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Rauno Pirinen

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RAUNO PIRINEN

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ABSTRACT

This study investigates the realization of research and development (R&D) of higher education institutions in response to the progress of information systems, security management, and service programs in a university of applied sciences (UAS) between 2003 and 2012. This study addresses to the integrated and student-centered R&D projects at Laurea UAS, which are advances by R&D collaboration and agenda within master's, bachelor's, and degree education in the programs of information systems (n=528 students in 2012), security management (n=403), and services (n=676). Altogether there were 7740 students at Laurea in 2012.

In this continuum of research, case study research (CS) provides an understanding of an object and can extend knowledge or add strength to what is already known through previous research. In addition, it can produce new knowledge for design and action. Action research (AR), as an extension of quality system, is used in the investigation of change. It focuses on the research of educational change, relations, models, and interactions. The integrated perspective of the information system's design research (DR) is in the systemizing of design – it focuses on research for building, improving, and evaluating artifacts, such as models, methods, constructs, information systems, and services for implementation of the change. In addition, these three research methods were used in the implementation and improvement of R&D-related study units in the programs by students.

The first study provides contributions to the integration of education by presenting the integrative process, which is seen as action logic of the integrative model for bridging a world of cyclic strategies, visions, thinking, and imagination-creativity activities to linear R&D and development-based activities, as well as integrating focused R&D profiles and the national R&D agenda with an emergent value network. The second study consists of analysis of R&D- and strategy-based actualization of the new study unit. The third study includes integrated CS and DR for designing and actualizing a competence-based curriculum model of the degree program of business information technology. The fourth study analyzes two canonical AR (CAR) cycles, which were based on the realizations of the learning by

developing (LbD) model and also the data of evaluations by FINHEEC (Finnish Higher Education Evaluation Council) between 2003 and 2009. The fifth study analyzes the cumulative data collection in regard to the R&D project SATERISK (satellite positioning risks), as a student-centered R&D project, activities, factors, and quality. The study also refers to the two latest FINHEEC evaluations and related research cycles, the evaluation of quality systems, and the evaluation of student-centered R&D between 2009 and 2011. Finally, the sixth study is a multiple case study analysis of 11 externally funded R&D projects concerning actualizations of R&D-based study units and realization of R&D tasks at Laurea UAS between 2008 and 2012.

The main new models contributed consist of three proposals: the integrative process model; the collectively developed LbD model, which was seen as a dimensional model of creative learning culture; and the concept of student-centered R&D. The answers to the R&D realization question in the six studies indicate that various forms of R&D activities can serve individuals, organizations, and entire domains. The integrative model is seen as one new proficient model for the future, and it can advance issues such as: 1) development of R&D capabilities; 2) joining the agenda-based R&D activities for collective education; 3) fitting together the strategies of domain, emergent R&D profiles, and education processes; 4) improvement of knowledge reserves; 5) raising the students' participation in R&D so that they are the activating forces in the collaborative R&D; 6) teachers in continuous interaction with the environment, which allows for quick reactions to changing, agile and dynamic needs; and 7) a guide of teachers' R&D-related activities and collective thinking.

Some of the central challenges faced by the six studies consist of: 1) continuous change poses great challenges for teachers; 2) establishment of the new management culture and controlling the mass of projects precipitated by the R&D-related education; 3) balancing and modularizing of cognitive load and challenges; 4) improving a signification of the student-centered R&D in the perspective of communities of work; 5) development of incipient internationalization and knowledge economy; 6) measuring of impacts and development of utility, usability, and strategic measuring as an evaluation design structure in a general; and 7) dissemination of the

new R&D-related model in context of higher education institution. In context of study, the first externally funded R&D project was started in August 2007, and by the end of this research, the volume of R&D was 12.5 M€ at Laurea.

In the conclusion, I outline that integrative process within student-centered R&D are based on and include collective R&D. Here, the R&D-related education comprises an individual's mind-on and hands-on activities, social interaction, creating something new within R&D, and knowledge sharing and collaboration between communities of work and communities of R&D.

Finally, the quality of research is discussed and future research questions are presented with their implications and final remarks.

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I wish to thank Laurea University of Applied Sciences for my study leave and for allowing me to participate in several conferences and allowing me to allocate my time for research and development, writing the articles, and composing this dissertation.

I want to thank all of my students for their research and development work and their contributions. Throughout the study, I have received support from a number of people, and in addition to those stated here, I would like to thank all with whom I have had exciting discussions and interactions over the themes touched upon by my research topic.

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Espoo, 30.6.2013

Rauno Pirinen

LIST OF THE PUBLICATIONS

This dissertation critically examines the new R&D-related task, its change and progression in the domain of UASs as demonstrated in the following collection of academic publications:

I. Pirinen, R. (2008a). Integrative Action Process in the Perspective of Globalization. *International Journal of Emerging Technologies in Learning (iJET), 3*(1), 61–68.

II. Pirinen, R. & Rajamäki, J. (2008a). Synthesis of Learning by Developing and Virtual Learning Case: Laurea's Network Design Specialisation Studies. *WSEAS Transactions on Advances in Engineering Education, 7*(9), 624–634.

III. Pirinen, R. (2009a). Thematic Curriculum to the Master and Degree Programme of Information System. *International Journal of Education and Information Technologies, 3*(4), 205–216.

IV. Pirinen, R. (2009b). Actualization of Learning by Developing (LbD): An analysis. *International Journal of Emerging Technologies in Learning (iJET), 4*(3), 46–58.

V. Pirinen, R. (2011a). Externally Funded Research and Development Projects in Perspective of Learning. *International Journal of Engineering Pedagogy (iJEP), 1*(3), 27–36.

VI. Pirinen. R. (2013). Analysis of regional development and externally funded research projects in higher education: a continuum of multiple case study analysis. *International Journal of Innovation and Regional Development, 5*(1), 73–90.

The original publications (Appendix D) have been included at the end of the printed version of this dissertation with permission by their copyright holders, who retain the copyrights of articles.

PUBLICATION FORUMS

The first, fourth and fifth journals (iJET, iJET and iJEP) were reviewed through IEEE Conference Proceedings (ISBN: 978-1-4577), which is quality classified by the publication forum initiative of the universities in Finland. The second journal was reviewed in the WSEAS Transactions on Advances in Engineering Education (ISBN: 1790-1979), which is also quality classified by the publication forum initiative of the universities in Finland. The third International Journal of Education and Information Technologies is double peer reviewed and a WSEAS affiliate. The sixth journal was reviewed by International Journal of Innovation and Regional Development (ISBN: 1753-0660), as well, it is quality classified by the publication forum initiative of the universities in Finland.

CONTINUM OF STUDIES AND JOINT ARTICLES

For all the six articles, I was the corresponding writer. I wrote the mainstream of the articles and the literature reviews. Paper II was written jointly with Jyri Rajamäki. As for the joined conference papers, I presented the papers at related conferences.

Pirinen, R. (2008a). Integrative Action Process in the Perspective of Globalization comprises Pirinen (2008c), Pirinen and Fränti (2007, 2008b), Rajamäki and Pirinen (2008) and Fränti and Pirinen (2005).

Pirinen, R. & Rajamäki, J. (2008a). Synthesis of Learning by Developing and Virtual Learning Case: Laurea's Network Design Specialisation Studies. This involves Pirinen and Fränti (2007, 2008b) and Rajamäki and Pirinen (2008).

Pirinen, R. (2009a). Thematic Curriculum to the Master and Degree Programme of Information System joins Pirinen (2009d, g, 2008a, b, d), Pirinen and Fränti (2008a) and Fränti and Pirinen (2005).

Pirinen, R. (2009b). Actualization of Learning by Developing (LbD): An analysis relates Pirinen (2008a, b, c, d, 2009c, d, g), Pirinen

and Fränti (2007, 2008a, b), Pirinen and Rajamäki (2008a, b), Pirinen, Rajamäki and Aunimo (2008), Pirinen, Tarkkanen and Teräs (2009), and Rajamäki and Pirinen (2008).

Pirinen, R. (2011a). Externally Funded Research and Development Projects in Perspective of Learning, makes a continuum from Pirinen (2010), Pirinen and Rajamäki (2010), Pirinen (2008a, b, 2009d, g), Pirinen and Fränti (2007), and Fränti and Pirinen (2005).

Pirinen, R. (2013). Analysis of regional development and externally funded research projects in higher education: a continuum of multiple case study analysis. Finally, this study makes a continuum of the research data regarding the realization of funded R&D projects (n=11). The R&D projects have involved the participators of regional innovation systems, higher education, industry, and service sectors.

LIST OF ABBREVIATIONS

AIS	Association of Information Systems
AMKOTA	AMKOTA is the information system for common follow-up data of all Finnish UASs
AR	Action Research
CS	Case Study Research
DR	Design Research in Information Systems
ER	Entity Relationship
FINHEEC	Finnish Higher Education Evaluation Council
IEEE	Institute of Electrical and Electronics Engineers
ICL	Interactive Computer Aided Learning
INKA	INKA is the information system for feedback from students during different phases and areas of studies
IS	Information Systems (discipline)
LbD	Learning by Developing
ODE	Oxford Dictionary of English
PBL	Problem-Based Learning
R&D	Research and Development
SID	Service Innovation and Design
SOA	Service Oriented Architecture
TEKES	Finnish Funding Agency for Technology and Innovation
UAS	University of Applied Sciences
UEF	University of Eastern Finland

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1 Introduction

Collaboration between universities of applied sciences (UAS) and many other competence and knowledge producers, such as firms, entrepreneurs, funding organizations, and other academic institutions, has gained increasing importance in regional and national R&D from practical, managerial, and scientific perspectives.

This study addresses the requirement that, in order to react to regional and national challenges, UASs need new perspectives in design and realization of their R&D tasks.

In this study, the focus of UAS is achieving a role as a trusted partner and co-operator in education, R&D networks, and combining knowledge from multiple sources and "co-creating" it with other actors for novel and benefiting competencies and capabilities which are related to authentic R&D projects, clusters, innovation systems, industry, region, and society. In the middle of this focus, there are collective higher education and collaboration activities with regional networked R&D actors (Pirinen, 2008a, b; Fränti & Pirinen, 2005; Rauhala, 2008; Pirinen et al., 2009; Tarkkanen, 2009; Pirinen, 2011a, b).

1.1 APPROACH TO RESEARCH CONTEXT

The challenges posed to the development efforts of UASs have changed rapidly in the last ten years, and it has been tough for them to respond to these challenges. The Finnish Act (351/2003) by the Parliament of Finland sets three tasks for UAS: 1) education, 2) research and development, and 3) regional development. The Act (351/2003, Section 2) decrees that UASs are part of the higher education system, and together, universities and UASs form the higher education system as a dual model in Finland.

It is the duty of a UAS to provide higher education focused on skills requiring professional expertise and based on the requirements of the labor market and its development, on scientific research, and on artistic principles, to support the professional development of individuals, and to carry out research and development work in service of the development of UAS education, the labor market, and regional development, taking into account the social structures of the region in question (351/2003, Section 4). Furthermore, UASs provide and develop adult education in order to maintain and increase workplace competency (Pirinen, 2009a, b).

In this study, the Oxford Dictionary of English (ODE, 2005) is used as a base glossary and Statistics Finland (Statistic Finland, 2011) give the definition of the most central and related term "R&D", which is understood as systematic activity directed towards acquiring more information and using the information to find new applications; the criterion of the term "R&D" is that the goal of the activity is something novel and new.

In this study, the term "context" refers to circumstances in which a particular activity, action, or event happens, or a combination of circumstances, variables, and conditions that affect an event, activity, or action at a known moment (Corbin & Strauss, 2008; ODE, 2005). This is seen as the context in which students develop the kind of expertise that guarantees their advancement in working life and creates the necessary conditions for a successful employment market as an experimental nature. During their studies, students learn to become experts in network flows and in development processes of new capabilities, which allow various cultures of expertise to be linked to education processes, such as collaboration in R&D-related activities that include an individual's development, community's progress, and activities by regional R&D agenda. This, in turn, means that students can include the best workplace competence in their higher education. In this study, the term "learner" refers to a student, teacher, or participator who enriches their own competence through collaborative R&D, by sharing expertise and learning from others, where collaboration is used (Pirinen, 2009a). The term "student" is used to address a person registered as a student in the database of the Ministry of Education and Culture (AMKOTA).

The term "communities of expertise" refers to internal, external, national, and international networks and pipelines, which help learners build their own communities of work and expertise (Lehtinen & Palonen, 1999; Tynjälä, 1999; Ruohotie, 2000; Poikela, 2001, 2009; Hakkarainen et al., 2004a; Teräs, 2008) and emergent value networks (Pirinen, 2008a, b; Fränti & Pirinen, 2005; Pirinen et al., 2009; Tarkkanen, 2009).

Competent graduates would then have comprehensive expertise and capabilities in various disciplines (Pirinen, 2009a; Fränti & Pirinen, 2005; Pirinen & Fränti, 2007, 2008a, b). This implies gathering and processing information, reflecting on one's own experiences, sharing knowledge with others, and continuously developing one's own working methods, such as learners' sustainable and lifelong development (Lehtinen & Palonen, 1999; Tynjälä, 1999; Ruohotie, 2000; Poikela, 2001). Here, knowledge refers to understanding the complexity of the environment in order to identify the influences behind various phenomena. Information management refers not only to managing content and applications, but it also joins the understanding of processes and practices by which information is produced (Laurea's Pedagogical Strategy, 2002; Fränti & Pirinen, 2005). In this study, the term "collaboration" addresses the actualization of the authentic R&D that is implemented in higher education in a student-centered and collective way within R&D and regional R&D agenda (Laurea's Pedagogical Strategy, 2007; Pirinen, 2009a). Students are then in the center of the process, which conducts regional profiles and capabilities by bridging novel knowledge and competencies in practice (Pirinen, 2011a, b; Harmaakorpi, 2004; Teräs, 2008).

In this study, the unit of analysis is a sample of evidence of R&D, as a case study in UAS where the emphasis is on the phenomenon of R&D actualization with authentic regional-national R&D agenda. The "sample of evidence" as "case" can be qualitative or quantitative, and the same unit of analysis as "display" or "sample of evidence" is used in analysis parts of all included six journal articles (Pirinen, 2008a, 2009a, b, 2011a, 2013; Pirinen & Rajamäki, 2008) and FINHEEC (KKA in Finnish) evaluation transactions of quality and excellence in education which are archived as: the KKA 3:2005 is edited and referenced by Salminen and Kajaste (2005); the KKA 2:2009 is edited

and referenced by Saarela et al. (2009); the KKA 1:2010 is edited and referenced by Auvinen et al. (2010); the KKA 18:2010 is edited and referenced by Lampelo et al. (2010); and the KKA 16:2011 is edited by Maassen et al. (2011).

1.1.1 Introduction of Participators and Roles

I have worked at Laurea University of Applied Sciences as principal lecturer in the area of R&D within information systems and multidisciplinary and externally funded research projects since 2002. In my work, learning within authentic R&D keeps an underlying focus on the actualizations of study units, integration of education and R&D with integrative environments, and development of action which relates education and R&D; there are my main tasks and form the basis of my work at Laurea UAS.

In my teaching work, students participate in R&D, such as externally funded R&D projects where the rising role of creativity takes place, and an emphasis is placed on the students' own thoughts and imagination creations, which leads to realizations where creativeness is seen as an underlying ability in a professional development context (West, 2009; Maassen et al., 2011, 2012). In this study, the "creation" is a thing that has been made or invented (ODE, 2005), and the learner's creations include almost anything created that can be demonstrated and assessed. This form of "creativity" appears often in educational interactions within activities for producing something essentially new through imaginative ability or skill, whether a new service, a new artifact as solution, or new knowledge, method, or construct. In this study, the term "artifact" is based on and used as an instance of an object made by a human being, and in turn, the term "construct" is understood as a concept constructed for describing relations among phenomena, something that exists on an abstract level and ontology, but is difficult to define in formal terms, e.g., the term "creativeness" is a construct in this context (Hevner & Chatterjee, 2010; Shostack, 1982; ODE, 2005).

In this type of integrative higher education, terms such as "collective" and "co-operative" are used. With this focus, learners are encouraged to develop their own ideas, and "collaboration" is the

secret to breakthrough creativity (West, 2009; Hakkarainen et al., 2004a, b), and learners can achieve the competencies required to become developers and researchers (Ruohotie, 2000). These transactions then enable learners to contribute to the collective understanding and advance regional capabilities (Harmaakorpi, 2004). In this study, the term "learner" includes a union of students and professional R&D actors and actors from a regional innovation system.

In this study, the term "insider" refers to deep involvement by an actor who participates intensively in the development of related actions as described in by Herr and Anderson (2005), Baskerville (1999), and Coghlan (2003). Regardless of the researcher having a particularly inside role, the research setting with a transparent quality system, multiple case studies, and open data collection enables this and future analysis of different types of researcher roles as "insider", "insiders with outsiders", "outsiders with insiders", and "outsiders" (Herr & Anderson, 2005; Baskerville & Myers, 2004; Baskerville, 1999; Stringer, 2007).

So far, master's students of information systems at Laurea (n=108) have participated as research colleagues in actualized research (Lau, 1999; Coghlan & Brannick, 2010) between 2003 and 2012. The researcher participated in the students' research work as teacher and occupied the role of a responsible principal lecturer of information systems program, and the trust-based management and leadership power of the international and integrative research projects were collaboratively shared with students and management.

The management at Laurea includes the vice president and the heads of the departments, and they occupied "insider positions and roles" in this research, as well as the management who participated intensively in management of R&D. This form of combined leadership and management was established with a bottom-up and student-centric vision; it was also grounded in an orientation and management culture and philosophy where the management focus was on variations of power, mutual trust, relationship management (Burr, 1995; Gibbons et al., 2008).

The "outsiders" in this study were the evaluators of the FINHEEC, actors of the target and result negotiations in the Ministry of Education and Culture, the owners of Laurea, actors of participating clusters,

regional actors, outside evaluators and visiting researchers, financiers, and visiting experts. The outsiders were involved cyclically in the action at Laurea, e.g., participation in evaluations and review sessions for personnel, development of regional aligned and shared strategy, "co-creation" of agenda-based scopes to actualizations, and collectively gathered competencies (Avison et al., 1999; Avison, 2002). In the outsiders' evaluation processes, the researcher was involved in the preparation of proposals, applications, data collection, fact finding, decision making, and interventions of audits (KKA 3:2005; KKA 2:2009; KKA 1:2010; KKA 18:2010).

1.1.2 Setting the Purpose and Context of the Study

The purpose of this study is to progress real life R&D realizations, such as R&D-based actualizations of study units in the context of UAS. In the beginning of the study, the purpose was considered between four settings: 1) traditional study unit implementation, such as classroom-based teaching and model-based learning; 2) learning with R&D projects, which are carried by professional staff and actualized in small-forced R&D units; 3) traditional case-study-based teaching; and 4) student-centered R&D with externally funded and authentic R&D projects.

The collective reasoning for selection was related to the transformations between these four settings. The authentic and collaborative ways of realization seem to strive from the early stage of the studies to knowledge bridging and competence development in the complexity of real and authentic R&D (Eraut, 1994; Lyytinen & Probey, 1999; Voorhees, 2001; Karjalainen, 2003; Laurea's Pedagogical Strategy, 2002, 2007; Harmaakorpi, 2004; Fränti & Pirinen, 2005). This selection involved various difficulties and was challenging because it required not only meeting the demands of the employment sector, but also study and training the employees and learners of the future, as well as promoting international interactions and improvements of regional development (Laurea's Pedagogical Strategy, 2002; Fränti & Pirinen, 2005; Pirinen, 2008a).

In an operative environment of a study, the purposeful use of new information requires that it be assimilated into a sufficiently broad

context, e.g., in networks and clusters, so that information is not just repeated but also understood, revised, and given value (Fränti & Pirinen, 2005). Based on this, I selected the challenging focus, a way of integrated education within authentic R&D, such as realizations of externally funded R&D projects in education, as the main scope, interest, and purpose of this study and dissertation.

As a scenario of the main alternative view: if the statutory tasks of R&D are implemented by way of isolated units, then influences on the students are challenging. Here, only small units are an information hub of knowledge, which co-operates in the field of R&D. These isolated departments then act as reserves of competencies that are rarely accessed (Lyytinen & Probey, 1999; Nonaka & Takeuchi, 1995; Fränti & Pirinen, 2005).

The assumption of the study was that if a large amount of learners from workplaces and students of higher education can be trusted to further regional-national R&D, then more advanced results and impacts would be achieved, even within a relatively short period of time (Fränti & Pirinen, 2005; Laurea‘s Pedagogical Strategy 2002, 2007).

Despite these concrete arguments, an alternative implementation model, which is often called the “separation model”, has been used, especially in realization of the R&D tasks in many Finnish UAS between 2003 and 2011 (AMKOTA, 2010, 2011).

1.1.3 Collaborative Research and Development

In this study, the term “collaborative” refers to the integration of education, R&D, and regional development in the perspective of the integrative model (Fränti & Pirinen, 2005). The “integrative model” is then related to the shared R&D activities within regional development, regional clusters, and innovation systems (Porter, 1990; Swann, 1998). It is related to organizational learning (Argyris & Schön, 1996; Engeström, 2001) and development of personnel as learners of the future, and it promotes international interactions in the collaborative learning community in the form of integrative environments, living labs, and pipeline structures (Ståhlbröst, 2008; Teräs, 2008). It refers to the learning activities as producing a

sustainable drive for the integration of R&D with various types of higher education (Pirinen, 2008a). The basis of this kind of work lies in transformation, which means a process of qualitative and structural change in work and educational practices (Engeström, 1987; Vygotsky, 1978a; Kauppi, 2007).

1.1.4 Realization of Research and Development

In this study, the term "integrative" takes the perspective that R&D and educational development strategies and agenda are recognized collectively. It addresses that students participate within authentic R&D frameworks. The regional-national-international research agenda and themes are then used for the "co-creation" of "scopes". Also, the integrative R&D transactions generate authentic results and impacts, which improve regional capabilities. The collaboration in the learning process focuses on the integrated expertise that arises from social interaction, "co-creation" and adjusting of scopes, knowledge and competence sharing, and complement realizations of R&D, which include evaluation and quality assurance systems.

So far in this study, regarding the proximity of the terms "scope" and "problem", the term "scope" is more wide and resilient than "problem". It includes: 1) a mental or physical target or subject matter that something deals with (ODE, 2005); 2) the aim is to support a student's imagination and creativity in R&D integrated education, and it generates and maintains the motivation and spirit for learning, it balances judgments and expectations of objectives, goals and targets, e.g., in the tuning of the cognitive load in settings of studies (Clark & Elen, 2006); 3) it addresses the idea that between two people there is always a third dimension, e.g., a model, artifact, tool, concept, or mental or social thing with which they share knowledge; it communicates, activates, and motivates their personal or their team's learning (Engeström, 1987, 2001; Hakkarainen et al., 2004a); then, 4) the "scope" is related to a satisfaction, atmosphere, mutual trust, and "learning to like or dislike" in a space where the learner takes "a tool" or "a scope" and makes his own personal activity or creation of it (Vygotsky, 1978a; Engeström, 1987).

In this study, the focus of realization is on activities and dimensions of creative developing culture, and this makes it possible to include various scientific perspectives and methods within R&D transactions. The term "factor" is understood as an influence that contributes to a result and is as a relevant element for making a decision within an activity (Robson, 2002; ODE, 2005). Then, one activity is related to many factors as a classification structure, and one factor is then related to one activity as an entity.

In the operative environment of this study, the view of the term "co-creation" refers to an activity of mutual creation, such as student-centered and user-centered approaches in design (Luojus, 2010; Mattelmäki, 2006; Metcalfe, 2004). In our context of services, the term "co-creation" (cf. ODE, 2005) often refers to customer-company interactions as mutual value creation (Keränen & Ojasalo, 2011). In our view, both of the terms "co" and "centered" refer to "participation of knowledge creation" rather than "consuming of knowledge" (Fränti & Pirinen, 2005). Through these interactions, learners can get an opportunity to take part in value creation of innovation system networks and become a "co-creator of value" (Pirinen, 2008c; Keränen & Ojasalo, 2011; Grönroos, 2011).

According to Freire (1970, p. 74), "the authentic study is not carried on by 'A' for 'B' or by 'A' about 'B', but rather by 'A' with 'B', and this authenticity is mediated by the world which impresses and challenges both parties 'A' and 'B' as well as it is giving rise to views or opinions about it." In this sense, the R&D-related study is seen as "A" with "B" within "C", where "C" describes a community of regional-national R&D. Then, the term "collaboration" gives the perspective of the development of individuals, communities, and regions, and the term "integrative model" addresses the strategy process and evaluation design, such as activities of strategy-based integration of three tasks.

According to this study, there are many influential aspects in this type of realization in literature: 1) facilitation of processes that underlie the creation of knowledge and expertise in the internalization-externalization process by (Vygotsky, 1978b); 2) creations of new forms of a competence community (Tuomi, 1999); 3) being instances of the community of expertise (Hakkarainen et al., 2004b); 4) social

studies, mutual and "authentic integration" of expertise to the studies (Freire, 1970); 5) transformations (Vygotsky, 1978a; Kauppi, 2007); and 6) new types of communities of practice (Tuomi, 1999; Engeström, 1987, 2001).

1.1.5 Settings of the Study

This study is titled "Towards Realization of Research and Development in a University of Applied Sciences". The study is delimited to the domain of UASs in the perspective of collaborative R&D activities in which empiric and tested evidences are mostly related to information-intensive studies and environments of information systems, security management, and services programs at Laurea UAS between 2003 and 2012. In this study, the term "empiric research" refers to observed and measured phenomena and the derived knowledge coming from experience rather than from theory or belief (Robson, 2002). The study focuses on the activities of R&D, realizations, concepts, and models, and collaboration with innovation systems.

The study sets out to define the qualities of integrated R&D to set guiding principles for designing a new way of R&D-related realizations of higher education that can impact the potential of the region and its capabilities and educational realizations within the regional-national innovation system. The study also explores how this new way of R&D realization can be implemented in curriculum-syllabus-based learning. A theme of the study is to outline a view of future situations as "The UAS of the Future," which is built on the six empirical and actualized articles. The dissertation elaborates on theoretical and empiric approaches that explicate imagination and creativity support in educational transaction and construct integrative activities for education within R&D; this also includes evaluation transactions by FINHEEC, in which this way of education, the integrative model, was called "the interoperative way".

The structure of this dissertation includes five chapters, which are followed by the six original research publications. I continue this introduction by presenting the theoretical framework of the study. Through the examples of the empirical R&D studies, I will outline the

main qualities and principles of R&D-related higher education that I have explored within the perspective of theories for models and approaches. The research methodologies, research questions, and analysis methods are described in detail in Chapter Two. The multiple research approach as a continuum, which has been used, gives views of the three methodological approaches: case study research (CS), action research (AR), and information systems' design research (DR). This continuum of research provides a systematic approach to identify the phenomena of R&D collaboration and student-centered R&D, and allow the researcher to produce a theoretical view of those phenomena and advance a new theory development. This is followed by an introduction and presentation of the contribution of the six empirical studies in Chapter Three. In Chapter Four, I describe the research implications and quality perspectives of the study. Finally, Chapter Five includes final remarks on the study.

1.2 EXPERTISE AND KNOWLEDGE

Tynjälä (1999) investigates the requirements for expertise, starting from Bereiter and Scardamalia's statement that true experts differ from experienced people who are not quite top-level experts in that their work method is a gradual and progressive problem-solving process (Bereiter, 1997; Scardamalia & Bereiter, 1999). Tynjälä (1999) notes that experts constantly redefine their tasks and sense of duty, which keeps the solved tasks from becoming routines, and instead turns them into new challenges. Thus, experts work at the upper limits of their competence and may need to exceed their own limits during the process. They continuously learn new things and increase their expertise during the process.

If expertise is seen as a continuous solving process, as working at and exceeding one's own competence limits, then it is close to the nature of R&D implementations of LbD noted (Fränti & Pirinen, 2005). Hence, in the integrative way of R&D-related learning, an individual learns along with a workplace, school and R&D community, as well as alongside with a learning organization which is often linked to its customers, users, capabilities, strategy and agenda.

1.2.1 Growth of Expertise

As Tynjälä (1999) states, the progressive problem-solving process is a continuous learning process where effective work in a development team requires creation and invention, as well as solid knowledge of the sector in order for the outcome criteria to be realistic and the development to be correctly aligned. In this sense, R&D projects can be considered to develop expert work skills (Helakorpi & Olkinuora, 1997). They examine the effects of the breakdown of bureaucratic and hierarchical work methods on an expert's work and find that work combines practicality and functionality; implementation skills on the one hand, and innovative and analytical skills and creativity on the other.

Tynjälä (1999) states that the main institution that builds the required elements of expertise is education. According to Tynjälä, in recent years, the institution has been subject to plenty of criticism and development suggestions from researchers specializing in expertise and learning. Traditional education methods focus on presenting, reproducing, and controlling information; rather than promoting the kind of expertise that is encouraged by progressive problem-solving, continuous learning, and self-challenge, they almost seem to hinder it. Tynjälä says that traditional university teaching methods have been criticized for all too often producing inert knowledge that is useful in educational tasks but not in real, complex workplace situations (cf. Barrows & Tamblyn, 1980).

Rauste-von Wright et al. (2003) state that that the general transference and applicability of knowledge and skills to practical situations is problematic; because of this, authentic integrative learning environments, such as living labs and integrative models, strive from the early stage of the studies to focus competence development on the complexity of the real world. Service tasks as actualizations of study units would need "genuine" customers, and the R&D projects produce practical solutions to real workplace scopes and R&D-agenda-based activities.

The fast rate of change of the employment sector, coupled with the rapid production and questioning of scientific data, is an important question in terms of education. Changes have affected the flexibility of world views, in that students should not learn isolated sets of

information that cannot be applied in practical contexts. A purposeful use of new information requires that it be integrated into a sufficiently broad context, so that information is not just repeated but also understood as dialog (Heikkilä-Laakso & Heikkilä, 1997). Education should support the creation of learning skills. The aim should be to adopt operating models that help students cope with new situations, meet new challenges, and approach problems from new perspectives (Rauste-von Wright et al., 2003).

Projects carried out in R&D make the problems of experts' development work evident for students. In traditional learning exercises that teach skills and existing work models, solutions already exist for all encountered problems – being either in the lecturer's possession or documented in resources. In case studies or exam questions, the lecturer's evaluation is used as an indicator of the value of the student's work in relation to practical problems. In such cases, the examiner's attention is often focused on how well students have learned the subject at hand, while the actual outcomes of the work are of secondary importance. In situations of genuine R&D, the goals of the work are often not possible to define clearly in advance, but are refined throughout the development process (Pirinen, 2008a; Fränti & Pirinen, 2005). The R&D process requires and improves critical thought strategies and skills in justifying solutions and evaluating evidence. In other words, actualizations would consist of a continuous problem-based setting, problem-based learning (PBL), with a focus on research, development, and generating new competence. As such, this was anticipated by Barrows and Tamblyn (1980) and Tynjälä (1999).

Lehtinen & Palonen (1999) compare the special individuals known as top-level experts with a vision of the groups that work in the background and with competence as a communal characteristic that cannot be described through the actions of one individual person. The fact that something is done in a specific way, using a certain method or application, reflects the knowledge links, shared language, and interpretation methods of a certain team. The authors note that in the perspective of learning, the individual always becomes linked to communal activities and a knowledge culture (Hakkarainen et al., 1999). They both stress the significance of communality in workplace practices and state that, in this sense, an individual view on learning

is insufficient, if true individual learning even exists (Lehtinen & Palonen, 1999; Hakkarainen et al., 1999, 2004a).

The difficulty of transferring lessons learned by the individual in education to workplace practices can, in some situations, be explained by the fact that workplace activities require communal competence linked directly to the operating environment (Ruohotie, 2000; Lehtinen & Palonen, 1999). In working life, learning often takes place in groups and as part of a whole work community's changing capacities. In an integrative process, the outcome is valued in a genuine R&D process, so it would be near applicable to the context in question. Thus, the competencies generated in the development process cannot be separate from the real world, but can be immediately applicable to genuine issues (Fränti & Pirinen, 2005). The activity may be a success even if the development goal is found to be impossible and the desired outcome is therefore not produced. Then, the value of the activity lies in learning from failure and learning from feedback, as this can prevent someone from investing erroneously.

1.2.2 Constructivist Sight

The constructivist point of view, based on cognitive psychology, widely influenced and was accepted in the context of this integrative theme and study since early 2002. According to this view, knowledge is not transferred to learners, but is constructed by the learners themselves (Tynjälä, 1999), or is "co-created" by participators (Burr, 1995; Niemi, 1998; Lehtinen & Palonen, 1999; Tynjälä, 1999; Kauppi, 2007). In this study, the term "constructivism" refers to reality being constructed individually or collectively, and social reality is constructed by those who participate in it. In this view, learners generate knowledge and meaning from an interaction between their experiences and their ideas, and the learning process is experiential, utilizing real life experience to construct and improve knowledge and understanding (Burr, 1995; Tynjälä, 1999).

In this collaborative process, learners interpret their observations on the basis of previous knowledge and experience, and thus continuously build a world view by attributing experiences with meaning through interpretation (Lehtinen & Palonen, 1999). This kind of reflection

means questioning the presuppositions on which beliefs are founded (Mezirow, 1981, 1991). The student's observations and knowledge construction are based on earlier individual experiences and knowledge, which produce individual learning outcomes (Tynjälä, 1999). In this view, the reflection on one's own starting points may lead to regenerative learning, as stated by Kauppi (1998).

In context of this study, participation in practical service and development tasks and R&D teams makes each learner an active actor, giving learners personal experience of the event. Here, experiential learning is described as a continuous cyclical process in which the observation, consideration, and conscious understanding of a phenomenon make up the basis of development. Conceptualization of the phenomenon uses a theory or model, and its application in practical operating environments leads to comprehensive learning (Kolb, 1984). This type of experiential learning emphasizes the individual in service tasks and R&D teams, and the nature of community is seen as another vital element of learning (Fränti & Pirinen, 2005).

In integrative environments, R&D is used for authentic targets within the context and agenda of regional innovation systems and the world of work; advances are then achieved through activities and experiences in these interventions. The focus of the experiential view (Kolb, 1983, 1984) concerns the adult's learning process that is related to the learner's professional growth and development, and it emphasizes the central role of concrete experience, which is mainly mental in the learning process. Kolb (1984, p. 21) states that "learning is the process whereby knowledge is created through the transformation of experience." The theory presents a cyclical model of learning, consisting of a four-stage sequence: 1) concrete experience, 2) reflective observation, 3) abstract conceptualization, and 4) active experimentation (Kolb, 1984; Kolb & Kolb, 2005; Tuomi, 1999; Hakkarainen et al., 2004b).

Active learning stresses the ideas of collaboration, teamwork, and community as a basis for learning. Thus, learning is seen as a communal activity where shared knowledge is acquired and experiences are collectively shared. In this view, Kolb's model can explain differentiation of activities that are required for expertise and organizational learning. These would then be interpreted by Vygotsky

(1978a, p. 27), where in a collective context, "people may share and resonance each other's cognition." In Kolb's (1984) model, learning happens in some way, and the model describes how it should be organized in each situation (Tuomi, 1999). In turn, Vygotsky (1978b) states that the individual, as a learner and an identity, is constructed through the same social process that makes the individual a member of an expertise community.

Kauppi (1998) describes transformative learning as being the opposite of reproductive learning. Kauppi states that workplace routines require reproductive learning and social participation in existing practices. Rapidly changing and developing practices, on the other hand, require transformative learning focused on the production of new ways of thinking and working in order to develop existing practices. Kauppi notes that, in practice, transformative learning implies having to understand the complexity of the whole surrounding environment, i.e., what happens and why. There is particular emphasis on the concept of dynamic complexity, an understanding of which comes from grasping the principles, processes, and effects behind phenomena. Kauppi's description significantly influenced the ideation and initial development of integrative environments and living labs (Fränti & Pirinen, 2005).

According to Niemi (1998), the basic skills of active learning are related to motivation and information gathering. The most important skill is the ability to control and evaluate one's own learning. Active learning also emphasizes the learner's co-operation and teamwork skills, e.g., the ability to solve problems with others, to share information, and to support others; also, another important skill lies in interaction and receiving other people's experiences and ideas. Niemi's view contains many of the components needed in learning environments and workshops; the model is applicable to the acquisition of diverse skills, and reflection on experiences and situations that require courage for learning from failure (Fränti & Pirinen, 2005).

Kauppi (2007) describes the challenge from the perspective of workers in workplaces; the knowledge societies and flexible systems of production and services are based on a continuous information flow and process construction that is in turn based on collaborative working

with multiple partners in different networks. In this kind of work, the worker has to construct and reconstruct a knowledge base of the whole process and use it to continuously create new processes. Kauppi states that the basis of this kind of work lies in transformation, and proposes that transformation is the process of qualitative and structural change in work practices.

1.2.3 Activities of Knowledge

In this operative environment of study, the term "knowledge" is seen as a crucial driver and composes a "body of knowledge" for our efforts of integration of higher education and R&D, and the development of workplaces in the integrative process. According to Miles et al. (1998), globalization and production change have set the stage for a new period of economic development, where power is knowledge, and the speed of its improvement and effectiveness of its utilization are key. According to Teece (1998), knowledge and its applications are at the frontline of modern economic growth and success (Teece, 1998). Therefore, knowledge is thought to be a meaningful resource today (Chen et al., 2006), and after a period of being one resource among others, it is becoming the primary resource (Stenmark, 2001). In this study, the focus is on the concepts of "drivers of knowledge", "bodies of knowledge", and "competencies".

Sfard (1998) uses two knowledge-related metaphors to guide the work of students, teachers, and researchers: the acquisition metaphor and the participation metaphor. According to Sfard (1994), the meaning of abstract concepts is created through the construction of appropriate metaphors. Sfard holds that metaphors, or figurative projections from the tangible or real world onto the world or universe of ideas, are the basis of understanding. Sfard suggests that the role of the metaphor of an object in the educational process cannot be overestimated. Sfard (1998) says that different metaphors may lead to different ways of thinking, and there is no clear border between metaphor and theory.

According to Sfard (1998, p. 5), the acquisition metaphor of knowledge is old. "Since the dawn of civilization, human learning has been conceived of as an acquisition of something." This statement

addresses the act of gaining knowledge and the growth of knowledge in the educational process, which has often been analyzed in terms of concept development. Concepts can be understood as basic units of knowledge that can be accumulated, refined, and combined to form rich cognitive structures (Lewin, 1947a, b). The learner is seen as a person who constructs meaning and knowledge.

Sfard (1998, p. 5) states that "the language of knowledge acquisition and concept development makes us think about the human mind as a container to be filled with certain materials and about the learner as becoming an owner of this material." The acquisition metaphor, in terms of action, is seen as "transformation, reception, acquisition, construction, attainment, development, accumulation and grasp and the teacher should help the student to attain the appropriate goal by e.g., delivering, facilitating and conveying" (Sfard, 1998, p. 5).

According to Sfard (1998), the participation metaphor should be viewed as a person interested in a certain kind of activity rather than in accumulating private property or possessions. Earning and knowledge achievement are conceived of as processes of becoming a member of a community, communicating in the language of that community, and acting according to its norms. The norms themselves are negotiated in the process of consolidating the community. While the learners are newcomers and reformers of practice, the teachers are preservers of the community. From the lone entrepreneur, the learners are an integral part of a group. Participation is almost synonymous with "taking part" and "being a part", and "both of these expressions signify that learning should be viewed as a process of becoming a part of a greater whole" (Sfard, 1998, p. 6).

In the integrative environments of this study, the instructions and acquisition-based knowledge are needed for understanding and solving complexity. In this view, the acquisition approach was integrated with workshops, where determined structures of knowledge were eventually used for guidance and definitions. Here, the unit of analysis in the knowledge acquisition approach was "a relevant entity of useful knowledge" for forming and defining known knowledge to particular scopes of R&D. Then, the acquisition metaphor of learning makes sense in our forums. In the integrative environment, the process of participating in social communities makes sense with shared cognitive

processes, values, relations, trust, identity creation, and situated learning. This is noteworthy, for example, due to long specialization careers and positions of networked students; they can advance the networked expertise of different requirements in the world of work and then represent the expertise organizations as a body of knowledge in a particular domain.

The third, according to Paavola et al. (2004), the knowledge-creation metaphor, is seen as analogous to processes of inquiry, especially to innovative processes of inquiry where something new is created and the initial knowledge is either substantially enriched or significantly transformed during the process. In our R&D transactions, the knowledge-creation is understood as a process of inquiry, where new ideas, tools, and practices are created, and the initial knowledge is either enriched or significantly transformed during the process. In this study, evidence-based knowledge creation was especially facilitated. For example, the long tradition of design science and design research processes was used for building, improving, and evaluating artifacts, such as models, design, methods, constructs, plans, information systems, and services for implementation of the change in organizations of networked expertise. Here the term "knowledge-creation" relates to transformations and their effects in terms of evidence-based new or improved knowledge.

The acquisition metaphor represents a traditional view of learning in which an individual acquires abstract and generalizable knowledge by following pre-given and clear-cut rules or algorithms (Engeström, 2001; Sfard, 1998; Hakkarainen et al., 2004a, b). The focus of the participation metaphor is on cultural, communal, and situated aspects, where activities and practices are the focus of learning (Sfard, 1998). The knowledge-creation metaphor addresses a collaborative effort to enhance some subject matter, i.e., R&D scope or integrative components in actualization, and it relies on an interaction between the individual and communal processes; it builds on a pragmatist conception of inquiry and learning conceptions by Dewey, as Hakkarainen et al. (2004a) state.

The participation metaphor focuses on cultural, communal, and situated aspects of learning, where activities and practices are an important part of achievements. Sfard (1998) notes that the decision

to view learning as integration with community in action gave rise to quite a number of conceptual frameworks. In this sense, it would be noteworthy to mention that the theory of situated learning and the theory of distributed cognition have similarities with Sfard's participation metaphor. In the environment of this study, "cognition" is understood as a mental process of knowing, including aspects such as awareness, perception, reasoning, and judgment, and "cognitive complexity" refers to the number of non-automated cognitive operations or strategies that learners must implement to achieve a specific learning goal (Bredo, 1994; Brown et al., 1989; Lave, 1988; Lave & Wenger, 2009; Collins et al., 1991; Clark & Elen, 2006).

The knowledge-creation metaphor has similarities and roots in the creative views of constructivism and in the pragmatic background of inquiry and learning, which rely on interaction between individuals and communal processes. The model is partly based on perspectives of learning in the workplace, and on the works of Nonaka and Takeuchi (1995), Engeström (1987, 2001), and Bereiter (2002). They have all focused on the creation of conceptual and cultural knowledge within processes of communities of expertise. They all agree that artifacts are part of a community's collective knowledge, and artifacts have an effect on learning, where the focus is on creating knowledge.

In this study, the situation, atmosphere, space, and environment where activities take place are relatively dynamic in R&D-related situations, and the "co-created" artifacts and services by the students are always new and creative; the concepts of knowledge acquisition, participation, and knowledge creation appear in many activities and forms in our samples of R&D (Pirinen & Fränti, 2007). In our view, the knowledge-creation metaphor is connected to the acquisition and participation metaphors, as it exists in terms of "knowledge-building and knowledge-creation", as in the research literature (Hakkarainen et al., 2004b; Scardamalia & Bereiter, 1999, 2006; Simon, 1996; Nonaka & Takeuchi, 1996; Popper, 1979, 2007, 2009).

In this study, the relatively new term "co-creativity" is used regarding collaboration, which is seen as the "secret to breakthrough creativity" (cf. Sawyer, 2008; West, 2009, p. 3) and which would lead to a group's advancement in creativity in the "co-creation" processes

of services, artifacts, and methodology, and knowledge is placed in collaboration with regional innovation systems (Fränti & Pirinen, 2005; Niitamo et al., 2006; Ståhlbröst, 2008). According to West (2009), collaboration during the creative process may not be new, but the necessity of group creativity is. As West states, "with the information explosion and growing necessity of specialization, the development of innovations will increasingly require group interaction at some stage of the process" (p. 3). In this study, the "required group interaction" is seen through shared integrative components in clusters and regional innovation systems and structures of regional development (Porter, 1998; Etzkowitz & Leydesdorff, 1998; Swann, 1998; Hendry et al., 2000; Kuah, 2002).

1.2.4 Competence-Based Higher Education

In the context of this study, it was soon evident after implementing the first pilots of R&D projects that the traditional curriculum process was "not optimally supportive" of the new R&D integration and the wider actualization of R&D cases in study units between 2002 and 2005. Then, the development objectives of the European Higher Education Area and research on curricula carried out by Finnish higher education institutions led to the adoption of a competence-based curriculum model. The model's focus was on the broader competencies needed in the workplaces of the future, and the aims of R&D dissemination (Voorhees, 2001; Gonzáles & Wagenaar, 2003, 2005; Dublin Descriptors, 2004; Ministry of Education, 2005; European Commission, 2006; ARENE, 2007; Kallioinen, 2007).

The concepts described for references regarding the dynamic change of knowledge production were highly considered to examine the knowledge generated in the R&D processes related to the competence-based core curriculum and higher education. Here, Gibbons et al. (2008) suggest two related approaches for knowledge management: the disciplinary "mode-1" and the intellectual "mode-2". The authors' "mode-1" is based on a disciplinary setting where the creativity of an individual is the driving force of development and is operated through disciplinary structures of identifying and improving the management and that collective perspective. Mode-1

includes control aspects as the consensual figure of the scientific community. "Mode-2" is the intellectual quality setting in management. Here, the creativity is collective as a group "co-creativity" phenomenon with the individual's contribution. In "mode-2", management is exercised as a socially extended process that accommodates a variety of interests in a process.

Gibbons et al. (2008, p. 9) state that these two imperative systems coexist in recent and future actualizations of the knowledge creation processes: 1) "mode-1," which represents "the ideas, methods, values and norms that have grown up to control the diffusion of the Newtonian model of science to more and more fields of enquiry and ensure its compliance with what is considered sound scientific practice"; and "mode-2," meaning knowledge production carried out in the context of application and marked by: transdisciplinarity; heterogeneity; organizational heterarchy and transience; social accountability and reflexivity; and quality control which emphasizes context and user dependency; the results from the parallel expansion of knowledge. In this view, the term "transdisciplinarity" refers to a research strategy that crosses many disciplinary boundaries to create a holistic approach (Gibbons et al., 2008, p. 4).

The approach includes regarding the dynamic change of knowledge production as highly applicable to examining the knowledge generated in the R&D processes related to the new curriculum. Gibbons et al. (2008, p. 3–6) studied the knowledge generated in transdisciplinary frameworks. "The knowledge produced in applied, processual studies are driven from broad-based collective reasoning between the participants and actors." "Knowledge and new competence are generated through continuous interaction and discussion; they cannot be generated without involving the active participants' interests." This is also the description of the meaning of authenticity and partnership in development projects, the principles on which LbD is based (Laurea's Pedagogic Strategy, 2002; Fränti & Pirinen, 2005).

Knowledge produced in R&D is also characterized is terms of interdisciplinarity, heterogeneity, organizational heterarchy and transdisciplinarity, social responsibility, and reflection and quality assessment, with a marked dependence on context. Here, knowledge is the result of the parallel growth of producers and users in society

(Lewin, 1947a; Lawrence & Lorsch, 1967; Lave, 1988; Gibbons et al., 2008; Laurea's Research and Development Strategy, 2004; Lave & Wenger, 2009; Lyytinen, 2009).

The challenge of this support is related to the dynamic needs and heterogeneity of a base situation, competencies, and skill levels of participators. This has, in turn, focused our view on situational cognition (Bredo, 1994; Collins et al., 1991; Brown et al., 1989) and situational support (Pirinen, 2008b; Hamel, 2006; Kolb & Kolb, 2005). In the context of curriculum, the term "heterogeneity" refers to the composition of dissimilar parts of the environment in the perspective of R&D and the dynamic nature of integrative environments such as living labs; hence, the students, participators, workplaces, and R&D communities are of a different kind and the instance of integrative environment is different in every particular reflection and actualization (Mezirow, 1981, 1991; Gibbons et al., 2008; Ståhlbröst, 2008). In this study, the transdisciplinary framework has four noteworthy characteristics, which are visible in the practical implementations of developed core curriculum: 1) the R&D leads to a developing framework for directing R&D-based and problem-solving efforts; 2) knowledge produced at the meeting points of different expertise sectors and context develops its own theoretical structures, research methods, competence field, and practices; 3) the research outcomes are transmitted to the participants of the process and may be disseminated as soon as they have been produced, and these outcomes are developed in new or emergent problem-solving or R&D situations; and 4) transdisciplinarity arises from dynamic motion at the intersection of various expertise sectors.

This summary of four characteristics consists of active R&D scopes and problem-solving abilities in which interaction networks are maintained through both official and unofficial means. "Maintaining the mobility of information and predicting the next area of application are also very difficult" (Gibbons et al., 2008, pp. 3–6).

An extensive curriculum reform was concluded in 2006, which led to the creation and implementation of a shared competence-based core curriculum for Laurea in 2006–2008. During the reform, a core curriculum model was created, which produces service innovations and competencies, and safeguards and facilitates the fulfillment of

strategies. All degree courses' curriculums were revised according to this jointly created model. The competence-based curriculum forms an innovative statement on Laurea's behalf, and also contributes to the metropolitan area's innovation environment and the development of the European Higher Education Area, as it allows R&D to be integrated into education (Gonzáles & Wagenaar, 2005; Dublin Descriptors, 2004; European Commission, 2006; ARENE, 2007; Kallioinen, 2007; Pirinen, 2009a; Rauhala, 2008).

In a deeper perspective of studies in information systems, security and services, the adjective and noun "thematic", relating to subjects or a particular subject, was treated as a body of topics for study or discussion. In the integrative process, the term "thematic" was related to aims of creativity and "co-creation" of innovations (Iivari, 1991; March & Smith, 1995; Hevner et al., 2004; Cross, 2001; Nunamaker et al., 1991; Nunamaker, 2010; Hevner & Chatterjee, 2010).

Its aim was to join and compose the promising creations, artifacts, or "objects of leading innovations" to regional or societal innovation systems and value networks. Hence, "creation" here means creation by a human. Three examples of creations are: services, practices, and events. The term "artifact: means a human-involved creation that includes technology such as animation, phone or information systems, etc. In this study, the term "thematic" means that R&D is related to the body of dynamic or agile scopes or themes for study; to important and interesting areas; to the theme of research agendas; or to focus areas of cluster within innovation systems.

In our context, the thematic curriculum defines "thematic competencies", theory binding, references of methodology and applied domain, and it makes it possible to join related thematic domains and thematic networks to collaborate by implementations of curriculum. Designed thematic curriculum was addressed to students who were interested in developing and using their own creativity and being motivated to develop information systems, networks, security topics, or information-system-related services in collaborative and innovation-system-related ways (Dewey, 1916; Schaefer, 1967; Revans, 1982; Bredo, 1994; Alter, 1999, 2008; Cockburn & Highsmith, 2001; Voorhees, 2001; Cooke, 2004; Kauppi, 2007; Hevner & Chatterjee, 2010).

1.2.5 Towards Knowledge Economy

In the domain of study, the integrative process advocates that knowledge and education can be preserved as a service, methodology, or product, or as educational, innovative, or intellectual assets which can be exported for a value return. Here, the incipient concept of "knowledge economy" includes its support for creation and "co-creation" of knowledge by learners and organizational employees and its encouragement of individuals to transfer and utilize their knowledge and competencies that are in line with the goals and strategies of organizations and the regional-national R&D agenda. Here, the term "knowledge economy" also implies the use of knowledge-intensive technologies and services, such as knowledge creation and knowledge management, to produce information-intensive economic benefits as well as new workplace creation as integrated into R&D-related themes. In macro scale, the global economy is in transition to a knowledge economy; in micro scale, education is transitioning to a knowledge economy of information-intensive services, products, and methodologies which are achieved in R&D.

The transition requires that the rules and practices that determine success in the industrial and service economies need reconsideration in an interconnected, globalized economy, where knowledge resources such as know-how, know-why, know-who, and expertise are as critical as other economic resources. These rules need to be revised at the levels of firms and industries in terms of knowledge management and at the level of public policy as knowledge policy or knowledge-related policy (Rutten & Boekema, 2007; Asheim, 2012).

The foundation for the "knowledge economy" was introduced in the book *The Effective Executive* (Drucker, 1969). Drucker describes the difference between the manual worker and the knowledge worker. The manual worker, according to him, works with his hands and produces goods or services. In contrast, a knowledge worker works with his or her head not hands, and produces ideas, knowledge, and information. In this setting, Piore and Sabel (1984) explain how new and flexible production technologies are transforming. Best (1990) and Porter (1990) explain how such production networks, which are resilient and dynamic, take the form of regional or territorial production systems (Best, 1990; Storper, 1997; Rutten & Boekema, 2007, 2012; Asheim

2012). The term "knowledge economy" and its implications for the organization of production and services are currently accepted in mainstream economic thought (Cooke & Morgan, 1998; Storper, 1997).

Best (1990) states that a knowledge economy differs from an industrial concentrated economy in that knowledge is a strategic resource and learning is an important process. In a knowledge economy, often a "social reality" is constructed by those who participate in it, and this is frequently referred to as "social constructionism" (Burr, 1995, pp. 1–5). According to Burr, "a focus of social constructionism is on interactions and social practices, a focus is on process" (Burr, 1995, pp. 6–7). To a single actor like Laurea, it is difficult to complete all knowledge which is needed for novel services or artifacts, since a knowledge economy is also a networked economy (Cooke & Morgan, 1998; Harmaakorpi, 2004; Fränti & Pirinen, 2005; Teräs, 2008; Rutten & Boekema, 2012; Asheim, 2012).

In an industrial concentrated economy, inventions and innovations are concentrated in manufacturing and a limited number of service industries (Rutten & Boekema, 2012). Here, value creation comes in the form of new production technologies and flexible production (Best, 1990; Huttula, 2001). In a knowledge economy, the most central value creator is knowledge itself (Malecki, 2012; Asheim, 2012). In our view of globalization, students are going global by networked media and utilize internship-based knowledge relations, and businesses, regions, and countries are pipelined and networked by global knowledge and activities (Friedman, 2005; Fränti & Pirinen, 2005; Teräs, 2008).

In a late industrial concentrated economy, which was a main influence in this study, between 1995 and 2005, the assumed form of knowledge was tacit or codified knowledge (Polanyi, 1966; Nonaka, 1994; Nonaka & Takeuchi, 1995). Now, after 2006, in the new approach of knowledge economy, knowledge is referred to as being context-depended, path-depended, and "co-created" (Burr, 1995; Teece, 1998; Fränti & Pirinen, 2005; Pirinen & Fränti, 2008; Rutten & Boekema, 2012; Asheim, 2012). According to Miles et al. (1998, p. 281) "globalisation and production change have set the stage for a new period of economic development, where the driving force is knowledge, the speed of its improvement, and the effectiveness of its

utilization". In a knowledge economy, learning is related to networks of individuals and is much more diffused, as individuals and participators occupy multiple social and professional networks. In the integrative environment as a space for transition of knowledge into live, learning bridges knowledge and competencies through R&D transactions and actions.

1.3 RELATED RESEARCH

This sub-chapter describes the search of the latest related research during the study period – between 2003 and 2012. The related studies were selected based on what is already presented and known and what is not known in relation to this study's focus.

According to Siltala (2010), future research is needed to understand and change the different roles and pre-conditions of organizations and participators in the context of co-operative education. Siltala notes that more research is needed for the creation of novel action logics and actualization models, as well as constructs in the context of collaborative and integrative education, and continues that collaborative activity would especially improve regional capability (Harmaakorpi, 2004) in regards to new and innovative entrepreneurs.

According to West (2009), little is known about: 1) the processes and attributes that influence creative collaborations; and 2) how innovative ideas are developed into community artifacts. Also, future research is especially needed to examine how innovative communities and collaboration can be fostered and developed. West puts forward plenty of related questions where future research is required; those questions include: what environmental factors (structure, scaffolding, instruction, setting, etc.) encourage group flow and how structure can most effectively support novices and expert members without limiting their creativity.

Ståhlbröst (2008) states that: 1) more research is needed in the "living lab approach" and the "living lab milieu" to increase the collected knowledge about this concept; 2) research is needed to develop tools to support distributed user involvement, if we want to involve users as private persons on their premises; and 3) research

on the methods and technological devices to support this process needs to be developed, and its influence on the user involvement approaches need to be researched (Mattelmäki, 2006; Luojus, 2010).

Regarding cluster integration and regional development, Teräs (2008) states that additional case studies, concentrating on only one or a selection of the key categories of cluster actors, would provide yet another viewpoint to further sharpen the picture of various types of regional clusters, especially regional science-based clusters (Teräs, 2008; Doloreux & Parto, 2005).

2 Research methodology

In this chapter I will present the central methodological issues of the study by: 1) introducing the research questions; 2) presenting the continuum of research methods; 3) describing the data and its collection process; and 4) presenting the data analysis. This study took the form of a continuum of research cycles and proposed articles of implemented R&D. The studies have been reported in 27 research articles, of which 12 have been published in refereed international scientific journals, and of which 6 conclude this dissertation. The research context, perspective, and conditions of this dissertation are delineated on the master, bachelor, and degree studies in information systems, security management, and service programs (n=1607 students in 2012) as one view of activities, operations, settings, and realization structures of R&D at Laurea between 2003 and 2012.

In this study, the term "research method" refers to procedures for collecting and analyzing data, and the term "analysis" addresses the processes of investigating and interpreting quantitative and qualitative data in order to gain deep understanding and new knowledge for designs and realizations (Brannen, 2004).

2.1 RESEARCH QUESTIONS AND THEMES

The study includes one main research question and theme, which is rounded out by 15 expressed and iterative research questions in the 6 studies, where the research questions and theme of each study produced a deeper iteration of the main research question and theme.

In addressing the research questions of the six studies, I have drawn three continuously deepened and iterative perspectives for the research: 1) integration of R&D and education; 2) integration of the national R&D agenda and higher education; and 3) investigation of the changes in realizations and education in everyday practice and the study context.

The main themes of studies I–VI are strongly based on a student-centered and collective method of R&D-related higher education. Then, the main theme of this research was to gain a deeper understanding for the design of the structures, characteristics, factors, and actualizations of the R&D in a UAS. The perspective and context of this study relates to integrative R&D-related higher education of information systems, security management, and services at Laurea UAS between January 2003 and December 2012. The main research question is:

How can research and development (R&D) be designed and actualized in a university of applied sciences?

Study I addressed the R&D-based strategy in an integrative model, R&D-related expertise, and way of thinking about R&D, as a methodology and a logic of action and collaboration, in the perspective of regional-global activities, which represent the most macro-level and interoperative viewpoints in this study (Laurea's Research and Development Strategy, 2004). The target of Study I was exploring the new proposition: the integrative process as a process model of R&D-related actualizations, dimensions, elements, and logic of activities. Then, the integrative process was used for the creation of a mostly macro-level and linear process model for cyclic activities and the implementation of R&D and regional activities, as well as views from wider globalization to everyday education at Laurea. The included journal of Study I joins five related articles of theme utilized by the researcher between December 2007 and November 2008. The research question was:

What are the constructions and models contributing to international and global (R&D) activities which are used in implementation and actualization by Finnish universities of applied sciences?

In Study II, the theme was the actualization of study units in an integrative and strategy-based way. The study addressed a case analysis of competing professional expertise in R&D and LbD in

network design specialization studies, which as a case represents the most micro-level integration and assessment viewpoints. The journal of Study II synthetizes three related articles of theme that were used by the researcher between December 2007 and October 2008. The common research question was:

How do the network specialization studies fulfill Laurea's (R&D) strategy and what are the lessons to be learnt when executing new integrative models and education products?

Study III was as continuation of Studies I and II and addressed the design and actualization of new and appropriate forms of competence-based thematic curriculum, and then the cases representing the research of concepts and models. The thematic viewpoint was the bridging of information-intensive education and regional-national R&D and its agenda and strategies. The journal article of Study III references seven related articles of theme used by the researcher between November 2008 and September 2009. In Study III, the research questions were:

What kind of competence-based curriculum produces thematic competencies and knowledge?

What type of action bridges knowledge and competence in the study of thematic networks, thematic cities, and living labs?

What should competitive research, last-mile research, and living-lab research be in the actualization of the thematic curriculum discussed?

What methods for evaluation and complexity management should be considered in this context?

The theme of Study IV was canonical research and analysis of the integrative method, interactions, models, realizations, and quality assessment that work as an "interoperational" spine for the R&D, LbD, and "co-creative" R&D activities between clusters, innovation systems, and the UAS. The journal article of Study IV references

fifteen related articles of theme used by the researcher between November 2005 and December 2009. The main research questions of Study IV were as follows:

What is the theoretical background of learning by developing (LbD)?

What models and constructions were developed and tested in the (R&D) actualization?

What results, impacts, educational differences, influences, and challenges were observed in the (R&D) actualization?

What new data concepts have been observed, and what products have been developed and demonstrated at Laurea University of Applied Sciences?

In addition, the extended research interest of Study IV was: 1) building and evaluating new information systems for new R&D-related education; 2) improving action, quality, and evaluation interventions; 3) dissemination of LbD and knowledge at Laurea; 4) collaboration with other universities, innovation systems, and global actors; 5) future work theorizing the LbD and integrative process towards a new interoperative theory; and 6) reducing diversity and ambiguousness in LbD.

Study V focused on student-centered integration and viewpoints of external R&D funding. Here, the regional-national R&D collaboration realizes higher education and research in a co-operative and student-centered way and shares the regional-national R&D agenda and its funding, capabilities, and interests. The study includes analysis of the research data regarding SATERISK (SATEllite positioning RISKs). In addition, the journal article of Study V refers to seven related articles of theme which were used by the researcher between September 2008 and October 2008. The main research questions of Study IV were:

How can the factors of learning and collaboration activities be understood in the R&D work at SATERISK?

What kind of main elements and factors can be identified in the performed R&D actualizations and learning in the SATERISK project?

Finally, Study VI includes a multiple case study of eleven externally funded R&D projects and proposes a model of extended analysis, a concept of value concentration, and a framework of research continuum for regional development and R&D integration. The cases addressed the realization of R&D and integration of education between October 2007 and December 2012. This final study concludes the research findings of a multiple case study analysis that addresses collaborative R&D and joins regional development in the perspective of:

Understanding and modeling (knowledge, action logic and process models) for designing (thinking, sharing, building, improving and testing) and research for new concepts in integration of R&D-related higher education and regional development.

2.2 CONTINUUM OF RESEARCH METHODS

This sub-chapter describes the continuum of research methods used in this study, which includes: case study research (CS); information systems' design research (DR in IS); and action research (AR). In this mostly qualitative study, action research with a quality assurance system is used in the investigation of organizational-regional change, the integrated perspective of information systems' design research in the systemization of design, new artifacts and services, and a multiple case study analysis which is integrated into the continuum to bring an understanding of the research scope, and in addition, produce new knowledge for design and action. The unit of analysis was a case as a sample of evidence of R&D activity and the analysis was undertaken using empirical, in-depth data collected between January 2003 and December 2012.

The form of AR used was mainly based on Lewin (1946, 1947b), Schaefer (1967), Clark (1976), Susman and Evered (1978), Susman, (1983), Checkland and Holwell (1998), Stringer (2007), McKay and

Marshall (2001), and Davison et al. (2004). The DR in IS was based mainly on Iivari (1991), March and Smith (1995), Nunamaker et al. (1991), Hevner et al. (2004), Lee and Hubona (2009), and Nunamaker (2010). The canonical form of AR (CAR) was based on Davison et al. (2004), Checkland and Holwell (1998), and the DR acronym of DR in IS was used. According to Yin (2009, p. 23), "case study research (CS) is bringing an understanding of a complex issue or object and can extend experience or add strength to what is already known through previous research" and "case studies emphasize detailed contextual analysis of a limited number of events or conditions and their relationships, but except when the relevant behavior cannot be changed or manipulated by a researcher" (Stake, 1995; Benbasat et al., 1987; Eisenhardt, 1989; George & Bennett, 2005; Dubé & Paré, 2003; Gerring, 2007; Yin, 2009).

According to Yin, CS relies on multiple sources of evidence with data needing to converge in a triangulation fashion, and it benefits from the prior development of theoretical propositions to guide data collection and analysis. Here, the term 'triangulation' (Campbell & Fiske, 1959; Patton, 1990; Robson, 2002; George & Bennett, 2005; Gerring, 2007; Yin, 2009; Nunamaker, 2010) refers to the usage of multiple sources of evidence such as:

1. data sources as data triangulation,
2. among different evaluators as investigator triangulation,
3. perspectives of the same data set as theory triangulation, and
4. an approach as methodological triangulation.

The reasoning for using a multimethodological approach as a continuum of CS, DR, and AR was due to the multiple interests involved in the integrative development processes of R&D-related education in the need for developing activities, facilities, information systems, and R&D-related pedagogy in the UASs that can contribute to a dimension of R&D activities (Pirinen, 2008a) and a student-centered R&D approach (Pirinen, 2011b) with a competence-based curriculum (Pirinen, 2009b), and to conduct further development of all participators involved in the perspective of education (Fränti & Pirinen, 2005). The multiple interests and activities were:

1. activities of quality implementation and confirmation,
2. research-based development of operations and strategies,
3. research interest by researcher, and
4. problem-solving interest (McKay & Marshall, 2001).

The empirical studies presented here marked the beginning of the unique research for the collaboration and education within the R&D approach in the context of the Finnish UAS, mainly through Pirinen (2008a), Auvinen et al. (2010), and Pirinen (2011a, b).

Consequently, the used form of AR and sustainably developed quality system with the AMKOTA database functions as the data repository and body of knowledge for the continuous development of Laurea's activities, and it is combined for all of Laurea's operations, as different monitoring and development measures and data collections, including both qualitative and quantitative data.

In the sense of integration of study units and actualization of student-centered R&D, the collected data structure design and the form of the main research question, "how", allows and extends to future uses of a variety of research methods and different roles of researchers for verification and complementation of thematic research scopes, such as: history study (Cohen et al., 2007); archival analysis (Denzin & Lincoln, 1994); grouted theory approach (Corbin & Strauss, 2008; Strauss & Corbin, 1994); or survey (Robson, 2002). In turn, using the sustainable quality system structure and data collection processes, which support a variety of qualitative or quantitative research methods, makes it possible to consider outsider or insider roles by researchers in current or future studies in this context (Stringer, 2007; Robson, 2002; Brannen, 2004).

2.3 DATA COLLECTION

In the beginning of the study, data collection and analysis methods which can be used to study the samples of evidence as cases in R&D were required. The cyclic progress of the research process and the authenticity of data collection and data processing focused on themes that complete each other and provide an opportunity to analyze the

research data by simultaneously specifying and complementing it, as well as deepening the researchers' understanding of the research phenomenon and research themes. The data collection methods used included design probes (Mattelmäki, 2006), evidence sampling as cases (Miles & Huberman, 1994), development days, workshops, outsider reviews, and FINHEEC evaluations.

The method of data collection used in this study was based on the theoretical sampling described by Corbin and Strauss (2008) and Strauss and Corbin (1994), which refers to derivation on themes and concepts from data. It also was based on the data collection suggested by Miles and Huberman (1994), Mattelmäki (2006), and Stringer (2007). In this, the end of data collection is indicated in by saturation – when no new data are emerging for research purposes (Strauss & Corbin, 1994; Stringer, 2007; Locke et al., 2007). Then, the data were collected and placed in a themed directory structure which integrated data from the quality assurance system and extended data collections of the research. The data collection directories of this study included seven themes that were used to structure the analysis phase of the study:

1. Management data, which describes Laurea's strategy-based data; the collected data is in form of: documents, applications, drafts of visions, legislation, papers of regional focus, strategies, scoreboards and indicators, related research documents, summaries of follow-up data, comparison data, presentations, and plans. Our development efforts and actualization activities are based on strategies and the data realizes triggers, enablers, and drivers of action in vision- and trust-based management and freedom within framework culture.
2. Evaluation data by FINHEEC, which includes applications and results of evaluations by outsiders; the data is represented in the archives of FINHEEC (KKA 3:2005), is edited and referenced by Salminen and Kajaste (2005); the KKA 2:2009 is edited and referenced by Saarela et al. (2009); the KKA 1:2010 is edited and referenced by Auvinen et al. (2010); the KKA 18:2010 is edited and referenced by Lampelo et al. (2010); and the KKA 16:2011 is edited by Maassen et al.

(2011); the feedback and transaction data of FINHEEC revises the concept development, iteration of models, dissemination of results, and quality.

3. Data of development days and seminars as development data; these data files were collected by calendar year and by current development themes and then placed in the themed directory; the purpose of this data collection was the "co-creation" of new ideas, data drawings, and data displays from everyday practices; the development days are also facilitated as an open space for discussions, dissemination, and sharing of experiences and emotions. The forum is also used as a stage for dissemination and implementation of models, realizations, reflection, and quality confirmation.
4. The AMKOTA database, which is mostly quantitative and common to all Finnish UASs; in this study, it was often used for follow-up and evaluation purposes. The collected data were in the form of a database (AMKOTA) and its longitudinal data views; the data of AMKOTA has an effect as an enabler of all activities and is a main body of relevant activities and development (Appendix C).
5. Feedback data from students; the collected data were in the form of a database (INKA). The question forms (Appendix B) for data collection were as follows: study unit feedback for every actualization of study units; early phase feedback for every incoming student; graduation feedback for every student; job placement and internship feedback for every student; feedback data from students affected by the balancing of cognitive load and consideration of challenges in realizations – this gives steering reference to the practice of implemented transactions.
6. Dedicated evaluation reports and references by outsiders and selected publication data and R&D series at Laurea; the collected data were in the form of publications and reports; this evaluation data produced numerous recommendations for improvements and quality.
7. Data of funded R&D projects (Appendix A) is available in the form of R&D documents and research papers, e.g., cases by

students, teachers, and participators; the R&D-related studies are concluded in the sample of evidence series: so far vol.1: RIESCA and vol.2: SATERISK, which are available at Laurea publication (Pirinen & Rajamäki, 2010; Rajamäki, Pirinen & Knuuttila, 2012).

In this study, the design of data collection was planned to answer the research questions, develop models, and investigate realizations related to R&D. This data collection was cumulative, and it was systematically used for analysis in all six studies between 2003 and 2012. The time delay of data coherence in AMKOTA is about half a year. Our first externally funded R&D project was RIESCA, between October 2007 and March 2010. Therefore, the data of externally funded R&D projects have been collected since 2008, and the timeframe for this part of the analysis was between January 2008 and December 2012.

The rationale for the selection of the complementary data collection process of quality assurance system at Laurea lies in the reasoning that there are about 500 faculty members, 8000 students, and about 70 co-operators that all use the quality assurance system for data collection, quality implementation, and confirmation, as well as development and verification purposes. In the selection process of the quality assurance and management model, one of the most well-known and evergreen models was the Deming-Shewhart cycles or Plan-Do-Check-Act (PDCA) model (Deming, 2000; Shewhart, 1939). This applied traditional model of PDCA was considered and reasoned to be light enough to use and meaningful for dissemination and co-operative action; but nevertheless, it was useful and interoperative in the study context and has increased quality and management that includes vision-strategy-based management and development as in our context. In the operative environment of the study, at Laurea, the actualization and data collection of quality assurance process includes such activities as:

1. Plan: Planning the design activities, i.e., what should be done, what results should be achieved, and what is necessary to change in the realizations? This concerns the "co-creative" and participative nature of planning and the implementation of

definitions into the design and optimization of the quality elements.

2. Do: Doing the actualization and implementation according to the plan, actualizing and implementing interests, and co-operating and participating, as well as generating new knowledge from the creation perspective of doing, e.g., the actualization of R&D-related study units and processes.
3. Check: Checking the activities and the results achieved, which involves development, the research interest, the knowledge creation interest, e.g., the reviewing of reports and updating of the syllabuses. The implementation of analysis, measurement, and verification interventions in the "quality sigma" (Deming, 2000).
4. Act: Acting systematically; taking into account the observations and results of the checking, regarding the consequences and especially implications of the realizations for the next stage and the body of knowledge, e.g., the binding of new theories and writing of a draft for the next syllabuses. Act responds to the questions of management regarding the continuation or falsification of some activity (Shewhart, 1939; Deming, 2000).

The AMKOTA is the information system for common follow-up data of all Finnish UASs. Here, the AMKOTA-based follow-up data were used in evaluating and developing operations, in internal and external reports, e.g., evaluations of centers of excellence (FINHEEC), and in support of the strategic, operative, and pedagogic planning. The data were also used when preparing for the agreement and plans with the Ministry of Education and Culture. The follow-up data are useful for different kinds of evaluations because they are common to all Finnish UASs (e.g. Laurea's R&D linked follow-up data in Appendix C).

2.4 EXTENDED DATA ANALYSIS

In addressing the research questions presented above for the six studies, the qualitative data analysis was continuously involved in organizing, accounting for, and explaining the collected data, and making sense of the data in terms of situation, themes, categories, entities, relations, and regularities (Patton, 1990; Miles & Huberman, 1994; Strauss & Corbin, 1994; Denzin & Lincoln, 1994; Robson, 2002; Locke et al., 2007; Corbin & Strauss, 2008).

The data collection included seven directory structures for the analysis phase, and this cumulative data collection was used separately in each of the six studies. The investigated data in each study represented one view from the whole data collection set, which included qualitative, quantitative, and longitudinal data as data views of AMKOTA. The term "longitudinal study" refers to the method of data gathering in which the process is repeated on several occasions over a period of time, repeating the same methodology each time. The practical and theoretical contributions of each study were drawn from the view of the data, and the selection of data samples was related to the theme and questions of each study.

While considering the unit of analysis for this study, the suggestion of Corbin and Strauss (2008), where the unit of analysis would be a concept in case of the grounded approach, was noted. According to Yin (2009), the unit of analysis in case study analysis depends on the case; it can be concrete, such as individuals, small groups, organizations, or partnerships, or less concrete, such as communities, relationships, decisions, or projects. In turn, Stringer (2007) suggests that the major unit of analysis in AR can be a key experience used to identify information that represents the perspectives of the stakeholding participants and actors in the context of the study. In this study, the selected unit of analysis was a sample of evidence of R&D activity as a case in a UAS, and the emphasis was on the phenomenon of education with authentic R&D. The sample of evidence used can be qualitative or quantitative, and the same unit of analysis as "display" or "sample of evidence" was used in the analysis sections of all included journal articles and the FINHEEC evaluation transactions of quality and excellence in education between 2003 and 2010.

In this study, all six studies utilized both quantitative and qualitative data. For furthering the quantitative mindset, the quantitative data were interpreted in an analysis using a qualitative sense of reduction, display, and drawing cycles of analysis (Miles & Huberman, 1994; Stringer, 2007; Lindgren et al., 2004). Information system analysis was then used as an extended cycle of qualitative analysis for utility in building, testing, and normalizing data structures, objects, and artifacts (Chen, 1976; Ullman & Widom, 2002).

Figure 1 shows the components of the extended analysis composing continuums from data to utility creation, e.g., by information systems.

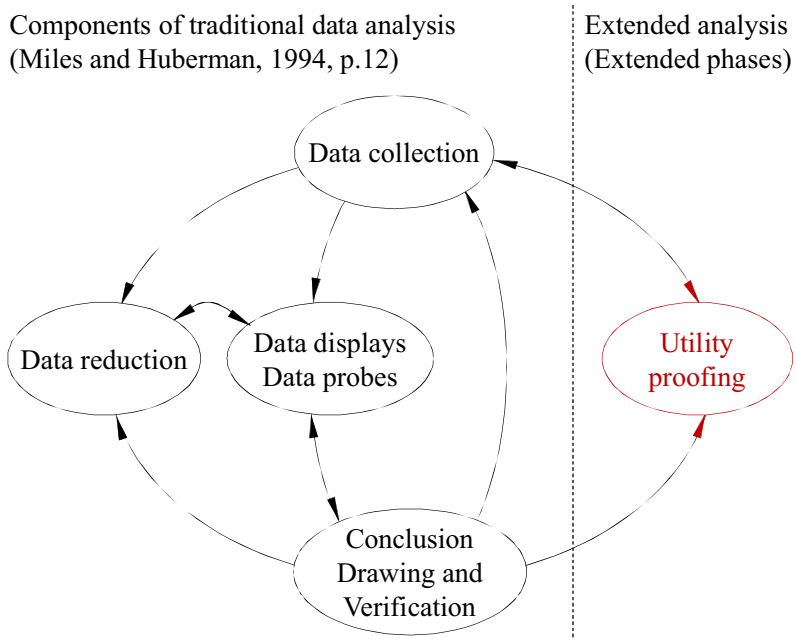

Figure 1. The extended analysis

The qualitative data were first analyzed in terms of systematic coding and categorization as data reduction, displays, and drawings of data in order to develop a synthesis which grasps the empirical evidence (Patton, 1990; Miles & Huberman, 1994; Denzin & Lincoln, 1994; Robson, 2002). First, the analysis refers to data reduction as the process of selecting, focusing, simplifying, abstracting, and transforming the data that appears continuously

throughout everyday activities and action, e.g., drafts in development days, memos, design probe, notes of team meetings, group documents, and live data of actualizations as syllabuses and reports.

In this study, the term ”memo” means a written or described record of analysis, which may be produced collectively as a conclusion of development days or issues of applications of the FINHEEC, or created by the researcher (Miles & Huberman, 1994). The term “design probe” refers to human-centered ways of information gathering of the student- and users-centered approaches (Mattelmäki, 2006). In this study, the design probes were explorative, design oriented, and based on self-documenting; they aimed at revealing teachers or students' personal perspectives to enrich design and implementation, and support empathy.

The second part of the analysis refers to the data display, which is an organized and compressed assembly of information that permits conclusion drawing (see also Study IV). In the course of our work, the displays are, for example, applications, R&D proposals, agreements, data matrices, graphs, and extended abstracts and descriptions (Miles & Huberman, 1994; Corbin & Strauss, 2008; Guba & Lincoln, 1994).

The third stream of the analysis contained conclusion drawing and verification. The purpose of the conclusion drawing was to decide what things mean in the context of the study, as: roots of strategies, evaluation reports, reviews, configurations, verifications of competencies, and elements of models, propositions, and proposals. The one advantage of the form of memos, design probes, and data displays used with personally involved data collection and participation is that the researcher has an understanding of the data, activity stream, and shared reactions in practical action (Mattelmäki, 2006; Miles & Huberman, 1994; Robson, 2002).

In the extended cycle of analysis, as proposed in Study IV, the results of the first cycle, such as categories, relations, and first drawings of qualitative analysis, were furthered with the information system's analysis (Chen, 1976). Then, the drawings of the first cycle could be used in management in a general sense, as suggested by Miles and Huberman (1994). In addition, this second view extends and utilizes the development of information systems. The second cycle of analysis included the technique that is commonly used for modeling

data structures in the field of information systems analysis (Chen, 1976; Lindgren et al., 2004; Cohen et al., 2007; Stringer, 2007).

In this extended phase of analysis, in Figure 1, there are beneficial correspondences between the terms of using these two sets of analysis, as the two integrated sets of concepts: the qualitative data analysis (Patton, 1990; Miles & Huberman, 1994; Denzin & Lincoln, 1994) and the information system entity and relationship analysis (Chen, 1976; Brady, 2000).

In the classification level of database structure, the term "entity type" refers to an implemented "table" in the database; this structure of information system corresponds to the term "category" in qualitative data analysis (Strauss & Corbin, 1994). The term "property" in qualitative data analysis represents a characteristic and provides specificity, and corresponds to the term "attribute" in database structure (Chen, 1976). The term "dimension" refers to the variation of a property over time (Strauss & Corbin, 1994) because it has a correspondence to the "permitted values" in a database structure. In a database there is an association level which includes "relationships" between tables and entity types, and relationships between attributes (Brady, 2000; Chen, 1976; Ullman & Widom, 2002). These associations are also described as "relationships" in qualitative data analysis.

In this analysis, the integration was used to further the drawings: first, from the qualitative data analysis which is used largely in social science research; and second, from the entity-relationship diagramming, a technique which is used to model data from the field of systems analysis. This setting was beneficial in the development of utility in the results, relations, and structures (Chen, 1976; Patton, 1990; Strauss & Corbin, 1994; Miles & Huberman, 1994; Ullman & Widom, 2002; Corti & Thompson, 2004; Erl, 2005, 2007; Study IV).

2.5 RESEARCH CYCLES AND ANALYZED DATA

In this sub-chapter, a more in-depth summary of the six studies is given regarding their research cycles, data, analysis, and references. The cyclic progress of the research cycles of each study and the

authenticity of the data collection focuses on the themes and research questions of each study.

These research interventions completed each other and provided an opportunity to analyze the research data by simultaneously specifying and complementing it, as well as deepening the researchers' understanding of the research phenomenon and research themes.

The data collection methods used included design probes (Mattelmäki, 2006), evidence sampling and data displays (Patton, 1990; Strauss & Corbin, 1994; Miles & Huberman, 1994), development days, reviews of actualizations, workshops, and outsider reviews and evaluations. Since 2002, the data has been collected in a quality assurance system and then included separately in seven themed data directories. The final end of the data collection was in December 2012, when AMKOTA completed the year 2011. Next, a more detailed continuum of research interventions of each of the studies, investigated data, used methods, and references are presented for reference.

2.5.1 First Study

In the first study, the empirical case element included design-science research and constructive development and analysis work, integrating the globalization perspective, which was conducted between 2001 and 2008 in cases at Laurea's Espoo unit in close co-operation with the Helsinki metropolitan area. The results were based on the identified best practices and empirical data collected at Laurea. In this view, researchers conduct continuous action research on their own processes and have several online databases whose content is used for action and R&D purposes.

Data collection between May 2002 and November 2008 included: Management Data: Eurostat, World Economic Outlook, and European Scoreboard (n=3). Development days (n=56); involved teachers (n=41); folders (n=98), and files (n=429). KKA 8:2001 (Huttula, 2001), KKA 12:2003 (Impiö et al., 2003), KKA 13:2006 (Käyhkö et al., 2006), and KKA 3:2005 (Salminen & Kajaste, 2005), which included n=39 evaluators. References in the study were n=28. R&D collaborators were n=10. Involved students were n=1120, in which master's level students were n=56. Funded R&D projects were n=4;

RIESCA, SATERISK, LaureaLivingLas (LLL), and FLOODWARE. There were more than 30 active and collaborative new drivers for R&D which were using the integrative model. Integrative environments were n=4; BarLaurea, REDLabs, Datacom-Lab, and Start-ups-incubator at Laurea.

2.5.2 Second Study

In the second study, the form of case study used utilized design research to provide an example of how higher education can face the requirements given in R&D and the regional development strategy and actualization plan of Laurea with regard to adult education. In this study, a new product in adult education was designed, executed, and evaluated. The realization consisted of LbD and actualization of R&D as new integrative environments which were formed as expansive virtual learning, virtual empowerment, and adult education.

The new product utilizes virtual learning, R&D, and LbD (Laurea's Actualization Plan of Strategy, 2007; Laurea's Research and Development Strategy, 2004; Pedagogic Strategy of Laurea, 2002). Data for Design Specialisation Studies May 2002 and October 2008. Development days were n=81; involved teachers were n=4; folders were n=26, and files were n=67. References in the article were n=25, and literature reviews were n=20. Involved students were n=15.

2.5.3 Third Study

The third study was related to an objective of Laurea UAS, which was to design, integrate, and implement the three statutory tasks (higher education, R&D, and regional development) into everyday action. In this study, a continuum of DR, AR, and quality analysis was used as main the method.

Data for the design of thematic curriculum and integrative environments between May 2002 and April 2009. Integrative environments were n=4; BarLaurea, REDLabs, Datacom-Lab, and Laurea Living Labs. Laurea's Regional Development Strategy 2002, 2005; Laurea's R&D Strategy, 2004; Laurea's Pedagogic Strategy 2002, 2007; and European Scoreboard, 2007. Data for design between

May 2001 and April 2009; development days were n=81; teachers were n=41; folders were n=132, and files were n=651; KKA 12:2003 (Impiö et al., 2003) and KKA 13:2006 (Käyhkö et al., 2006) included n=17 evaluators and n=31 article references.

2.5.4 Fourth Study

The focus of the fourth study was the analysis of two cycles of canonical action research which were described in detail by Pirinen (2009a), and the analysis of the integrative R&D, interactions, models, realizations, and the quality assessment that work as an interoperational spine for the LbD and R&D, as well as for "co-creative" regional activities between clusters, innovation system, and the UAS.

First, the conceptual categories (open categories) for qualitative analysis were generated in the evaluation phases, the documents, transcripts, and databases were analyzed using open coding (Corbin & Strauss, 2008; Strauss & Corbin, 1994). The relational results and development targets (axial categories) for the diagnosis and reflection phases were then composed. The data were analyzed using selective coding. The analysis of data for the concepts involved combines the fundamental bases of the grounded theory approach with the technique used to model data from the field of systems analysis in information systems design research (Chen, 1976).

Development days and seminars on the quality assurance system in 2008 included n=3 development days, n=48 teachers, and n=26 files. Development days and seminars on the quality assurance system in 2009 included n=17 development days, n=52 teachers, and n=145 files. Development days and seminars on the quality assurance system in 2010 included n=4 development day, n=54 teachers, and n=56 files; KKA 13:2006 (Käyhkö et al., 2006), KKA 1:2010 (Auvinen et al., 2010), and KKA 18:2010 (Lampelo et al., 2010), which included n=16 evaluators; n=37 article references, and n=26 literature reviews.

2.5.5 Fifth Study

This fifth study included both qualitative and quantitative data of the SATERISK which were collected together at Laurea between 2008 and 2011, and the data collection was completed in May 2011. The data were categorized for analysis in regard to the case of SATERISK. Then, the collected data were as one view in Laurea's whole collection which included qualitative (interpretative), quantitative (AMKOTA), and longitudinal (views of AMKOTA) data, between 2003 and 2011. The selection of case was addressed to student-centered R&D in the SATERISK project. The qualitative data were analyzed in terms of systematic coding and categorization of comments and statements given in the students' feedback and students and participants' reports and reviews, in order to develop a synthesis which grasped this empirical evidence.

Data for governance and management: data of funded R&D projects (n=11) as cross-cases; management data (n=89) files, which include strategies, drafts of visions, legislation, papers of regional focus, scoreboards and indicators; data of development days and reviews, (n=438) files, which include data displays, evaluations, reviews, learning diaries, development proposals and reports; data of FINHEEC evaluations regarding the regional development and R&D, (n=4) evaluation reports; and feedback data from students, (n=143) reports from the INKA system, which is the information system for feedback from students during different phases and areas of study. KKA 1:2010 (Auvinen et al., 2010), KKA 7:2012 (Maassen et al., 2012), which included n=12 evaluators and n=30 article references.

2.5.6 Sixth Study

In the sixth study, the multiple-case study method was used for analysis; this method is well known, and figures in Yin (2009). Here, content or textual analysis was a research tool that examined the presence of words, phrases, concepts, or themes within texts. Characteristics of content were analyzed and interpreted by breaking down the texts into meaningful units of information. Here, the use of an inductive and qualitative study was justified, since the study did not test whether an existing theory explained the phenomenon; rather, it

investigated a new phenomenon – realization and models of R&D that had not been studied as multiple cases in context.

The data were collected at Laurea UAS and included five themes as "a triangulation of data sources" (Yin, 2009, p. 116): data of funded R&D projects, (n=11) cases: e.g., documents of R&D projects and research papers of the cases by students, teachers, and participators; management data, (n=91) files, which included strategies, drafts of visions, legislation, papers of regional focus, scoreboards and indicators, related research documents, summaries of follow-up, comparison data, and presentations; data of development days and reviews, (n=412) files, which included data displays, evaluations, reviews, team notes, development proposals, and reports; data of FINHEEC evaluations regarding the regional development and R&D-related samples, (n=6) evaluations: e.g., reports, applications, evidence and analysis; feedback data from students, review data and interviews, (n=156) files, such as reviews, interviews, and reports from the INKA (Appendix B).

3 Contribution of the study

This dissertation consists of six articles, as studies which are referred to in the text by their Roman numerals. This chapter summarizes the advantages, main results, contributions, and evaluations of each study. The research methods used in these articles are discussed in Chapter 2 of this dissertation.

3.1 STUDY I: INTEGRATIVE MODEL

Pirinen, R. (2008a). Integrative Action Process in the Perspective of Globalization. *International Journal of Emerging Technologies in Learning (iJET)*, 3(1), 61–68.

3.1.1 Integrative Process Model

In the article, Pirinen (2008a) includes all six data collections for answering the research question of Study I: 1) management data and Laurea's Quality Handbook (2008); 2) evaluation data by FINHEEC (Salminen & Kajaste, 2005) and the data of the first AR cycle, which is reported in Pirinen (2009d); 3) data of development days and seminars between 2003 and 2007; 4) AMKOTA data between 2003 and 2007; 5) insiders' references and publication series (Rajamäki & Pirinen, 2008; Fränti & Pirinen, 2005); 6) evaluation interventions and references by outsiders (Vyakarnam et al., 2008); and 7) the references by the author (Pirinen, 2008c; Pirinen & Fränti, 2008b). The empiric study was delimited to the domain of Laurea's Espoo unit, which was in close collaboration with the Helsinki metropolitan area.

The research question of the study was: what are the constructions and models contributing to international and global activities, which are used in implementation and actualization by Finnish UASs? Then, the objective of the new concept was to integrate the three statutory tasks in a UAS: 1) education, 2) R&D, and 3) regional development. The new proposition was the integrative process model, with its four

elements: 1) cyclic, 2) thematic, 3) linear, and 4) relevant. These elements are also called upon "forums" in later studies. The integrative process is seen as a macro-level action logic, which describes operational components and activities of integration of body of knowledge, knowledge base, and knowledge economy in everyday action. The components of the integrative process model are described in Figure 2.

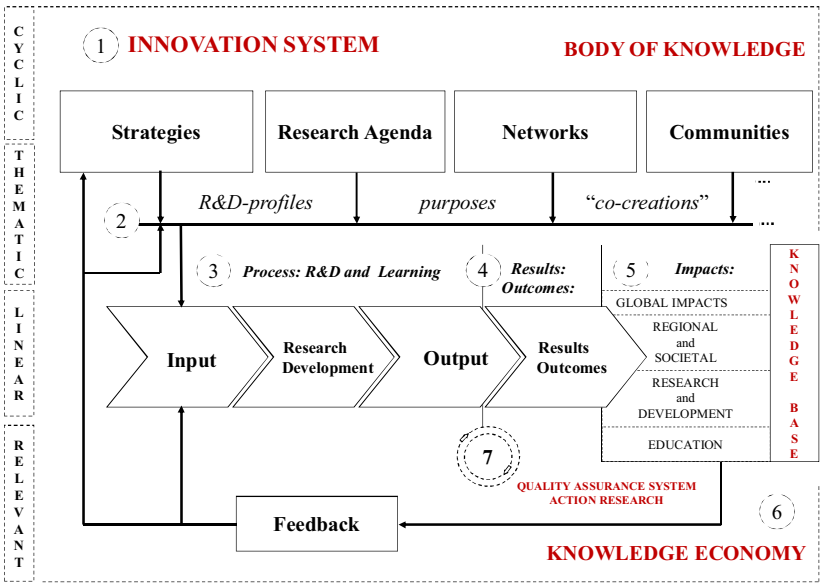

Figure 2. The integrative process

The assumption of the study was that transformations of knowledge and R&D with international experts and co-operators are becoming increasingly common and an important part of international competitiveness and the global knowledge economy. The purpose of the study lay in the concept of integration, which included globalization, innovation system, body of knowledge, knowledge economy, R&D-related activities, and quality assurance system. The timeframe of the study was January 2003 to December 2008.

3.1.2 Contribution of Integrative Process

The overall contribution of the integrative action was the creation of a sustainable and linear relevant framework for cyclic-thematic innovation activities and the macro-level model and action logic for the integration of regional development, strategic profile selection, and globalization perspectives as integration of knowledge economy for everyday development and research activities (Porter, 1998; Etzkowitz & Leydesdorff, 1998, 1999; Harmaakorpi, 2004). The integrative process was a proposition for R&D-collaboration in higher education. The case was an outcome of integrated DR and AR cycles, which conceptualized the one possible setting as a process model for the actualization of R&D in a UAS (Pirinen, 2008a; Pirinen, 2009d). In the model, the cyclic element addresses the support of agility in activities towards new competencies, imagination, and creativity support in education, where the lessons of learned outcomes (4), in Figure 2, or impacts (5) cannot be foreseen clearly at the start of the R&D process (1 and 2).

This integrative way includes such approaches as: the Gibbons Mode-2 in regards to new production of knowledge (Gibbons et al., 2008); the study of knowledge creation (Nonaka, 1994; Nonaka & Takeuchi, 1995; Paavola et al., 2004); and students' creations, "co-creation" of objectives, and educational processes. In turn, the thematic element bridges the strategic R&D agenda, regional profiles, and learning scopes (2) to the continuum of syllabus-curriculum-regional-national-international relations and interactions (1 to 5) and studies (3 to 5) (Pirinen et al., 2009; Teräs, 2008; Harmaakorpi, 2004). In integration or knowledge economy and education (1 to 6), the term "living labs" addresses a approach where creations, such as services, products, or application enhancements, and artifacts, are created and validated in collaborative, multi-contextual, and empirical real-world environments; here, it is understood as "transition to live" (Fränti & Pirinen, 2005; Niitamo et al., 2006; Ståhlbröst, 2008).

The identified challenges of the integrative system address that achievements within cyclic and thematic elements (1 to 2) rely heavily on group commitment and coaching; the challenge of how to reach creative objects and the latest knowledge in an appropriate context would be actualized in a more systematic way. This statement was

based on the view of Vyakarnam et al. (2008) that self-learning takes much longer than traditional teaching-based learning. The implications of this were that the cyclic-thematic driver (2) would keep its proactive nature, but it would also be revised so that it includes more background work, co-instructions, and living lab relations. As a consequence of this, the sustainable R&D driver activity was described in Study V (Rajamäki & Fred, 2011; Pirinen & Rajamäki, 2010).

In evaluations by FINHEEC (Salminen & Kajaste, 2005), the integrative model was seen as a new and promising interoperative method; and in this way, the three tasks can be successfully realized in a UAS (Salminen & Kajaste, 2005; and later Auvinen et al., 2010; Lampelo et al., 2010). Lampelo et al. (2010) furthered and suggested several revisions to the model: 1) development of deeper and relevant measures; 2) improving usability of the quality assurance system in practice; 3) improving relations between implementations and the quality system; 4) dissemination of review processes; 5) improving the assessment process in (4 to 5); 6) synchronizing feedback systems in actualizations of study units; and 7) development of impact analysis. In summary, the first study produced the starting point for all parts of the research question about design, model, and actualization of R&D.

3.2 STUDY II: ACTUALIZATION OF STUDY UNITS

The concept of integrative action was created as a way to implement the three tasks in practice within the processes, while fostering sustainability and international collaboration and response to the addressed challenges of knowledge economy (Drucker, 1969; Porter, 1990; Best, 1990; Storper, 1997). In Study II, the focus of integration of the R&D process was in the transformative collaboration with new cyclic innovation activities and linear development orientations, with quality and relevance. The perspectives of R&D and education were synthesized by the dimensions of LbD, which has been collectively created and actualized since 2003.

Pirinen, R & Rajamäki, J. (2008). Synthesis of Learning by Developing and Virtual Learning Case: Laurea's Network Design

Specialisation Studies. *WSEAS Transactions on Advances in Engineering Education*, 7(9), 624–634.

In Study II, the LbD dimensions were actualized in network design specialization studies; in this case, DR and AR were an obvious choice for R&D. The following concepts of DR were applied: 1) improvement and execution of models and 2) evaluation of the experimental actualizations of R&D-related studies.

3.2.1 Learning by Developing

A significant crystallization for Laurea's pedagogical thinking and theoretical view was provided by the constructivist approach, learning of expertise, action learning, principles of reflection, and progressive inquiry learning (Scardamalia & Bereiter, 2006; Mezirow, 1981, 1991; Revans, 1982; Niemi, 1998; Tynjälä, 1999; Lehtinen & Palonen, 1999; Rauste-von Wright et al., 2003; Hakkarainen et al., 2004a; Kauppi, 2007). Some studies referenced between 2003 and 2005 include Rauhala (2008), Kallioinen (2007), Salminen & Kajaste (2005), and Fränti and Pirinen (2005). This meant learning was seen from three perspectives: the information-gathering metaphor or knowledge acquisition (Sfard, 1998), the participation metaphor (Sfard, 1998), and the knowledge-creation metaphor (Paavola et al., 2004).

Study II describes that Laurea UAS has been developing its unique pedagogical and integrative model, in which the LbD has been a pedagogical ground, since 2003 (Fränti & Pirinen, 2005; Pirinen & Fränti, 2008a). LbD focuses on collective and authentic design and realization, where an individual learns along with the community, and new competencies and capabilities are built by both individual and community work in relation to knowledge reserves and the even wider global knowledge economy (Fränti & Pirinen, 2005; Pirinen & Fränti, 2008a). The dimensional LbD model is described in Figure 3.

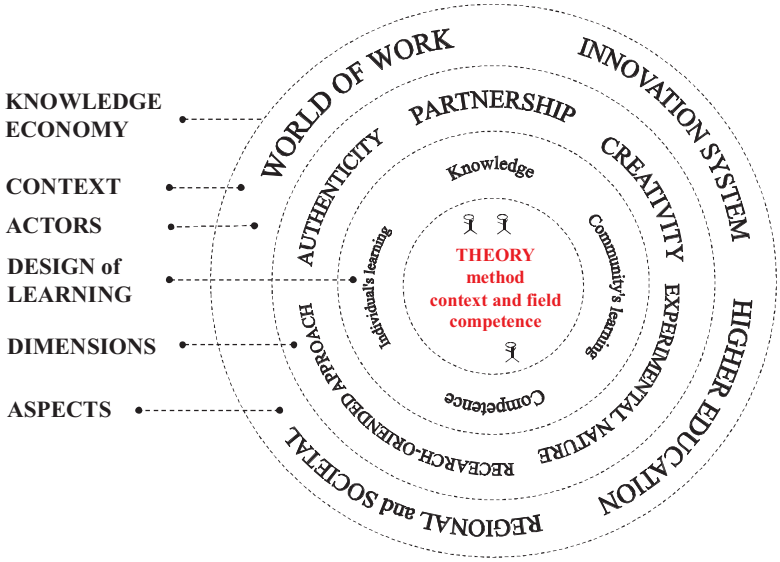

Figure 3. Dimensions of learning by developing

The LbD model allows the binding and testing of different or related theories of context, and it conducts the development of new theories as sound kernel theories (Gregor & Jones, 2007; Gregor, 2002). Here, the testable theory or testable proposition was a theoretical hypothesis in actualizations of study units which includes four dimensions: theory bindings, used method, context, and domain. In Study II, one contribution was in the analysis of theories, such as the three metaphors of learning (Sfard, 1998; Paavola et al., 2004) through the LbD dimensions.

Study II set out to design a "how to integrate" understanding of the learner's thoughts and learning processes in early R&D projects, and to create work methods and practices by which R&D skills and competencies can be developed in integrative environments and a bridge to transition to live (Pirinen & Rajamäki, 2010). The focus of Study II was that higher education processes and actualizations of study units should be well prepared in order to: 1) face the dynamics of the job market and stakeholders; 2) follow the tough competition within and between the public education sector and the private education sector; 3) adapt to the radical changes in higher education

studies and curricula; 4) set-up a reliable, internationally recognized system of quality assessment; and 5) improve the attractiveness and competitiveness of the European knowledge economy.

3.2.2 Contribution of Learning by Developing

In the FINHEEC evaluation (Salminen & Kajaste, 2005, p. 82): "The model represents a management and work philosophy based on the production of shared competence and creativity. However, in setting their own targets, students should know on what and how they will be evaluated in relation to the starting points and objectives of the process and to other participants, as they do in traditional assessment concepts or when using the evaluation methods used by the employment sector for leadership best practices. The model emphasizes collaboration with the employment sector to learn about the authentic developments and problems encountered at work. These are addressed in the integrative environment's R&D. The model systematically seeks answers to problems whose solutions require new knowledge. The core of the model is formed by object-oriented work, which means that learning focuses on genuine development of the workplace. The efforts has a clear objective and takes place through the process of generating new competence."

The FINHEEC evaluation report (2005) summarizes the contribution of LbD: "The operating model is clear and transparent. As such, it can be adopted by other universities of applied sciences. The structure of the model is also easy to adapt and renew if changes take place, which means that on the one hand it can develop from the inside, and on the other hand it can produce innovations." Furthermore, "it is also evident that the model is supported in the integration principles of the management system. This prepares the ground for future strengthening of communal and cultural processes, fostering the organization's broad-based commitment to the chosen model" (Salminen & Kajaste, 2005, pp. 80–82; Auvinen et al., 2010; Tarkkanen, 2009; Rauhala, 2008; Kallioinen, 2007).

There were many theoretical bindings and aspects of LbD realizations between 2002 and 2012, for reference: Lehtinen and Palonen (1999) examined expertise from the point of view of high-

level competence; Tynjälä (1999) investigated the requirements for expertise, starting from Scardamalia and Bereiter's (1999) statement that true experts differ from experienced people; according to Helakorpi and Olkinuora (1997), effective work in a development team requires creations and inventions; Rauste-von Wright et al. (2003) note that that the general transference and applicability of knowledge and skills to practical situations is challenging; Hakkarainen et al. (1999) state, "progressive inquiry-learning refers to a process which systematically searches for a solution to a problem that cannot be solved using existing knowledge"; facilitation of learning processes that underlie the creation of expertise and knowledge in the internalization process (Vygotsky, 1978b); creations of new forms of a competence community (Tuomi, 1999); community of expertise and progressive inquiry learning (Hakkarainen et al., 1999, 2004b); social learning, mutual and authentic integration of expertise with the learning (Freire, 1970); dimensions of transformations (Vygotsky, 1978a; Kauppi, 2007); new types of communities of practice and expansive settings (Engeström, 2001); integrative components in thematic collections (Scardamalia & Bereiter 1999; Bereiter, 2002, 2007; Star & Griesemer, 1989; Kolb, 1984; Lewin, 1942, 1946, 1947a; Dewey, 1938; Peirce, 1909; Nonaka & Takeuchi, 1995; March & Smith, 1995); influences of constructive learning theories and "co-creations" (Tynjälä, 1999; Lehtinen & Palonen, 1999; Ruohotie, 2000); binding and testing of different actualization of R&D theories and development of new theories as sound kernel theories in the core of the LbD model (Gregor & Jones, 2007; Gregor, 2002); and knowledge economy (Cooke & Morgan, 1998; Rutten & Boekema, 2012; Asheim, 2012).

3.3 STUDY III: CURRICULUM REFORM

The objectives of European higher education and research on curricula, approved by Finnish higher education institutions, led to the adoption of a competence-based curriculum model in the master's and degree programme of information systems between 2004 and 2008. The model's focus was on the broader competencies needed in the

workplaces of the future (Kallioinen, 2007; Rauhala, 2008; Pirinen, 2009f). As a strategic approach, the integrative process (Study I) and the concept of LbD and its actualizations and theoretical foundation (Study II) were in line with strategic intent, which was recorded in Laurea's pedagogical strategy in 2002 and 2007. An extensive curriculum reform was then concluded in 2006. It led to the creation and actualization of a shared, competence-based curriculum at Laurea since 2006.

According to the Laurea's pedagogical strategy (2002), learning takes place through education and R&D. The principle of triple-task integration (Study I) was approved for Laurea's strategy; it was then titled "learning in projects" in 2003. While implementing the Laurea's pedagogical strategy (2002), the triple-task principle was collectively refined into the actualization of the dimensional LbD model (Study II). The LbD model combined two of the major orientations of a UAS: professional education for learning and research-oriented higher education for development. Then, Study III presents the R&D process and design of a competence-based curriculum for the master's and degree programme of information systems.

Pirinen, R. (2009a). Thematic Curriculum to the Master and Degree Programme of Information System. *International Journal of Education and Information Technologies*, 3(4), 205–216.

3.3.1 Reflection of Domain Ontology

One advantage of Study III, where reflection was concerned, was in the collective interpretation of domain ontology and related terms. The term "thematic" was addressed to the continuum of syllabus-curriculum-regional-national-international relations, which included collaboration, agility, trust, and value in R&D collaboration (Pirinen et al., 2009). The thematic region, thematic living-labs, novel R&D activities, thematic curriculum, and thematic actualizations of study units have corresponding interests in R&D agenda. This means that learning is related to a body of dynamic and agile themes for thematic studies, which are important to region, society, and innovation systems (Harmaakorpi, 2004). This way, research areas of agenda and a

regional innovation system interact with the generation of new competencies, regional capabilities and knowledge economy in realizations of a UAS (Pirinen, 2009a, 2011b). The study provides insights into interpretation of the term "innovation" in an integrative context. Schumpeter's (1939) five meanings of the term "innovation" are: new goods; new processes; new markets; new sources of supply of new materials; or a new organizational status. Tichy (1998) relates that "innovation is an organizational capability which includes: scientific; technological; socioeconomic and even cultural aspects." Geffen and Judd (2004) advocate and extend that "the successes of commercialization and commercialized advantages are major determinant of innovation." Most appropriate here, Galanakis (2006, pp. 1222–1232) proposes a broader definition for the term "innovation": "the creation of new products; processes; knowledge or services by using new or existing scientific or technological knowledge, which provides a degree of novelty either to: the developer; the industrial sector; the nation or the world; or to succeed in the market place."

In this thesis, the term "innovation" is used mostly in the context of regional development (Galanakis, 2006). In the integrative action process, the focus was on achievements for improving regional innovation capabilities, and the results of R&D transactions included student's own or collaborative creations, such as artifacts, designs, and services. These results, in turn, can be related to the new regionally achieved advantages.

The target of thematic curriculum was then related to the support of imagination-creativity-based creations as activators and the achieved competencies, which were related to the thinking, building, improving, and evaluating of new services, artifacts, and inventions. These results would then conduct innovations, which would need more funding and collaboration, and would be realized, probably, years later within the activities of regional innovation systems and commercialization structures.

Doloreux and Parto (2005) state that the concept of a regional innovation system is understood as a set for integrating public and private interests, formal institutions and organizations, as well as relationships for conducting generation and dissemination of new

knowledge. Cooke (2004) defines a regional innovation system as consisting of integrated knowledge generation and exploitation of other regional, national, and global systems to commercialize new knowledge. It is limited in scenes of geographical existing, as well as meaning of regional was related as nested territorially beneath (Cooke, 2004).

3.3.2 Contribution of Thematic Curriculum

Following the theoretical framework above, the interpretation in developing the thematic curriculum was that a student's intellectual abilities are specific to aspects of regional expertise cultures (Hakkarainen et al., 2004b), knowledge reserves (Nonaka & Takeuchi, 1995), regional capabilities, and economical success profiles in a region (Harmaakorpi, 2004; Teräs, 2008) and knowledge economy (Friedman, 2005; Malecki, 2012; Asheim, 2012). This culture makes contributions to the student's intellectual development and "regional advances" as "mind in region," which is seen to be dependent on its expertise culture, history, and experimental setting (Vygotsky, 1978c; Kolb, 1984; Tuomi, 1999; Engeström, 2001), and the "mind in region" is seen to be based on the regional resources, especially regional capabilities and dynamic settings of its configurations (Harmaakorpi, 2004; Teräs, 2008; Etzkowitz & Leydesdorff, 1998). In an agile and turbulent world, these settings have to be regenerated over time with dynamic capabilities (Harmaakorpi, 2004), international pipelines (Teräs, 2008), transformations (Vygotsky, 1978a; Kauppi, 2007), and knowledge economy (Malecki, 2012; Asheim, 2012).

According to this study, Laurea has participated in teamwork for the generic competencies of the national ECTS project, which has increased awareness of the comparability of competencies on a European scale (Karjalainen, 2003). All curriculums of degree courses were then revised according to this jointly created model, where the competence-based curriculum formed the statement of the European Qualification Framework (EQF, level 6 Bachelor's and 7 Master's). The framework has served as the foundation for the competence targets of the curriculum process, and actualized generic competencies

were comparable to the definitions for European and national generic competencies (cf. American model: Voorhees, 2001).

Integration of R&D particularly challenges competence evaluation practices. A student's workplace competence is displayed in slightly different ways, depending on the context, which requires teachers to have a high standard of competence for evaluating prominent, often communal, competence instead of the traditional way of focusing solely on individual written performance. In the competence-based curriculum process, the subject-related competence of students is evaluated numerically, and generic competencies qualitatively. Competence evaluation has been constantly developed. A competence evaluation team was set in 2007, which has resulted in the publication of shared competence evaluation criteria. Different evaluation trials related to pedagogical development are still in progress.

One advantage of the competence-based curriculum process is that the shaped profiles in strategy 2010 were developed as a UAS that specializes in service innovations and whose specific task is to foster the competitiveness and regional development of the Helsinki area. The role of Laurea was formed for regional networked expertise and learning organization, and its strategy for 2010–2015 comprises the following: 1) service innovations and value networks, 2) internationally acknowledged and productive research, development, and innovation activity, 3) an operating model that promotes the development of working life by integrating learning and R&D (learning by developing and student-centered R&D).

The curriculum development process was evaluated externally with interim and final evaluations (Auvinen et al., 2006). Competencies were developed through project-based implementations of the curriculum and were displayed as R&D credits, a number of project-based theses, and student feedback (Auvinen et al., 2007).

3.4 STUDY IV: EDUCATION AND INFORMATION SYSTEMS

In Study IV, the analysis of LbD, its design, and model focused on the actualization of the three statutory tasks of a Finnish UAS in respect to studies in information systems, security management, and service

programs. Then, an analysis of the case was conducted at the study program level, and it included the two CAR cycles and data collection between 2003 and 2009.

Pirinen, R. (2009b). Actualization of Learning by Developing (LbD): an Analysis. *International Journal of Emerging Technologies in Learning (iJET)*, 4(3), 46–58.

Here, the DR in IS was included for the utilization of the CAR and quality management systems within the integrative process in the perspectives of R&D and education. The objective of DR was the models, categories, and information system for the R&D-related education and quality management system.

3.4.1 Extended Analysis

First, the study reconsiders the canonical form of AR and its analysis in the educational applications and practices of the integrative actualization of the three tasks, which were performed at Laurea between 2003 and 2009. In the study, the focuses of the AR cycles were on excellence and quality in education. The AR cycles are described in detail by Pirinen (2009d), who also journals the analysis. The first phase of AR covered the evaluation of LbD from 2003 to 2006, and the second phase covered the actualizations of the security management program from 2006 to 2009 (Pirinen, 2009d). The two AR phases (Pirinen, 2009d) included the data collection, which were related to the two FINHEEC evaluations (Salminen & Kajaste, 2005; Saarela et al., 2009). The study (Pirinen, 2009d) also includes a canonical evaluation of the AR cycles, as Davison et al. (2004) suggest.

Second, the study extends the analysis from this and includes a categorization and DR by the utility provided to the organization and developers in such forms as categories, models, and schemas of information systems (Markus et al., 2002; Iivari, 1991; March & Smith, 1995; Nunamaker et al., 1991; Hevner et al., 2004; Nunamaker, 2010).

3.4.2 Evaluation and Contribution

The six years of research clarified that CAR was a sustainable body to our research processes and the quality-assurance-based framework (Cole et al., 2005; Pirinen, 2009e). This approach involved the collection of numerous views of data and analysis (Patton, 1990; Miles & Huberman, 1994; Denzin & Lincoln, 1994; Robson, 2002; Ladkin, 2004; Kelly, 2004; Corbin & Strauss, 2008). It included different activities such as projects, building, improving, and testing models, prototypes, services, and "co-creative" activities. Both AR as Baskerville and Myers (2004), Baskerville and Wood-Harper (1998), and Checkland and Holwell (1998) present, and DR as March and Smith (1995) and Hevner and Chatterjee (2010) extend with the development research of Nunamaker et al. (1991) and Nunamaker (2010), were suitable to the integrative model.

The study provided evidence that a cyclical AR process model, and its canonical rigorous structure, were implemented as well as tested in the context: in general, CAR, as Davison et al. (2004) propose, was an applicable approach in the context of an integrative process. Furthermore, it complements our quality assurance system. Thus, CAR was the backbone of rigorous and relevant action in an integrative model. In this study, integrative learning within CAR focused on the binding of theory, research, and development in an integrative model, the evaluation of action within an innovation system, freedom within a framework, student-centric "co-creation" in action and learning, and reflection and "co-creation" within an innovation system and its value network.

In the evaluation of the first CAR cycle, the LbD and integrative action used empirically demonstrate that the integrative environment, which includes co-instructing, co-operating, and co-constructing activities, can further extend students' collective work for R&D collaboration within the regional innovation system (Pirinen, 2009b, d; Pirinen & Rajamäki, 2010; Rajamäki et al., 2012).

The study revealed that integrative environment has a significant role, as noted in the FINHEEC evaluation: "the learning environment is conceived broadly from the perspectives of: the workplace; the region; a science university; and even an incipient internationalisation" (Saarela et al., 2009, pp. 76–78; Salminen & Kajaste, 2005, pp. 80–

82). This adds credibility to the future significance of the pedagogical development work.

In addition, the integrated pedagogical approach was based on student-oriented or -centered activities and focused on future workplace skills (Saarela et al., 2009). It produced insights focused on entrepreneurial elements in a UAS, such as the derived overall profiles (Strategy of Laurea, 2010). "It is a procedural and proactive model that integrates students' everyday activities with the development of the employment sector, which is based on working towards solving genuine problems, and the model's theoretical foundations are solid and built on carefully considered analyses of chains of operation" (Saarela et al., 2009, p. 77; Salminen & Kajaste, 2005, pp. 80–81). This demonstrated that the paradigm balancing in education, between traditional methods and methods based on imagination-creativity-creation and knowledge creation through R&D, is possible. In this sense, the term "paradigm" refers to an analytic strategy for integrating strategy with its process as the integrative process represents (Corbin & Strauss, 2008).

An advantage of Study IV is that it extended an aspect of utility in analysis: the integrative process contributed information systems as a logical model of action or, in other words, "action logic"; so it has similarities to business logic in service-oriented architecture (SOA), where the used components are represented as units and services (Erl, 2005) and forms of data structures (Chen, 1976; Ullman & Widom, 2002). The model can then answer questions, such as: what system architecture and philosophy should be used in the management of a networked international innovation system in higher education? It also provides a conceptual framework for understanding management in higher education. As an example, take the information systems' development of the mutable teacher's tasks in the UAS; in Figure 4, the view of the teacher's task planning system is described, using a plain sample of the applied entity and relationship model (Chen, 1976).

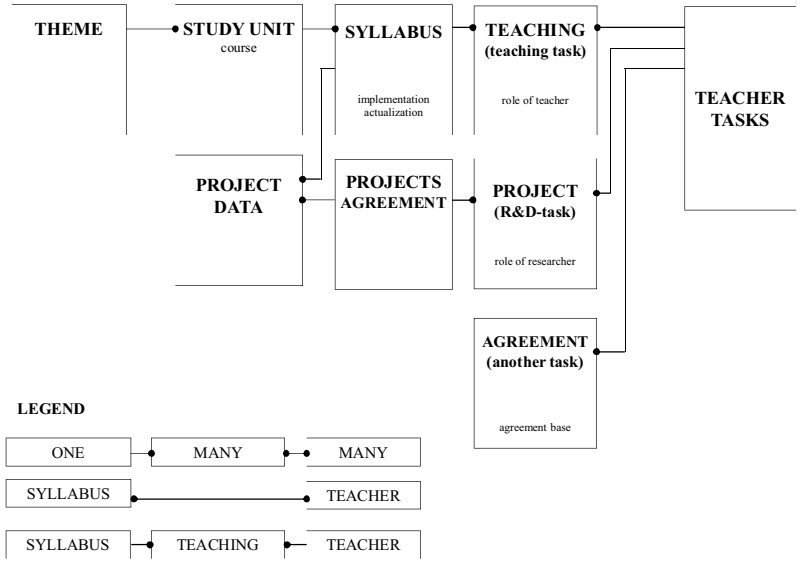

Figure 4. Teacher's tasks in R&D-related actualizations

Figure 4 was drawn from the analyzed categories of displays and then led to the tables of the information system (Lyytinen, 2009). The information system was called the REDTAS and was used between 2002 and 2006. The term "REDTAS" is an acronym for Resource and Time Planning System used for the actualization of the three tasks: research (R), education (E), and development (D). Further development work with the ERD schema was continued with the product called SOLEOPS, being developed in collaboration with Solenovo Ltd.

3.5 STUDY V: STUDENT-CENTERED RESEARCH AND DEVELOPMENT

In Study V, the focus was on student-centered R&D, which collaborates in an interoperative way and shares the regional-national R&D capabilities, interests, and agenda. The study addressed the collaboration model and factors of education within R&D projects that develop academic knowledge, competencies, and regional capabilities for all participants by contributing

to externally funded R&D projects in real-life situations, in the context of a UAS and regional innovation systems.

Pirinen, R. (2011a). Externally Funded Research and Development Projects in Perspective of Learning. *International Journal of Engineering Pedagogy (iJEP)*, 1(3), 27–36.

The study was journaled from the presentation at the International Conference of Interactive Computer Aided Learning ICL2011 (Pirinen, 2011b) and the evaluation of FINHEEC and its application in 2010 (Auvinen et al., 2010; Tarkkanen, 2009). In the study, the focus of the LbD model was shifted from pedagogical orientation (Study II) to R&D orientation, and the LbD model was gradually developed into a collaboration model where student-centered activities were integrated with R&D. At the same time, the focus of education moved to a learning space, which integrated the complexity of real-life, international expertise, and R&D and the wider global knowledge economy.

3.5.1 Contribution of the Student-centered Approach

Study V presents triggers, drivers, and enablers of student-centered R&D and R&D-related education in the context of study. In addition, the study revises the sustainable driver model for integration of R&D in the thematic forum of integrative action process, which was earlier described (Study I).

In Study V, the R&D was based on student creation, upward-oriented ideation, and refining of R&D ideas, with a shift toward customer-, user- and student-driven activities (Viitanen, 2009; Ojala, 2011). The strengths of the study lie in its findings regarding the significant change in education, which denotes "allowing and throwing oneself into learning something new within R&D" (Tarkkanen, 2009) and in students' competence-based changes and advantages, which were facilitated as sustainable drivers (Rajamäki & Fred, 2011) for lifelong learning (Pirinen, 2011b). This integrative R&D driver is presented in Figure 5.

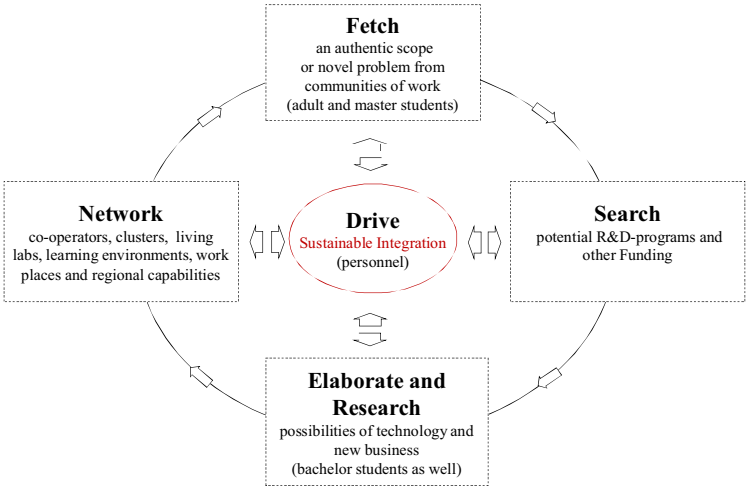

Figure 5. Sustainable driver for student-centered R&D

In Figure 5, a project-specific, competence-based R&D group was created for a student's created idea, which included the authentic view of working life. This new form of an integrative driver acts as a project preparation team, which searches for R&D funding, and a collaborative R&D program is in a central role in learning. In this view, the base of the R&D scope is drawn from the student's motivation, expertise, and working life's body of knowledge, which was bridged to the competencies by learning activities and integrative processes (Rajamäki & Fred, 2011; Pirinen 2011a, b).

In regard to future studies, this stream and change of the method of realizations has also changed the leadership/management model of higher education institutions. This managerial implication and transformation lies in the view of the mode migration (Gibbons et al., 2008); from a coordination- and control-oriented leadership mode-1 into an expert-oriented model-2 where the attendees share a common vision, results, and influence of higher education in the region and society (Tarkkanen, 2009; Pirinen et al., 2009; Gibbons et al., 2008). Here, it can be worded that *Gibbons mode-2 leadership was implemented into the Gibbons mode-1 institution*.

The study represents the furthered steps in investigating the prerequisites to and factors of the LbD model for conducting R&D integration in collaboration and education. In R&D, the co-operating environment dialogue referred to a future orientation, the national innovation policy, and the public-academia-industry relations as a co-operating culture that jointly develops knowledge and competencies (Pirinen et al., 2009; Pirinen, 2008c; Etzkowitz & Leydesdorff, 1998).

3.5.2 Evaluation of the Student-centered Approach

According to Auvinen et al. (2010), "the actualizations of student-centered R&D were integrated into education as a part of its LbD-dimensions, and it forms part of an organization's profile." Furthermore, "the revised R&D related model has shifted the focus of teaching to R&D; and the students' participation in R&D has been raised to a new level; so that they are now the main activating forces in the process; and the student-centered R&D was strongly supported by management; and it was purposefully developed throughout the organization" (Auvinen et al., 2010, pp. 146–148). In this view, Rajamäki and Fred's (2011) focus is that the role of personnel is centered on facilitation and as a guide to the continuance and creation of R&D themes and applications. In turn, the role of the quality assurance system is placed as an enabler of activities: it involves gathering feedback of all results, organizing, conducting, and utilizing feedback data for varying decisions (Study I). The student feedback system produces systematic and comparable data for use in quality assurance, operational development, and strategic, operational, and pedagogical planning. The feedback system includes themes for students to evaluate their progress into developers and to provide feedback as part of the R&D activities (INKA).

However, student-centered R&D is challenging in many ways; the first challenge is in the student's commitment to the demanding study model (Auvinen et al., 2010; Vyakarnam et al., 2008); the second challenge is in the transformations of the management model and culture in a UAS (Auvinen et al., 2010; Tarkkanen, 2009); the third challenge is in controlling the mass and cognitive load of projects precipitated by the R&D-related model (Clark & Elen, 2006; Fränti &

Pirinen, 2005); and the fourth identified challenge is related to the systematization of stakeholder partnerships.

Auvinen et al. (2010) summarize that the focused development and continuous change have created great challenges for teachers, but the samples of evidence in evaluation can already provide proof of the successful support provided by team coaching, job orientation and development resourcing; and despite the strong emphasis on R&D, theory and practice were well balanced in the education. Furthered, the student-centered R&D was particularly well suited to the UAS context; information on the students' development as developers and on their learning through R&D was also gathered through the student feedback system. The feedback has so far led to demonstrable development actions being taken (Auvinen et al., 2010; Tarkkanen, 2009).

The strengths of study are as follows: the role of students as central actors and responsible participants; the sustainable integrative driver facilitates learning; an open interaction with an R&D operating environment and an agility in responding to the needs of the environment; teachers involved in the continuous interaction with the environment, which allows for quick reactions to actualization of needs; and the focus itself, which was on the development of permanent collaboration structures and employment in the local region (Auvinen et al., 2010; Saarela et al., 2009; Salminen & Kajaste, 2005).

3.6 STUDY VI: VALUE CONCENTRATION IN A REGIONAL CONTEXT

This final study concludes the research findings of a multiple case study analysis of realized R&D projects (n=11) that addresses the regional development and collaborative R&D in the perspective of: understanding and modeling (knowledge, action logic, and process models); designing (thinking, sharing, building, improving, and testing); and research for new concepts in the integration of R&D-related higher education, regional development, and respected value network.

Reference to this paper should be made as follows: Pirinen, R. (2013). Analysis of regional development and externally funded

research projects in higher education: A continuum of multiple case study analysis. *International Journal of Innovation and Regional Development*, 5(1), 73–90.

The domain of study refers to collaboration of higher education, regional development, and R&D, where the research data were collected from R&D-related studies of security management, services, and information systems programmes at Laurea UAS between October 2007 and December 2012.

3.6.1 Extended Analysis and Research Continuum

The main contribution of the study consists of the three drawn proposals: 1) extended analysis; 2) framework of research continuum; and 3) concept of value concentration. The extended analysis implicates the methodological contribution: according to this study, "the traditional qualitative data analysis by Miles and Huberman (1994) was extended with the second phase of analysis, which can include one, two or all three extended phases to analysis, which are: 1) analysis of information systems; 2) analysis of service design in service science; 3) analysis of management models in management science." The extended analysis is discussed in Chapter 2 of this thesis. The framework of the research continuum associates the union of the methodological and practical contribution of the prediction of research results and impacts in the way of the multi-methodological binding of research methods between extending understanding and "co-creation" of the business value of research and its results and impacts. This is also discussed in Chapter 2 of this thesis.

3.6.2 Concept of Value Concentration

The new concept of value concentration implicates the contribution to the actualizations of focused R&D. It states that the investigation of R&D co-operation in higher education, industry, service, security, and government sectors implies that it is extremely efficient in integrating actions and values. According to the data of this study, a participant's motivation, inspiration, and interests in co-operation are based on

values – what value can be gained from a network and what value can be given to the R&D network. Here, the statement that "participants have value relation to the network" is furthered to the concept of value concentration in union with higher education and regional development.

The contribution of this concept lies in producing understanding, new knowledge, and design of regional value network in the context of collaborative R&D. This concept utilizes the regional "co-creation" of strategy scenarios and common sense which act as facilitation triggers and motivation forces in shared expertise and value addition. In addition, the concept is useful in utilizing operative and business scenarios in regions which act as drivers and enablers of R&D collaboration, higher education, and utilization. In the proposed concept of value concentration (Figure 6), the macro-level situation is that regions are in a long transition from a linear production economy to a knowledge economy, where competitiveness in a region is required to be approached by competencies, knowledge, services, and applied technologies.

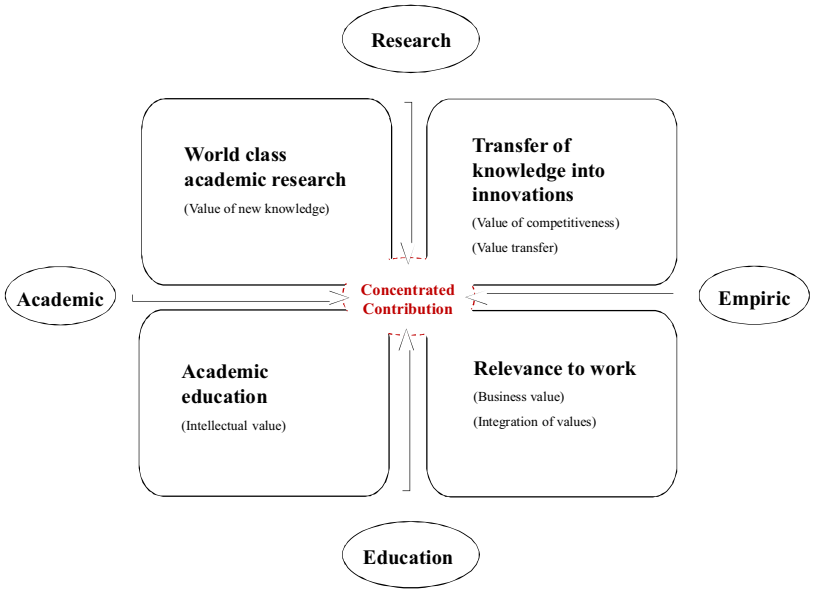

Figure 6. The concept of value concentration

In Figure 6, the key entity is categorized as "transfer of knowledge into innovations" as a function between research and practice, and results and impacts are achieved by profiled R&D collaboration of academia, education, and research actors. It is noteworthy that there are R&D activities which are carried out by higher education and which integrate academic values, education, and world class academic research into the regional R&D processes, and the empiric results and impacts of R&D act as a vital feedback force in knowledge-intensive production of services, security, and artifacts.

In this concept, trust and collaboration play an active part in the strengthening of higher education, business, and government. The key regional development contribution of this concept of value concentration includes "co-creation" of innovative activities, knowledge transformation, and bringing the concepts of science and innovation closer to users and citizens through living labs, clusters, and regional innovation systems (Ståhlbröst, 2008; Sölvell, 2008; Doloreux & Parto, 2005). In the micro-level view, the competencies are created and facilitated with knowledge for the well-being of people and relevance to the world of work. Here, the created competence, knowledge, and professional growth take place by using a concentrated and shared body of knowledge (Nunamaker et al., 1991), and this particularly describes a "direction of new or improved capability and knowledge in region" (see the arrows in Figure 5).

In the cases of this study, the trust was shared with academic, research, education, and empiric parties in funded R&D. In the higher education domain, the drawn concept of value concentration can be assimilated to the kind of "cluster of networked expertise", both in strategy scenarios and operation scenarios. One of the key contributions of this study is an achieved understanding that the strategy scenario and common sense (mode of leadership, thematic interactions, regional profiles, and collective mind) act as facilitation trigger-drivers and motivations for shared R&D expertise and values of:

1. entering new markets,
2. developing new products and services,
3. fostering regional and national R&D profiles,

4. "co-creation" of regional R&D strategies and management,
5. networking of critical mass for starting new businesses, and
6. flexibility of competitive response.

In turn, the operative and business scenarios act as linear drivers and enablers for:

1. leading and promising R&D scopes for higher education,
2. advances in business opportunities,
3. increased innovations and entrepreneurship by way of collocation and profiles,
4. innovation stimulation in the early stages of higher education,
5. familiarity, relationships, and knowledge bridges between actors in regional innovation systems,
6. agile networking of living labs for understood community-led and user-centered incipient innovations, and
7. management of economical balance in action and quality in R&D.

From an empiric perspective, in Figure 6 the role of customers has changed dramatically during this research. Customers take a more active role in concentrated value creation, and the focus of the value creation processes is rapidly transitioning from a supplier-company-centric view to a more customer-centric approach that aims to support customer experiences and joint value "co-creation".

Companies are moving from business models in which value comes mainly from physical goods to models where value comes more from intangible things such as services, knowledge, and relationships. In this shift, the empiric view in Figure 6 can be compressed to the wording: transition to live, customers, and the role of higher education should be seen as "co-creators" of value rather that as passive recipients of goods, knowledge, and services.

4 Discussion

This chapter begins with a discussion of the most advanced methodological, managerial, and regional implication of the six studies. The goal of the integrative model is to expand the latest theoretically implicated proposal towards an integration of R&D and future higher education. Regarding this challenge, the second sub-chapter proposes a revised approach toward theory development as a model of furthered integrative R&D, which can be seen as a new theoretical instance of "co-creation" of knowledge, methodology, artifacts, and services in knowledge economy. Here, higher education would be able to contribute within an interdisciplinary framework for regional-international competitiveness and "co-creations" of the wider knowledge economy in varied perspectives. Third, the audit of the six studies is discussed, which considers the external validity, internal validity, construct validity, and reliability. Finally, recommendations for future research and some final remarks are presented.

4.1 IMPLICATIONS OF THE STUDY

This sub-chapter includes a description of the most forward-thinking methodological, managerial, and regional implications of the six studies and how they reveal the composed theoretical foundation.

4.1.1 Methodological Implications

The most advanced methodological implication of the six studies for the field of research itself was the progress regarding the LbD model, which enables the binding, testing, and developing of different knowledge theories and R&D methods and methodological selections. The LbD model conducts development of new theories as sound kernel theories. In this, the testable theories, or testable propositions, are like theoretical hypotheses inside knowledge transactions and dimensions of LbD. Then, the contribution is in the binding and developing of the

theories. The integrative process is especially useful at the beginning and end of research cycles; in the beginning, it joins collective creativity and evaluation to the process, and in the end, it supports the furthering of the research results to new artifacts, services, methods, and knowledge to the field within the innovation system (Gregor & Jones, 2007; Gregor, 2002).

The main methodological implication of the six studies for the field of data collection is that the empirical studies presented here mark the beginning of unique research for collaboration and education within the R&D approach in context of the Finnish UAS, mainly through Pirinen (2008a, 2011a, b) and Auvinen et al. (2010). Consequently, the sustainably developed quality system with the AMKOTA database and INKA functions as a combined data collection system and data repository of a body of knowledge for the continuous development of R&D activities, and it is transparent for operations as different monitoring and development measures and data collections, including both qualitative and quantitative data.

4.1.2 Managerial Implications

In this study, it can be states that "Gibbons mode-2 leadership mode was implemented into the Gibbons mode-1 institution" (Gibbons et al., 2008). This implicates that besides these R&D efforts, the bottom-up and vision-based management was the force of a sustainable driver and also an enabler for the agile scopes in the realization processes, so that the ecosystems of different stakeholders can come up with new creative ideas. The management's statement of direction was "freedom within framework".

4.1.3 Implications for Regional Development

The main implications regarding the national and regional advantages of the integrative model concern the creativity improvement and new artifacts, security, and services which are produced through the dynamics of interactions and communications among academia, industry, and government, and on the social mechanisms of selection, variation, and retention responsible for their evolution as sectors

(Porter, 1998; Etzkowitz & Leydesdorff, 1998, 1999; Harmaakorpi, 2004; Doloreux & Parto, 2005; Teräs, 2008).

This implicated realization of the integrative model lies in the implementation of environment with innovativeness, consisting of UAS spin-offs and initiatives for knowledge-based economic development, and strategic alliances between the actors of the regional R&D (Drucker, 1969; Best, 1990; Storper, 1997; Rutten & Boekema, 2012; Asheim, 2012). Here, the drivers of the integrative model consist of: regional innovation system; "co-created" strategies and emergent value networks; international pipelines; and vision-based management with its: "co-creative" discursion, transparency, conduciveness, regional R&D agenda, mutual trust, strategic selections, triggers to the wider knowledge economy, and volition.

4.2 TOWARDS THEORY DEVELOPMENT

In the six articles, the transformations were understood as simultaneously existing, qualitative, and structural changes in interactions and activities (Vygotsky, 1978a; Kauppi, 2007). In light of the R&D transactions, it would also be redrawn that "a type of action and activity changes between forums". Examples of this are the transformation from idea to scope, from scope to problem, and then from problem to new or improved service, artifact, competencies, and knowledge; developers, users, and consumers of the new services or artifacts may then again produce new ideas and activities which lead to the repetition of the process and transformations. This revised view of transformations in the integrative process is illustrated as a quartet of forums in Figure 7.

The transformations in the integrative process are as follows: from cyclic forum, such as thinking and ideas, to thematic forum, such as regional planning and "co-creative" designing; from thematic forum, such as R&D agenda, to linear forum, such as R&D processes; and from linear forum to relevant outcomes, such as services, artifacts, collaborative capability, competencies, and new or improved knowledge; then, proofing and feedback continue this iterative R&D-related action. The impacts of these

transformations, such as new or improved artifacts or new knowledge, can be proved in regional-national-international forums.

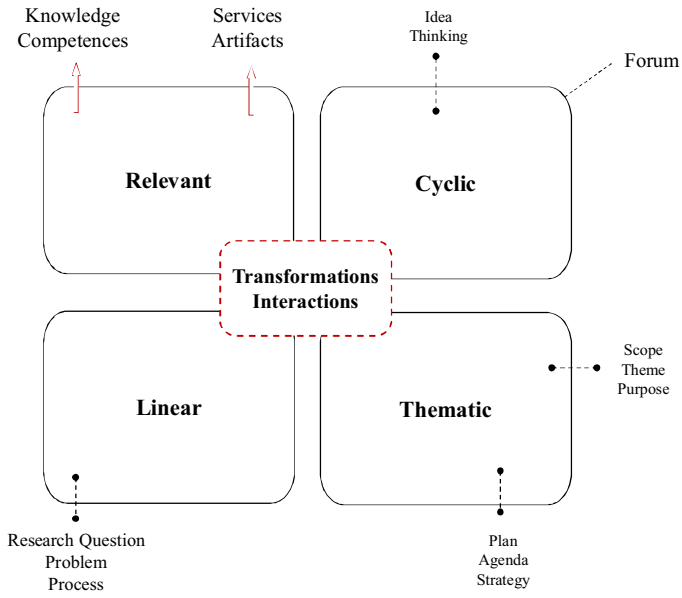

Figure 7. Transformations in the integrative process

In turn, the ontological view of the integrative process and transformations takes place in the meanings of terms in an evolution of services or artifacts, which are first thought, internalized, and developed inside an idea or cyclic forum; it is then externalized to the thematic meaning and purpose, and then extended to the terms and definitions of linear R&D, and in the end to the terms which are assimilated in the context of service or artifact and to the body of knowledge in an appropriate domain. Then, in the next loop, the meanings of terms in a new service, which were first developed by an individual's mental intra-level, are then disseminated to the regional agenda, and then extended to the national level, and in the end to the international level. With these transformations, the meaning of a relatively new term, such as "co-creation", what it means in this newly developed service as a view of ontology, is extended, externalized, and

synthetized from the individual understanding level to the regional thematic forum, and in the end to the international forum and body of knowledge. So, methodology, as a way of thinking and studying, is related to phenomena which grow from the domain of practice of service or utility of artifact, and then it is also influenced and synthetized by the beliefs, attitudes, and culture of the domain. It is also noteworthy that the described transformations do not necessarily follow a fixed order or direction, and do not definitely complete all of the four forums in action, but rather the forums are in mutual interaction and all forums include a perspective of learning.

4.3 AUDIT OF THE STUDY

The method used for auditing and judging the quality of the study consisted of asking and answering a set of questions during and alongside the six studies (Miles & Huberman, 1994; Seale, 2004), and using the canonical form of AR in the early phases of the study (Davison et al., 2004). All six of the articles included a double review process by international reviewers with expertise in the relevant subject area; furthermore, the related parts of the studies have been presented at 16 international conferences. In particular, the study was involved in outsiders' evaluation, such as FINHEEC, including 24 peer reviewers in the UAS network and one dedicated evaluation by four international evaluators. The consideration of the quality of the study includes: external validity, internal validity, and construct validity, as well as reliability, objectivity, and utilization of the study with implemented research criterions.

4.3.1 External Validity and Transferability

In this study, the external validity and transferability refers to establishing the domain in which a study's findings and integrative models, including: 1) the integrative process; 2) the LbD; and 3) the student-centered R&D, can be generalized. It deals with the larger significance of results and advances of the study and the level of

possible generalization in the domain of higher education (Miles & Huberman, 1994; Denzin & Lincoln, 1994; Lincoln & Cuba, 1985).

Laurea UAS and its development network were successfully used as a domain where the integrative models were built, improved, and tested within the integration of CS, AR, DR, and the Quality Assurance System between 2003 and 2011. As a learning organization, Laurea UAS has collectively developed its unique pedagogical culture and learning models: LbD (Pirinen, 2009b; Pirinen & Fränti, 2007a; Fränti & Pirinen, 2005), the integrative process (Pirinen, 2008a; Pirinen et al., 2009), and student-centered R&D (Pirinen, 2011a; Fränti & Pirinen, 2005) since 2002. National evaluations have recognized the evidence of a new way of learning and future-oriented development and research of the integrative model; Laurea UAS was nominated as a Center of Excellence in Education by the Finnish Higher Education Evaluation Council (FINHEEC) for 2005–2006 (Salminen & Kajaste, 2005) and 2008–2009 (Saarela et al., 2009). The student-centered R&D led to a nomination as a Center of Excellence in Education for 2010–2012, and Laurea was the only UAS to receive a nomination for the entire University (Auvinen et al., 2010).

As a summary of the three educational evaluations by FINHEEC in the perspective of external validity of the propositions of an integrative model: "the integrative model as a whole can particularly be well suited to universities of applied sciences, and Laurea can set an example for the Finnish UAS; the model has actively been presented in national and international forums, and a significant proportion of Laurea's research and publication activity was also related to the model; the operations have been actively developed in order to become established in the European Higher Education Area" (Salminen & Kajaste, 2005; Saarela et al., 2009; Auvinen et al., 2010).

The reviews and visitations of outsiders produced effects to the external validity aspects, such as: a comparison with other samples of evidence; the used constructs were discussed and analyzed; producing a larger view of the theoretical framework; observation of general boundaries and delimitations in a UAS context; discussions of potential transferability and recreation of models; discussions of theory binding; transferability to different settings; suggestions for future settings of testing; replications, collocation, and collaboration with

other UASs and regional innovation systems (Salminen & Kajaste, 2005; Vyakarnam et al., 2008; Saarela et al., 2009; Lampelo, et al., 2010; Auvinen et al., 2010).

4.3.2 Internal Validity and Authenticity

In this study, the internal validity and authenticity, as well as credibility, refer to the establishment of casual relationships; the targets of the studies focused on increasing the trustworthiness and understanding that studies make sense and are credible enough for audiences (Miles & Huberman, 1994).

The design of the study was based on a combination of a thorough understanding of the theoretical framework, and wide experimental knowledge, e.g., the concepts and their relationships, which were used to explain actions and meaning concerning the research questions. The internal validity of the results produced by the newly created models was in the realizations, both parallel and alongside the analyses and methods, models, and new processes. The objective was ensuring that the new propositions were logical, authentic, and internally valid in the perspective of implementations and information systems, security, and services in the context of a UAS.

In the perspective of authenticity, the transparency of data displays inspired my thinking and allowed new ideas to emerge, as well as new models and new information systems. In the first studies (I and II), the analysis was carried out in collaboration with colleagues in the workplace, and the data were reduced and understood first separately, and then discussed, compared, and combined with the displays, categories, and models; finally, information structures systems were built, improved, and tested (Study IV). In addition to increasing the internal validity, such researcher triangulation (FINHEEC transactions) facilitated the emergence and elaboration of different theoretical views and concepts before the final categories, and a theoretical model (e.g., collective created LbD, the integrative process, and student-centered R&D) was created which best explained the phenomenon and dimensions of the integrative theme and context domain.

I started the data reduction and data coding in accordance with the sampling technique and continued data collection in all six studies. I

compared the results and interpretations, which correlated with each other. As described in the chapter on methodology, the data were reduced, analyzed, and tested collaboratively (Study IV) in a setting which reinforced the internal validity of all six studies. According to Strauss and Corbin (1994), the term "FIT" pertains to the validity of the study and means that the theory must fit the substantive area to which it will be applied; therefore, the theoretical binding was focused in Study II and verified in all studies. The term "FIT" also indicates that the data categories should not be chosen from pre-established theoretical points of view. In the propositions of the studies, the integrative models were developed as inductive and constructive design-stream from the empirical data, as described earlier in the methods chapter (Patton, 1990; Miles & Huberman, 1994; Strauss & Corbin, 1994; Denzin & Lincoln, 1994; Robson, 2002; Brannen, 2004; Seale, 2004; Stringer, 2007; Corbin & Strauss, 2008).

The reviews and visitation of outsiders produced effects on the internal validity aspects, such as: an expanded perspective to the theoretical framework; the configuration of regional development and collaboration within innovation systems; triangulation with other institutions and used methods; increased data relationships with the inquiry learning theories, e.g., the term scope and new roles of teachers; relations of concepts as in quality system evaluation; negative feedback and challenges for improvement, e.g., learning by success, learning by failure, and learning by feedback (Huttula, 2001; Salminen & Kajaste, 2005; Vyakarnam et al., 2008); rival explanations; replications of findings; and produced predictions in strategies (Salminen & Kajaste, 2005; Vyakarnam et al., 2008; Saarela et al., 2009; Lampelo et al., 2010; Auvinen et al., 2010).

This study then involved a number of decision makers, researchers, and other experts in fields of the national UAS forum, and also the supervisor of the study, with whom the research findings, rival explanations, and possibilities were discussed and reviewed.

4.3.3 Construct Validity

In this study, "construct validity" refers to the correct operational measures for the integrative theme being studied. Construct validity

was addressed to the extent of "what was to be measured was actually measured" or "does it measure what you think it measures?" as Robson (2002) proposes. As Robson states, there is no easy, single way to determine construct validity.

In this study, I considered combining the wide theoretical basis with the action element and development cycles in the research, which included plenty of interventions, such as: actualizations of study units; evaluations; reviews; measures; development days; and reflective discussions with participators, evaluators, and actors of regional development networks, which can all be conductive to the construct validity of the research. The result estimations or measures, which were established regarding R&D, were mainly defined by the collaboration of UASs and the Ministry of Education and Culture.

The advance of the construct validity in the actualizations of study units addresses the statistical nature of the analyzed units, such as: the theses which are based on projects or R&D, the publication number produced, and the external funding of R&D. The one weakness of the construct validity of the actualizations concerns the estimation nature of the criterion-based analyzed units, such as the number of credits completed in R&D, which is basically an estimation. The study has also had significant implications for future research, in that the development of multiple evaluation methods "over actors of a region" for measuring impacts is required, because the impacts would exist in actualization, research environment, working life, or regional-societal networks, and during the time of actualization, or long after that. Research on measuring impact would be also useful in the perspectives of learning by success, learning by feedback, and learning by failure. For advancements, measuring impacts would require an integrated view of regional, national, and global factors; the difficulties here are that different actors need different measures, and also the overall maintenance of the regional measures.

The correct operational measures can be met by multiple sources of evidence (Robson, 2002) in this sense; the study has used seven collected themes of data as documents, archival records, extended abstracts, presentations, collected observations, and publication series, which include participant observations as sources of evidence by colleagues. Feedback was given by numerous experts on the

conclusions and verifications of the collected data. The validating procedures also include 16 presentations at international conferences, and obtaining comments and suggestions from the conference participants regarding the research issues. All six journal articles in the studies included a double review process by international reviewers with expertise in the relevant subject area.

4.3.4 Reliability and Auditability

In this study, the terms reliability, dependability, or auditability refer to demonstrating that the operations of a study, such as the data collection procedures, can be repeated with the same results (Miles & Huberman, 1994; Robson, 2002). I have limited the activities and the creation of the models to the scope of R&D progress in all of the studies. In that view, it should be relatively easy to repeat similar integration in any UAS and higher education. In this kind of integration of CS, AR, and DR, the influence of the researcher and other insiders, such as the spirit of management, might be somewhat difficult to renew in an exactly similar way. My role during this work has been as an insider, who has affected the aspects of recent development, established strategies, and developed institutional settings in the region. Due to the environment and management of the research organization, the performed interventions and spirit of action might be difficult to repeat. However, the quality-system-based data collection and themed data categories can be used for verification of reliability. The setting of the study enables both insider and outsider roles as researchers, as in Stringer (2007), where the research framework describes the integration of qualitative research, quantitative research, case studies, and action research. Then, a separate qualitative or quantitative research can be used for verification of the reliability of this study (Brannen, 2004).

The reviews and visitations by outsiders produced effects on the reliability. The research results and conclusions of this study which were explicitly drawn and based on the various selected studies included: description of the researchers' role; consideration of the data collection across the full range of appropriate settings; multiple evaluation results converging different themes of evaluation

transactions; performed peer reviews; colleges' participation in transactions and feedback sharing; and clear parallelism of data across collected data files of themes.

4.3.5 Objectivity and Confirmability

In the integration of CS, DR, and AR, my role was as a researcher, and the nature of the inquiry process involved a cultural setting, which was conductive and "co-creative", as well as interactional, emotional, historical, and social. Then, the participators interacted at different times and places for varying purposes by bringing their own experience and understanding that led to different views and orientation settings in ways that contribute to life and the community. As described in the methods chapter, the research objects were thus being perceived relatively subjectively, although the research data also consisted of a set of quantitative data that were partially objective. This study then represented the idealist view of ontology and followed the hermeneutic tradition more than the positivist research tradition. By working collaboratively, a collaboration of participants developed a collective vision of their situation that provided the basis for action; this activity was a liberating resource, enabling people to manage and motivate their world as they saw it in different ways.

However, there is a real sense of objectivity in the study; the quality-system-based data and extended research data were gained directly from the recent practice, and were not tainted or manipulated by the perspectives, biases, defenses, or experience of the researchers or other facilitators. The samples of evidence were gathered, partially from concrete evidence and partially from the reality that came from the participators' experience, bringing their assumptions, views, thinking, beliefs, trust, and spirit out with the collective reflection of the data.

The environment, reviews, and visitation of outsiders also produced effects on the objectivity of this study; the data were in the quality assurance system (Lampelo et al., 2010) and in a form that was available for reanalysis by others regardless of the method or role of the researcher between insiders and outsiders (Stringer, 2007). The rival models, as the separation model to the actualization of R&D in a

UAS, were considered in longitudinal form in FINHEEC evaluations. The rivals were plausible, or even better, in the view of learning by staff, but the integrative model clearly produced advances in the perspective of learning of students, as in student-centered R&D (Salminen & Kajaste, 2005; Saarela et al., 2009; Auvinen et al., 2010). The methods and evaluation procedures were described in detail and available in FINHEEC and AMKOTA for future audit trails. This dissertation includes the same data with extended data categories; it is relatively easy to follow the actual sequence of data collection, process, data transformation to the information systems, and to the results which were drawn.

4.3.6 Utilization and Action Orientation

In this study, the terms utilization, application, and action orientation refer to the empiricist view of validity (Popper, 1979; Haack, 1976; Markus et al., 2002; Baskerville & Myers, 2004; Davison et al., 2004) and affect the participants and domain of research and the Finnish UAS (Miles & Huberman, 1994). The study represents the first six steps in investigating the prerequisites for a view of R&D. The findings are then intellectually and physically accessible to potential colleagues, where the primary targets were addressed in the context of a regional-national-global higher education and its networks. The study produced three main outcomes: the integrative process, the collectively created LbD, and the approach to student-centered R&D.

The overall utilization of the integrative process is that it is an application of a sustainable and linear relevant learning process within cyclic-thematic innovation entities and the guidance model of action logic to implementation of regional development and globalization perspectives to everyday learning, development, and research activities in a UAS. The integrative process utilizes information systems as an action logic, so it utilizes business logic in service-oriented architecture, where the used components are represented as units and services (Erl, 2005) and forms of data structures (Chen, 1976). Then, the proposed application can answer questions, e.g., what system architecture and philosophy should be used in the management of a networked international innovation system in higher education? It

also provides a conceptual framework for understanding the management of competence creation in higher education, which ensures that the system, or process of it, does not prevent imagination and creativity or innovation from occurring in education.

The study further extends the conceptualization of knowledge, competence, and creativity at the level of individuals and collaboration. The collectively created LbD utilizes the collaboration and authentic nature of learning, where an "individual learns" and a "community learns", and new competencies and capabilities are built by both individual and community work. The utilization of LbD was addressed by the Finnish UAS which trains students as professionals in response to labor market needs, and conducts R&D activities which support learning. The utilization of LbD is based on the collective and authentic nature of learning, where new competencies and capabilities are built by both individual and community work. The dimensions in this model are 1) research-oriented approach, 2) experimental nature, 3) authenticity, and 4) creativity and partnership. These dimensions can exist with or without processes in learning, and then the LbD utilizes the dimensional conceptualization of knowledge economy in the integrative model.

In the student-driven R&D approach, student-centered R&D-related learning, students not only implement authentic and commissioned R&D projects, but they also take and utilize a creative and active role and responsibility for the related preparation and applications. The one utility of the student-centered R&D relates that students would complete the majority of their studies in connection with real life, such as recent R&D projects and the development of new expert networks for their own future and that of the work communities. Furthermore, the additional utility lies beside these activities; the bottom-up and vision-based management is the force of a sustainable learning driver, and it enables agile scopes in the integrative processes, so that the ecosystems of different stakeholders can come up with new creative ideas (Gibbons et al., 2008).

The analyzed categories of action produced practical utility to the building, improving, and testing of data structures and tables of new information systems. As an example: the Study IV described the REDTAS, which was developed and used between 2002 and 2006.

Further development work with the schema of REDTAS was conducted with a product called SOLEOPS, which was developed in collaboration with Solenovo Ltd. The quality assurance system has been utilized in R&D activities; one example of this is the new R&D-estimations and measures in WinhaPro, which work as a management system for students during the actualizations of studies. WinhaPro maintenance has been managed by Logica. The data category, which includes the data of development days and seminars, was classified to the data structure of Optima, which is a product of Discendum Ltd, and they have been co-operating in the implementation of online learning projects since 2003. Based on actualizations of R&D, an example of the new type of virtual learning environment is MentorAid by Mamentor Ltd, which is a platform for future online-media-based actualization (Pirinen & Rajamäki, 2008a). One example of student-centered R&D is Render Farm, which is a computer cluster built to render computer-generated imagery, typically for film and television visual effects, using offline batch processing in an international network (Tuomisto, 2011).

4.4 LIMITATIONS OF THE STUDY

According to the well-known Contingency Theory of Organizations by Lawrence and Lorsch (1967), there is not a single action or educational model that suits all intensive actors; rather, the selection of the actualization model for collaborative realization depends on the actor's profile, situation, and logic of action and environment. Lawrence and Lorsch state that, an actor's environmental and cultural requirements should determine the appropriate creation structure for a realization model and used implementations. Then, the propositions of this study, the integrative models, can work as an interoperative theory, guideline, or structural reference for improving or creating situations where creativeness and innovativeness work for improvement of capabilities, such as learning capability or innovation capability within a regional R&D context.

In this study, the main limitation is related to the difficulties of identifying and measuring the constructs which refer to relations

among the phenomena being studied, such as the "innovativeness", "flow", and "spirit". For example, the study uses the term "innovation" in the integration of regional R&D support because these forms of student creations are unusual, uncertain, and particularly abstract in the creation phase, but these creations would become realized and evident slowly a "long time" after a first idea is implemented in a collaboration and learning context. Similarly, the meaning of the terms "innovativeness" and "co-creativeness", relates to the development of an idea to a new service, and terms such as "dynamic expertise", "flow", "spirit", and "community" provide identification and data searching and measuring difficulties because of abstract and diverse expressions and various meanings of used terms in everyday practice.

The general delimitation of qualitative analysis is that it applies to presenting the study, where the results lack statistical reliability, and they cannot be generalized without a deeper quantitative analysis, or that additional multimethodological and multidisciplinary research and analysis is needed for proofing the research results in the future with several domains (Gummesson, 2000; Robson, 2002; Gobo, 2004; Locke et al., 2007; Nunamaker, 2010).

4.5 IMPLICATIONS FOR FUTURE RESEARCH

The study has significant implications for further research. The first implication addresses the collaboration and activities of regional development in a UAS. This research question would be: how would collaboration in regional development be understood, designed, defined, and actualized in a UAS? This question would extend to: 1) what are the characteristics of the dynamic and core capabilities in a region? 2) How would the regional capabilities be linked to the competencies, curriculum, and R&D and innovation activities? 3) How could future research be used more effectively to explore potential regional development and learning environments, such as living labs and last-mile research? 4) How could enough shared vision be built in a region where the regional development network consists of actors with different backgrounds and aims? 5) How can we build a portfolio of strategies in a region to enable a successful

future development path to take place? And 6) how should the significance of regional innovation networks be thoroughly analyzed as part of regional, national, and sectorial innovation systems?

Second, several implications in this study address future research on the interests in management-leadership concepts and models, which would support imagination-creativity-innovation activities in a higher education and boost collaboration in its networks. Education within R&D requires a close and trust-based collaboration between personnel and management, as well as with students and participants of work communities, which have an increasing role in collaboration and R&D activities. The development of organizational culture, agility-profile relations, and trust-commitment-based management between all actors would then be in the interest of future research. The implication in this study includes two relatively different views: 1) how to understand the everyday line management in this situation, and 2) how to conduct and save agility-, trust-, motivation-, creativity- and vision-based profiles, triggers, drivers, and enablers in higher education with its collaborative networks.

Third, the study has implications for future research for a deeper understanding in the measuring of results and impacts as evaluation design; future research questions could include: 1) how to understand conceptualization of information and its quality in the union of regional innovation networks and higher education, and 2) how to measure achieved impacts such as longitudinal impacts over regional actors in the perspectives of learning by success, learning by feedback, and learning by failure. In this study, it was challenging to distinguish the influences of individual characteristics and group contributions on "co-creations", as well as understated interpersonal effects. I understand that instructors contribute to creativeness within the community, but measuring mutual influences is challenging; regardless, it is necessary in the perspective of assessment of learning, because the results can be reported and often demonstrated in the end.

5 Final remarks

This study investigated how R&D was modeled and actualized at Laurea UAS between 2003 and 2012. The study focused on the collectively developed integrative model, student-centered integration of R&D in higher education, and regional development in regard to actualizations of study units within authentic R&D projects in the progress of information systems, security management, and service programs. The study addressed the development of R&D in the domain of UASs and investigated the R&D in progressive viewpoints of changes, models, and actualizations. The unit of analysis was a sample of evidence as a case of R&D in a UAS, where the emphasis was on the phenomenon of integration, modeling, and actualization of R&D projects. The dissertation included the continuum of the six studies which were comprised of six double-reviewed journal articles and which composed the conclusion.

The first study provided insights into R&D-related higher education by presenting the integrative process, which is currently seen as action logic of the integrative model for bridging a world of cyclic strategies, visions, thinking, and imagination-creativity activities to linear R&D methods and R&D-based education, as well as integrating regional development activities, key regional profiles, and a UAS with an emergent value network. The focus of the second study was the actualization of study units in the way of an integrative model; it presented the collectively created LbD model, which is, at this time, seen as a dimensional model of our creative learning culture. The third study included design, model, implementation, and analysis of a competence-based curriculum of the degree program of business information technology. The fourth study involved an analysis of two canonical AR cycles, which were based on the data collection and data of evaluations by the FINHEEC between 2003 and 2009. The fifth study performed analysis regarding student-centered R&D activities, factors, and quality, and the analysis included the two latest FINHEEC evaluations, the evaluation of quality systems, and the evaluation of student-centered R&D between 2009 and 2011. Finally, the sixth study

was a multiple case study analysis of externally funded R&D projects in the perspective of actualizations of R&D-related study units and realization of R&D and regional development task at Laurea UAS between 2008 and 2012.

The studies showed that various forms of R&D-based education can serve individuals, organizations, and entire regions. The integrative concept is seen as one possible setting for the future, and it could answer several challenges, such as: development of regional capabilities; joining the regional R&D activities; fitting together the regional strategies, emergent R&D profiles, and learning processes; improvement of knowledge reserves; raising the students' participation in R&D so that they are the activating forces in the collective R&D; teachers in continuous interaction with the environment, which allows for quick reactions to changing, agile and dynamic needs; and a guide of teachers' R&D and pedagogical thinking.

The central challenges faced by the studies consist of: development and continuous change posing great challenges for participators; establishment of the new management culture and controlling the mass of projects precipitated by the R&D; balancing and modularizing of cognitive load and challenges; improving the significance of student-centered R&D in the perspective of communities of work; development of incipient internationalization; measurement of impacts and development of utility, usability, and strategic measuring as an evaluation design structure in general; and dissemination of the new R&D-related education model in the context of higher education.

The contributions of the study to fields of information systems science and association of information systems (AIS) were focused on improving issues related to integration of higher education studies, e.g., creativity supporting in design, R&D-related learning, and advances of authentic and focused R&D collaboration between "global innovation networks" and UASs. Producing and developing the infrastructure and collaboration paths of applied R&D for the information society related to innovation systems and global pipelines would be considered as one new focused subject area of information systems science, especially when the investigation relates to non-trivial software-based information systems and information-intensive services

(see integration of student-centered R&D and PERSEUS project, which is described in Appendix A).

The contributions of the study to the field of research itself were the advances of the LbD model, which enable the binding, testing, and developing of different learning theories and R&D methods and methodological selections. The LbD model allows development of new theories as sound kernel theories. In this, the testable theories, or testable propositions, are like theoretical hypotheses inside R&D transactions and dimensions of LbD. Then, the contribution is in the binding and developing of theories, such as socio-constructivism or research cycles through the LbD. The integrative process is especially useful at the beginning and end of research cycles; in the beginning, it joins collective creativity and evaluation to the process, and in the end, it supports the furthering of research results to new artifacts, services, methods, and knowledge to the field within the innovation system.

The main national advantages of the integrative model relate to the creativity improvement and new artifacts, services, innovations, and designs (SID) that are produced through the dynamics of interactions and communications among user-centered views, academia, industry, and government and on the social mechanisms of selection, variation, and retention responsible for their evolution as sectors. The impact of actualization of the integrative model lies in the realization of environment with innovativeness, consisting of UAS spin-offs and initiatives for knowledge-based economic development, and strategic alliances between the actors of regional-national R&D. The drivers of integrative action consist of: regional innovation system; “co-created” strategies and emergent value networks; international pipelines; and vision-based management with its: “co-creative” discursion, transparency, conduciveness, regional R&D agenda, mutual trust, strategic selections, and volition.

References

Alter, S. (1999). A general, yet useful theory of information systems. *Communications of the Association for Information Systems, 1*(13), 1–70.

Alter, S. (2008). Defining information systems as work systems: Implications for the IS field. *European Journal of Information Systems, 17*(1), 448–469.

ARENE. (2007). *Rectors' Conference of Finnish Universities of Applied Sciences: The Bologna Process and Finnish Universities of Applied Sciences. Participation of Finnish Universities of Applied Sciences in the European Higher Education Area.* Final project report. Helsinki: ARENE.

Argyris, C. & Schön, D. A. (1996). *Organizational learning II: Theory, method and practice*. Massachusetts: Addison-Wesley.

Asheim, B. (2012). The changing role of learning regions in the globalising knowledge economy. *Regional Studies, 46*(8), 993–1004.

Auvinen, P., Kauppi, A., Kotila, H., Loikkanen, A., Markus, A., Peltokangas, N., Holm, K., & Kajaste, M. (2010). Ammattikorkeakoulujen koulutuksen laatuyksiköt 2010–2012. KKA 1:2010. Tampere: Publications of the Finnish Higher Education Evaluation Council (FINHEEC) (in Finnish).

Auvinen, P., Mäkelä, J., & Peisa, S. (2006). *Laurea-ammattikorkeakoulun opetussuunnitelmatyön arviointi*. B15. Vantaa: Laurea Publications, (in Finnish).

Auvinen, P., Mäkelä, J., & Peisa, S. (2007). *Laurea-ammattikorkeakoulun opetussuunnitelmatyön arviointi: Loppuraportti 30.3.2007*. B24. Vantaa: Laurea Publications, (in Finnish).

Avison, D. E. (2002). *Action research: A research approach for cooperative work*. In Proceedings of the International Conference on Computer Supported Cooperative Work in Design, Rio de Janeiro, 19–24.

Avison, D. E., Lau, F., Myers, M., & Nielsen, P. (1999). Action research to make academic research relevant, researcher should try out their theories with practitioners in real situations and real organizations. *Communications of the ACM, 42*(1), 94–97.

Barrows, H. S. & Tamblyn, R. M. (1980). *Problem-based learning (PBL): An approach to medical education*. Springer Series on Medical Education, 1, New York: Springer Publishing.

Baskerville, R. (1999). Investigating information systems with action research. *Communications of the Association for Information Systems (CAIS), 2*(19), 2–32.

Baskerville, R. & Myers, M. D. (2004). Special issue on action research in information systems: Making IS research relevant to practice–foreword. *MIS Quarterly, 28*(3), 329–335.

Baskerville, R. & Wood-Harper, A. T. (1998). Diversity in information systems action research methods. *European Journal of Information Systems, 7*(2), 90–107.

Benbasat, I., Goldstein, D. K., & Mead, M. (1987). The case research strategy in studies of information systems. *MIS Quarterly, 11*(3), 369–386.

Bereiter, C. (1997). Situated cognition and how to overcome it. In D. Kirshner & J. A. Whitson (Eds.), *Situated cognition: Social, semiotic, and psychological perspectives* (pp. 281–300). Hillsdale: Erlbaum.

Bereiter, C. (2002). Design research for sustained innovation. *Cognitive Studies, Bulletin of the Japanese Cognitive Science Society, 9*(3), 321–327.

Bereiter, C. (2007). Learning to work creatively with knowledge. In E. Corte, L. Verschaffel, N. Entwistle, & J. van Merriënboer (Eds.), *Powerful Learning Environments: Unravelling Basic Components and Dimensions* (pp. 55–68). Bingley: Emerald Publishing.

Best, M. (1990). *The new competition: Institutions and industrial restructuring*. Cambridge: Polity Press.

Brady, M. (2000). *Use of entity or relationship diagramming as a technique in the grounded theory approach to social science research*. In proceedings of the Irish Academy of Management Annual Conference, 7–8 September, Dublin: Dublin Institute of Technology.

Brannen, J. (2004). Working qualitatively and quantitatively. In C. Seale, G. Gobo, J. F. Gubrium, & D. Silverman (Eds.), *Qualitative Research Practice* (pp. 312–326). London: Sage Publications.

Bredo, E. (1994). Cognitivism, situated cognition, and Deweyan pragmatism. In M. S. Katz (Ed.), Proceedings of the Fiftieth Annual Meeting of the Philosophy of Education Society, March 18–21, Charlotte: North Carolina.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Research, 18*(1), 32–42.

Burr, V. (1995). *An introduction to social constructionism*. London: Routledge.

Campbell, D.T. & Fiske, D.W. (1959). Convergent and discriminant validation by the multitrait-multimethod matrix. *Psychological Bulletin, 56*, 81–105.

Checkland, P. & Holwell, S. (1998). Action research: Its nature and validity. *Systemic Practice and Action and Research, 11*(1), 9–21.

Chen, P. P. (1976). The entity relationship model: Toward a unified view of data. *ACM Transactions on Database Systems, 1*(1), 9–36.

Chen, S., Duan, Y., Edwards J. S., & Lehaney, B. (2006). Toward understanding interorganizational knowledge transfer need in SMEs: Insight from a UK investigation. *Journal of Knowledge Management 10*(3):6–23.

Clark, A. W. (1976). *Experimenting with organizational life: The action research approach*. Tavistock Institute of Human Relations, London: Plenum Press.

Clark, R. & Elen, J. (2006). When less is more: Research and theory insights about instruction for complex learning. In J. Elen & R. Clark (Eds.), *Handling complexity in learning environments* (pp. 283–295). Amsterdam: Elsevier.

Cockburn, A. & Highsmith, J. (2001). Agile software development: The people factor. *Computer*, November, 131–133.

Coghlan, D. (2003). Practitioner research for organizational knowledge: mechanistic- and organistic-oriented approaches to insider action research. *Management Learning, 34*(4), 451–463.

Coghlan, D. & Brannick, T. (2010). *Doing action research in your own organization* (3rd ed.). London: Sage Publications.

Cohen, L., Mainon, L., & Morrison, K. (2007). *Research methods in education* (6th ed.). London: Routledge.

Cole, R., Purao, S., Rossi, M., & Sein, M. (2005). *Being proactive, where action research meets design research*. Proceedings of the International Conference on Information Systems (ICIS), Las Vegas, 1–21.

Collins, A., Brown, J. S., & Holum, A. (1991). Cognitive apprenticeship: Making thinking visible. *American Educator, 6*(11), 38–46.

Cooke, P. (2004). Introduction: Regional innovation system. In P. Cooke, M. Heidenreich, & H.J. Braczyk (Eds.), *Regional innovation systems: The role of governance in a globalized world* (pp. 1–18). London: Routledge.

Cooke, P. & Morgan, K. (1998). *The associational economy firms, regions, and innovation*. Oxford: University Press.

Corbin, J. & Strauss, A. (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (3rd ed.). Los Angeles: Sage Publications.

Corti, L. & Thompson, P. (2004). Secondary analysis of archived data. In C. Seale, G. Gobo, J. F. Gubrium, & D. Silverman (Eds.), *Qualitative research practice* (pp. 327–343). London: Sage Publications.

Cross, N. (2001). Designerly ways of knowing: Design discipline versus design science. *Design Issues, 17*(3), 49–55.

Davison, R. M., Martinsons, M. G., & Kock, N. (2004). Principles of canonical action research. *Information Systems Journal, 14*, 65–86.

Deming, W. E. (2000). *Out of the crisis*. Cambridge: Massachusetts Institute of Technology Press.

Denzin, N. K. & Lincoln, Y. S. (1994). Introduction: Entering the field of qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 1–17). Thousand Oaks: Sage Publications.

Dewey, J. (1916). *Democracy and education: An introduction to the philosophy of education*. New York: Macmillan.

Dewey, J. (1938). *Logic: The theory of inquiry*. New York: Henry Holt and Company.

Doloreux, D. & Parto, S. (2005). Regional innovation systems: Current discourse and challenges for future research. *Technology in Society, 27*(2), 133–154.

Drucker, P. (1969). *The age of discontinuity: Guidelines to our changing society*. New York: Harper and Row.

Dubé, L. & Paré, G. (2003). Rigor in information systems positivist case research: Current practices, trends, and recommendations. *MIS Quarterly, 27*(4), 597–635.

Dublin Descriptors. (2004). Shared 'Dublin' Descriptors for Bachelor's, Master's and Doctoral Awards.

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of Management Review, 14*(4), 532–550.

Engeström, Y. (1987). *Learning by expanding. An activity-theoretical approach to developmental research*. Helsinki: Orienta-Konsultit Oy.

Engeström, Y. (2001). Expansive learning at work: Toward an activity-theoretical reconceptualization. *Journal of Education and Work, 14*(1), 133–156.

Eraut, M. (1994). *Developing professional knowledge and competence*. London: Flamer Press.

Erl, T. (2005). *Service-oriented architecture: Concepts, technology, and design*. Boston: Prentice Hall.

Erl, T. (2007). *SOA: Principles of service design*. Boston: Prentice Hall.

Etzkowitz, H. & Leydesdorff, L. (1998). The endless transition: A "triple helix" of university-industry-government relations. *Minerva, 36*, 203–208.

Etzkowitz, H. & Leydesdorff, L. (1999). The future location of research and technology transfer. *Journal of Technology Transfer, 24*, 111–123.

European Commission. (2006). Proposal for a recommendation of the European Parliament and of the Council on the Establishment of the European Qualifications Framework for Lifelong Learning. 2006/0163 (COD). COM(2006) 479 final.

Freire, P. (1970). *Pedagogy of the oppressed*. New York: Continuum International Publishing.

Friedman, T. L. (2005). *The world is flat: A brief history of the twenty-first century*. New York: Farrar, Straus and Giroux.

Fränti, M. & Pirinen, R. (2005). *Tutkiva oppiminen integratiivisissa oppimisympäristössä.* B10. Helsinki: Laurea Publications, (in Finnish).

Galanakis, K. (2006). Innovation process: Make sense using systems thinking. *Technovation, 26*(11), 1222–1232.

Geffen, C. & Judd, K. (2004). Innovation through initiatives: A framework for building new capabilities in public sector research organizations. *Journal of Engineering and Technology Management, 21*(4), 281–306.

George, A. L. & Bennett, A. (2005). *Case studies and theory development in the social sciences*. Massachusetts: MIT Press.

Gerring, J. (2007). *Case study research principles and practice*. Cambridge: Cambridge University Press.

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., & Trow, M. (2008). *The new production of knowledge* (12th printing). Los Angeles: Sage Publications.

Gobo, G. (2004). Sampling, representativeness and generalizability. In C. Seale, G. Gobo, J. F. Gubrium, & D. Silverman (Eds.), *Qualitative research practice* (pp. 435–456). London: Sage Publications.

Gonzáles, J. & Wagenaar, R. (Eds.). (2003). *Tuning educational structures in Europ: Final report, phase one*. Bilbao: Universidad de Deusto.

Gonzáles, J. & Wagenaar, R. (Eds.). (2005). *Tuning educational structures in Europe. Universities' contribution to the Bologna process. Final report, phase two*. Bilbao: Universidad de Deusto.

Gregor, S. (2002). Design theory in information systems. *Australian Journal of Information Systems*, Special Issue, 14–22.

Gregor, S. & Jones, D. (2007). The anatomy of a design theory. *Journal of the Association for Information Systems (JAIS), 8*(5), 312–335.

Grönroos, C. (2011) Value co-creation in service logic: A critical analysis. *Marketing Theory, 11*(3), 279–301.

Guba, E. & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 105–117). Thousand Oaks: Sage Publications.

Gummesson, E. (2000). *Qualitative methods in management research* (2nd ed.). Thousand Oaks: Sage Publications.

Haack, S. (1976). The pragmatist theory of truth. *British Journal of Philosophical Science, 27*, 231–249.

Hakkarainen, K., Lonka, K., & Lipponen, L. (1999). *Tutkiva oppiminen: älykkään toiminnan rajat ja niiden ylittäminen.* Porvoo: WSOY (in Finnish).

Hakkarainen, K., Palonen, T., Paavola, S., & Lehtinen, E. (2004a). *Communities of networked expertise: Professional and educational perspectives*. Amsterdam: Elsevier.

Hakkarainen, K., Lonka, K., & Lipponen, L. (2004b). *Tutkiva oppiminen: järki, tunteet ja kulttuuri oppimisen sytyttäjänä*. Porvoo: WSOY (in Finnish).

Hamel, G. (2006). The why, what & how of management innovation. *Harvard Business Review, 84*(2), 72–84.

Harmaakorpi, V. (2004). *Building a competitive regional innovation environment: The regional development platform method as a tool for regional innovation policy*. Doctoral dissertation, 1(2004). Helsinki University of Technology. Espoo: Monikko.

Heikkilä-Laakso, K. & Heikkilä, J. (1997). *Innovatiivisuutta etsimässä: Irtiottoa keskinkertaisuudesta*. Turku: Painosalama (in Finnish).

Helakorpi, S. & Olkinuora, A. (1997). *Asiantuntijuutta oppimassa: Ammattikorkeakoulupedagogiikka*. Porvoo: WSOY (in Finnish).

Hendry, C., Brown, J., & Defillippi, R. J. (2000). Understanding relationships between universities and SMEs in emerging high technology industries: The case of optoelectronics. *International Journal of Innovation Management, 4*(1), 51–75.

Herr, K. & Anderson, G. L. (2005). *The action research dissertation: A guide for students and faculty*. Thousand Oaks: Sage Publications.

Hevner, A. R. & Chatterjee, S. (2010). *Design research in information systems: Theory and practice*. New York: Springer.

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. *MIS Quarterly, 28*(1), 75–105.

Huttula, T. (toim.). (2001). *Ammattikorkeakoulujen aluekehitysvaikutuksen huippuyksiköt 2001*. KKA 8:2001. Tampere: Korkeakoulujen arvioneuvoston julkaisuja (in Finnish).

Iivari, J. (1991). A pragmatic analysis of contemporary schools of IS development. *European Journal of Information Systems, 1*(4), 249–272.

Impiö, I., Laiho, U.M., Mäki, M., Salminen, H., Ruoho, K., Toikka, M. & Vartiainen, P. (2003). *Ammattikorkeakoulut aluekehittäjinä. Ammattikorkeakoulujen aluekehitysvaikutuksen huippuyksiköt 2003–2004. Korkeakoulujen arviointineuvoston julkaisuja 12:2003*. Helsinki: Edita (in Finnish).

Kallioinen, O. (Ed.). (2007). *The competence-based curriculum at Laurea*. B25. Vantaa: Laurea Publications.

Karjalainen, A. (toim.). (2003). Akateeminen opetussuunnitelmatyö. Oulu: Oulun yliopisto, opetuksen kehittämisyksikkö (in Finnish).

Kauppi, A. (1998). Curriculum development for integrating work and learning. *Lifelong Learning in Europe, 2*, 76–85.

Kauppi, A. (2007). *From curricula to competences: Changing VET in practice*. In Proceedings of the Vocational Education and Training in a Globalized World (pp. 71–84). Göttingen: Georg-August-University.

Kelly, M. (2004). Qualitative evaluation research. In C. Seale, G. Gobo, J. F. Gubrium, & D. Silverman (Eds.), *Qualitative research practice* (pp. 521–535). London: Sage Publications.

Keränen, K. & Ojasalo, K. (2011). *Value co-creation in b-to-b-services*. In Proceedings of the Campus Encounters – Bridging Learners Conference "Developing Competences for Next Generation Service Sectors", April 13–14, Porvoo.

Kolb, D. (1983). Problem management learning from experience. In *Executive Mind* (pp. 109–143). San Francisco: Jossey Bass.

Kolb, D. (1984). The process of experimental learning. In *Experiential learning: Experience as the source of learning and development* (pp. 19–38). New Jersey: Prentice-Hall.

Kolb, A. & Kolb, D. (2005). Learning styles and learning spaces, enhancing experiential learning in higher education. *Academy of Management Learning and Education, 4*(2), 193–212.

Kuah, A. T. H. (2002). Cluster theory and practice: Advantages for the small business locating in a vibrant cluster. *Journal of Research in Marketing and Entrepreneurship, 4*(3), 206–228.

Käyhkö, R., Hakamäki, S., Kananen, M., Kavonius, V., Pirhonen, J., Puusaari, P., Kajaste, M., & Holm, K. (2006). *Uudenlaista sankaruutta. Ammattikorkeakoulujen aluekehitysvaikutuksen huippuyksiköt 2006–2007*. KKA 13:2006. Tampere: Publications of the Finnish Higher Education Evaluation Council (in Finnish).

Ladkin, D. (2004). Action research. In C. Seale, G. Gobo, J. F. Gubrium, & D. Silverman (Eds.), *Qualitative research practice* (pp. 536–548). London: Sage Publications.

Lampelo, S., Kainulainen, S., Turunen, J., Viljanen, J., Yanar, A. Mattila, J., & Saarilammi, M-L. (2010). *Laurea-ammattikorkeakoulun laadunvarmistusjärjestelmän auditointi*. KKA 18:2010. Tampere: Publications of the Finnish Higher Education Evaluation Council (in Finnish).

Lau, F. (1999). Toward a framework for action research in information systems studies. *Information Technology and People, 12*(2), 148–175.

Laurea University of Applied Sciences. (2002). *Pedagogic strategy of Laurea*. Vantaa: Laurea-ammattikorkeakoulu (in Finnish).

Laurea University of Applied Sciences. (2002). *Regional development strategy of Laurea 2002*. Vantaa: Laurea-ammattikorkeakoulu (in Finnish).

Laurea University of Applied Sciences. (2004). *Research and development strategy of Laurea 2004*. Vantaa: Laurea-ammattikorkeakoulu (in Finnish).

Laurea University of Applied Sciences. (2005). *Regional development strategy of Laurea 2005*. Vantaa: Laurea-ammattikorkeakoulu (in Finnish).

Laurea University of Applied Sciences. (2007). *Laurea's actualization plan of strategy 2007–2009*. Vantaa: Laurea-ammattikorkeakoulu (in Finnish).

Laurea University of Applied Sciences. (2007). *Pedagogic strategy of Laurea*. Vantaa: Laurea-ammattikorkeakoulu (in Finnish).

Laurea University of Applied Sciences. (2008). *Laurea's quality handbook*. Vantaa: Laurea-ammattikorkeakoulu (in Finnish).

Laurea University of Applied Sciences. (2009). *Research and development strategy of Laurea 2009–2012*. Vantaa: Laurea-ammattikorkeakoulu (in Finnish).

Laurea University of Applied Sciences. (2010). *Strategy of Laurea 2010–2015*. Vantaa: Laurea-ammattikorkeakoulu (in Finnish).

Laurea University of Applied Sciences. (2010). *Laurea's actualization plan of strategy 2010–2012*. Vantaa: Laurea-ammattikorkeakoulu (in Finnish).

Laurea University of Applied Sciences. (2010). *Laurea's quality assurance handbook*. Vantaa: Laurea University of Applied Sciences.

Lave, J. (1988). *Cognition in practice*. Cambridge: University Press.

Lave, J. & Wenger, E. (2009). *Situated learning: Legitimate peripheral participation* (20th printing). Cambridge: University Press.

Lawrence, P. R. & Lorsch, J. W. (1967). *Organization and environment: Managing differentiation and integration*. Boston: Harvard University.

Lee, A. S. & Hubona, G. S. (2009). A scientific basis for rigor in information systems research. *MIS Quarterly, 33*(2), 237–262.

Lehtinen, E. & Palonen, T. (1999). Kognitio, käytäntö ja kulttuuri: Lintubongarin pidempi oppimäärä. Teoksessa A. Eteläpelto & P. Tynjälä Päivi (toim.). Oppiminen ja asiantuntijuus: Työelämän ja koulutuksen näkökulmia. (pp. 146–159). Porvoo: WSOY.

Lewin, K. (1942). Field theory & learning in social sciences. In D. Cartwright (Ed.), *Field theory in social science: Selected theoretical papers* (pp. 212–230). Washington: American Psychological Association.

Lewin, K. (1946). Action research and minority problems. In G. W. Lewin (Ed.), *Resolving social conflicts: Selected papers on group dynamic* (pp. 143–152). Washington: American Psychological Association.

Lewin, K. (1947a). Frontiers in group dynamics: Concept, method and reality in social science; Social equilibria and social change. *Human Relations, 1*, 5–41.

Lewin, K. (1947b). Frontiers in group dynamics II: Channels of group life; Social planning and action research. *Human Relations, 1*, 143–153.

Lincoln, Y. S. & Guba, E. G. (1985). *Naturalistic inquiry*. Beverly Hills: Sage Publication.

Lindgren, R., Henfridsson, O., & Schultze, U. (2004). Design principles for competence management system. *MIS Quarterly, 28*(3), 435–472.

Locke, L. F., Spirduso, W. W., & Silverman, S. J. (2007). *Proposals that work: A guide for planning dissertations and grand proposals* (5th ed.). Thousand Oaks: Sage Publications.

Luojus, S. (2010). *From a momentary experience to a lasting one: The concept of and research on expanded user experience of mobile devices*. Doctoral dissertation. A559. Department of Information Processing Science, University of Oulu.

Lyytinen, K. (2009). Data matters in IS theory building. *Journal of the Association for Information Systems (JAIS), 10*(10), 715–720.

Lyytinen, K. & Probey, D. (1999). Learning failure in information systems development. *Information Systems Journal, 9*, 85–101.

Maassen, P., Spaapen, J., Kallioinen, O., Keränen, P., Penttinen, M., Wiedenhofer, R., & Kajaste, M. (2011). *Evaluation of research, development and innovation activities of Finnish universities of applied sciences*. Helsinki: KKA 16:2011.

Maassen, P., Kallioinen, O., Keränen, P., Penttinen, M., Spaapen, J., Wiedenhofer, R., Kajaste, M., & Mattila, J., (2012). *From the bottom up Evaluation of RDI activities of Finnish universities of applied sciences*. Helsinki: KKA 7:2012.

Malecki, E. (2012). Regional societal capital: Why it matters. *Regional Studies, 46*(8), 1023–1039.

March, S. T. & Smith, G. F. (1995). Design and natural science research on information technology. *Decision Support Systems, 15*(4), 251–266.

Markus, M. L., Majchrzak, A., & Gasser, L. (2002). A design theory for systems that support emergent knowledge processes. *MIS Quarterly, 26*(3), 179–212.

Mattelmäki, T. (2006). *Design probes*. Doctoral dissertation. A69. University of Artand Design Helsinki, Vaajakoski: Gummerus Printing.

McKay, J. & Marshall, P. (2001). The dual imperatives of action research. *Information Technology and People, 14*(1), 46–59.

Metcalfe, M. (2004). Theory: Seeking a plain English explanation. *Journal of Information Technology Theory and Application, 6*(2), 13–21.

Mezirow, J. (1981). Critical theory of adult learning and education. *Adult Education, 32*, 3–24.

Mezirow, J. (1991). *Transformative dimensions of adult learning*. San Francisco: Jossey-Bass.

Miles, G., Miles, R.E., Perrone, V., & Edvinsson, L., (1998). Some conceptual and research barriers to the utilization of knowledge. *California Management Review 40*(3): 281–288.

Miles, M. B. & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. Thousand Oaks: Sage Publications.

Ministry of Education, Finland. (2005). *Qualifications framework. description of Finnish higher education qualifications*. Committee Records and Reports 4. Helsinki: Yliopistopaino.

Moonen, R., Kauppinen, S., Iyer, A., & Ojasalo, K. (2010). *Methods and challenges of doing research with intellectually disabled people: An ongoing empirical study*. Proceedings of the International Workshop on User Modeling and Adaption for Daily Routines (UMADR, 2010). June 21, Hawaii.

Niemi, H. (1998). Jos sulla on halu oppia. Teoksessa H. Niemi (toim.). Opettaja modernin murroksessa. (pp. 9–19, pp. 42–50). Juva: WSOY (in Finnish).

Niitamo, V.P., Kulkki, S., Eriksson, M., & Hribernik, K. (2006). *State-of-the-art and good practice in the field of living labs*. Proceedings of the International Conference on Concurrent Enterprising, Innovative Products and Services through Collaborative Networks, Milan, 349–357.

Nonaka, I. A. (1994). A dynamic theory of organizational knowledge creation. *Organization Science 1*(5), 14–37.

Nonaka, I. A. & Takeuchi, H. A. (1995). *The knowledge-creating company: How Japanese companies create dynamic of innovation*. Oxford: Oxford University Press.

Nunamaker, J. F., Chen, M., & Purdin, T. (1991). Systems development in information systems research. *Journal of Management Information Systems, 7*(3), 89–106.

Nunamaker, J. F. (2010). Interview with Jay F. Nunamaker, Jr: On toward a broader vision of IS research. *Business and Information Systems Engineering, 5*, 321–323.

Ojala, J. (2011). *Tekninen seuranta poliisin salaisena pakkokeinona*. Master Thesis. Theseus. Espoo: Laurea (in Finnish).

Oxford Dictionary of English. (ODE, 2005). *Oxford Dictionary of English* (2nd ed.). Oxford University Press.

Paavola, S., Lipponen, L., & Hakkarainen, K. (2004). Models of innovative knowledge communities and three metaphors of learning. *Review of Educational Research, 74*(4), 557–576.

Parliament of Finland. (2003). Ammattikorkekoululaki. (ACT, 2003/351). April, 2003. Helsink: Eduskunta (in Finnish).

Patton, M. (1990). *Qualitative evaluation and research methods* (2nd ed.). London: Sage Publications.

Peirce, C. S. (1909). Letter to William James. In Peirce Edition Project (Eds.) (1998), *The essential Peirce: Selected philosophical writings (1893–1913)* (pp. 500–502). Bloomington: Indiana University Press.

Piore, M. & Sabel, C. H. (1984). *The second industrial divide: Possibilities for prosperity*. New York: Basic Books.

Pirinen, R. (2013). Analysis of regional development and externally funded research projects in higher education: a continuum of multiple case study analysis. *International Journal of Innovation and Regional Development, 5*(1), 73–90.

Pirinen, R. (2011a). Externally funded research and development projects in perspective of learning. *International Journal of Engineering Pedagogy (iJEP), 1*(3), 27–36.

Pirinen, R. (2011b). *Learning within externally funded research and development projects in University of Applied Sciences: An analysis*. Proceedings of the International Conference of Interactive Computer Aided Learning (ICL), September 21–23, Piešťany.

Pirinen, R. (2009a). Thematic curriculum to the master and degree programme of information system. *International Journal of Education and Information Technologies, 3*(4), 205–216.

Pirinen, R. (2009b). Actualization of learning by developing (LbD): An analysis. *International Journal of Emerging Technologies in Learning (iJET), 4*(3), 46–58.

Pirinen, R. (2009c). Inter-operative learning and research with quality management: A categorization. *International Journal of Education and Information Technologies, 3*(4), 226–240.

Pirinen, R. (2009d). *Integrative action and learning by developing (LbD): Canonical action research*. Proceedings of the International Conference of Interactive Computer Aided Learning (ICL), September 23–25, Villach.

Pirinen, R. (2009e). *Action research in integrative action*. Proceedings of the International Conference on Education and Educational Technology, 17–19 October, Genova.

Pirinen, R. (2009f). *Thematic curriculum*. Proceedings of International Conference on Education and Educational Technology, 17–19 October, Genova.

Pirinen, R. (2009g). *Integrative action in higher education, industry collaboration and regional development: An action research approach*. Proceedings of the ICEIRD 2009. Thessaloniki, Greece, 221–230.

Pirinen, R. (2008a). Integrative action process in the perspective of globalization. *International Journal of Emerging Technologies in Learning (iJET), 3*(1), 61–68.

Pirinen, R. (2008b). Integrative action process in perspective of the three metaphors of learning. *International Journal of Education and Information Technologies, 2*(4), 226–237.

Pirinen, R. (2008c). *Integrative learning environments in perspective of regional development*. Proceedings of the Pascal International Conference, University of Limerick, 28–30 May.

Pirinen, R. (2008d). *Integrative action and process mode*. Proceedings of the International Conference on Education and Educational Technology (EDU'08). WSEAS, 21-23 November, Venice, 2008, 89.

Pirinen, R. & Fränti, M. (2008a). *Framework and culture of proactive competencies learning: Learning by developing*. Proceedings of the International Conference on Education and Educational Technology, 21–23 November, Venice, 83–88.

Pirinen, R. & Fränti, M. (2008b). *Integrative learning environments in perspective of globalization models and effects in higher education*. Proceedings of the International Conference of Interactive Computer Aided Learning (ICL), 24–26 September, Villach.

Pirinen, R. & Fränti, M. (2007). *Learning by developing*. Proceedings of the Information Technologies, Theory, Practice, Innovations, In Alytus International Conference, 6–7 December, Alytus College.

Pirinen, R. & Rajamäki, J. (Eds.). (2010). *Integrative student-centered research and development work: Rescuing of intelligence and electronic security core applications (RIESCA)*. B37. Vantaa: Laurea publications.

Pirinen, R. & Rajamäki, J. (2008a). Synthesis of learning by developing and virtual learning case: Laurea's network design specialization studies. *WSEAS Transactions on Advances in Engineering Education, 7*(9), 624–634.

Pirinen, R. & Rajamäki, J. (2008b). *Modeling and simulation of critical infrastructures case: Rescuing of intelligence and electronic security core applications (RIESCA)*. In Proceedings of the European Computing Conference. (ECC 08), WSEAS, 11-13 September, Malta, 2008, 403-408.

Pirinen, R., Rajamäki, J., & Aunimo, L. (2008). Rescuing of intelligence and electronic security core applications (RIESCA). *WSEAS Transactions on Systems, 7*(10), 1080–1091.

Pirinen, R., Tarkkanen, J., & Teräs, J. (2009). *Integrative action models in regional development, applied triple helix*. Proceedings of the Triple Helix XII Conference, 17–19 June, Glasgow.

Poikela, E. (2001). Ongelmaperustainen oppiminen yliopistossa. Teoksessa E. Poikela & S. Öystilä (toim.). Tutkiminen on oppimista ja oppiminen tutkimista. (pp. 101–117). Tampere: University Press (in Finnish).

Poikela, E. (2009). Oppimisen design. Julkaisussa S. Ruohonen & L. Mäkelä-Marttinen (toim.) Kohti osaamisen ekosysteemiä. Kymenlaakson ammattikorkeakoulun julkaisuja. Sarja A. Nro 24. Jyväskylä: Kopijyvä Oy, 10-17 (in Finnish).

Polanyi, M. (1966). *The tacit dimension*. Chicago: University Press.

Popper, K. (2009). *Conjectures and refutations: The growth of scientific knowledge*. London: Routledge Classics.

Popper, K. (2007). *The logic of scientific discovery*. London: Routledge Classic.

Popper, K. (1979). *Objective knowledge: An evolutionary approach* (revised ed.). Oxford: Clarendon Press.

Porter, M. E. (1990). The competitive advantage of nations. *Harvard Business Review*, March–April, 73–93.

Porter, M. E. (1998). Clusters and the new economics of competition. *Harvard Business Review*, November–December, 77–90.

Rajamäki, J. & Fred, M. (2011). *Externally funded research, development and innovation projects as learning environment*. Proceedings of the International Technology, Education and Development Conference, 7–9 March, Valencia, 4130–4139.

Rajamäki, J. & Pirinen, R. (2008). *Linkage of LbD and virtual learning: Case, network design specialisation studies*. Proceedings of the European Computing Conference, 11–13 September, Malta, 397–402.

Rajamäki, J., Pirinen, R., & Knuuttila, J. (Eds.). (2012). *SATERISK risks of satellite-based tracking: Sample of evidence series: Volume (2)*. Vantaa: Laurea publications.

Rauhala, P. (2008). R&D activities in Finnish universities of applied sciences promoting regional development. In K. Laine, P. van der Sijde, M. Lähdeniemi, & J. Tarkkanen (Eds.), *Higher education institutions and innovation in the knowledge society* (pp. 95–101). Helsinki: Nord Print.

Rauste-von Wright, M., von Wright, J., & Soini, T. (2003). *Oppinen ja koulutus*. Helsinki: WSOY (in Finnish).

Revans, R. (1982). *The origins and growth of action learning*. Bromley: Charwell-Brat.

Robson, C. (2002). *Real world research* (2nd ed.). Oxford: Blackwell Publishing.

Ruohotie, P. (2000). *Oppiminen ja ammatillinen kasvu*. Juva: WSOY (in Finnish).

Rutten, R. & Boekema, F. (2007). Regional social capital: Embeddedness, innovation networks and regional economic development. *Technological Forecasting and Social Change, 74*(9), 1834–1846.

Rutten, R. & Boekema, F. (Eds.). (2012) From learning region to learning in a socio-spatial context. *Routledge, Regional Studies Association, 46*(8), 981–1099.

Saarela, M., Jaatinen, P., Juntunen, K., Kauppi, A., Otala, L., Taskila. V-M., Holm, K., & Kajaste, M. (2009). Ammattikorkeakoulujen laatuyksiköt 2008–2009. KKA 2: 2009. Publications of the Finnish Higher Education Evaluation Council (FINHEEC) (in Finnish).

Salminen, H. & Kajaste, M. (Eds.). (2005). *Laatua, innovatiivisuutta ja proaktiivisuutta, Ammattikorkeakoulujen koulutuksen laatuyksiköt 2005–2006*. KKA 3: 2005. Tampere: Publications of the Finnish Higher Education Evaluation Council (FINHEEC) (in Finnish).

Sawyer, K. (2008). *Group genius: The creative power of collaboration*. Cambridge: Perseus Books Group.

Scardamalia, M. & Bereiter, C. (1999). Schools as knowledge building organizations. In D. Keating & C. Hertzman (Eds.), *Today's children, tomorrow's society: The developmental health and wealth of nations* (pp. 274–289). New York: Guilford.

Scardamalia, M. & Bereiter, C. (2006). Knowledge building: Theory, pedagogy, and technology. In K. Sawyer (Ed.), *Cambridge handbook of the learning sciences* (pp. 97–118). Cambridge: Cambridge University Press.

Schaefer, R. (1967). *The school as a center of inquiry*. New York: Harper and Row Publishing.

Schumpeter, J. A. (1939). *Business cycles: A theoretical, historical and statistical analysis of the capitalist process*. New York: McGraw-Hill.

Seale, C. (2004). Quality in qualitative research. In C. Seale, G. Gobo, J. F. Gubrium, & D. Silverman (Eds.), *Qualitative research practice* (pp. 410–419). London: Sage Publications.

Sfard, A. (1998). On two metaphors of learning and the dangerous of choosing just one. *Educational Researcher, 27*(2), 4–13.

Sfard, A. (1994). Reflection as the birth of metaphor. *For the Learning of Mathematics, 14*(1), 44–55.

Shewhart, W. A. (1939). *Statistical method from the viewpoint of quality control*. New York: Dover Publications.

Shostack, L. (1982). How to design a service. *European Journal of Marketing, 16*(1), 49–64.

Siltala, R. (2010). *Innovatiivisuus ja yhteistoiminnallinen oppiminen liike-elämässä ja opetuksessa. Väitöskirja*. C304. University of Turku (in Finnish).

Simon, H. (1996). *The sciences of the artificial*. Cambridge: MIT Press.

Stake, R. (1995). *The art of case study research*. Thousand Oaks: Sage Publications.

Star, S. L. & Griesemer, J. R. (1989). Institutional ecology, 'translations' and boundary objects: Amateurs and professionals. *Berkeley's Museum of Vertebrate Zoology, Social Studies of Science, 19*, 387–420.

Statistics Finland (2011). *Research and development activity: Concepts and definitions*.

Stenmark, D. (2001). Leveraging tacit organizational knowledge. *Journal of Management Information Systems, 17*(3): 9–24.

Storper, M. (1997). *The regional world: Territorial development in a global economy*. London and New York: Guilford Press.

Ståhlbröst, A. (2008). *Forming future IT: The living lab way of user involvement*. Doctoral dissertation. (62)2008. Luleå: University of Technology.

Strauss, A. L. & Corbin, J. (1994). Grounded theory methodology: An overview. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 273–285). Thousand Oaks: Sage Publications.

Stringer, E. T. (2007). *Action research* (3rd ed.). Los Angeles: Sage Publications.

Susman, G. (1983). Action research: A sociotechnical systems perspective. In G. Morgan (Ed.), *Beyond method: Strategies for social research* (pp. 95–113). Beverly Hills: Sage Publications.

Susman, G. & Evered, R. D. (1978). An assessment of the scientific merits of action research. *Administrative Science Quarterly, 23*(4), 582–603.

Swann, P. (1998). Towards a model of clustering in high-technology industries. In P. Swann, M. Prevezer, & D. Stout (Eds.), *The dynamics of industrial clustering* (pp. 52–70). Oxford: University Press.

Syrjänen, K. (2009). *Maturity modelling as a catalyst for IT continuity management implementation in a large company*. Master thesis. Theseus. Espoo: Laurea.

Sölvell, Ö. (2008). *Clusters: Balancing evolutionary and constructive forces*. Stockholm: Ivory Tower Publishers.

Tarkkanen, J. (2009). Application for the centre of excellence in education evaluation starting 2010. In R. Hemmilä (Ed.), *Student-centred R&D work integrated in learning: Centre of excellence in education for 2010–2012* (pp. 5–24). Vantaa: Laurea University of Applied Sciences.

Teece, D. J. (1998). Capturing value from knowledge assets: The new economy, markets, and intangible assets. *Californian Management Review, 40*(3): 55–79.

Teräs, J. (2008). *Regional science-based clusters: A case study of three European concentrations*. Doctoral dissertation. C302. Oulu: University Press.

Tichy, G. (1998). Clusters: Less dispensable and more risky than ever. In M. Steiner (Ed.), *Clusters and regional specialisation* (pp. 226–237). London: Pion Limited.

Tikanmäki, I. (2011). *Possibilities to operational use of remotely piloted aircrafts in Finland: Miehittämättömien ilma-alusjärjestelmien operatiivisen käytön mahdollistaminen Suomessa*. Theseus. Espoo: Laurea (in Finnish).

Tuomi, I. (1999). *Corporate knowledge: Theory and practice of intelligent organizations*. Helsinki: Metaxis.

Tuomisto, J. (2011). Elokuvantekoa näytönsäästäjällä. *Prosessori*, (1–2), 32–34 (in Finnish).

Tynjälä, P. (1999). Konstruktiivinen oppimiskäsitys ja asiantuntijuuden edellytysten rakentaminen koulutuksessa. Teoksessa A. Eteläpelto & P. Tynjälä (toim.). Oppiminen ja asiantuntijuus. (pp. 160–179). Juva: WSOY (in Finnish).

Ullman, J. D. & Widom, J. (2002). *A first course in database systems* (2nd ed.). New Jersey: Prentice-Hall.

Viitanen, J. (2009). *SATERISK-projektin suunnittelu ja vaatimus-määrittely*. Master thesis. Theseus. Espoo: Laurea (in Finnish).

Voorhees, R. (2001). Competency-based learning models: A necessary future. *New Directions for Institutional Research, 110*, 5–13.

Vyakarnam, S., Illes, K., Kolmos, A., & Madritsch, T. (2008). *Making a difference: A report on LbD, innovation in higher education at Laurea University of Applied Sciences*. B26. Vantaa: Laurea Publications.

Vygotsky, L. S. (1978a). Tools and symbols in child development. In M. Cole, V. John-Steiner, S. Scribner, & E. Souberman (Eds.), *L.S. Vygotsky mind in society* (pp. 19–30). Cambridge: Harvard University Press.

Vygotsky, L. S. (1978b). Internalization of higher psychological functions. In M. Cole, V. John-Steiner, S. Scribner, & E. Souberman (Eds.), *L.S. Vygotsky mind in society* (pp. 52–57). Cambridge: Harvard University Press.

Vygotsky, L. S. (1978c). Interaction between learning and development. In M. Cole, V. John-Steiner, S. Scribner, & E. Souberman (Eds.), *L.S. Vygotsky mind in society* (pp. 79–91). Cambridge: Harvard University Press.

West, R. E. (2009). *Communities of innovation: Exploring collaborative creativity within a community of graduate instructional designers*. Doctoral dissertation. Doctor of Philosophy: 2009. University of Georgia.

Yin, R. K. (2009). *Case study research design and methods* (4th ed.). Thousand Oaks: Sage Publications.

APPENDICES

APPENDIX A. RESEARCH AND DEVELOPMENT PROJECTS

RIESCA: Rescuing of Intelligence and Electronic Security Core Applications (October, 2007 to March, 2010) was the first of our externally funded R&D projects. The research of RIESCA addresses a number of systems, such as transport and logistics, power and telecommunication, hydropower and nuclear power stations, which are critical to the day-to-day functioning of any technologically advanced society, such as Finland. When assessing possible risks, it is only seldom taken into account that power, hydropower and nuclear power plants are critically dependent on the reliability and security of information systems. The aim of RIESCA was to offer contributive and constructive solutions, such as DR-based solutions, to this problem. The student-centered R&D viewpoint was integrated in RIESCA: an individual student or larger student groups were assigned to defined parts of the project. There are two notable advantages conferred by the use of students on the project, namely: 1) confidential information management can be used and developed in actualizations; and 2) the students acquire more new professional expertise that fits with the principles of LbD framework. In view of collaboration, the trust-based networked expertise relationships were achieved in RIESCA. The student-centered R&D activities in RIESCA are accessible in (Pirinen & Rajamäki, 2010); this first volume of our Sample of Evidence Series includes the description of RIESCA, see also (Syrjänen, 2009; Pirinen, Rajamäki & Aunimo, 2008).

SATERISK: Risks of Satellites and Satellite Tracking System. The idea to study risks related to satellites was created by students of Laurea in 2008 (Viitanen, 2009; Ojala, 2011). Funding from TEKES was secured on 14.11.2008 and allocated for the period 1.9.2008 to 31.8.2011. The goal of SATERISK was to study the risks connected to satellite tracking and to ascertain if the use of satellite tracking can generate further risks. The project analyses risks using different

approaches: legal, technical and mode of use; it will also study potential future requirements and risks (Kämppi, 2011). SATERISK has expanded into an academic multi-disciplinary collaboration with the University of Lapland, ITMO in St. Petersburg, Russia and the BORDERS network, coordinated by the University of Arizona, USA. In addition, the collaboration was extended with four companies in the field of satellite tracking and government officials such as customs and police in Finland. As towards future continuums and activities, there are two main spin-offs of SATERISK: the AIRBEAM FP7, and PERSEUS FP7. Here it is noteworthy that SATERISK inspired students' thinking and gave the possibility for something else to emerge; SATERISK temporarily moved students' minds far away from daily official routines and responsibilities. This clearly advanced the aspects of motivation. SATERISK also demonstrated that a student's expertise itself and student-workplace relations can trigger externally funded R&D projects. SATERISK is analysed in Study V, in the perspective of learning, and described in (Pirinen, 2011a, 2011b, 2009a; Rajamäki & Fred, 2011). The Sample of Evidence Series includes the details of SATERISK (Rajamäki, Pirinen & Knuuttila, 2012).

MayFly: MayFly is the driver project in the fields of security and public safety. Collaboration: the University of Arizona (USA) and the University of Information Technologies, Mechanics and Optics, ITMO in St. Petersburg, Russia. The scope of R&D addresses the investigation of novel uses of Micro Air Vehicles (MAVs) for use in the security and public safety fields. MAVs are miniaturised remote-control and/or autonomous air vehicles, which can collect imagery and other information from the air and send it back to ground stations or mobile networks, allowing users to understand and respond to a variety of critical scenarios. The scope of R&D includes developing service models and business cases for a variety of MAV applications, including police, border control, rescue services, customs, and industrial surveillance. The plan of R&D includes a demonstration to test the University of Arizona's Dragonfly MAV in Finnish winter conditions. The uses in MAVs of novel electro-optical sensors developed by ITMO are also included in the R&D plan. The MayFly

was initiated in the SATERISK project, and it was furthered for gaining new expertise in the field in a proactive sense. Despite MayFly not being externally funded, a spin-off, the AIRBEAM, was initiated in March, 2011. As a driver, the scopes of MayFly were integrated in the master studies between 2009 and 2011 (Tikanmäki, 2011; Rajamäki & Fred, 2011; Pirinen & Rajamäki, 2010). In a general sense, this demonstrates advances of the sustainable R&D driver (Study V).

ORE: Open Rendering Environment (June, 2008 to December, 2009). Rendering is the process of generating 3D images and movies on computers. The ORE project aims to bring the Berkeley Open Infrastructure for Network Computing-based Big and Ugly Rendering Project distributed rendering service to Finland. This goal was realized by the opening of the "Renderfarm" service in June 2009. The Renderfarm service is the world's first publicly distributed rendering service advocating the use of Creative Commons licenses. The ORE project also aims to help companies and universities adopt the open source 3D-modeling suite, Blender, into their everyday workflow (Tuomisto, 2011). While creating new information about social behaviour and distributed computing, Laurea and the project also function as a pilot project for TEKES, as it researches the possibility of using a Finnish UAS as a supporting structure for bringing new technologies into the reach of small and medium-sized enter-prises. ORE is the pure creation of a student, and it has a spin-off company.

LLL member of ENoLL: Laurea Living Labs (LLL) is a member of the European Network of Living Labs (ENoLL). ENoLL has a Europe-wide platform for providing user-driven innovation capabilities and services to small and medium-sized enterprises, international corporations, public sector agencies, academic institutions and individual citizens. LLL is an approach to stimulating and accelerating industrial and societal innovation. It is also a way of connecting and empowering users to participate in research, development and innovation. This partnership has been related to the actualizations of Hospitality Management and Information Systems studies since 2008, and it has advanced to the acceptance of DiYSE and GUARANTEE.

The ITEA2-DiYSE (March, 2009 to December, 2011) – The Do It Yourself Smart Experiences project will enable people to direct their everyday environment (and the objects, sensors, devices and media therein) into a highly personalized meaningful communication/interaction experience that can span the domains of home and city. The project aims to create a sustainable marketplace for user-generated applications for an Internet of Things world, in which non-technically skilled people can participate by using well-abstracted components, capabilities and devices. As such, it goes beyond web, mobile or multimedia applications (Moonen, Kauppinen, Iyer, & Ojasalo, 2010). A Finnish consortium aims to develop and evaluate technologies that empower elderly and disabled people, as well as young children, to create interactive experiences like quizzes, collaborative school assignments or educational games. The R&D scopes of DiYSE have been integrated to the actualizations of study units since 2009.The DiYSE was initialized in LLL and RIESCA.

The ITEA2-GUARANTEE (September 2009 to August 2012) – provides a technical solution for personal safety in the home environment. It introduces local and network-supported decision making for safety applications on the basis of sensor input and with immediate response and feedback to the people concerned. Technology and services that address the specific personal safety needs of individuals in residential environments will be researched and developed. The R&D scopes of GUARANTEE have been integrated to the actualizations of study units since 2009. The GUARANTEE is related to LLL collaboration and RIESCA.

MOBI: The target of a Finnish national research, development and innovation program, 'Mobile Object Bus Interaction' (September, 2010 to October 2013) aims to create a common ICT hardware and software infrastructure for all emergency vehicles. This infrastructure includes devices for voice and data communications, computers, screens, printers, antennas and cablings. Additionally, the interlinking with factory-equipped vehicles' ICT systems is researched. The project utilizes the results of the related research project and aims to develop product concepts, which have potential in both domestic and export

markets. The R&D scopes of MOBI have been integrated to the actualizations of study units since 2010. MOBI is a spin-off of RIESCA.

FROM Co-PRODUCTION to Co-CREATION (CoCo): The research project From Co-production to Co-creation (CoCo 10/2010-12/2012) is an ongoing TEKES-funded project in the service field. Laurea holds the ownership and the administrational responsibility for this project. The project is carried out in conjunction with five companies. The scope of CoCo is that companies are moving from business models in which value comes mainly from physical goods to models where value comes more or less from intangible things, such as services, knowledge and relationships (Keränen & Ojasalo, 2011). Moreover, within this shift, customers should be seen as co-creators of value rather than as passive recipients of goods and services. For this transformation, traditional marketing and strategy literature lack explanatory power. Therefore, the CoCo research project focuses on creating new knowledge in the service field by encouraging the development of competitive value co-creation service concepts. The aim of R&D is to develop a conceptual framework of value co-creation in B2B (business to business) services which offers tools for co-creation (Keränen & Ojasalo, 2011). The research is accomplished using action research. In the first phase of the empirical research, the current state of the business approach is analyzed in the case companies. The second phase of research will focus on the value co-creation development based on the needs identified in the current-state analysis. This will include several development rounds within the case companies carried out using service design methods. So far, CoCo has been one of the most student-intensive and student-centered R&D projects at Laurea (Keränen & Ojasalo, 2011).

PERSEUS: Protection of European borders and Seas Through the Intelligent Use of Surveillance (PERSEUS) (January, 2011 to December, 2014) is coordinated by INDRA Sistemas S.A, with 29 partners. PERSEUS represents the first demonstration project implemented by the FP7 Security Research Theme. Demonstration programs represent a novelty for the EU Framework programs. They

are aimed at large-scale integration, validation and demonstration of novel security systems of systems, and represent European flagships, providing a federative frame to join research in areas of significant European interest. PERSEUS is expected to deliver tested, demonstrated and validated recommendations.

AIRBEAM: AIRBorne information for Emergency situation Awareness and Monitoring (March, 2011 to February, 2015) is a Seventh Framework Programme (FP7) project related to crisis management. The goal is to develop a multi-platform approach to situational awareness for crisis management, especially utilizing Unmanned Aerial Vehicles (UAVs), aerostatic platforms and satellites. In addition to EADS, the AIRBEAM Consortium includes 22 partners, including some of the largest high-tech companies in Europe. The role of Laurea is as the coordinator of Work Package 1 of AIRBEAM, which focuses on studying potential concepts of use and specifying end-user requirements. This work is in close collaboration with end-user organizations.

APPENDIX B. DATA COLLECTION FORMS

The collected data from students was in the form of database INKA which is the information system for feedback from students during different phases and areas of studies. The question forms of data collection were follows: study unit feedback per every actualizations (SU), early phase (EP) feedback per every incoming students including; graduation feedback per every student (GF); and job placement and internship feedback per every student (JP). The evaluation statements were used as scale questions between 1 as completely disagree and 5 as completely agree, in addition the written feedback was provided. Here, one credit is equivalent to 27 hours of work. The questions and forms are followed:

The Forms of Data Collection:

Identification form (SU, EP, GF, JP)		
1	Field of study:	select
2	Degree programme:	select
3	Type of education:	select
4	Degree that will be:	select
5	Laurea Unit (location):	select
6	Gender:	select
7	Citizenship:	select
8	Age:	select
9	Basic education:	select
10	Work experience before entering Laurea:	select
11	Occupation before entering Laurea:	select

Job placement: internship (JP)		
6.1	Job placement is part of my personal career plan.	scale
6.2	I had gathered enough information about the practices of finding/reserving job placement.	scale
6.3	I had familiarized myself with the objectives of the job placement as described in the curriculum.	scale
6.4	I had familiarized myself with the job placement	scale

	beforehand.	
6.5	I had familiarized myself with the contents of the job placement.	scale
6.6	I had enough information on the job placement reporting.	scale
6.7	The instructions for the job placement provided by the higher education institution were clear.	scale
Job usefulness: internship (JP)		
7.1	My previous know-how and skills supported the job placement.	scale
7.2	The work duties during my job placement/internship supported my learning.	scale
7.3	I was able to apply my Learning by Developing - skills during the job placement.	scale
7.4	The guidance and tutoring I received during my job placement/internship was sufficient.	scale
7.5	The guidance discussions I had supported the development of my competencies.	scale
7.6	I reached my objectives set for the job placement/internship.	scale
7.7	I will be able to apply the skills learnt in job placement in future work functions.	scale
Development of competences by job placement (JP)		
8.1	My ability to evaluate my own competence in relation to the contents of the job placement/internship has improved.	scale
8.2	During the job placement/internship I have learned to use the terminology of my field.	scale
8.3	During the job placement/internship I have learned to look for and evaluate information critically.	scale
8.4	My ability for responsible cooperation with different actors has improved during the job placement/internship.	scale

8.5	My professional communication and interaction competence has improved during the job placement/internship.	scale
8.6	During the job placement/internship I have learned skills needed in multicultural co-operation.	scale
8.7	My ability to look for customer-oriented, sustainable and financially profitable solutions has improved during the job placement/internship.	scale
8.8	During the job placement/internship I have acquired skills relevant in my field.	scale
8.9	During the job placement/internship I have learned to apply research and development methods.	scale
Quality of education (EP, GF, SU)		
12.1	The content of the degree programme was appropriate to the requirement of working life.	scale
12.2	The content of the degree programme formed a suitable body of learning.	scale
12.3	Learning by Developing (LbD) as a study method supported the achievement of learning objectives.	scale
12.4	The teachers' / lecturers' professional skills were at high level.	scale
12.5	The professionals I have met from the working world were experts in their fields.	scale
Quality of integrative environment (EP, SU)		
12.1	The learning environment is encouraging.	scale
12.2	The learning possibilities are versatile.	scale
12.3	The studies are tightly connected to working life.	scale
12.4	The learning environment supports internationalisation.	scale
12.5	The eLearning environment supports my learning.	scale
12.6	The library services support my studies.	scale
12.7	The services offered by the student affairs office	scale

	support my studies.	
12.8	The IT services support my studies.	scale
12.9	The premises and equipment used in the teaching are appropriate.	scale
	Study planning and tutoring (EP)	
13.1	I know the curriculum of my degree programme and the structure of the studies.	scale
13.2	I can study according to my personal study plan.	scale
13.3	My teachers / lecturers are interested in my personal development.	scale
13.4	My teachers / lecturers give me enough feedback in relation to the progress of my studies.	scale
13.5	Guidance supports the progress of my studies.	scale
13.6	How would you develop teaching and guidance?	written
	Quality of facilities and integrative environments (GF)	
13.1	The learning environment was encouraging.	scale
13.2	The library services supported my studies.	
13.3	The services offered by the student affairs office supported my studies.	scale
13.4	The activities and services offered by Laureamko supported my studies.	scale
13.5	The teaching facilities and schedule were clear and well organised.	scale
13.6	The IT services supported my studies.	scale
	Study Experiences (EP, SU)	
14.1	Studying is inspiring.	scale
14.2	The standard/ requirements of the studies give a good starting point for the development of my expertise.	scale
14.3	The amount of work during the study units corresponds to the amount of credits gained.	scale

14.4	There is enough personal guidance and/or teaching.	scale
14.5	Working in a small group has been beneficial for my learning.	scale
14.6	Research and development work is an essential part of the studies.	scale

Development of competences (GF)		
14.1	I'm able to self-evaluate and develop my competence and learning style orientation.	scale
14.2	I'm able to retrieve and analyse information and evaluate it critically.	scale
14.3	I'm capable of taking responsibility for collaborative learning and sharing knowledge in teams.	scale
14.4	I'm able to take responsibility for my own actions and for the consequences of these actions.	scale
14.5	I'm able to work according to the ethical principles of the subject field.	scale
14.6	I'm able to take other people into account in my actions.	scale
14.7	I'm able to apply the principles of equality.	scale
14.8	I'm able to apply the principles of sustainable development.	scale
14.9	I'm capable of social influencing based on ethical values using my competence.	scale
14.10	I'm able to operate as a member of a work community and to promote the welfare of the community.	scale
14.11	I'm able to operate in communicative and interactive situations in working life.	scale
14.12	I'm able to utilise information and communications technology in my subject field.	scale
14.13	I'm able to create personal contacts in working life and to operate in professional networks.	scale
14.14	I'm capable of decision making in unpredicted	scale

	situations.	
14.15	I'm able to apply the principles of organizational management and leadership in working life and to work independently as an expert.	scale
14.16	I possess entrepreneurial skills.	scale
14.117	I'm capable of creative problem solving and development of working methods.	scale
14.18	I'm able to work in projects.	scale
14.19	I'm able to conduct research, development and innovation projects applying the existing knowledge and methods of the field.	scale
14.20	I'm able to find customer-oriented, sustainable and profitable solutions.	scale
14.21	I possess communicative competence necessary for my work and for professional development in the subject field.	scale
14.22	I'm able to operate in a multicultural environment.	scale
14.23	I'm able to take into account the effects of and opportunities for internationalization development in my own field.	scale
Commitment to studies and learning skills (EP)		
15.1	I believe, I have chosen a degree programme that suits me well.	scale
15.2	My studying skills are sufficient for succeeding in the degree programme.	scale
15.5	I believe that I will graduate within the planned time limit.	scale
16	In case you would like to give some open feedback, please use the space provided.	written
OPALA: effect of the studies on employment (GF)		
15	Laurea has helped me in developing working life contacts in various ways.	select
16	Your work situation after graduation?	select

17	How would you characterise your work after graduation?	select
18	What is your place of work after graduation?	select
18a	If in Finland, please indicate the city or town.	select
18b	If outside Finland, please indicate the country.	select
19	Have you established a company during your studies?	select
19a	What is the name of the company?	select
19b	What is the year of establishment of the company?	select
19c	What is the Business Identity Code of the company?	select
19d	What is the company form?	select
19e	What is the main business area of the company?	select
OPALA: evaluation of education (GF)		
20	In my work after graduation, I can make use of my studies at the university of applied sciences.	select
21	The teaching at the university of applied sciences has been professional and of a high level.	select
22	The guidance and tutoring related to studies at the university of applied sciences have supported my progress in studies.	
OPALA: work placement (GF)		
23	The guidance and tutoring I received during my placement/internship was sufficient.	select
24	The work experience I gained during my placement/internship supported my learning.	select
25	Please select the option that is most appropriate to your placement/internship during the studies.	select
25a	Number of credits completed during the placement/internship in Finland?	select
25b	Number of credits completed during the placement/internship outside Finland?	select
OPALA: open feedback (GF)		

26	What kinds of research and/or development projects related to working life have you taken part in, and how significant has this been to developing your competence?	written
27	Please evaluate to what extent you can use your competences in your future work? You may also describe your job after graduation.	written
28	In case you would like to give some open feedback, please use the space provided.	written

APPENDIX C. FOLLOW-UP DATA OF R&D

The credits completed in R&D activity is defined by the Ministry of Education: completed credits in R&D activity include all credits that have been completed in such projects or assignments integrated in the student's curriculum that have been intended for R&D of working life and that have been implemented by internal or external funding of a UAS. The follow setting of R&D data has been collected systematically since 2006:

R&D-related Follow-up and Evaluation Data at Laurea

	2007	2008	2009	2010	2011
Number of Students	7826	7719	7685	7724	7691
Number of credits completed in R&D	35315	31140	49111	64321	73340
Number of theses	1329	1273	1232	1201	1435
Theses that are based on project or R&D	1052	1073	1049	1014	1210
Number of persons involved in R&D	290	276	391	314	323
Man-years involved in R&D	88	97	132	131	132
Publication number produced by staff	142	125	139	88	117
R&D budget (1000 €)	7712	8585	11718	10998	12503

The statistics of the number of credits completed in R&D activities or projects by students in degree-awarding education are compiled for the AMKOTA database as credits included in thesis and credits included in studies. The statistics of completed credits are compiled by calendar year and by field of education. Completed credits are credits that have been completed with a passing grade.

Rauno Pirinen

Towards Realization of Research and Development in a University of Applied Sciences

This study investigated the realization of research and development (R&D) function in a university of applied sciences, Laurea, between 2003 and 2012. The thesis aims at improving issues relevant to the integration of R&D related higher education studies and national R&D agenda. The perspective of the study consists of master's, bachelor's and degree education in the programs of information systems, security management and services.

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