Synthesis of Learning by Developing and Virtual Learning Case: Laurea's Network Design Specialisation Studies

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Abstract: - Specialisation studies are an efficient and flexible way of completing and updating professional knowledge, since the multi way of learning also suits the timetables of those who work and study simultaneously. In this design-science research, a new innovation in adult education, 'Network Design Specialisation Studies' is executed and evaluated. The theoretical background consists of Learning by Developing (LbD), expansive virtual learning and virtual empowerment, and adult learning. Laurea University of Applied Sciences' strategy is to integrate its three statutory tasks of education, research and development, and regional development by utilizing its LbD model. Laurea's Network Design Specialisation Studies splice virtual learning and LbD. Virtual learning includes virtual lessons, exercises and examinations, but its main innovative part is a virtual laboratory with a virtual laboratory engineer. Laurea's new virtual learning environment plays a remarkable role of developing the competences of each individual learner, while the LbD concept steers the entire specialisation studies. This study shows that LbD and virtual learning support each other. Utilizing Web 2.0 technologies in the future, Laurea's innovative learning environment could be a part of global expert communities. This may lead to the materialization of the virtual empowerment, influencing the development of the future society during the next decade.

Key-Words: e-Learning, Higher Education, Learning by Developing, Virtual Empowerment, Virtual Laboratory, Virtual Learning

1 Introduction

Higher education processes and products should be well prepared in order to: (1) face the dynamics of the job market and stakeholders environment; (2) follow the tough competition within and between the public education sector and the private education sector; (3) adapt to the radical changes in the higher education studies and curricula; (4) set-up a reliable, internationally recognised system of quality assessment; and (5) improve the attractiveness and global competitiveness of the European University system. Therefore, issues like mobility, internationalisation of studies, degree structure, recognition of degrees, qualification frameworks, lifelong learning, sustainability of competencies and professional development, quality assurance, doctoral studies, students as well as social dimensions need to be analysed, implemented and monitored Europe wide, in order to continuously improve the current situation and to promote good practice. Furthermore, awareness is increasing that a significant outcome of the process will be a move towards student-centred higher education and away from teacher driven provision [1].

During the last two and half decades a learning revolution known as e-Learning, raised anticipations. "The world of Internet and the web technologies have spread over even in the construction of internal applications running on an intranet. However, the actual situation does not match forecasts. In many cases, e-Learning has only been a coined name used to describe old applications and ancient optics, with little concern for the learning problem that still lies at the core of the educational process" [2].

Specialisation studies are a type of adult education product offered by universities of applied sciences. Specialisation studies are an efficient and flexible way of completing and updating professional knowledge, since the multi way of learning also suits the timetables of those who work and study simultaneously. The extent of the specialisation studies is usually 30 credits with duration of one year. Specialisation studies are meant for persons who have a bachelor's degree or a

corresponding institute level qualification, together with working life experience. Principles of adult studies are followed, implying learner directed focus with each learner provided with an individual study scheme. [3]

This case study utilizes design-science research methods in providing an example of how a higher education innovation can face the requirements given in [1] with regard to adult education. In this study, a new innovation in adult education is executed and evaluated. The theoretical background consists of Learning by Developing (LbD), expansive virtual learning and virtual empowerment, and adult learning. The innovation utilizes virtual learning and LbD. Virtual learning includes virtual lessons, exercises and examinations, but its main part is a virtual laboratory with a virtual laboratory engineer. Laurea's new virtual learning environment plays a remarkable role of developing the competences of each individual learner, while the LbD concept steers the entire specialisation studies. This study shows that LbD and virtual learning support each other.

2 Research Environment and Problem Area

2.1 Laurea University of Applied Sciences

Laurea University of Applied Sciences operates in the Helsinki metropolitan area, one of the most competitive regions in the world. Laurea's strategic choice is to implement, develop and use Learning by Developing (LbD) as an operational model in order to contribute to the growth of the region around Helsinki, as well as to increase the employability of its 8000 learners. According to the Finnish legislation, universities of applied sciences have three tasks to fulfil. These are: (1) education; (2) research and development; and (3) regional development. By utilizing LbD model, Laurea can integrate these three statutory tasks [4].

Laurea's learning environment facilitates competence development for learners, organisations, regions and partners. The learning environment is a physical, emotional and virtual space that embodies the culture, spirit, time, community and practices of the ongoing development work. The aim of the learning environment is to generate and develop high-quality competence and to interact with the operating environment. [5]

With regard to Network Design Specialisation Studies, Laurea's most important learning environment is the Data Communications Laboratory, which is a development environment for learners, personnel and partners. The environment offers the possibility to do networking exercises, real life research, development projects and project based theses, with students working either individually or in groups. The laboratory's fields of expertise are e.g. Wireless Local Area Networks (WLAN), indoor positioning systems, and innovative use of existing data communications technologies and implementation of secure remote access technologies. [3]

2.2 Research Methods and Questions

The subject of this study is a new innovation; the creation of the Network Design Specialisation Studies. And so, it is obvious to use the design-science research approach, described in [6].

In this study, the following sub-concepts of design-science research are applied; (1) the building process, (2) evaluation of constructive results, and (3) action research. Within the first sub-concept, the main goal is the specification and implementation of the Network Design Specialisation Studies based on the demand from the industry, Laurea's strategy and relevant theoretical background is illustrated in next Fig. 1 and Fig.2:

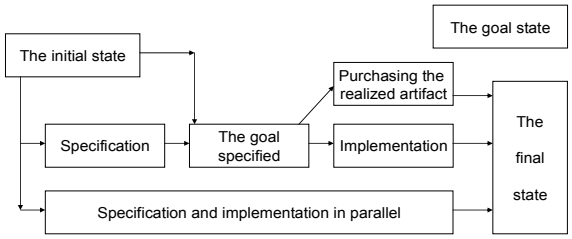

Fig. 1 Different alternatives concerning the building process and its outcomes [6].

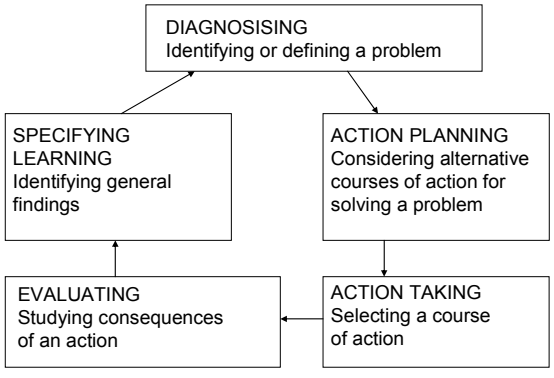

Fig. 2 Cyclical process of action research [7].

In Fig. 2, above within the third sub-concept, the building and evaluation processes are combined in action research and a new improved execution phase of specialisation studies.

The sub-concept 'evaluation of constructive results examines how 'the final state' differs from 'the goal state' and tries to answer the research questions: (1) How does the Network Specialisation Studies fulfils Laurea's pedagogical strategy? (2) What are the lessons to be learnt from the Network Specialisation Studies when executing new adult education products for Laurea?

3 Theoretical Background and Earlier Studies

3.1 Learning by Developing (LbD)

Learning by Developing (LbD) is a pedagogical and communal approach in which learning is linked to applied research and development projects and culture. It means learning expertise that arises from social interaction, knowledge and competence sharing, researching and problem solving of collective objects. The model (Fig. 3) emphasizes on cooperation and creating a 'learning and developing' culture and makes it possible to include and use various scientific perspectives and methods of learning, researching and developing in operation and action. The integrative dimension model represents a management and work philosophy and culture based on the production of shared competence and creativity.

In Laurea's current developing culture there are genuine research- and development tasks; there are no ready-made solutions. The learning process starts by identifying the initial objectivity or strategic research object (elastic perspective), perceiving, incepting, elaborating, analyzing and describing it, and selecting appropriate work methods.

The model is not applicable for solving problems set in advance by someone else. It also does not support the commissioned project principle, because the starting points (objectivities) are often determined by the cooperating participants of the value network, together with professional developers from research and development organizations. The objective of the work is usually not possible to define clearly in advance, but is specified throughout the development process. The process requires critical thought strategies and skills for justifying solutions and evaluating evidence. Work consists of a continuous development process, focusing on research, development and generating new competence (creativity perspective). The end result is a creation, a new operating method, a model, a service or a product. [8]

LbD is like an innovative operating culture which requires that learners undertake projects based on real life work aiming to produce new practices, the progress of which requires collaboration between teachers, learners and workplace experts.

Implemented scaffolding structures of LbD may be seen as a learning vehicle for the development of two sets of competences; namely: (1) generic competences such as work or life knowledge and skills; and (2) subject specific competences; and these two sets may be seen as a pre-studies for third set (3) creativity and innovation part of studies.

LbD culture also contributes to regional development through the leaner interaction on projects and especially through Laurea playing a strong role in creating international links. Much effort is expended in ensuring local, regional and international ties. Laurea's pedagogical strategy is to apply and further develop LbD concept. [9]

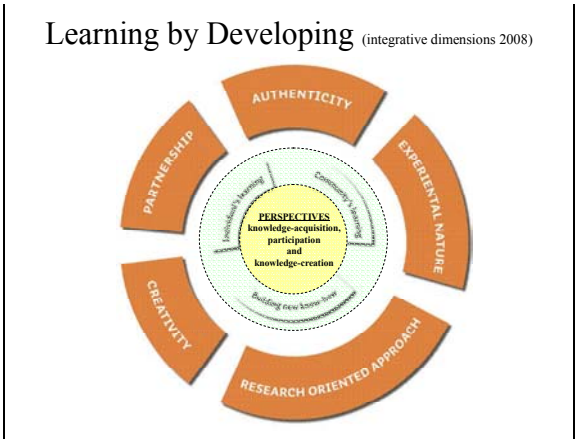

Fig. 3 Integrative dimensions of LbD, three perspectives of learning [16]: the knowledge-acquisition, the participation and the knowledge-creation. Derivative dimensions of learning: individual's learning; community's learning and building new know-how. Impacts of LbD: with supporting creativity; within partnership in action; based on authenticity; using of experimental nature and doing own research with international research cooperation.

The elastic perspective and objectivity refers to entity for creativity in general. It means supporting space to elastic nature of objectivity. It contributes to improving the possibilities of inspiration, interest and use of creativity. Furthermore, it gives the possibility that "valuable output results are not well known in beforehand", and way of action that

"innovation results are evaluated but not formalized in advance".

Phenomenon of the Elastic Objectivity appears especially at the inception, the perceiving and the elaboration phases of new development activities and it obviously ends at the start of the specification phase of development process. The typical examples of elastic objectivities: objectivities of visioning; service design; proactive objectivities; futurology speculations and phenomena of semiotic and some examples of elastic objects: terms; opinions; plans; value; meaning of signs and early perceived models of constructions. The Elastic Objectivity improves and supports creativity and coherence of new communal knowledge.

3.2 From e-Learning to Virtual Empowerment

3.2.1 E-Learning

The development of the information society and its learning infrastructure are a function of the innovative implementation of information and communication technology. Electronic learning, e-learning or eLearning, is not semantically an established concept, but a general term used to refer to computer-enhanced learning. Other terms used synonymously include web-based learning, online learning and online teaching. [10]

In cases where mobile technologies are used, the term M-learning has become more common. In many respects, eLearning is commonly associated with the field of Advanced Learning Technology (ALT), which deals with both the technologies and associated methodologies in learning using networked and/or multimedia technologies. Most eLearning situations use combinations of the above techniques. E-learning is naturally suited to distance learning and flexible learning, but can also be used in conjunction with face-to-face teaching, in which case the term Blended learning is commonly used.

Especially in higher education, the increasing tendency is to create a Virtual Learning Environment (VLE) in which all aspects of a course are handled through a consistent user interface standard throughout the institution. According to [11], artificial intelligence conceives the following learning scenarios for the near future: (1) virtual campuses promoted by Universities and Academic Institutions offer a variety of degrees and specialised courses; (2) virtual projects and problems aiming at interactive, cooperative and collaborative learning more related to the student centred education paradigm; (3) experience management systems and model promoted by companies, such as e.g. the organisational memory model, the experience factory, the quality improvement paradigm, and the case-based reasoning model; and (4) performance support systems and media laboratories requiring the integration of tools, procedures and simulations, which weave all the elements required for the expert execution of the task.

However, it can always be noticed that the exploitation of the media and information technology in learning has two aims: (1) the added value for learning assisted by multimedia, artificial intelligence and/or virtual reality; and (2) the time saving proffered by network technologies [12]. In this study, virtual learning means that multimedia and virtual reality are simultaneously used to enhance learning, and new network technologies are utilized due to time saving reasons.

3.2.2 E-Laboratory

With regard to engineering education, there is a long history of e-Laboratories use. An example of the development and evaluation of a remote laboratory for student manipulation and learning is reported in [13]. This laboratory allows students to observe and control a physical setup of a multi-pipe fluid flow experiment through the Internet and to predict and analyze the results. The laboratory learning environment interface was developed and structured to enhance students understanding of basic engineering concepts, problem solving, experimental error, data analysis and curve fitting. It provides students the opportunity to apply engineering software in developing their own algorithms to predict the results. The main aspect of the remote experimentation design is that it allows students to manipulate flow paths on a test bed section of the pipe flow network to obtain parameters they require for the prediction of the results. This allows the use of creativity in experimentation, a feature available in physical experimentation but often restricted in web-based remote laboratories. The remote environment provides increased individual access to equipment during and outside of regular hours from any web-enabled location. According to [13], the overall architecture of the remote laboratory can be easily applied to other technical fields.

Another example of e-Laboratory is the software support tool for an electronics laboratory session on circuit synthesis presented in [14]. The application provides the students a tool for structural synthesis of translinear circuits. For a given arbitrary function, the program yields a set of realisations, which are automatically compared by SPICE simulation, considering the criteria: stability, bandwidth and

magnitude of circuit - induced errors. The software tool was developed in C++ code using Visual C++ 2005 programming environment and is specifically designed for students' use. [14] Until now, an educational e-Laboratory has usually been either a remote laboratory with real equipment or artificial computer simulation software.

3.2.3 Participation

Growing up with an expert culture through participation needs a great deal of support and guidance, especially at the beginning of the process. Within this framework, an important aspect of growing up with an expert culture is the model provided by more experienced members and participation in more and more demanding activities. The expert's direct instruction is replaced with direct guidance adjusted to the level of the apprentice's developing skills. It is also relatively easier to understand phenomena when learners are receiving continuous support that is adjusted to the right competence level. This kind of support is called scaffolding. It is an instructional strategy that involves supporting novice learners by limiting the complexities of the context and gradually removing those limits as learners gain the knowledge, skills, and confidence to cope with the full complexity of the context [15]. An essential aspect of scaffolding is: to adjust the amount of support to the learner's dynamically changing needs; to divide too complex problems into a series of simple ones; to structure the learner's activities in a way that facilitates engagement in higher-level processes; and to provide more help when needed, but to gradually decrease the amount of help as the learner's skills develop. [16] Scaffoldings based learning and training starter marks often includes: ability and aspiration to develop right aptitude; competence at working heights; motivation to take available opportunities; and motivation to progress professionally.

3.2.4 Virtual Empowerment

In the future, cooperative sharing of knowledge will be a normal part of our daily life. For higher education, it is fundamental to develop new and flexible ways of linking learning, social and economic change to facilitate the dynamic development of expertise and innovation [17]. Learning is expected to be a process of creating knowledge and achievements rather than assimilating existing knowledge [18]. The 'virtual empowerment' is amplifying the social network based human communities and their capabilities. It is increasing human competences by using the digital technology environment and the result is a new sociotechnological action space – knowledge space. The main features of virtual empowerment are: the application of personal learning to group based reflective learning methods, extending even to open global communities; the extension of the one-way communication to interactive, world wide community. All of the above are based on added value communication and the exponential growth of the media technology influence on the features. [19]

3.3 Adult Learning

The definitions of adult learning vary. In the communication from the European Commission it is defined as all forms of learning undertaken by adults after having left initial education and training, however far this process may have gone e.g. including tertiary education [20]. Adult learning often happens in the workplace, through extension or continuing education courses at secondary schools, colleges or universities. Other common learning places are folk high schools and community colleges as well as lifelong learning centres.

However, irrespective of the learning place, educating adults differs from educating children and young people in several ways. It has also been referred to as andragogy to distinguish it from pedagogy. One of the most important differences is that adults have accumulated knowledge and experience that can add or hinder the learning experience. Adults frequently apply their knowledge in a practical way to learn effectively. In general, they must have a reasonable expectation that the knowledge recently gained will help them further their goals.

The future working life community including their established network connections to experts is constantly evolving. Experts come to and leave from the community [16]. People are required to keep up with the dynamically changing network connections which bring the necessity for a framework for lifelong learning [21]. Lifelong learning is a philosophy that has taken root in a whole host of different organisations. It is attitudinal; one can and should be open to new ideas, decisions, skills or behaviours. It sees citizens provided with learning opportunities at all ages and in numerous contexts: at work; at home; and through leisure activities. The European Commission's action plan on adult learning considers the following five key challenges in adult learning [22]:

1.) Lift the barriers to participation. Adult participation in education and training remains limited and imbalanced, with those with the lowest levels of initial education, older people, people in

rural areas, and the disabled being the least likely to participate. Member states of the European Union should introduce high-quality guidance and information systems, as well as targeted financial incentives for individuals and support for local partnerships.

2.) Ensure the quality of adult learning. Poor quality provision leads to poor quality learning outcomes. To ensure the quality of adult learning special attention has to be paid to the various dimensions of quality with a special attention to staff development, quality assurance mechanisms and methods and materials.

3.) Introduce systems that recognise and validate learning outcomes. These are essential to motivate adults to participate in lifelong learning. European countries are invited to link these systems to their national qualification frameworks, within the context of the European qualification framework.

4.) Invest in the ageing population and migrants. Member states of the European Union should invest in older people and migrants, through education and training that matches the needs of the learner, while raising awareness about the important role of migrants and older people in European society and economy. In particular, immigration can be seen as a partial counter-balance to an ageing population and to skills shortages in certain sectors, and adult learning has a key role to play to support the integration of migrants in society and the economy.

5.) Be in a position to measure progress. Reliable data, with appropriate indicators and benchmarks, are essential for evidence-based policy-making. Unfortunately, data availability in adult learning is limited, not least because providers often operate outside the public sector. The quality and comparability of data must continue to be improved. More analysis and monitoring are needed of the benefits of adult learning and the barriers to its uptake. If relevant data remains unavailable, European countries should consider commissioning new data collection or surveys.

4 Implementation of Network Design Specialisation Studies

4.1 Implementation Process

Laurea University of Applied Sciences got feedback from the industry that in the near future there will be a massive lack of professionals in data systems and professionals who are able to design and maintain wide-flung enterprise and operate Internet Protocol networks. Therefore, Laurea started to plan its Network Design Specialisation Studies (NDSS) in the spring of 2006, together with a master programme for data systems. The first master programme started in January 2007 and the first NDSS in September 2007. The second batch of the master programme started in September 2008 and second NDSS will start in January 2009.

4.2 Study Modules

Laurea's Network Design Specialization Studies splice virtual learning and Learning by Developing. Figure 4 pictures the study modules of the Specialization Studies. Virtual learning modules include virtual lessons, exercises and examinations, but their main part is a virtual laboratory with a virtual laboratory engineer. The new virtual learning environment of Laurea's Data Communications Laboratory has a remarkable role of creating new know-how and developing the competences of each individual leaner, but Learning by Developing concept steers the entireness of specialization studies.

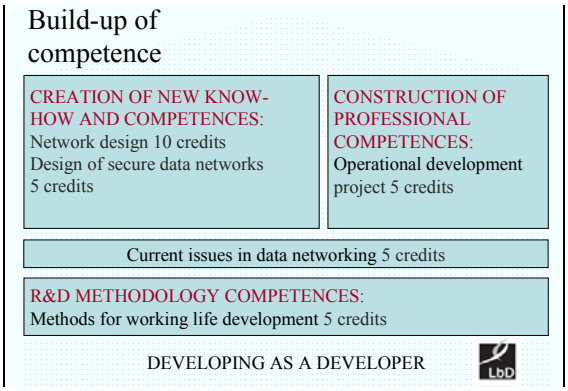

Fig. 4 Study Modules.

4.3 Learning Process

The learning process is developed in order to response to challenges in situations where the learner is already having basic knowledge and understanding of the field with some years of work experience. The learning objective is to integrate the learner into an expert culture by working as an expert developer. The learning path starts from the idea of scaffolding where the learning system's and expert's personal coaching and guidance is adjusted and suitable for the learning group's competences and development skills. The implementation occurs by replacing the expert's direct instruction with direct guidance and coaching which is adjustable to the level of the learning group and individual learner's development skills and competences. The quality of learning increases where learners receive

continuous support adjusted to the right and tuned competence level. It is also substantial to increase trust, spirit and responsibility within the learning groups to facilitate team work, making experts equality a part of the development groups. The next scaffolding step is to increase the group's participation in a community of practices with authentic development projects where the integration to an expert culture is a natural part of the learning process. The target is the LbD culture, meaning that new experts may willingly work in an "uncomfortable" area of development challenges, where no ready answers exist. Hereby building and sharing new competences in a distributed expertise network which improves the learning at higher education. The Virtual Learning case is naturally implemented and linked to the Learning by Developing (LbD) approach.

The nature of objectivity has changed during the process of learning in studies. In the problem base orientation, development objects are often well known and defined. In this implementation, the new proposition is the integration of innovation to the workplace's authentic development processes. The outcomes meet different challenges and needs as objects. Flexibility and resiliency of development objects are needed to allow for more motivation, spirit and flow as well as innovation creation in the cyclic innovation process. The changing of objectivity is presented in Figure 5.

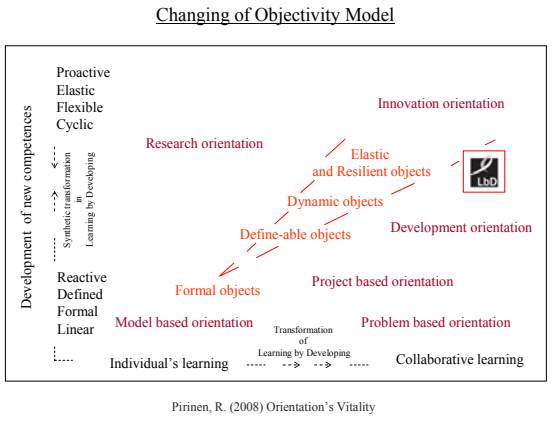

Fig. 5 Resilient Objects and Elastic Objectivity.

In the implemented cases, the learning process integrates scaffoldings with cyclic innovation based research and development action with more trusting based and linear development processes. In innovative orientation, the incepted objects are rather types of modelling clay, flexible, dynamic or resilient than specified, defined or formal. In other perspective the picture presents a balanced combination of reactive and proactive actions to produce new innovations.

The implementation learning process employed here is scaffolding for future creativity studies and it is emphasised in the curriculum. The synthetic transformation in Learning by Developing is not same that compromising, but rather it is an integration of different and opposing aspects through a dynamic and elastic process. The synthetic transformation is achieved through trilogy (elastic objectivity, actor and value network) and action is based on shared context which has meaningful link to elastic objectivity. "Meaningful" is emphasised because it creates the motivation for needed knowledge acquisition. The synthetic transformation process starting point can be the objectivity or the object of innovation system. The reason why and other questions has to be clear enough from the start of the transformation. The synthetic transformation process may continue through shared elastic objectivity by using freedom within framework principle where inside participants control the development and make decisions on relevant questions and future prospects. The two tailored learning perspectives produce couching and scaffolding structure for research activities on ICT Networks.

4.4 Virtual Learning Environment

The new virtual learning environment 'MentorAid', offered by Mamentor Ltd, is a platform for future online learning. It is based on four different modules that are combined in a unique way: (1) MentorHR collects, measures, follows and reports organization's knowledge. (2) MentorNET controls and executes projects that increase organization's knowledge in a networked environment. (3) MentorLABS models Information and Communication Technology (ICT) systems in a virtualised environment. (4) MentorCAST empowers organization's own knowledge content creation in a networked environment.

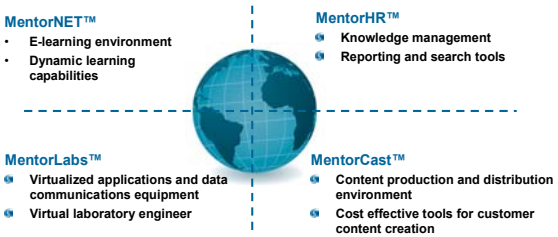

Fig. 6 MentorAid solution modules.

4.4.1 MentorHR

MentorHR is the module that is built upon the common idea of knowledge levels. There are different presentations of these, e.g. the one from Bloom, Hastings and Madaus [23]. But, these have been collected and synthesized into a single model. The levels of knowledge that MentorAid currently uses are: (1) Knowing, which means that a person has heard about the subject; (2) Remembering, which means that a person remembers some parts of the subject; (3) Understanding, which means that a person understands, how the subject affects real life; (4) Ability to apply, which means that a person is able to apply his/hers knowledge in a real-life situation; (5) Ability to evaluate, which means that a person can evaluate different approaches to the same subject; (6) Ability to build new, which means that a person knows so much about the subject that he/she is able to build new things based on this knowledge. These levels of knowledge have been taken into account throughout the MentorAid learning platform. The idea is that each person has an individual account and each time a person does something inside the platform, she/he will gather knowledge points. For example, there might be an online lesson that explains the basics of international marketing and thus this person will be assumed to have levels 1-2 after taking the lesson on this subject. Levels of knowledge are divided into two different sections: gathered; and shown knowledge. Gathered knowledge comes from taking online lessons, doing lab exercises and inputting e.g. information about relevant industry certificates. Shown knowledge comes from taking tests inside MentorAid.

MentorAid has a highly sophisticated testing system within MentorHR. The idea is to enable online testing either via questions of various forms, e.g. multi-choice, multiple-answer, pictorial and Java-application. Once these questionnaires have been evaluated, either automatically or manually, the person taking the test is given indication about the knowledge in each of the areas of the test. All the information that is gathered via these two methods can be represented in various forms. Since MentorAid is powered by a database, there is no limitation on the amount and form of the reports. These can be further used for e.g. final evaluations of the learners.

From teacher's point of view, evaluation and rating in e-Learning process is difficult, especially in tests based on open questions, but also in multiple choice tests with no immediate answer validation [24]. Whenever whatever material from MentorAid is listened to, watched or exercised, the information on these activities is put into the database in this person's account. So, MentorHR serves as an effective aiding system for student evaluation.

4.4.2 MentorNET

In recent years, a lot of work has been done on developing systems and their control applications that allow performing lectures and training remotely [25]. MentorNET is the module that is used to stream online lessons. The key functions of this module contain: (1) ability to take SCORM-formatted lessons as the input; (2) ability to stream simultaneously to large audience; (3) ability to track the usage of the online material; (4) ability to report the usage of the online material; and (5) seamless integration to the MentorHR module. The sole idea of MentorNET is based on the evolution of online learning. Originally, eLearning has been done with static written material on a server that also provides the possibilities to e.g. discuss about the material. Although this can be effective for learners that have the ability to understand written material, most of the people prefer somebody to explain the subject matter thoroughly. Therefore the material that is created for MentorNET can include audio and also video material, if needed. It seems that video should be used only in occasions, where something is actually illustrated (such as, how to make something) and not with a so called "talking head". At least this has been the feedback received from the users of MentorAid.

The material that is fed to MentorNET contains information about the subject and also about the keywords in the subject. Whenever the material is listened to or watched, the information about this is put into the database and in the person's account.

4.4.3 MentorLABS

MentorLABS is the module that distinguishes MentorAid from all the other offerings in the market. MentorLABS consists of fully virtualised, customisable ICT laboratory environment that can be used for multiple purposes including learning of software features and technology concepts, testing people's knowledge about different subjects and documentation. For educational purposes, the first two features are the most important.

MentorLABS serves as a virtual laboratory engineer. It contains a graphical user interface that can be used to build the laboratory. As an example, this laboratory can be one Linux server or it can be a large operator network. Each learner has an own working space where she/he can build different topologies and access configurations of different equipment. Everything runs on separate server(s)

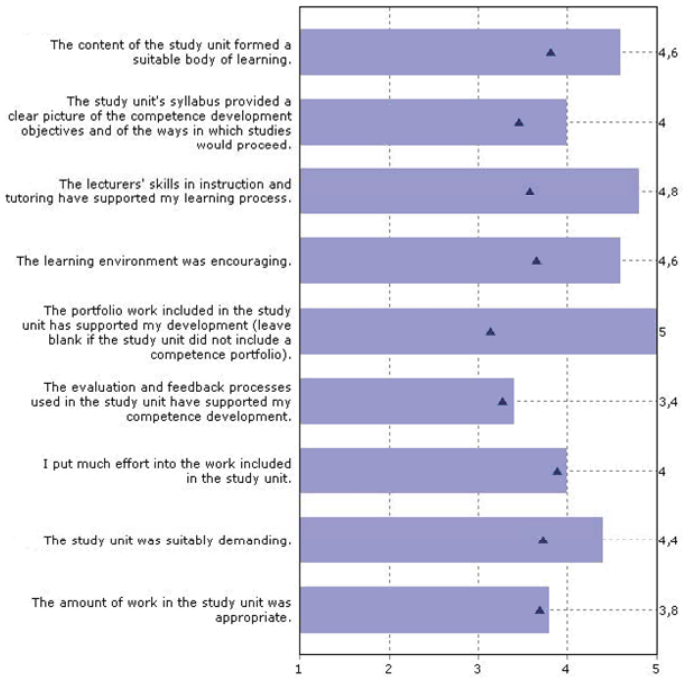

Fig. 7 Quality of the education and learning environment: contents, instruction, your own work, learning environment and cooperation. Student feedback evaluated by the statements on a scale of 1 (Completely disagree) to 5 (Completely agree).

and each MentorAid installation may contain multiple servers. Each user of MentorLABS will reserve suitable time to do whatever is needed on the virtual laboratory and the system ensures that the resources are available.

At the moment, MentorLABS is able to run on virtually all relevant Personal Computer (PC) operating systems (anything on top of x86 architecture), anything that can be used in a regular PC, Cisco IOS, Juniper Junos and Cisco PIX. New features are added constantly to the virtual laboratory and this will extend its usage possibilities for teaching and learning new ICT technologies.

4.4.4 MentorCAST

MentorCAST is the module that can be used to create own content. It is basically an environment to create standardised learning content that can be easily put to usage via MentorNET. MentorCAST uses available components like Camtasia recording tool and Reload SCORM.

5. Experimental Evaluation

5.1 Student Feedback

According to Laurea's quality assurance system, feedback from students is gathered and examined regularly. From the students of Laurea's first batch of Network Design Specialisation Studies, feedback was asked twice; in January and May 2008. The questions in the inquiry were divided into seven different categories. For example, summary of results from the category "Quality of education and learning environment: contents, instruction, your own work, learning environment and cooperation" is shown in Figure 7.

5.2 General Findings

Although the general feedback from the students was positive, MentorAid has shortcomings within its group functioning, interaction and operation aiming at cooperative and collaborative learning.

5.3 Diagnosing and 2nd Action Planning

In the future, MentorAid should be able to cope with the simultaneous use of a learning team who discuss and analyse cooperatively and make decisions as an individual or as a full group. Even in the case of a single student using the system, it should provide means for collaborative learning. Before this modification is made in MentorAid system, Web 2.0 technologies can be applied in parallel.

6. Conclusions

Currently, computers allow virtualization with all sorts of multimedia effects that can be used as

pedagogical aids. Also, the computer can impersonate human tutors or colleagues who play an important role in learning. Affective computing is an important ingredient for its role in student's motivation and in the learning process.

MentorAid makes the latest knowledge from the latest development field available to learners and teachers. The aim of the learning environment is to generate and develop an up-to-date high-quality competence and to interact with the operating environment. This concept provides a meeting point for value network participants where working life experts meet learners, participants and teachers. When full-professionals from different organisations are studying together in an innovative learning environment and they are currying out R&D projects, a great innovation potential is created and huge results can be realized.

With virtual learning, resource allocation could be made eminently effective. Learners as well as personnel save time, and with the use of the virtual laboratory even hardware costs can be reduced. It is a well-known fact that laboratory exercises are essential when applying new technologies. Earlier, arranging these exercises has been very time consuming, but with the virtual laboratory engineer, arrangements can be made automatically. Also, the maintenance of the laboratory system is much quicker and easier, because updating of the virtual laboratory needs only new versions of the software of communications devices but no installation of the physical devices.

Here are some of the strengths of the system from learners perspective: effective participation in authentic development projects; learners are in the origo of development work; highly experimental learning; raised aspiration; social skills; self confidence; personal responsibility for results; contact with companies and organizations; coaching learners rather than manage study events; systematic way to reach relevant and new last known context. The main key challenges for future work are: system relies hugely on group or individual commitment, motivation as well as coaching methods; and deciding the optimum radio of direct inputs and resilient objects and initiatives for learning of creativity in LbD. [9]

The three perspectives of learning are presented in Fig. 8. These perspectives are based and referred from Communities of Networked Expertise [16]. The specialisation studies fulfil knowledge acquisition variables quite well, the knowledge transferring process and learning within individual's mind is motivated, studies produces last known and up to date competence. Furthermore expertise community within learning environment keeps relevance of known competences in last known level.

The knowledge participation is particularly implemented; more knowledge sharing is needed and recognized for future work. The role of the specialization study is to be effective scaffolding structure to knowledge creation. The implementation is currently ongoing, and the future developing key points are: creativity, proactivity and innovative constructions. Fig. 8 illustrates the variables of the three learning perspective of the case study:

Elements of Integrative Action (implementation of three perspectives)

Knowledge Acquisition (1)	**Knowledge Participation (2)**	**Knowledge creation (3)**
knowledge transferring	knowledge sharing	new knowledge creation
process of learning within individuals' mind	social activities and practices as bases for learning	new knowledge objects and activities are collaborative created
process-based	progressive	creative
instructive	co-operative	constructive
reactive	active	proactive
Element of Processing Nature	Element of Knowledge Sharing Community	Element of Creative Community

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Fig. 8 Elements of Integrative Learning. Tree perspectives of learning, leaded from Communities of Networked Expertise [16].

From the universities perspective, specialisation studies are like a product development process leading to a master programme. Also, partly shared implementations between specialisation studies and master programmes create synergy. For example, they gives more study module options and at the same time save resources.

Virtual learning and knowledge creation is expanding into the value adding Web 2.0 technologies in global expert communities, this may be followed by the combination of digital empowerment, explorative and investigative learning. This development could lead to the materialisation of the virtual empowerment, which will influence the development of the future society during the next decade.

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