselves.

Games are often a complex system of logical operations and state machines. Project groups often include distinct roles for the students, because games utilise deep knowledge in many areas. There is a lot of designing before starting a game project, or the hastily made initial design decisions will greatly limit you later when the implementing and extending of the game features is ongoing.

Students often get a sense of autonomy with their game projects, which pushes them further in learning programming for example. Many students have spent a lot longer than necessary on game projects that have been a part of a course. With the fast development of the gaming industry in Finland, a significant number of students have found internships and even work in game companies around the Game Tech & Arts Lab. Game projects are great for personal portfolios as they show the ability to design, communicate, work together and operate a piece of new technology conceived by a multidisciplinary group effort.

GAME DEVELOPMENT AT TUAS

In the upcoming academic year, we will present Game Development as a part of the curriculum structure in the B.Eng. Degree Programme in Information Technology at Turku University of Applied Sciences. The IT programme relies currently on the problem-based learning (PBL) implementation. Several courses contain PBL learning assignments. For example the first semester course in Product Development has been successful. In the Game

Development specialisation area, PBL implementations will be covered on courses such as Computer Skills, Introduction to Databases, Introduction to Game Development, Capstone project, and Game Development 1–2.

Our curriculum has been developed based on the CDIO initiative and the Capstone project will be the latest step in this process. We have found that external objectives will motivate students to work more efficiently and intensively, for example on the so called ICT ShowRoom concept. The ICT ShowRoom is an event in which students organise an exhibition and a competition open to all students, and it gathers every year students, staff and industrial representatives together. As a result, the groups are motivated to keep up the pace during the project and game projects are excellent for the ICT ShowRoom.

Based on industrial feedback, we have chosen Unity 3D and Microsoft XNA as development tools. Unity is a cost efficient approach for SMEs, and the local industry is largely using this tool. The latter one is a strategic choice due to the presence of Nokia and Microsoft in this region.

HEALTH INFORMATICS

Elina Kontio & Teppo Saarenpää

Europe is ageing and the number of elderly people is quickly increasing. At the same time the costs of health care are rising and pose challenges to service providers and productivity in healthcare altogether. One possible way to tackle these challenges is Information and Communication Technology that offers tremendous opportunities to improve healthcare processes and productivity (Ammenwerth et al., 2004). In past two decades several types of information systems have emerged in the field of healthcare. Today it is commonplace that healthcare organisations use information systems for clinical purposes to improve patient care (Chaudhry et al., 2006). Actually, healthcare is one of the most information-intensive sectors of European economies and can greatly profit from recent advances in information and communications technology (Stroetmann, Jones et al. 2006). The future in healthcare is going towards integrated healthcare information systems. For example, planning and managing the day-to-day running of a hospital requires thorough understanding of the system together with detailed information for decision-making (van Merode et al., 2004). Technological and business processes offer a new type of possibility to view healthcare. There is a need to take a more technological and business process view on healthcare delivery and to identify the appropriate organisational and information infrastructures to support these processes (Grimson et al., 2000). Altogether, new expertise is needed in order to answer the challenges in hospital and healthcare. There is a need for specialists that understand both the field of information systems and the special characteristics of health care.

All of the above was recognised at Turku University of Applied Sciences, too, and a novel engineering degree programme in Health Informatics program was designed. Health Informatics was in this context defined to focus on ICT-based solutions designed for and used, especially, in the field of healthcare. Health informatics, Healthcare informatics or Medical informatics is the intersection of information science, computer science, and health care (Figure 1). It deals with the resources, devices, and methods required to optimise the acquisition,

storage, retrieval, and use of information in health and biomedicine. Health informatics tools include not only computers but also clinical guidelines, formal medical terminologies, and information and communication systems.

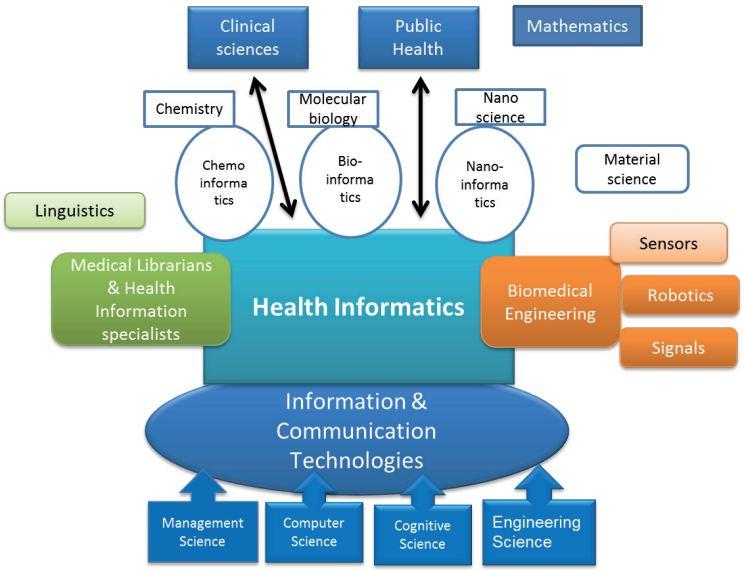

FIGURE 1. *Health Informatics in a bigger picture (modified from Mantas et al., 2010).*

Health Informatics is a specialised education branch offered by the Information Technology Bachelor programme at Turku University of Applied Sciences (TUAS). Furthermore, we have defined health informatics as one of the focus areas in our Applied ICT research and development programme, too.

The education itself consists of two courses: Health Informatics 1 (15 ects) and Health Informatics 2 (10 ects). In addition to these special courses there are a number of courses that support the field of health informatics. Altogether, at least one third of the studies of a student graduating from the health informatics specialisation are directly related to health informatics. The rest is more general information technology related and general studies such as communication skills. The students who choose this specialisation have Health Informatics 1 in the 3rd semester and Health Informatics 2 in their

4th semester. Teaching on both of these courses is very practice oriented and the main topics are project planning and management, usability, social and healthcare structure, healthcare processes and standards. The guideline for implementing these courses has been to include one major project in each course where students manage the project by themselves, contact customers and learn skills determined in the curricula. During the academic year 2010–2011 such project was to develop a future nurse call system concepts for Miratel (Figure 2). This company has a solid share of nurse call systems in Finnish hospitals, but they wanted to start planning the next generation device for this same purpose and this task fell on the shoulders of Health Informatics students. The project was run in co-operation with Industrial Design students from TUAS.

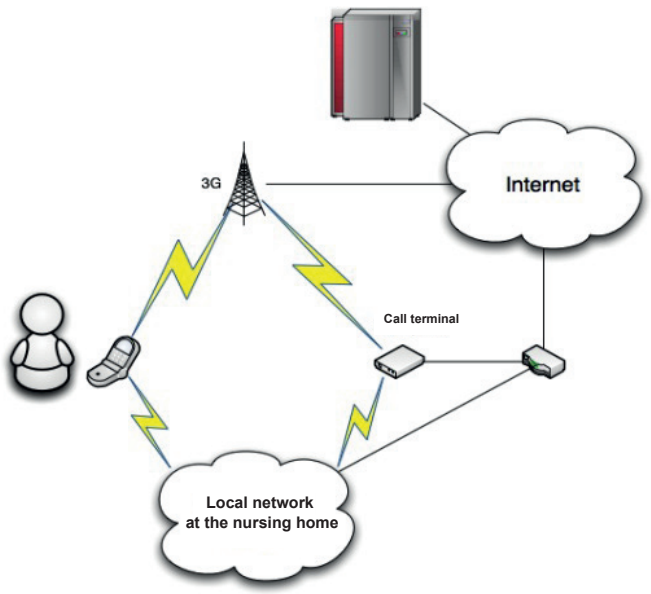

FIGURE 2. *Nurse call system overview.*

Heath Informatics students were responsible for managing the project and designing the systems functions while Industrial Design students took care of the interface and outlook for the device (Figure 3).

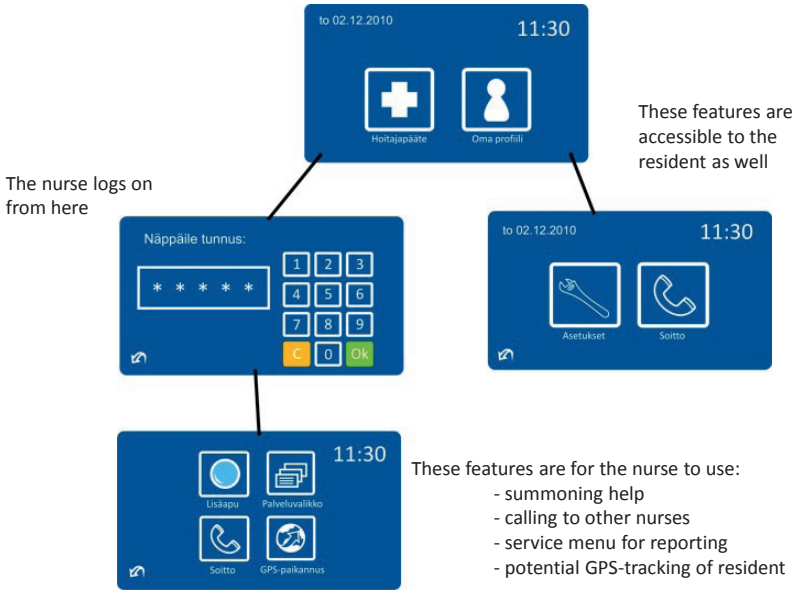

FIGURE 3. *User interface.*

This interdisciplinary approach proved very useful and students learned a great deal from working in this environment. The project lasted altogether seven months. After four months of work ten initial concepts were presented to Miratel. Miratel decided to take two of these concepts to further research. The last three months of the project were used to modify these concepts according to the input received from Miratel. At the end of the course, the students presented their work which was received with enthusiasm and actually one of them was decided to be continued in the company's own R&D process into a final product. Students found this type of teaching and learning very motivating, allowing them to work in an actual environment with real users and customers. It gave them valuable contacts and confidence in working on multidisciplinary projects.

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THE B21C PROJECT – BROADCAST FOR THE 21ST CENTURY

Reijo Ekman, Atte Vainisto & Niko Aurala

Turku University of Applied Sciences' (TUAS) radio laboratory has participated in the international research project B21C from January 2007 to December 2009. The project constituted a task force with the goal to elaborate the technical propositions for the future of digital video broadcasting. The task force consisted of 35 partners from 9 European countries working with digital television. The partners were industrial companies, network operators, SME's, universities and research institutes. The Finnish partners were Nokia, Digita, Elektrobit, Åbo Akademi, University of Turku, Tampere University of Technology and TUAS.

In practice, the work done in the B21C project supported the long term success of the latest and future broadcasting technologies developed by the Digital Video Broadcasting consortium (DVB). The focus was on the three latest technologies designed by DVB: DVB-H (TV to handheld devices), DVB-SH (from satellite to handhelds) and DVB-T2 (2nd generation high definition terrestrial TV).

The project was divided in five different work packages: WP1 management, WP2 standardisation, WP3 channel studies & network aspects, WP4 prototyping & trials and WP5 dissemination. The work packages were still divided in smaller task forces. The way of working was to meet each other every three months in face-to-face meetings, which were hosted by project partners in turns. In addition to the meetings, several co-operated laboratory and field measurement campaigns were carried out in different countries. The dissemination group was responsible for raising and introducing the work done in the project in various international forums, seminars and exhibitions.

TUAS's main focus was in DVB-H validations. For a year, TUAS carried independently out an extensive laboratory and field measurement campaign. The goal was to evaluate the previously defined radio propagation channel models with fully operational receivers. In addition to the independent work, TUAS coordinated a co-operative handover test session. The Turku DVB Test Network enabled the participants to test their prototype receivers in a proper network and TUAS's radio laboratory offered excellent facilities and equipment to test and fine tune the devices.

In its entirety, the project gave a lot for TUAS. TUAS gained internationally accepted knowledge and experience in the field of wireless communications measurement technology, digital video broadcasting, real-time radio channel testing and simulation. The funding enabled the procurement of specific measurement and test equipment, which can be exploited in the laboratory courses with students. In addition to the five Bachelor of Engineering theses, the project employed a couple of research engineers.

The project has also earned good reputation among the broadcasting circles nationally and internationally. The DVB consortium has utilised the project's results and findings in the standardisation process. In addition, the project has won the Silver Celtic Excellence award. Internally in TUAS, the project group was awarded with a certificate of honour in the internationality category (Vuoden Kultainen Purje 2010). In consequence of the inclusive work performed in B21C, a successor project ENGINES managed to get the funding and continue to develop the valuable research work with the future broadcasting standards.

WORKING LIFE CONNECTIONS

ADVISORY BOARDS

Juha Kontio

According to the Lisbon strategy, Higher Education Institutes (HEI) are expected to provide education that answer to the competence requirements of working life (European Union, 2004). Answering to these changing and growing competence requirements need active cooperation between HEIs and working life (Ministry of Education, 2006; Ministry of Education and Culture Finland, 2011). Furthermore, universities of applied sciences should primarily focus on the needs of working life and they should further increase cooperation with companies and the public sector (SITRA, 2005). The education provided by the universities of applied sciences should be developed in close co-operation with workplaces (Confederation of Finnish Industries, 2010).

The main idea of the CDIO approach is to support education development and educate students who are able to (Crawley et al., 2007):

- master a deeper working knowledge of technical fundamentals
- lead in the creation and operation of new products, processes and systems
- understand the importance and strategic impact of research and the technical development on society.

The CDIO approach emphasises active connection with working life with different ways – for example competences, workspaces, learning methods, design-build projects and faculty skills. One way of maintaining the connection and discussion with working life is advisory boards. Advisory boards are forums for developing our education, degree programmes and other activities such as R&D and continuing education. The advisory boards provide feedback and views from the regional perspective and help us to support the wealth of the region better. The advisory boards consist of members from the local industry, public sector and other education providers. Each advisory board also has student representatives and degree programme representatives.

The advisory boards are created around degree programmes, a collection of degree programmes or even around some key activities such as entrepreneurship. Most of the advisory boards operate within one faculty but there are also some cross-faculty advisory boards. There are over 25 advisory boards with 6–15 members each in Turku University of Applied Sciences. Altogether almost 300 representatives from working life work for better higher education!

There are three advisory boards in the Faculty of Telecommunication and e-Business (Figure 1): ICT engineering, Library and information services and e-Business. The advisory board of ICT engineering covers the activities of four degree programmes: three Bachelor of Engineering programmes (Electronics, Information Technology and Information Technology (an English-language programme)) and one Master of Engineering programme (Technological competence management). The advisory board of e-Business works with the questions and challenges related to the Bachelor of Business Administration programmes (Business and Business Information Technology). Finally, the advisory board of Library and information services is for the Bachelor and Master programmes in this field.

Our advisory boards meet three to four times per year. The meetings focus on topical questions such as curriculum reform or continuing education needs. The discussions in the advisory board meetings have given us valuable input on our development activities and we have got confirmation for some of our plans. For example, the plans on rescheduling the work placements in the curriculum were thoroughly discussed in the advisory board and the final modifications we confirmed.

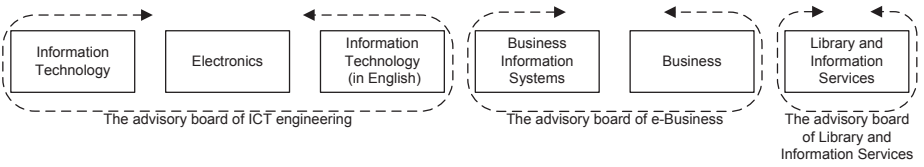

FIGURE 1. *The advisory boards of the Faculty of Telecommunication and e-Business.*

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PRACTICAL TRAINING

Päivi Killström, Markku Karhunen & Yngvar Wikström

Practical training is a great opportunity for a student to get started with his/her career. The student finds a training place by him/herself, taking into account his/her interests and goals. The whole training period lasts twenty weeks.

The practical training as a whole is split into basic training and professional training. Both parts last 10 weeks. The first part is carried out in the second semester and the other in the third semester. The web-based tutoring uses the *Action Reflection Learning* method where the student has to reflect and analyse his experiences and outcomes. Then he/she reports how the goals he/she has set for him/herself are fulfilled. After he/she has carried out the training and completed required tasks, he/she will get an accepted grade.

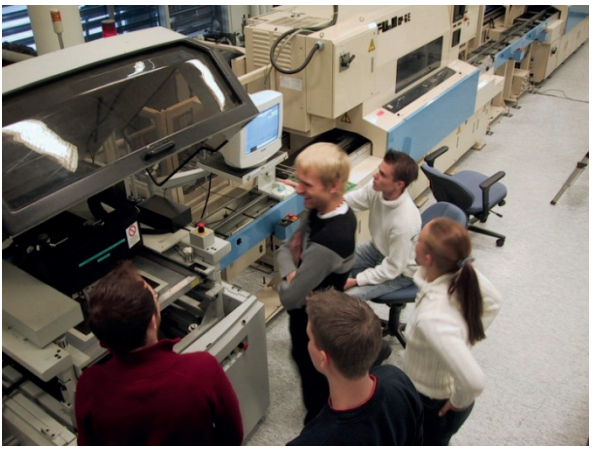
BASIC TRAINING (10 WEEKS, 15 CTS)

Basic training (10 weeks, 15 cts) shall be related to the professional field. The student makes his/her study plan before each work placement period. After the tutor has accepted the plan and the practical arrangements are made, the period can be started. The student writes a portfolio following the given instructions. After the period is completed, the tutor and the student's mentor at the company evaluate the results together. Seminar presentations and other types of reporting are also required as the final part of the work placement process.

PROFESSIONAL TRAINING (10 WEEKS, 15 CTS)

In some degree programmes the practical training is recommended to be carried out as one single 20 week long professional training period in the third year. The goal of the professional training is to learn the central tasks and methods relevant to the student's own professional field in a real-life environment, as well as to gain new knowledge and skills. In addition, the goal is to get familiar

with industrial and commercial organisations and their social atmosphere and moreover to highlight the importance of productivity, profitability, efficient processes and entrepreneurship. The student prepares for his/her future thesis project by learning the connections between his/her thesis writing process and the daily life of a highly qualified employee of the company. The final reporting is a seminar where the student plots out the engineer's or BBA's keys to success and shares his/her experiences with his/her classmates.



PICTURE 1. *Better toys at the company.*

THESES

Timo Tolmunen & Minna Paakki

During their final year the students have to write a thesis. They have to find a project in the private or public sector or within TUAS in a research group. Industrial thesis projects are most recommendable, because they often offer the gateway to the first graduate job for many students, or at least they generate contacts and networks for the future job search. Thesis work placement in firms can inspire and spur to great things in a future career.

Traditionally students in Electronics engineering and Information technology have made their thesis in local companies in Turku–Salo area. However, this varies highly according to the economic situation. During the telecommunication market upswing at the end of the 1990's, more thesis workers were needed than were available, and almost everyone was hired well before they were ready to start their thesis project. Since then, expense reductions in all sectors have made it more difficult to hire new employees. Cost cutting and emergent reorganisations also put a lot of strain on the employees, and having to instruct a student just puts another burden on their shoulders. Especially small companies are cautious, but in many cases a well-motivated student has shown to be an excellent resource for them and worth a slight instruction burden. Many innovative ideas have emerged in students' thesis work.

Although all students have short compulsory practice training periods in the industry during the second and third academic year, it is commonly so that during the thesis process they became conscious of their overall employability skills or the lack of these. It usually will also become evident for students that working life conditions are quite different from the study conditions, when it comes to autonomy, possibilities to influence their personal work conditions and time management as well as the composition of work teams. From the CDIO point of view the thesis is a project where the student really must take an active role. A few years ago theses were mainly graded based on the thesis reports. Nowadays the evaluation criteria include the whole thesis process. In order to obtain a level "good" the student should, for example, plan and carry out the project within the agreed time frames, show good initiative and

be open to supervision and critique. In order to obtain level "excellent" the student should do this individually. Of course the thesis supervisor at TUAS guides the student especially in the thesis writing process and the instructor in the company guides and supports the student with the daily problems that occur during the project, but the student's active role must be clearly visible.

EQF AND SUPPORTING INNOVATIVE IDEAS

The thesis project is also a final test on that the student meets the learning outcomes on the European Qualifications Framework (EQF). The EQF has eight reference levels of which Level 6 applies to the Bachelor's Degree. Each level describes learning outcomes on knowledge, skills and competence. With regard to skills, the student is assumed to obtain the advanced level, demonstrating mastery and innovation, required to solve complex and unpredictable problems in a specialised field of work or study. On competence, EQF states that students manage complex technical or professional activities or projects. Many thesis work subjects carried out by the students cover completely new fields, where they face a great deal of fascinating problems and challenges. Some examples of previous theses that have been conducted at TUAS show that the learning outcomes on the EQF have been achieved:

> *One company was manufacturing flow meters which suffered from low reliability at high temperatures. Flow meters are used, for example, in paper mills to control lubrication of production machinery and more importantly to prevent break-offs in the production. Flow meters' annual production in that company was more than 10 000 pieces. Poor reliability was solved in the thesis by designing a novel inductive sensor and renewing electronics and control algorithms. Furthermore, the production costs of the novel flow meter were 30 per cent lower in comparison to earlier version.*
>
> *In another project new features were developed to an ultrasonic measuring device used to examine sinus cavities. In healthcare, measurements must be printed out for analysis and filing purposes. High safety regulations make all medical projects demanding. More versatile functionality was obtained with a microcontroller based appliance suitable for medical environment designed in this thesis work.*

Sometimes the topic of the thesis may pop up in the student's mind. Some students have an innovative idea of novel products or a new feature to the product, another wants to design or build an alternative product to replace expensive cheap. Examples of these theses are a simple and low cost ultrasonic phone for scuba diving with a microphone in a regulator or an automatic timing system for motocross competitions. In best cases, new ideas can generate new entrepreneurship and companies. Supporting students' innovative ideas is also one important objective of a successful education.

ICT-PORTTI – EVERYBODY LEARNS, EVERYBODY BENEFITS

Marika Säisä

DESCRIPTION

ICT-portti is conducted in collaboration with Turku University of Applied Sciences, University of Turku and Turku Science Park Ltd. The aim of this project is to support small and medium sized enterprises in exploiting information technology more efficiently. The project co-operates with ICT service providers in the region of Southwest Finland.

Work satisfaction, fluency of the work and productive work environment: technology has several roles related to work. It is very important that the service is about changing the current routines, not just about delivering some IT services or products. Therefore, for example new software is always taught to customers and the changes that happen afterwards are followed.

The project's idea is to add co-operation between educational institutions and business life, ease graduates' transition into working life, ease companies' recruitment of new employees and include industry needs into teaching. The main idea is that "everybody learns something, everybody benefits somehow". Universities keep up the constantly changing edge of need in industry, students gain real business related knowledge and benefit from this after graduating, SMEs (Small and Medium Enterprises) get help and training in using technology more efficiently and ICT service providers have a possibility to influence ICT students to make sure that they get more professional graduates later on (Figure 1).

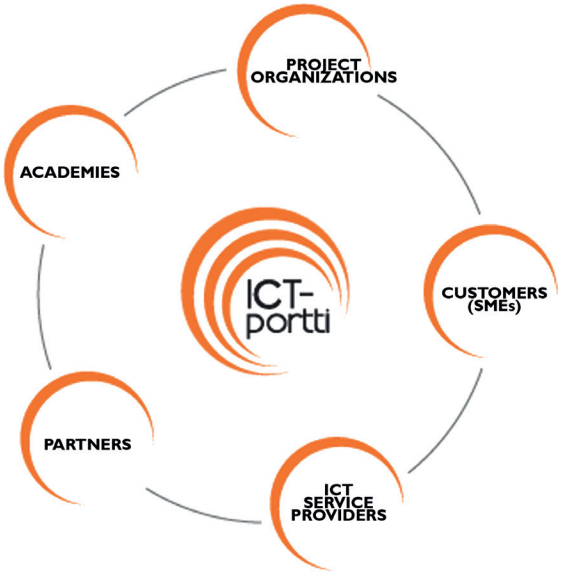


FIGURE 1. *Organisations in ICT-portti.*

HISTORY

The ICT industry is a demanding industry where continuous development takes place. The technology in use and customer needs change quickly. The companies must keep track of ongoing development in the ICT industry. Especially small companies might have a lack of resources to keep in touch with all aspects of business. For universities it is very difficult to keep up the edge in the constantly changing and developing ICT sector. The curricula are often slow in responding to the changing needs in the economy and fail to anticipate the careers of tomorrow. Graduates strive to find quality employment in line with their studies. The solution for keeping up the edge is to modify the education to be more flexible to fill in the needs of the ICT sector. This is done by cooperating with ICT service providers, SMEs and regional operators.

Every company needs IT, even though in most cases tasks done with IT are not the core business of the company, but tools that support the core business. For example a hairdresser's core business is cutting and dyeing people's hair. That is where the money comes from. However, an entrepreneur needs IT for example to do the accounting, to design a website or an advertisement to attract more potential customers and so on. If an entrepreneur does not know how to use

PICTURE 1. *Students in ICT-portti.*

the necessary IT to implement these tasks, it takes a lot of time to learn these things (and usually poorly, not efficiently).

These are the reasons for setting up the ICT-portti project. ICT-portti was initiated in the beginning of 2009 and the feedback from customers has been very supporting and satisfying. Work assignments vary from specification on information systems to supporting initialisations of new applications and designing and implementing websites. All of the assignments are customised based on customers' needs.

ICT-portti I (2009–2011) was funded by European Social funding. ICT-portti II (2011–2013) is currently funded by the Technology Industry's 100-year association. In the long run, the aim is to institutionalise ICT-portti in Turku University of Applied Sciences and the University of Turku.

METHODOLOGY

The ICT-portti model is based on the learning by doing method. Students use the information gained in theory classes to resolve troublesome assignments given by customers. Customers learn to use technology more efficiently during the projects. Teachers and ICT service providers collaborate in order to put the experiences gained in customer projects into teaching to ensure that the ICT education meets the requirements of business life.

The novelty of the project is to be an interface between universities, SMEs and ICT sector. At the moment students have different kinds of work placements, where they might learn some interpersonal skills. Universities also do different

kinds of projects in cooperation with regional enterprises. However, the benefit from utilising the gained experiences is not evident. The overall process where gained experience is put into teaching is missing in most cases. The project adds co-operation between educational institutions and business life, eases graduates' transition into working life, eases companies' recruitment of new employees and includes industry needs in teaching.

RESULTS AND FUTURE

During the years 2009–2011 10 teachers, over 300 students and several ICT service providers implemented 76 customer projects in ICT-portti. During the project ICT-portti has built up a strong network of regional ICT service providers. ICT-portti has organised events for the network, where for example a big ICT company has found a regional subcontractor of which they did not know before the event. Also some students have been hired to work in an ICT company after a successful project. The feedback of the participants is on such good level that it is definitely worthwhile to develop and improve the ICT-portti model regionally and globally. At the moment, the project plan is to disseminate the results to Poland, Portugal and Germany.

Productising and institutionalising the ICT-portti model at Turku University of Applied Sciences and the University of Turku is the main goal to ensure that the results of the project will not be wasted. In fall 2011, ICT-portti and other learning environments got permanent premises at Turku University of Applied Sciences. This is one factor that reinforces the goal. The co-operation with regional operators such as entrepreneur associations is also constantly maintained.

In Europe more than 99% of the companies are SMEs of which the majority need to improve their technical skills to use IT more efficiently. If the time used on struggling with problems related to IT would be significantly less, companies would have more time to concentrate on their core business. This will lead to better well-being in working life, more efficient working habits and more productive business. In the aspect of constant development, it is fair to say that a lot of work is still ahead.

Knowledge work, as a phenomenon and profession as we know it today, is much more than using tools and techniques. ICT experts must be prepared to meet the individuals behind any intellectual and target-oriented human action. This requires more emphasis on individuals and attitudinal competencies. These are the things that we are focusing on in a new kind of learning environment.

ENHANCING FACULTY COMPETENCES

ENHANCING ACTIVE LEARNING

Juha Kontio

INTRODUCTION

According to a recent OECD publication, about 27 per cent of students enrolling to higher education institutes leave without a degree in Finland [1]. There are many different risk factors affecting student withdrawal [2-5]. Identified risk factors are for instance: low motivation [2], poor quality of the student experience [4] and lack of commitment to educational objectives [5]. Students expect to have interesting and challenging courses. Furthermore, students expect to have versatile teaching with advanced learning methods. [6]

One of the basic requirements of the CDIO initiative is to make engineering more interesting, to increase students' motivation and retention [7]. Active learning is one answer to support this. Standard 8 of the CDIO initiative focuses on active learning. It defines that teaching and learning should be based on active and experiential learning methods. Active learning methods engage students in activities that support a deeper approach to learning. [8] The standard describes what this means and rationalises the use of the following active and experiential learning methods:

- ***Description***: Active learning methods engage students directly in thinking and problem solving activities. There is less emphasis on passive transmission of information, and more on engaging students in manipulating, applying, analysing, and evaluating ideas. Active learning in lecture-based courses can include such methods as partner and small-group discussions, demonstrations, debates, concept questions, and feedback from students about what they are learning. Active learning is considered *experiential* when students take roles that simulate professional engineering practice, for example, design-build projects, simulations, and case studies.

- ***Rationale***: Students remember less than a fourth of what they hear and only about half of what they see and hear. By engaging students in thinking about concepts, particularly new ideas, and requiring some kind of overt response, students not only learn more, but they recognise for themselves what and how they learn. This process of metacognition helps to increase students' motivation to achieve programme learning outcomes and form habits of lifelong learning. With active learning methods, instructors can help students make connections among the key concepts and facilitate the application of this knowledge to new settings.

The Faculty of Telecommunication and e-Business at Turku University of Applied Sciences wanted to enhance the use of active experiential teaching and learning methods and to lower the risk factors of student withdrawal. Therefore a training programme was started autumn 2008.

THE ACTIVE LEARNING TRAINING PROGRAMME

The training programme was designed to support and enhance our faculty in the use of active and experiential learning methods. The main aim of the training was to learn new methods for active and experiental learning. In addition, the training aimed at new viewpoints for the teacher's role, new tools for assessing active learning and concrete and practical ideas for instant use in teaching. Altogether 55 teachers participated in the training. The training had four contact days and between the contact days study groups of four to six teachers were supposed to work with the agreed topics. There were altogether 10 study groups which all had a different study and development focus. The focus of each group was supposed to be as concrete as possible. The aim was that the study groups actively test and try the ideas they are working on in their teaching. During the four contact days several active learning methods were studied (Table 1).

TABLE 1. *Studied active learning methods.*

Method	Short description
Creative problem solving: 8 * 8	• the problem is written on a paper and around this paper eight papers are set • in each of these eight papers a viewpoint rising from the problem is written • after the viewpoints are set, eight ideas are generated from each viewpoint
Creative problem solving: brainstorming	• every member of the group writes an idea on a paper and puts the paper on the table to his/her right side • this continues as long as new ideas come to mind • when new ideas are finished, you take the first paper from the pile on your left side and develop this idea further and put the paper to your right side on top of the pile • at the end the idea papers are sorted and assessed • the rotation of the idea papers is meant to give new views to idea generation
Gallery walking	• a form of cooperative group work • makes free riding quite difficult • there are home groups and walking groups • one topic is learned in each home group and a poster is prepared • each walking group consists of one member from each home group • the posters are set up in a "gallery" and walking groups study each poster one by one • each student teaches his/her own group's poster to other members of the walking group • at the end the results are discussed and unclear topics are clarified
Puzzle	• cooperative group work • basic idea is presented in Figure 1
6-3-5 method	• also known as brainwriting [9] • with this method 108 new ideas can be generated • a group of six people writes three ideas in five minutes • the papers are forwarded to the next member of the group, who reads the papers and adds three new ideas in the next five minutes • the papers are circulated every five minutes until the round is finished

Debate	• effective way to support information adoption and usage • traditional debate is the most common form of debate in education • phases of traditional debate are the following - chairman, secretary, referees, two teams of debaters and public are selected - theme of the debate is selected; one team is against it and the other team for it - teams prepare their arguments - debates last 10 to 20 minutes and each address is 1 to 3 minutes (both sides have the same amount of time to speak) - at the end of the debate closing speeches are given - finally the referees assess which team won (based on relevance of arguments, presentation, entertainments and credibility)
Six hats [10]	• the idea of six different hats is to have six different viewpoints and roles in looking at the problem • the six hats are - white – "let's look at this objectively" - red – "let's listen to our feelings and intuition" - black – "let's look at the risks and weak points" - yellow – "let's think about the advantages" - green – "let's develop new ideas, let's fool around" - blue – "let's think how we have progressed so far and how we should continue towards the goal" • there are three different ways to use this method - In a group with all hats in use at the same time - In a group with one hat in use at the same time - By yourself

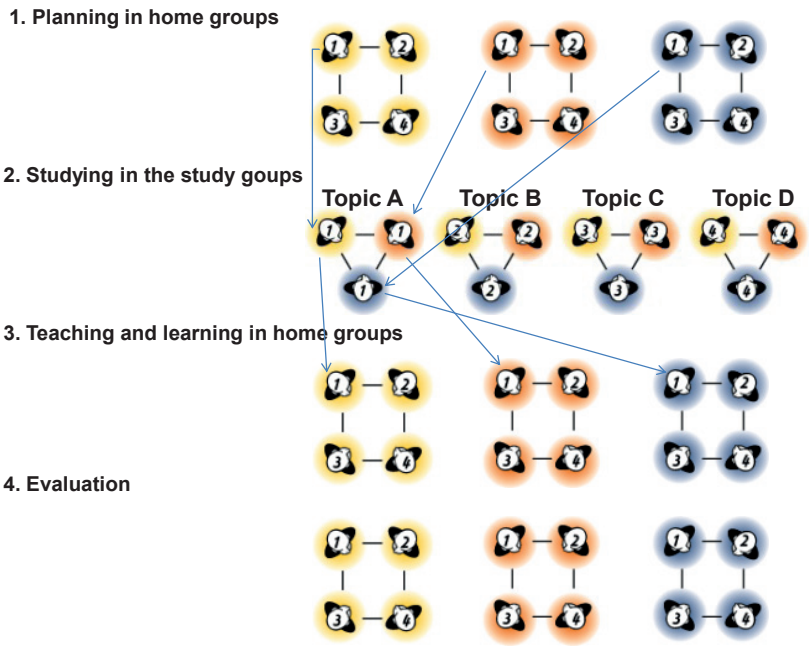


FIGURE 1. *Puzzle method.*

DISCUSSION

The training programme was quite intensive and suffered a little from the other responsibilities the faculty had parallel to the training. Still, the faculty was very active and committed to the training as the results described earlier showed. The training resulted in new ideas and plans to implement teaching. Some of the plans are already tested and some are still to come. Besides the information on active learning, the training provided time for discussion and networking for faculty members. The training has initiated several discussions over pedagogical choices and solutions.

The active learning methods learned were not totally new to our faculty, but this training refreshed the methods in our minds and hopefully encouraged our faculty to use these methods more. A very helpful matter was that the training was arranged in a way where we studied the active learning methods with active learning methods. While learning active learning methods we

gained experience from these methods at the same time. This teaching method worked for us because the level of knowledge on active learning methods was quite good at the beginning.

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INTRODUCING PROBLEM-BASED LEARNING PEDAGOGY – A CHALLENGE TO FACULTY MEMBERS

Janne Roslöf & Raija Tuohi

In autumn 2002, Turku University of Applied Sciences announced additional project financing for developing and implementing new pedagogical methods. The teachers in the Degree Programme in Information Technology applied for this financing to launch a problem-based learning (PBL) pilot. The financial support was received and the first PBL implementation was decided to be started in autumn semester 2003. Many practical challenges were set forth: which teachers would start with PBL, which student groups would do PBL and when, how to plan the schedule, how to assess, and how to start applying PBL in the first place? This led to a faculty competence development programme that, actually, turned out to become the starting point of a major change process for the years to come.

FROM IDEAS TO IMPLEMENTATION AND COMPETENCE DEVELOPMENT

Traditionally, co-operation between the teachers had mainly concentrated on planning the curriculum. The teachers worked at their own offices, held lectures on their core subjects and disciplines and talked different jargons. They usually met each other monthly in a staff meeting. Of course, some of them had daily chats in the coffee room during the breaks, but they had no regularly planned gatherings in order to discuss, for example, learning and teaching methods or assessment policies.

To begin with, the main issue was to strike a chord with the teachers and to find examples of PBL implementation. For this reason, other Finnish degree programmes using PBL were benchmarked. Two interesting PBL implementations were identified; one in Lahti and another in Jyväskylä. The representatives of those PBL practitioners were invited to Turku to a half-day seminar. They were enthusiastic about PBL, accepted the invitation and gave exhilarating lectures about their experiences. The speakers showed examples of their learning assignments and pictures of students unravelling them and, for instance, building different prototypes and gadgets. This seminar had a major influence on the opinion among the teachers. It was important that they were exposed to PBL by other teachers in a field close to their own. The whole idea about trying PBL became plausible with these real examples.

After the seminar a six-day tailored training course in PBL started in April and ended in August 2003. In total, twelve teachers attended the course organised by leading Finnish PBL researchers and practitioners. During this course the teachers planned the forthcoming PBL pilot. They had to co-operate to make a continuum from the learning assignments. They wrote and rewrote assignments and asked for each other's help. They also made the decision to start the PBL with all new students simultaneously, not only with one or two selected groups. Also, a guide for tutors was written to keep the basic facts and rules in mind. The tutors had, and actually still have, weekly meetings in order to discuss their experiences and support each other as well as agree upon the same rules, for example, in assessment.

It was not difficult to find teachers who were willing to tutor PBL teams. Still, the first year made the tutors understand that they need more knowledge in tutoring. So, in summer 2004, after the first PBL year, ten teachers travelled to Aarhus University in Denmark for a three-day training course in tutoring. Even in summer 2005 an additional training course in tutoring was tailored for the teachers.

SMALL STEPS TOWARDS A CULTURAL CHANGE

This process meant a radical change in the role of the traditional teacher and it did not happen in a year or two. Actually, a change in the entire degree programme culture was needed. Today, after several years of practising the art, there is yet much to learn and develop in the way of utilising different active

learning and teaching methods; with PBL as one of them. It is also clear that there are teachers who are not quite sure if they are doing the right thing, and if, for example, PBL really is a good way of learning. However, the teachers spend much more time and effort in discussing these topics together and contribute to the continuous development than they used to do ten years ago.

FIGURE 1. *A group of teachers studying the Lego Mindstorms® robotics platform that is utilised on a PBL course in Product Development.*

After all, applying PBL was started at short notice. Many actions had to be taken without any experience. Problems had to be solved with scarce resources, especially time. The teachers wondered if the right decisions were made. In general, how is it ever possible to make these types of changes in the right direction? Much has changed since the first pilot, and the latest (but for sure not last) major modification in the PBL implementation was made in spring 2011. To enable continuous development, the tutors' and students' opinions have been asked each year using forms with the following types of questions:

Which things have functioned well? Which things should be handled in a different way next year? How? Which learning assignments have served well and why did they serve well? How could we make a perfect assessment system?

The answers have been collected and disseminated to all teachers before an annual evaluation meeting. In this meeting the results are discussed and the changes to the previous practice are decided. These evaluation meetings have led to modifications in the curriculum, class room schedules, the number of student teams, the number of tutors, learning assignments and the assessment process. The tutor teachers have a central role in making the decisions and following through the reforms. They need to know how to handle the situations and what kind of experience the other PBL implementations have brought. So, the tutors have had additional training courses and some of them have attended international conferences and contributed to the global development of engineering education, too.

One pedagogic goal at the universities of applied sciences in Finland, and perhaps at the higher education institutions in general, is learning to learn. The students should learn to be capable of collaborative learning and knowledge-sharing in teams and future professional communities. They should learn how to plan, organise and develop their own actions. In order to reach these goals, it is obvious that a fundamental change in the role of teachers was and is needed. This change can take decades.

COMPETENCES, LEARNING OUTCOMES AND ASSESSMENT

Raija Tuohi

SYSTEMATIC DEVELOPMENT OF CURRICULA

Curriculums have been developed systematically according to CDIO principles. Table 1 shows this history.

TABLE 1. *Short history of curriculum development.*

Year	Main objective	Detailed objectives
2008	Assessment analysis	Assessment analysis, first introductory course implementations, planning new design-build packages in curricula
2009	Active learning	Active learning training for teachers, CDIO Fall meeting in Turku
2010	Learning outcomes and assessment	Learning outcomes – training for teachers, improve learning outcomes in curricula, from competences to assessment training for teachers
2011	Integrated curriculum	Assessment seminars, write clear assessment criteria in implementation plans, align competences, activity and assessment

Assessment methods and principles were analysed during 2007 and 2008. The results of analysis were published in a report (Gylen et al. 2008) which suggested the following actions to be taken:

1. Learning outcomes of courses should be defined and combined with the competences which are already published in the form of a matrix in curricula.

2. The methods of assessment and grading need to be defined in the implementation plans of courses in a clear way.
3. Assessment criteria need to be discussed and written down.

LEARNING OUTCOMES

All faculty teachers attended a learning outcomes course in the beginning of 2010. After the course, the teachers wrote new learning outcomes for their courses. New course descriptions are seen in 2010–2014 and later curriculums.

The learning outcomes in course descriptions are all started with the phrase: "After having completed the course a student can". It is followed by bullet points listing all the things a student is expected to be able to do after having finished the course. It was stressed that the learning outcomes should be easily understandable and assessable. In Figure 1, an example about learning outcomes of 3 Credit course is presented.

Study module	Physics 1
Extent	3.00
Objectives	After completing the course, a student can • calculate normal forces acting to a particle at circular motion. • apply circular motion to a path of satellite. • calculate electric forces acting on charged particle. • solve magnitude of electric field and electric potential formed by a point charge. • calculate a voltage caused by uniform electric field and by electric potential. • avoid problems that electrostatics might cause to hardware.
Contents	Circular motion, gravity, Coulomb´s law, electric field, electric potential, Gauss´s law, capacitance
Assessment	Assessment in the scale 0–5

FIGURE 1. *An example of learning outcomes of a course in curriculum.*

A feedback team of two teachers and three students studied the new learning outcomes and gave written feedback about readability (a suitable amount of learning outcomes per course), visibility of the core content and easiness of assessment. A teacher was asked to diminish the amount of learning outcomes if for example there were more than eight outcomes in a three-credit course.

COMPETENCES

The feedback team tried to find out *the courses' core content* by reading the learning outcomes. *Generic competences* defined by a national team of representatives of Universities of Applied Sciences in Finland (Arene 2006) and *subject-specific competences* defined by programme-specific teams (Arene 2006–2007) had been integrated to curriculums already in 2008 in the form of a matrix. Figure 2 shows the competence matrix of first year studies in the curriculum 2010–2014 of the Degree Programme in Information Technology. In curricula 2010 also yearly themes were introduced in order to make it easier for students to plan their studies and understand how the knowledge, skills and competence is expected to be achieved during the study years. In Figure 2, the first six competences are generic and the last eleven competences are programme-specific. Generic and programme-specific competences were expected to be included in the learning outcomes. Some feedback was given to teachers about forgetting the learning outcomes derived from generic competences shown in the competence matrix.

Yearly theme and competence goals

Degree Programme in Information Technology (Turku), NTIETS10

Common studies Digital Media Software Business Embedded Software Health Informatics

Yearly theme and competence goals

1st year (2010-2011) POWER USER (Operate)
- Technological and Scientific Foundation
The student is familiar with the most important technological and mathematical tools and is able to utilize her/his knowledge in problem solving. She/he can work in a project team, use modern ICT tools and applications efficiently and support others in using them.

2nd year (2011-2012) IMPLEMENTER (Implement)
3rd year (2012-2013) DESIGNER (Design)
4th year (2013-2014) DEVELOPER (Conceive)

Competence goals of the degree programme

Course unit	Extent	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
5051006 Open-source Software Applications	5									◆								
5051039 Electronics and Computer Design	7	Learning Competence						◆	◆									
5051047 English Foundation Course	3			◆			◆											
5051037 Physics	6		◆	◆	◆			◆	◆									
5051043 ICT Engineering	3		◆	◆		◆												
5051038 Mathematics	12							◆	◆	◆								
5051040 Software Design	9		◆	◆				◆		◆								
1001001 Study Skills and Professional Growth	2	◆	◆	◆		◆	◆											
5051025 Finnish Language and Communication	3	◆	◆	◆														
5051051 Data communication 1 / CCNA1: Network Fundamentals	4								◆									
5051028 English for Working Life	3	◆		◆			◆											
5051042 Product development	6			◆	◆				◆	◆	◆							
1st year (2010-2011) Total	63																	

1	Learning Competence	7	Mathematical and Scientific Skills	13	Digital Media: Proficiency in digital media services
2	Ethical Competence	8	Hardware Expertise	14	Digital Media: Proficiency in media technology
3	Communicative and Social Competence	9	Software Expertise	15	Software Business: Proficiency in SW Engineering Methods
4	Development Competence	10	Proficiency in ICT Business	16	Software Business: Proficiency in SW Engineering Processes
5	Organizational and Societal Competence	11	Health Informatics: Proficiency in healthcare and well-being	17	Embedded Software: Proficiency in SW Engineering in Embedded Systems
6	Internationalization Competence	12	Health Informatics: Information systems expertise		

FIGURE 2. *A competence matrix of the first year studies in the curriculum 2010-2014 of Degree Programme in Information Technology.*

ASSESSMENT

Every learning outcome should be *easily assessed*. It should also be easy for students to check/reflect if he/she is able to give evidence about having acquired a learning outcome. The verbs used in learning outcomes can be chosen for example from a paper by Moon (Moon 2005). Learning outcomes such as "a student is aware of…" or "during the course a student gets the idea of…" lead to regard a student as a passive person who only needs to be and let the teacher infect him/her with knowledge, skills and attitudes. This is really against CDIO principles according to which students' active role should be highlighted.

Writing *assessment criteria* and connecting them to learning outcomes and assessment methods is under work in 2011. Teachers have attended two assessment seminars during 2010 and in April 2011 the teachers had workshops on writing assessment criteria. The teachers, having planned a course together, could sit and plan assessment criteria for the course or at least get the work started. It was asked that every teacher writes assessment criteria at least to one of his/her courses by May 2011. Some teachers have already written criteria to all of their courses and have also tried to use them. Experiences have been discussed and also new assessment methods have been found and developed.

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A FIELD TRIP TO PROFESSIONAL DEVELOPMENT – ICT PROF

Tiina Suni

The CDIO approach emphasises the importance of promoting the development of teachers' professional expertise by strengthening the connections to working life (CDIO 2010). According to the initiative, the working life relations are regarded as important from two perspectives. Firstly, the close interaction between higher education institutions (HEIs) and companies promotes the curriculum development process by fostering the linkage between the competence requirements of working life and the teaching contents. Secondly, the cooperation between companies and HEIs further promotes teachers' professional development by equipping the teaching personnel with information on the latest technology, techniques and knowledge. Yet the development of the teachers' professional expertise is considered as important, however the possibilities of maintaining and developing these skills may vary in HEIs (Malmqvist et. al. 2008).

In order to promote teachers' professional development, the *ICT Prof* project was launched in our faculty during the spring term 2006. The main goal of the project was to upgrade the teachers' knowledge on working life practices and processes. In addition, the project initiative aimed at promoting educational development and teaching practices by renewing the curricula with the latest knowledge in the field. Furthermore, the project activities were aimed at strengthening the interactive relations between working life organisations and our HEI, which would further support cooperative activities for example on the R&D sector. The project was funded by European Social Fund with the total budget of 385 000 Euros. The project was implemented in close cooperation with the Faculty of Telecommunication and e-Business and the Faculty of Health Care. (Holma et. al. 2008)

During the project, altogether twenty-three teachers from the two participating faculties worked in real-life companies and organisations for a three-month period. According to the project plan, the teachers were responsible for searching

the suitable organisation and negotiating the further details of the training period, including the job description, schedule and other practical issues. The project activity plan allowed the teachers to accomplish the training period either in a company or in a public sector organisation including third sector organisations and foundations. The partner organisation types are demonstrated in the Figure 1. To mention some partner companies, the training periods were performed e.g. at Nokia, Microsoft, Oracle, Teleste and Fujitsu.

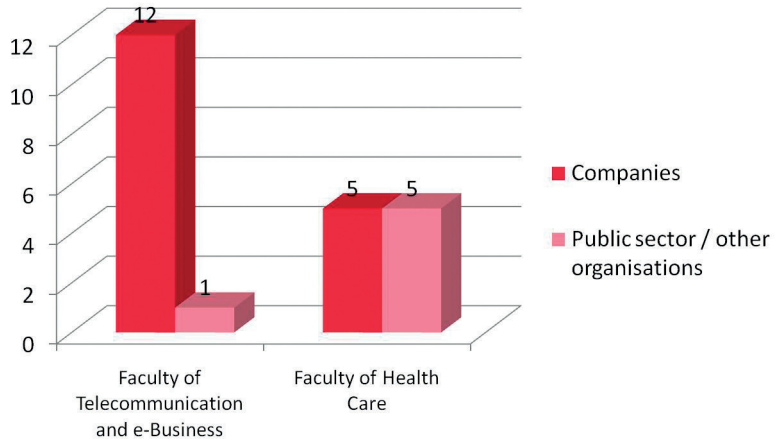

FIGURE 1. *The partner organisations of the working life periods.*

The main criteria for selecting the partner companies were the teacher's personal interests on professional development and the needs for upgrading the professional skills. Since the project resources were limited to a certain amount of working life periods, the teachers with long-lasting work history in the university were preferred in the selection process.

According to the project plan, the teachers were free from their normal responsibilities on teaching, tutoring and other duties in the university during the working life period. Thus, this arrangement allowed the teachers to concentrate exclusively on the project without other obligations. At the same time, the project defrayed the teachers' salary expenses as a whole, which in practice relieved the partner companies of financial commitments to the project cooperation. However, it was recommended to every partner

organisation to nominate a contact person whose main responsibility was to act as a tutor for the teacher during the training period. A special agreement, which further specified the details and contents of the period, was established and signed by the partners.

The results of the project are promising. According to the teachers, the periods in companies increased their professional and practical know-how, promoted their professional development and equipped them with the latest information on technological solutions. In addition, the project supported the teachers' occupational identity and deepened the understanding on competence requirements of the future professionals of the field. In addition, the project challenged the teachers to evaluate their own professional skills, which is further reflected in the teachers' activities on professional development. This was reflected for example in increased initiatives on further education and research.

The working life periods have also promoted the curriculum development processes. Due to the project, the teachers reported on introducing new course materials, renewing the course contents and applying new teaching methods. Besides this, the training periods supported networking activities and promoted teachers' personal contacts to the companies. After the project, the results can be seen as an increased amount of cooperation initiatives e.g. on R&D projects and experts exchange. (Kontio & Suni 2008.) According to a small-scale survey on the project results among the teachers, the project implementation has promoted for example the following areas (Figure 2).

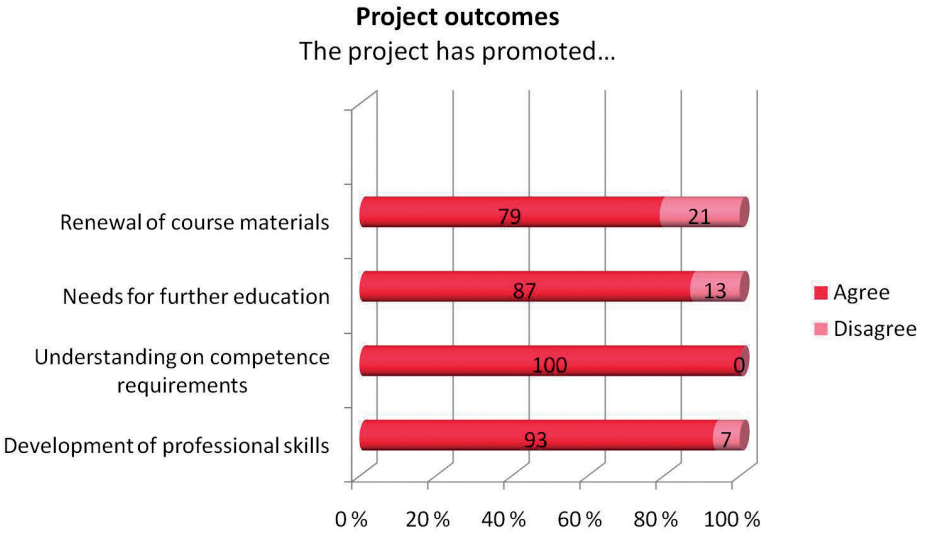

FIGURE 2. *Project outcomes.*

Regarding the CDIO framework, the cooperation between companies and higher education institutions by practical working life periods supports the development of education and promotes the professional expertise of the teachers. Since these activities are of great importance in the process of educational development, the communication between HEIs and real-life companies should be further supported by finding new solutions to promoting cooperation in practice. Although such close cooperation requires long-term commitment and efforts, this aspect should be further discussed and considered in the processes of educational development in HEIs.

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