USING CDIO METHODOLOGY TO INTEGRATE DIGITAL COMPETENCIES IN TEACHER TRAINING

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ABSTRACT

This paper will point out that the CDIO principles and methodology can be used in another area then engineering education. CDIO has been used as a role model, in the LIKA-project for curricula development in teacher's education programs at four universities in Sweden. The objective with the LIKA-project is to integrate digital competencies in all teachers' education programs. The LIKA project looks upon digital competencies as processes for Learning, Information, Communication and Administration (LICA/LIKA). These processes need to be addressed from a didactical, technical and theoretical perspective. To assure the success of curricula development 10 key principles, like the ones outlined by CDIO, where accepted and signed by leaders of the participating university organisations. The experiences from the LIKA project could also be used as a feed-back to the CDIO community.

KEYWORDS

Teacher Education, Curricula Development, Application of CDIO, Digital Literacy, Digital Competencies, Learning Outcomes..

THE LIKA PROJECT – MAIN OBJECTIVES AND TARGET GROUPS

The main objective with this contribution is to report that the CDIO methodology [1], [2], [3] has been adapted to another field of higher education.

As a result of rapid changes in a digitalized society, an initiative was taken by the Swedish Knowledge Foundation (KKS) in 2005, with focus on ICT in Teacher training. KKS allocated 100 MSEK for projects during a period of sex years. The LIKA project was successful in the first call for proposals together with two other projects in Sweden to get funds for a project of six years of duration (2006 – 2011).

An inquiry from the Swedish Ministry of Education on a new teacher education programme was presented in December 2008 and the report is entitled Sustainable teacher education. [4] In the report, four overall perspectives have been found to be so essential that they should run through all teacher education.

These are: [4]
"- a scientific and critical approach
- a historical perspective
- an international perspective
- information and communications technology (ICT) as an educational resource.

All four perspectives are areas that need to be strengthened in teacher education.

ICT as an educational resource is an absolutely essential part of a teacher education programme attuned to the digitalization of society and school.

The implication of the inquiry will probably be that all teacher education programs in Sweden will be changed. The LIKA project is cited in the report, as an example of how to work with implementation of digital competence.

The LIKA project is a collaboration project between Royal Institute of Technology KTH, Royal College of Music in Stockholm KMH, Stockholm University SU and The Swedish School of Sport and Health Sciences GIH, all responsible for teacher education programs.

The project objective is to ensure digital competencies in teacher training. This requires a model for systematic curricula development. To be able to define and integrate ICT as a progressive part in programs and courses throughout the education, CDIO is used as a model and guideline. Newly examined teacher students have to have a tool box and a wide repertoire of pedagogic ideas about how to utilize ICT in their work at schools. This includes planning, executing and evaluating learning processes with digital tools. [5]

Project Target groups are: (i) Teacher educators, (ii) Teacher students, and (iii) In-service teachers in partner schools working as mentors for teacher students during periods of practice.

To reach the objectives, key activities in the LIKA project has been defined. These are program and course development, methodological development, access to research and experts in the field of ICT and learning, training for teacher educators, implementation processes, and evaluation and disseminate results.

LEARNING OUTCOMES AS A BASE FOR DESCRIBING PROGRAMS, COURSE OBJECTIVES AND EXAMINATION REQUIREMENTS

Around the world, the development of higher education is ongoing, to meet new demands from society and industry. Swedish universities are heavily influenced by what happens globally and now primarily in Europe through the so-called Bologna process. There are new and clearer requirements on higher education leading to employment in a profession and students should be able to be globally mobile both during their training and in the future professional life. Within the engineering field, this is significant, while primary and secondary school teachers, is still characterized by a more local relevance.

Both engineering and teacher training are leading to a professional degree. These degrees are regulated in Swedish Higher Education Ordinance system, where the examination requirements are formulated in the so-called Learning Outcomes, LO.

As support for the formulation of LO national authorities, accreditations bodies and various interest groups has formulated requirements for knowledge, skills and attitudes.

Examples from the engineering field are:
- Australian Council for Educational research ACER [6]
- ABET2000 in the U.S [7]
- Washington Accord [8]
- EUR-ACE labels [9]
- Tuning project [10]
- Dublin Descriptors [11]
- Engineering Subject Centre UK [12]
- CDIO initiative [1].

All these examples are trying to define and produce conceptual frameworks of expected desired learning outcomes in the field of engineering. These examples also assume that the goals of higher education should be formulated in Learning Outcomes.

ADAPTION OF THE CDIO PRINCIPLES INTO THE LIKA PROJECT

As stated earlier, one of the key activities, within the LIKA project is the work with a systematic integration of digital competencies in programs and courses.

Programs and courses have been put through a due diligence process, to define why, what, where and how digital competencies should be integrated as progressive generic and transferable skills. [13]

The CDIO method serves as a guideline in this work. It is not to be used as a blue print but as a methodology and a structured model to support the implementation work in the context of the LIKA project. [14]

The objective with the LIKA project is to ensure that teacher student graduates has proficient competence to use ICT in a broad sense to enhance learning in all K12 school settings. The Swedish Curriculum for the compulsory school system states that teachers should "prepare the pupils for participating in and sharing the joint responsibilities, rights and obligations that characterize a democratic society." [15] In order to take active part in society of today, citizens must be equipped with the digital competencies a digitalized society requires. Hence, the LIKA project stresses digital competencies, on a societal, institutional and individual level.

How does the CDIO syllabus [1], treat ICT competencies?

In the CDIO syllabus the generic skills are defined in two main categories;
- personal and professional skills and attitudes
- interpersonal skills: teamwork and communication

The two main categories have then an underling structure in two levels with more detailed formulated generic skills. In total the CDIO syllabus contain approximately 40 generic skills.

To what extend does the CDIO syllabus cover digital competencies, digital literacy, information literacy or ICT skills either as personal, professional or interpersonal skills? Just a few will explicit point out these competencies. For example in 2.2.2 Survey of Print and Electronic Literature CDIO point out *"information search and identification using library tools (on-line catalogs, databases, search engines)"* and in 3.2.4 Electronic/multimedia Communication *"Preparing electronic presentations, norms associated with the use of e-mail, voice mail, and videoconferencing. Various electronic styles (charts, web etc)"*

In many others, digital competencies is implicit a requirement for fulfilling the learning outcome. For example in 2.1.2 Modeling. *"Mostly all modeling and simulations, requires skills to use computers in one or another way, which implicit needs some digital competencies of the user."*

CDIO CONTRIBUTION FOR DEVELOPMENT OF A LIKA MATRIX

One important contribution from KTH into the LIKA project is the use of the CDIO model. The experiences KTH has from the CDIO work has largely inspired and formed the LIKA project. The work with identifying and integrating digital competencies in teacher training requires program and course analyses and development. The CDIO method serves as a guideline for this work within the LIKA project, meaning that program and courses has to be put through a translucent process which aligns with the method process used in the LIKA project.

The Swedish School of Sport and Health Sciences (GIH) has during the last 15 month (Sept 07 – Dec 08) carried out a rewriting process where all courses, 16 in a total, in the Teacher Education Program. This work has been done in parallel to the Bologna process work to gain synergy effects and to stress the importance of seeing digital competencies as a generic skill that needs to be examined during teacher training. In parallel to the processing of the curriculum, the project has worked out a syllabus and a matrix, meant to serve as support for systematic integration work. The LIKA syllabus and matrix are dynamic and changing as digital competences are defined and developed. It provides opportunities for faculty members to identify the progression of competence as knowledge are and skills are tagged as generic or specific and to see where they are introduced, examined and applied.
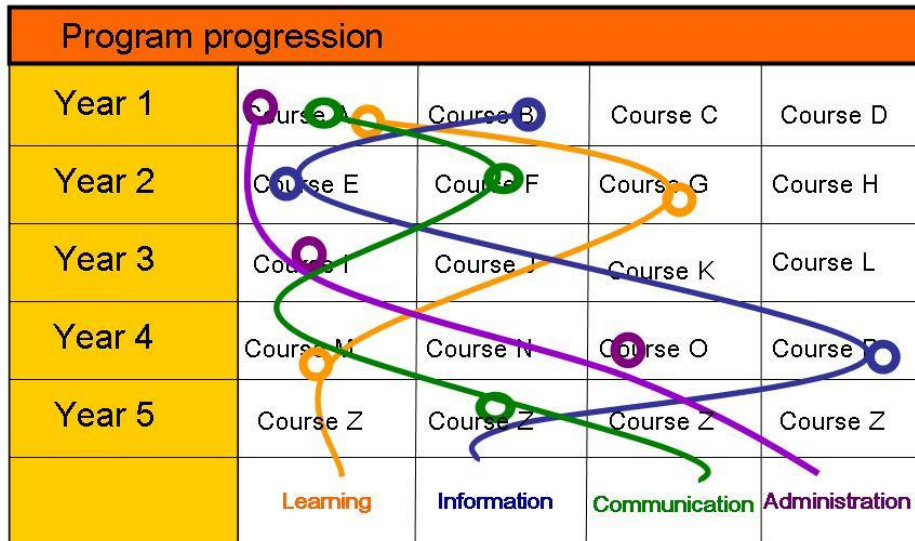

Figure 1, Systematic Integration

The LIKA matrix

The LIKA project looks upon competences as representation of a dynamic combination of knowledge, understanding, skills, abilities, judgment and approach.

Skills are abilities formed in learning activities which can be divided into 'subject specific' and 'generic'. All skills range from a low to a high level.

I.e. *Low:* discuss, explain, describe, tell, etc.

High: rank, create, show, design, decide, analyze, etc.

Skills listed below in the matrix are interchangeable due to the technological development and the rapid change in society.

The progression has to be planned within each educational program.

Table 1 The LIKA Matrix Digital Competence in a Technical Perspective

Digital competence	Learning processes	Information processes	Communication processes	Administration processes
Technical competence *A digital technical competence implies that teachers can decide when and what digital tool to use in a pedagogic environment. The person should have technical skills and be continually updated within this area.*	**Skills* (examples)** Virtual formal and informal learning environment settings Digital portfolio DV cams Film editing Games Hart rate monitor Open Learning resources Wearable digital devices Reference library Simulations Software (Open source, Free ware, commercial programs) Virtual recourses Identifying and classifying tools Digital recycling	**Skills* (examples)** Search engines Search tools Databases, statistical and science databases Webb publishing Webb design Creative commons and other Search techniques Advanced Web design Advanced databases Data mark-up (xml) Legal aspects Ethical aspects	**Skills* (examples)** Collaborative online communication environments Collaborative online writing tools Community systems Digital environments PLE/LMS Legal and ethical aspects Mobile communication Communication tools and options for collaborative work Information security aspects Legal and ethical aspects	**Skills* (examples)** Administrative programs Collaborative online documentation Systems for administration, like schedule, registering absence, grading, assessment System and tools for shared documentation Legal and ethical aspects Administrative programs Information security Risk analysis Legal and ethical aspects

Table 2 The LIKA Matrix Digital Competence in a Didactical/Pedagogical Perspective

Digital competence	Learning processes	Information processes	Communication processes	Administration processes
Didactic pedagogical competence *A digital didactic pedagogical competence is to be able to judge when, what, why and how ICT should be used as a pedagogic and methodological support for learning.* *Teachers should be able to choose methods and digital tools suitable to the content, environment and the context.*	**Skills* (examples)** Use of digital tools and learning objects to support teaching, learning and pedagogic development. ICT support for learning (write, read, communicate, explore) Information grows into knowledge Examination forms Multimedia/modal creating Creative production Reproduction, meta-cognition Adaptation to learning styles Experiential learning Adaptation/including Interactive learning Choosing form of examination adapted to own teaching model	**Skills* (examples)** Who is the owner of texts, pictures etc. Be conscious about the need of analysis of the sources Information search Discussions about citations vs. plagiarism, cutting and pasting Adapt teaching about analysis of the sources to different student ages Applying analysis of the sources on the Web	**Skills* (examples)** Digital social competence, like netiquette, norms, communication codes Women's and men's language Mechanisms within interactive and asynchronous communication Communication ethics, like what to disseminate or not, bullying Consequences of internationalizing and globalization Distance education International collaboration Presentation and communication through digital media The use a communication platform Planning teaching when a communication platform is used Adaptation of communication to disabled students Individualization	**Skills* (examples)** Administrative ICT routines Digital archives Digital documentation of students learning processes and results Digital grading Adapt/adopt digital documentation for specific needs

Table 3 The LIKA Matrix Digital Competence in a Theoretical Perspective

Digital competence	Learning processes	Information processes	Communication processes	Administration processes
Theoretic competence *A digital theoretic competence implies that teachers has knowledge about ICT-pedagogic theories and methods for teaching and learning, and is able to value how a different theoretical aspect affects practical professional pedagogic activities. A digital theoretic competence also requires knowledge about research within the field of ICT and learning.*	**Skills* (examples)** Learning theories Theories about computer-supported collaborative and multimodal learning, Theories about hyper-textual (non-linear) thinking ICT in multidisciplinary, interdisciplinary and research based learning environment	**Skills* (examples)** Information theories Theories about computer-supported information-searching Theories about valuing information The principle of public access to official documents Information theories Value theories	**Skills* (examples)** Communication theories Theories about children's and youths' communication Theories about children's and youth's development Applied theoretical discussion	**Skills* (examples)** Organization theories Activity theories Theories about monitoring systems

The table 4 is used as a work sheet to ensure a progressive integration of digital competencies in courses at The Swedish School of Sport and Health Sciences.

Table 4 The LIKA Work Sheet

Perspective Digital competence	Processes L I C A	Course	Learning Outcomes	Progression
Technical competence	**Skills* (examples)**	X1	Formulate by: Knowledge and understanding Skill and ability Attitude and approach	Course X1 Course X2 Course X3 Course Z1
Didactical Competence				
Theoretical Competence				

Examples

Progression for learning processes from a technical and didactical perspective

Student graduates will be able to apply the soft and hardware for motion analysis, and show the learning process influences from a didactic perspective.

Progression

Take down the progression forward and how can it be traced. (Example: X1-Z1 level)

After course X1, the student will be able to handle and apply the camcorder and transfer video to computer unit.

After course X2, the student will be able to apply and manage, and produce videos for motion analysis and to demonstrate analytical ability. The student should be able to describe the specific responsibilities of teachers for students' privacy protection in relation to video recording and photography.

After course X3, the student will be able to plan and assess and show in what context, video and video analysis can enhance individual and group learning processes.

After course Z1, the student will be able to create, asses and analyze the effects of video and motion analysis programs in a situated learning context, from a didactical perspective.

DISCUSSION

CDIO principles and methodology focus on the development of engineering curricula with the objective to graduate engineers who can engineer. The CDIO syllabus has been designed so that knowledge, skills and attitudes can be formulated in learning outcomes. The learning methods of the engineering program and courses are designed to fulfil learning outcomes. The course design matrix has successfully been used to assure coverage, progression and assessment.

As shown in this paper, the CDIO principles and methodology is now used as a role model in teacher's education. The LIKA project has adopted and modified the CDIO principles and methodology to secure that digital competencies will described as learning outcomes, learned and assessed in all branches of teacher training.

GIH has advanced most in the review process of the curriculum for the specific purposes of making digital competence visible. Work is still in a initial stage and far from all who work with program and course development, use of the produced models. In contrast, the CDIO aroused great interest among teacher trainers, as methodological model and support .

The LIKA project has chosen to use the term digital competency as it grasps over a wider field than the more common used term digital literacy, which is more closely associated with text, reading and writing. In this respect, the work also highlights the difficulty of balancing between the general and the specific in formulating learning outcomes for generic knowledge, skills and attitudes.

It's too early to make any assessment on graduates, but the process is in place, major changes have been made and the implementation phase has started. Digital competency is on the agenda, which hopefully will lead to a more rapid change in the educational system, from pre schools to universities, to meat the demands of competencies formed by a digitalized society.

The process is ongoing and not just within the LIKA partner universities. LIKA also participates within the national network for ICT in Teacher Education and has a genuine interest in international collaboration to improve the knowledge in the field.

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GIH is the oldest University College in the world within its field, founded in 1813. The University College offers advanced degree programs and courses preparing for the teaching profession in Physical Education as well as for careers in Sports Coaching and Preventive Health. At present, about 650 students are enrolled.

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