

AIMING TO EDUCATE INNOVATIVE ENGINEERS

Dr. Liisa Kairisto-Mertanen, Dr. Olli Mertanen

Turku University of Applied Sciences, technology, environment and business;
Turku University of Applied Sciences
Federation of South-West coast universities of applied sciences in Finland

ABSTRACT

The way how work is done undergoes big changes in the future. It will not be enough to just merely follow the pre-set goals and use methods defined in advance. It is important to realize that one's competence is actually built in relation to others and it is used as part of a whole. Fewer and fewer jobs can be done in isolation. (Oivallus 2011.) This change means that a boundary crossing approach for instance in problem solving, service or product creation, research or organizational is needed (Lehto, Kairisto-Mertanen & Penttilä 2011).

The Turku University of Applied Sciences (TUAS) has developed a concept called innovation pedagogy which aims to give our students possibilities to educate themselves to be the innovative citizens of tomorrows learning organizations. The ultimate aim of innovation pedagogy is to reach the final learning outcomes, innovation competencies, which are related to the competencies possessed by the students when entering working life once having completed their degrees. (Kairisto-Mertanen & al. 2011; Kairisto-Mertanen & Mertanen 2012; Kairisto-Mertanen & al. 2012.)

This paper will present how the concept of innovation pedagogy contributes to the development of future engineers capable of engaging themselves in the requirements of "not-by-the-book-work" when innovations are needed. We also present innovation competencies which we have defined to include individual, interpersonal and networking aspects of the competencies. Finally we explain different methods to be applied when reaching these competencies.

KEYWORDS

Learning environment, innovation pedagogy, innovation competence, curricula development

INTRODUCTION

The world surrounding practically any university all around the world is under a constant change because of such issues as technical development, globalization, climate change and economic crises. The rate of this change accelerates on a speed never seen before. The availability of the Internet has brought knowledge and information to the reach of everybody having access to the network. Every possible piece of information needed for educating high level professionals is easily available. However, at the universities we still tend to educate students with traditional methods meant originally for a world, which is stable and emphasizes mainly learning of explicit knowledge. Methods better suited for a constantly

changing world focus on activating students in learning and include also unofficial and exceptional situations.

The way how work is done undergoes big changes in the future. Once our present students enter working life after the university they are most likely to find less and less situations where the goal of work and the methods to be used are pre-determined. Instead they will find themselves in situations where the methods to reach a goal are not carved in stone. Sometimes even the goal itself might be left open. This change requires new skills from university graduates, engineers among them. It becomes necessary to develop not only one's individual competences but even more importantly to realize that competences are actually built in relation to others and used as part of a whole. Fewer and fewer jobs are done in isolation. Working life is based on teams that work together to solve a problem or to create something new. (Oivallus 2011; Kairisto-Mertanen al. 2012; Kairisto-Mertanen & Mertanen 2007.)

The on-going change and new requirements set by different bodies mean that modern world is facing issues and challenges, which are becoming more and more difficult to address within the framework of a single method, be that a discipline or a profession. When aiming to create new innovations, which not have previously been thought about it becomes necessary to enhance creativity by crossing boundaries in problem solving, in service or product creation and in research or organizational team work. (Penttilä & al. 2012)

Also the engineering profession is undergoing big changes what comes to the requirements set for our young graduates. When entering working life they are facing the challenge of global environment, increasing competition, temporary working positions, demand to be innovative, capability to work in multi professional teams and an independent way of doing things. It is obvious that if their studies include elements preparing them for this kind of working life situations it is a benefit not only for them but for their employers as well.

Turku University of Applied Sciences is one of the big multidisciplinary universities of applied sciences in Finland. Its organization has been built in such a way that the faculties include not only engineering programs but other programs as well. This makes it possible to create a working environment which corresponds to the need of having multiple surfaces where different people studying totally different subject matters can meet. The way how studies are organized leaves the students space for individual choice and a practical way of engaging oneself with the different projects being carried out by the extensive research and development activities of the faculties. A lot of emphasis is put on creating a social learning environment which supports creativity and which is tolerant for new contacts to be made and new ideas to be born as it is known that innovations are best born in a special culture which includes freedom to think, equality and brotherhood.

INNOVATION PEDAGOGY

There are various definitions for an innovation which makes it important to define the concept when talking about them. An innovation can be defined as an idea, practice or object which is considered new by the people (Rogers 2003) or a solution which brings economic benefits (Sitra 2006). In Finland's national innovation strategy (Innovation Strategy 2008), an innovation is understood as a *competitive advantage* based on knowledge. In the context of innovation pedagogy, an *innovation is understood as the process of constantly improving knowledge, which leads to new sustainable ideas, products, further knowledge or other*

practices applicable in working life. (Lehto & al. 2011.) According to this definition in addition to a more traditional view an innovation can also be understood as a process which can be already existing but new in the circumstances where it is being applied.

The universities of applied sciences have a big role in developing a new generation of professionals whose conceptions of producing, adopting and utilizing knowledge make innovative thinking and creating added value possible (Lehto & al. 2011; Putkonen al. 2011.) Especially engineers are in a key position because they in many cases are the ones who make and design the ideas into a form which can be commercialized. A challenge is to integrate applied research and development, entrepreneurship and flexible curricula to meet the multi-field customer needs in regional and international networks. (Kettunen 2011) It has become necessary to develop learning and teaching processes so that they provide improved competences for the students and enable personal and professional growth. Learning is deeper when the previously gained knowledge is continuously applied in practical contexts. (Kairisto-Mertanen al. 2009.)

To a big extent the role of education has traditionally been to give knowledge-based readiness, which later would be applied to practice in various innovation processes in working life. Innovation pedagogy is a new approach to learning which introduces how the development of students' innovation skills from the very beginning of their studies can become possible. According to its definitions it is *a learning approach that defines in a new way how knowledge is assimilated, produced and used in a manner that can create sustainable innovations* (Kairisto-Mertanen al. 2010). It is a new strategic approach to learning – the innovation culture to be followed in the university. Innovation pedagogy contributes to the development of new generation of professionals whose conceptions of producing, adopting and utilizing knowledge make innovative thinking and creating added value possible. (Kairisto-Mertanen al. 2009.)

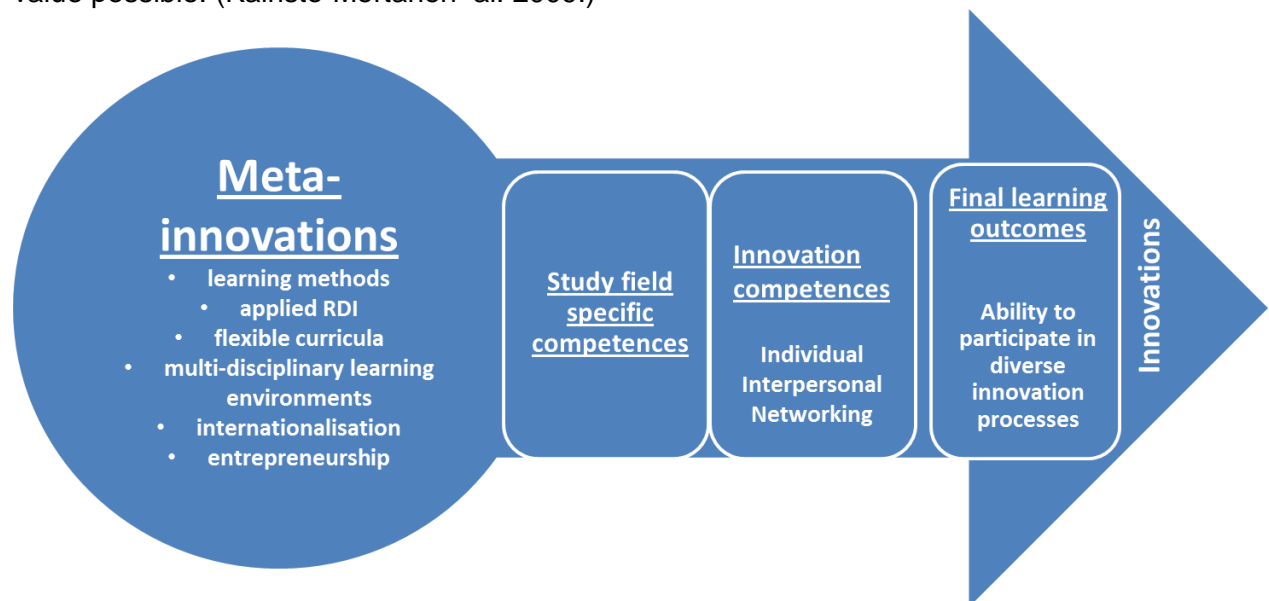


Figure 1. Methods, objectives and learning outcomes according to innovation pedagogy

As figure 1 shows the ultimate aim of innovation pedagogy is to reach the final learning outcomes which are related to the competencies possessed by the students when entering working life once having completed their degrees. The aim of the whole educational process is to equip students with the core competencies of their own subject matter and in addition to

that also prepare them to become active contributors in the different innovation processes they are facing when working as entrepreneurs or employees. (Harden 2002) To reach this goal it becomes essential to define the desired goals, knowledge, skills and attitudes, which refer to the learning outcomes related with the capability of being able to act innovatively. These learning outcomes are called *innovation competencies*.

The meta-innovations are essential requirements for innovation pedagogy to succeed and they must be developed and used so that the cornerstones of innovation pedagogy are enabled in the learning environment. The cornerstones, which are existing in all education delivered in TUAS include innovative learning and teaching methods, cross-disciplinary learning environment/boundary crossing, integrated and extensive research and development activities, flexible curricula, concentration of acknowledging the importance of entrepreneurship and service production and internationalization in the level of research, development and student engagement. The methods used target specially to contribute to the development of student's interpersonal and networking competencies.

INNOVATION COMPETENCIES

Learning outcomes are statements which are used to describe specifically what is expected from a learner related to understanding, knowledge and know-how at the end of a certain period of learning. They are broad statements of what is achieved and assessed at the end of the course of study. (Harden 2002, Buss 2008.) They represent an approach to education in which the decisions about the curriculum are driven by the outcomes the students should display by the end of the course. In outcome-based education, a product defines a process. The curriculum is being developed from the outcomes the students are wanted to demonstrate rather than writing objectives for the curriculum which already exists. A learning outcome is a written statement of intended and /or desired outcome to be manifested by student performance. (Spady 1988; Harden al. 1999; Proiz 2010.) The guidelines for defining learning outcomes recommend that they should be clearly observable and measurable. (Buss 2008.)

Innovation competencies are the learning outcomes which refer to knowledge, skills and attitudes needed for the innovation activities to be successful. The methods applied and the way how teachers and students interact constitute the basis for learning and thus enable the development of them. The methods used also facilitate intuitive and unexpected learning during the learning process and make transmitting of tacit knowledge possible when dealing with working life. In innovation pedagogy this kind of learning outcomes can manifest themselves in the format of intuitive and tacit learning which takes place in the learning situation. They can be e.g. experiences on cultural differences, on working at customer surface etc. The core idea in innovation pedagogy is to bridge the gap between the educational context and working life. Learning and teaching processes are developed so that they provide improved competences for the students and enable personal and professional growth. Learning is deeper when the previously gained knowledge is continuously applied to practical contexts. (Putkonen al. 2011.)

The outcomes cover both cognitive and practical skills and are divided into components consisting of cognitive, psychomotor and affective domains of an outcome. They can be called knowledge or understanding, skills and attitudes, feelings and motivation accordingly. The distinction among knowledge, skills and motivation is important because performance can be enhanced or inhibited by any one or all of these components. Learning outcomes are also guaranteed achievements which can be institutionalized and incorporated into practice.

The ownership of the outcomes represents a more student-centered approach. Students take responsibility for their own learning. (Harden 2002) As it is argued that learning outcome might not be suitable for every discipline of education, literature also speaks of emerging learning outcomes and thus leaves room for emergent ones which differ from the predetermined intended ones and make unexpected occasionally occurring learning possible. (Buss 2008.) The future curricula also in technical education calls for flexibility, ability to be rapidly modified and adapted to new circumstances, instead of fixed and strict structures. Curricula should be designed and developed in an open and network-based environment in order to observe societal development pressures emerging from the economy, to react to them, and to act in a value increasing way in national and global value chains. The circle of continuous improvement contributes not only to the continuous development of the included elements in curricula but also ensures the competencies and professional qualifications of students. This professionalism is responsibility-centered as well as development-oriented; it encourages actors to absorb and create new knowledge, which supports creating innovations in working life. (Penttilä 2012.)

Innovation competencies are learned gradually as new information is added to our knowledge structures. Knowledge acquisition and application are critical components in this process. Thus, creating new services, products and organizational or social innovations – new added value – requires both knowledge and skills, which are applied to an innovation process. (Penttilä 2012; Nonaka & Takeuchi 1995; Nowotny & al. 2001; Nowotny 2003.)

The innovative individual forms the base for any innovation activities to take place. Innovativeness at individual level usually demonstrates itself as creativeness. But in many cases this is not enough, instead the idea needs to be examined by other creative individuals who get the chance to contribute and develop it further. In this phase the further development of future innovations calls for interpersonal competences in the participating individuals. After interpersonal examination the next level is to connect to the existing networks of the individuals involved. In order to reach successful results a well working network and competencies to operate in the network are needed. Only flowing information and knowledge can create learning in the organization and organizational learning in many cases is an antecedent of innovational behavior.

As a result of the development work at TUAS three categories of innovation competencies were defined (Kairisto-Mertanen & al. 2011): 1) Individual innovation competencies, 2) interpersonal innovation competencies and 3) networking innovation competencies. The defined innovation competencies cover generic individual competencies, and also generic interpersonal and networking competencies, following the guidelines presented by EQF (EQF 2011.). Individual innovation competencies include independent critical thinking and decision-making; target-oriented and tenacious actions; creative problem-solving and development of working methods; self-reflection and development of own skills and learning methods. Interpersonal innovation competencies focus on the ability to co-operate in a diversified team or working community; ability to take the initiative and to work for the public benefit; ability to work in research and development projects by applying and combining knowledge and methods of different fields; ability to work along internalised principles of ethics and social responsibility; and ability to work in interactive communication situations. Networking innovation competencies cover the ability to create and maintain working connections; ability to work in networks; ability to co-operate in a multidisciplinary and multicultural environment; and ability to communicate and interact in an international environment. Innovation competencies, therefore, cover the entire range of social competencies, as often listed as learning outcomes within EQF.

INNOVATION PEDAGOGY AND DIFFERENT EDUCATIONAL RESEARCH, DEVELOPMENT AND INNOVATION METHODS

Innovation pedagogy is a learning approach but it is also a strategic decision to reform existing pedagogical structures and curricula in higher education, the field of technical education being one of the fields. Several actors are influencing to the pedagogical climate. Grass-root level feedback from students and teachers is needed in order to ensure a new way of building the curricula and applying novel methods in delivering the education. However, without a joint vision and strong engagement of the management, the sustainability and coherence of the educational services cannot be ensured.

How to make the reform possible? We trust on a step by step approach and on the power of positive experiences. There are several practical and concrete examples of delivering the education according to the principles of innovation pedagogy in the field of technical education. [For examples see: Kairisto-Mertanen al. 2012). According to the aims of innovation pedagogy different educational research development and innovation methods must be developed so that when the meta-innovations, cornerstones of innovation pedagogy can be found in the learning environment as presented in figure 1. The meta-innovations contribute especially to the development of student's interpersonal and networking competencies. They include gross disciplinary environment, research and development activities executed by a big amount of students, flexible curricula, concentration of acknowledging the importance of entrepreneurship and service production and internationalization in the level of research, development and student engagement.

R&D projects carried out together with external operators and undertakings funded from external sources are part of everyday functions at TEB. An increasing amount of work conducted in the projects is performed by the students of the faculty. Thus the ability for independent and responsible working methods as well as the mastery of the basics of project work is expected of the students throughout their studies. (Kairisto-Mertanen al. 2012.)

One of the new ideas for applying and carrying out education according to the principles of innovation pedagogy is a method called hatchery work. This method combines real life assignments, peer counselling and working in gross disciplinary groups including the international aspect in all work. It is a teaching and learning method which includes different types of hatcheries. The principle of carrying out the work in the hatcheries is approximately the same but the expertise level of student varies in the different hatchery types. A first year student is capable of handling less complicated assignments requiring not so much expertise whereas a third year student has much more content, often individual, knowledge to be used when participating in the hatchery work.

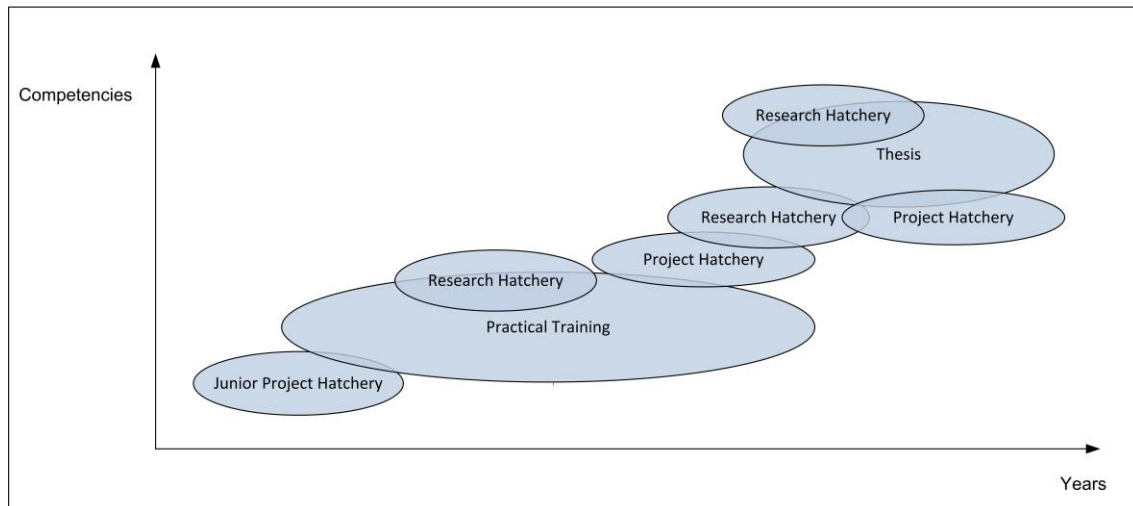


Figure 2. The different hatcheries in the student's path

The first step is to create a multidisciplinary learning environment. One successful example is project hatchery designed in TUAS. It is by making new students work in multidisciplinary teams during the first semester of their studies we have been able to create a tolerant and supportive learning environment where students in one discipline do not feel themselves better or worse than students in another discipline.

When applying new pedagogical methods according to innovation pedagogy it seems to be critical to put a lot of emphasis in mentoring the students. (Lappalainen 2012.) Using these methods seems to require cooperation and careful planning of how the division of tasks is done among university personnel.

The need for innovative engineers and other professional in the field of technical education is global which means that the interest towards new teaching and learning methods also should be global. Future engineers will be working in companies with global orientation. This requires active global attitude and cooperation, also in the development of curricula and planning of pedagogical and didactical methods.

When innovation pedagogy is applied it is essential, as can be seen from figure 2, to give the students several opportunities to engage themselves in different kinds of hatcheries during their studies. Junior project hatchery forms the base and introduces the capabilities needed for this type of studying and working. After that it is up to the student to choose between different available options.

The research hatchery is meant for the students in the beginning of their studies who have completed their basic studies and, as a result, are familiar with the basic methods of the field and have thus reached an appropriate level of general knowledge on the topics of the more advanced hatchery. The students may also have experience of project activities when they get involved with the research hatchery.

Both the research hatchery and the advanced Project hatchery are essentially content-orientated. In other words, the target learning outcome of them relate to the subject matter itself. The difference between the research hatchery/advanced Project hatchery and the junior project hatchery is at its greatest in this context, in junior project hatcheries the orientation is towards methods rather than contents when compared to junior Project

hatcheries. Working within the conceptual sphere of the project hatchery and gaining methodological skills precedes the production of content which happens in the research hatchery.

Practical training is a compulsory part of the education in a university of applied sciences and it always takes place out at the workplace where contacts to real working life are natural. Thesis work is another compulsory part of a university degree; it is preferably accomplished in close co-operation with working life. Research hatcheries bring the research done at the university to the proximity of every student. A student can participate in a research hatchery several times during the studies and move from less complicated tasks to more complicated ones as the studies progress. Advanced Project hatcheries bring the working life problems to the university to be solved by the students. They offer a great and easy access point to the surrounding environment and make it possible for the students to start building networks with working life partners already during their studies.

INNOVATION PEDAGOGY AND CDIO

It seems obvious that the CDIO approach and Innovation pedagogy share similar goals. Both share the ideology about defining the key competences needed in working life and both intend to activate the student and define the learning goals deriving from the needs of the surrounding environment. The CDIO approach has a clear focus on engineering education whereas innovation pedagogy tries to bear in mind the broader needs of the entire economy and focuses on producing valid competencies for the future society where special emphasis is put on innovation creation. Innovation pedagogy can be applied to all the disciplines and to all education be it in the university at any program but also to other levels of education e.g. to secondary education where the basis for the students' understanding of learning is created.

The CDIO syllabus goes to a deep level of detail while defining the necessary competences, but it is good to remember that CDIO syllabus is also a reference list and all of the features are not meant to be followed in detail. Innovation pedagogy focuses on providing the methods and tools to provide the three categories of innovation competencies: individual, interpersonal and networking innovation competences. Innovation pedagogy states that certain cornerstones or "meta-innovations" are needed to succeed in this task. In all, innovation pedagogy can form an extensive pedagogical strategy for any educational institution providing both objectives and methods and tools in order to reach the desired learning outcomes leading to innovation creation. (Penttilä al. 2013.)

Part of the innovation pedagogy cornerstones are easily found in CDIO too. For example innovative learning and teaching methods corresponds well with the CDIO standards 7 (Integrated learning experiences) and 8 (Active learning). Cross-disciplinary learning environments and integrated and extensive research and development activities are not specifically emphasized in CDIO, but for example working in different types of teams and cross-disciplinary teams are listed in CDIO syllabus. These competences can be achieved for example with a cross-disciplinary implementation of standard 5 (Design-Build Experiences). When entrepreneurship is understood to include behaviors and skills that allow individuals and groups to engage them in creating innovations and coping with high levels of uncertainty in all aspects of their life it seems obvious that innovation competencies include many of the competencies needed when becoming an entrepreneur. (Penttilä & al. 2013.)

Entrepreneurship and internationalization are included in the CDIO syllabus in various parts. Internationalization is mentioned as communication skills in foreign languages, developing a global perspective and working in international organizations. Entrepreneurship is named in

enterprise and business context as well as in the new syllabus addition engineering entrepreneurship.

CONCLUSION

Innovation pedagogy is being developed further to correspond to the needs of new generations of students and to the needs of future working life. We feel that there is a need for a new culture in education. This new culture should guarantee that all work in the higher education institutions is done so that the requirement of the changing working life is being met. These requirements affect also the engineering profession. The new engineers must be able to work in multicultural and multi professional teams finding creative and unique ways to solve the problems which will bring added value to the whole society. Understanding about work at customer surface and about the mechanisms how to best contribute to the creation of competitive advantage for the organization are essential for any engineer in the future.

On a practical level innovation pedagogy integrated with CDIO approach means applying existing learning and teaching methods in a creative, value-increasing way. Simultaneously, new methods are developed and put into practice while ensuring that students take responsibility for their learning and that they actively pursue their learning objectives. As a result, graduating students have professional skills and qualifications that are both innovative and development-oriented. Innovation pedagogy strengthened with CDIO approach moves further from traditional theoretical learning to the application of learned skills to practical development challenges.

According to our understanding and experiences the CDIO concept has proven to be a the way how to apply innovation pedagogy in engineering education. We believe that when multidisciplinary operations and real life assignments within research and development work are included into the CDIO thinking it will contribute to the emergence of even more innovative engineers. Innovation pedagogy is a whole new innovation culture needed in the universities and in every field of education.

REFERENCES

Buss, D. (2008) Secret Destinations. *Innovations in Education and Teaching International*, Vol 45, No. 3, August, pp. 303-308.

Council conclusions of 12 May 2009 on a strategic framework for European cooperation in education and training ('ET 2020'), *Official Journal of the European Union* (2009) C 119/2.

EQF 2011. http://ec.europa.eu/education/lifelong-learning-policy/doc44_en.htm 31.3.2011; *EQF for Lifelong Learning 2011*. http://ec.europa.eu/education/pub/pdf/general_eqf/leaflet_en.pdf 31.3.2011

Gibbons M., Limoges C., Nowotny H., Schwartzman S., Scott P. & Trow, M. (1994). *The New Production of Knowledge. The dynamics of science and research in contemporary societies*. London: Sage.

Finland's National Innovation Strategy (2008). http://www.tem.fi/files/19704/Kansallinen_innovaatiostrategia_12062008.pdf.

Oivallus report (2011) <http://ek.multiedition.fi/oivallus/fi/liitetiedostot/arkisto/Oivallus-Final-Report.pdf>. *Final Report*. Confederation of Finnish Industries

Harden, R. M., Crosby, J. R. & Davis, M. H. (1999) An Introduction to Outcome Based Education. *AMEE Guide No. 14*, part 1. Medical Teacher.

Harden, R. M. (2002) Learning outcomes and instructional objectives: is there a difference. *Medical Teacher*, Vol. 24, No 2, pp. 151-155.

Kairisto-Mertanen, Liisa & Mertanen, Olli (2007) Different methods –different outcome? student opinion about their learning. *Paper presented in the ICEER conference in Melbourne Australia*, 2-7.12.2007

Kairisto-Mertanen, L., Kanerva-Lehto, H., Penttilä, T. (2009) Kohti innovaatiopedagogiikkaa – Uusi lähestymistapa ammattikorkeakoulujen opetukseen ja oppimiseen. *Turun ammattikorkeakoulun raportteja 92*, Tampereen yliopistopaino, Tampere.

Kairisto-Mertanen, L.; Penttilä, T. & Putkonen, A. (2010), Embedding innovation skills in learning. Innovation and Entrepreneurship in Universities. Ed. Marja-Liisa Neuvonen-Rauhala; *Series C Articles, reports and other current publications, part 72*, Lahti University of Applied Sciences; Tampereen yliopistopaino, Tampere.

Kairisto-Mertanen, Liisa; Penttilä, Taru & Nuotio, Johnna (2011) On the definition of innovation competencies in innovations for competence management, Conference proceedings. eds. Tornainen; Ilona, Mahlamäki-Kultanen, Seija, Nokelainen Petri & Paul Illesley; *Series C, reports and other current publications, part 83*, Lahti University of Applied Sciences, Esa print Oy.

Kairisto-Mertanen, L.; Räsänen, M.; Lehtonen, J.; Lappalainen, H. (2012). Innovation pedagogy – learning through active multidisciplinary methods. *Revista de Docencia Universitaria. REDU. Monográfico: Buenas prácticas docente en la enseñanza universitaria*. 10 (1), 67- 86. Recuperado el (25.4.2012) en <http://redaberta.usc.es/redu>

Kairisto-Mertanen, Liisa & Mertanen, Olli (2012) Innovation pedagogy - producing qualifications needed by higher education students, *paper presented in the 11th International Conference on Science-To-Business Marketing, Entrepreneurial Universities*, April 25-27, 2012, Münster, Germany.

Kairisto-Mertanen, L.; Räsänen, M.; Lehtonen, J.; Lappalainen, H. (2012). Innovation pedagogy – learning through active multidisciplinary methods. *Revista de Docencia Universitaria. REDU. Monográfico: Buenas prácticas docente en la enseñanza universitaria*. 10 (1), 67-86.

Kettunen, J. (2011) Innovation pedagogy for universities of applied sciences. *Creative Education*, 2(1), pp. 56-62.

Lappalainen, H. (2012) Auraamo – muotoilun toimintakeskus. Loppuarviointiraportti.

Lyytinen, S., (2011) Project Hatchery – interdisciplinary learning through project methods, In *Towards Innovation pedagogy. A new approach to teaching and learning in universities of applied sciences*, ed. by Lehto, A., Kairisto-Mertanen L., Penttilä, T. *TUAS Reports 100*. *Turku University of Applied Sciences*.

Lehto, Anttoni; Kairisto-Mertanen, Liisa & Penttilä, Taru (eds.) (2011) Towards innovation pedagogy. a new approach to teaching and learning in universities of applied sciences. *Reports 100. Turku University of Applied Sciences.*

Nonaka I. & Takeuchi H. (1995). *The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation.* New York: Oxford University Press.

Nowotny, H., Scott, P. and Gibbons, M. *Re-Thinking Science. Knowledge and the Public in an Age of Uncertainty.* London: Polity Press, 2001.

Nowotny H., Scott P. & Gibbons M. (2003). Mode 2' Revisited: The New production of Knowledge. *Minerva* 41(3), 179 – 194.

Penttilä, T (2012) Environmental issues in business education curricula at Finnish universities of applied sciences. Towards a postmodern curriculum? *Research reports from Turku University of Applied Sciences* 35. Turku.

Penttilä, Taru; Jagiello-Rusilowski, Adam & Kairisto-Mertanen, Liisa (2012) Validating social competencies as learning outcomes of innovation pedagogy –experiences in finland and poland. *Paper presented in the The International Conference on Engineering Education 2012 (ICEE 2012), July 30 – august 3, in Turku, Finland.*

Penttilä, Taru; Kontio, Juha; Kairisto-Mertanen, Liisa & Mertanen, Olli (2013) Integrating Innovation Pedagogy and CDIO Approach – Pedagogic and Didactic Viewpoints; *paper presented in the ICEE/ICIT conference in Cape Town, 8-12. Dec 2013.*

Proitz, T. S. (2010) Learning outcomes: What are they? Who defines them? When and where are they defined? *Educational Assessment, Evaluation and Accountability, No 22, pp. 119-137.*

Putkonen, Ari; Kairisto-Mertanen, Liisa & Penttilä, Taru (2011), Enhancing engineering student's innovation skills through innovation pedagogy – experiences at turku university of applied sciences, *Innovations 2011: World Innovations in Engineering Education and Research, ed. W. Aung, et al., iNEER, Potomac, MD, USA, pp. 161-172.*

Rogers E. M. (2003). *Diffusion of Innovations.* Fifth edition. New York: Free Press

SITRA, 2006

Spady , W. (1988) Organizing for the results: The basis of authentic restructuring and reform. *Educational Leadership*, pp. 4-8.

Watts F, Aznar-Mas L.E., Penttilä T., Kairisto-Mertanen L., Stange C., Helker H.. Innovation Competency Development and Assessment in Higher Education. *Proceedings of INTED 2013 conference, Valencia, Spain, 2013.*

BIOGRAPHICAL INFORMATION

Dr. Liisa Kairisto-Mertanen: Turku University of Applied Sciences, dean at the faculty of technology, environment and business. Prior to joining the university she served in business life. She received D.Sc. in marketing in year 2003. Her special interests are in developing sales education both in the field of business administration as well as in the field of engineering in Finland. As a dean she has strongly contributed to the development of cross-disciplinary pedagogy and studies in her faculty. Currently she is very much involved in the development of a new pedagogical approach called innovation pedagogy.

Dr. Olli Mertanen: Executive director at the federation of south-west coast universities of applied sciences in Finland, Former Vice President, Turku University of Applied Sciences. He has long background as well in industry in the field of communications technology as in engineering education in the field of information technology. He received B.Eng. in automation technology (1976) in Kotka Institute of Technology. He continued his studies in Tampere University of Technology where he received M.Sc. in digital and computer technology (1979), Lic.Sc. in computer science and telecommunications (1985) and D.Sc. in computer communication (1992). His industrial background includes positions in Philips Data Systems and Ericksson telecommunications. During his university career he was mentioned among 100 Finnish avant-gardists in the field of industry and business and awarded the recognition of EIS / excellent educator in electronics. Last year he got an Achievement Award by INEER organization for his excellent work in the field of education and for his contribution to the creation of entrepreneurial spirit among future engineers. At the moment he is active in the field of enhancing creation of innovations as a result of co-operation between industry and University and furthermore leading to entrepreneurship.

Corresponding author

Dr. Liisa Kairisto-Mertanen
Turku University of Applied Sciences
Sepänkatu 1
FI 20700 TURKU
Finland
+358 50 3854118
liisa.kairisto-mertanen@turkuamk.fi



This work is licensed under a [Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported License](https://creativecommons.org/licenses/by-nc-nd/3.0/).