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LECTURERS' AND CLIENTS' EXPERIENCES OF USING LEARNING BY DEVELOPING ACTION MODEL WITH PROJECT-BASED COMPUTING SCIENCE STUDY MODULES IN FINLAND AND THE UK

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Abstract

This article describes research in which the Learning by Developing (LbD) action model has been used as a teaching and learning method for computer science students in Finland and Great Britain. The study has been conducted as action research, and its research target has been Laurea University of Applied Sciences (Laurea) and Haaga-Helia University of Applied Sciences from Finland and Robert Gordon University (RGU) from the United Kingdom. The research aims to gain information about lecturers' and clients' experiences of the LbD pedagogy and its applicability to study modules containing an authentic client project. The lecturers were also asked how well the students' skills developed during the study module. The customers were asked how beneficial the project's result was for their organisation and whether it produced new insights into operational development. The research has been conducted as action research, and separate research cycles have been implemented in all three higher education institutions. Research data from lecturers and project clients have been collected through thematic interviews. Narrative analysis has been used in the study of the thematic interviews because the number of participants is limited.

Keywords: Learning and teaching methods, Learning by Developing, computing studies.

1 INTRODUCTION

The research aims to discover the development of computer science students' competence with study modules that apply the Learning by Developing (LbD) action model, which includes customer projects in Finland and the UK. The study aims to determine whether the LbD action model is a suitable learning and teaching method for computer science students' study modules, including genuine customer projects. This article has compiled and compared research results from the studies conducted at all three higher education institutions. The research cycles are related to research in three higher education institutions, Laurea University of Applied Sciences (Laurea) and Haaga-Helia University of Applied Sciences (Haaga-Helia) in Finland and Robert Gordon University (RGU) in Great Britain. In autumn 2019, the first research cycle was carried out in Laurea. The following cycles were carried out in RGU in Autumn 2020 and 2021 and Haaga-Helia in Spring 2022. The research examines the lecturers' experiences using the LbD action model and its suitability for studying computer science and using the LbD action model in real customer projects. In addition, the study examined customers' experiences participating in student projects. In the survey, customers were also asked how well the students succeeded in the project work. With the help of thematic interviews, lecturers and project client surveys have been conducted. The similarities and differences between the responses of lecturers from different institutions are examined in the analysis. In the same way, the customers' answers are reviewed to see how they differ from each other or whether they have any similarities.

2 BACKGROUND

The Finnish higher education system is built on a dual model, consisting of 16 universities and 25 Universities of Applied Sciences (UAS). The tasks of UAS are presented in the Act on Universities of Applied Sciences (2003/351) [1]. The tasks of UAS are pedagogy, regional development and research and development. In Laurea, these tasks are integrated as a whole. The creation of the Learning by Developing (LbD) action model in Laurea was influenced by the identification of changes, learning in projects related to study, and identifying the characteristics and stages of learning. The LbD action model was initially developed in Laurea to support teaching and learning, regional development tasks based on the University of Applied Sciences Act and creating innovations for companies and as an enabler of a new competency-based curriculum. [2].

LbD includes research, authenticity, partnership, experience and creativity as part of competence development (Figure 1) [3]. An essential part of the LbD pedagogy is the meaning and importance of lifelong learning for students' future [4].

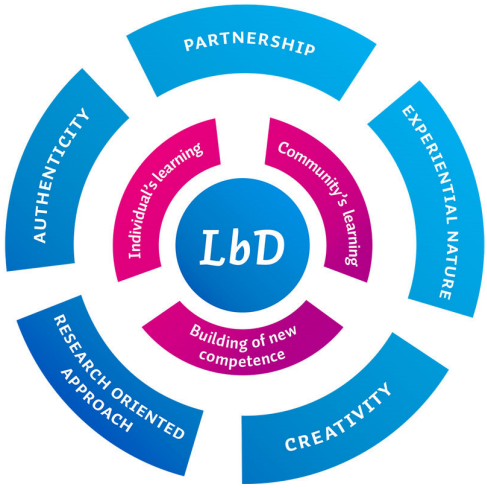

Figure 1. The LbD Action Model [3].

The LbD action model has been used at Laurea since 2006, and it is a valuable way to teach new skills needed in working life in higher education institutions [5]. The research information obtained from the study is also used as source material in the development work of the LbD model.

3 METHODOLOGY

The research strategy of the study is action research, which is well suited to a development-oriented approach, where the researcher acts as an active actor as part of the organisation being developed and new ways of operating. Action research is also characterised by the researcher's participation in data acquisition. In action research, the researcher's goal is also to change practices in the future based on the information obtained [6]. The researcher has been personally involved in the role of a lecturer in the early stages of the research. At the same time, the researcher examined teaching practices systematically and carefully using research methods. In the later stages of the study, the researcher played the role of an external observer and information seeker [7]. In the educational institution, a group of teachers can participate in the action research, or just one teacher or the entire school faculty with a common problem for which a solution is desired. Action research is well suited for educational research [8].

A cyclical progression characterises action research. In each cycle, new information is always obtained from the situation under study. Based on the analysis of the research data of each cycle, the researcher maps a picture of the current state, and based on this information, the researcher plans the target state. The researcher reflects on the situation of other participants, and the researcher participates in the development process and develops it further [9].

Narrative analysis has been used as an analysis method in the thematic interviews. Narrative, which means story, can be used in research conducted through interviews. Narratives are used to discover the meanings of people's actions and phenomena, built into different stories. The basis of the narrative strategy is language and the use of language in creating meanings. A narrative perspective helps to understand individual personal implications and entities and to create collective interpretations. From the perspective of the narrative research strategy, the stories described in the research are the narrative told in the cultures or societies that are the subject of the research and are fascinating. [10].

When narrative research relates to the change process, one must understand history; specific actions must be understood by referring to past and future possible actions in temporal relation. Narrative research also usually proceeds in cycles when trying to develop something. Narrative analysis interprets the findings through people's stories about their social and educational situations. The researcher analyses and reflects on the narrators' experiences by referring to a broader context. Similar stories create a body of evidence that supports an understanding of their effects. [11].

Narrative analysis is suitable for survey analysis in studies where the object of the study changes in one way or another. In narrative research, background information can be essential; the researcher often relates the narrative to its contexts and the texts to their narrators. In this study, the narrators play a significant role as storytellers and background tellers because each research subject had a slightly different background. This study had few interviewees, and everyone had slightly different starting points [12].

The SWOT analysis model is also used to analyse and classify the results. SWOT analysis is an analysis method typically used to assess the "strengths", "weaknesses", "opportunities", and "threats" of an organisation, plan, project, person or company. SWOT analysis is a tool designed for organisations' strategic planning and management. SWOT analysis is an easy but effective situational analysis tool that helps to identify organisational and environmental factors. [13]. In this study, SWOT analysis has been used to analyse lecturers' answers.

4 RESEARCH CYCLES

This study collected research data from Laurea, RGU and Haaga-Helia computer science students, lecturers and project clients who participated in the study module. In all three higher education institutions, the research subjects were computer science students who participated in study modules that included a project client's genuine customer project or projects. During the study module, the students participated in a development project related to working life in cooperation with a client. Students communicate with project clients independently and under the guidance of the lecturer.

The research included interviews with lecturers, where information was collected about the suitability of LbD pedagogy for computer science project studies. Through interviews, project clients were asked about their experiences participating in a study module where the LbD model was used as a pedagogical method. This study reviews the research results of these three institutions. All of these educational institutions implemented study modules that included project clients' IT projects, but the topics of the projects were slightly different. The research material was collected in 2019-2022 from the thematic interviews with the clients and lecturers of the projects. The interviews of project clients and lecturers were carried out remotely. All interviews were recorded and transcribed for analysis.

4.1 Participants

Participants were recruited from three study modules across three institutions. The modules were chosen according to the following criteria: the study modules were the studies of computer science students, the study modules included a customer project, the topics of the projects were related to software development, and the students of the study module were at least second-year students. When the module leader agreed to participate in the study, the students were given the following information: the study modules include participation in client projects, which are done as group work, and the study module includes several different assessment methods, including peer assessment, and the LbD model is used as the pedagogical method of the study module. If the students could not commit to the client project, they could opt out of participating in the study module.

At the beginning of all study modules, the researcher introduced the LbD model to students, clients and lecturers and explained why this pedagogical method is used so that everyone understands the principles of LbD. At the beginning of the study module, project clients and lecturers were told about the interview conducted after it and asked if they could participate.

4.1.1 Laurea University of Applied Sciences

Laurea University of applied sciences operates in Finland. The Service Design study module was chosen as the study module, which consisted of computer science students and the staff of Laurea. The study module also included project clients whose software projects the students were involved in developing.

Laurea study module included two lecturers; only one was interviewed because the other lecturer was a researcher. In addition, two other lecturers from Laurea who simultaneously taught the corresponding study module were interviewed to gain more valuable information about the lecturers' experiences. Five project clients from four client organisations participated in Laurea's study module, and all were interviewed.

4.1.2 Robert Gordon University

Robert Gordon University is situated in the UK. Software Engineering was chosen as the study module in RGU, which consisted of computer science students and RGU staff.

Only one lecturer and one project client were involved in RGU's study modules, which were the same people in both years. In 2020, theme interviews were conducted remotely for RGU's lecturer and the project client of the study module. In 2021, RGU's lecturer and project client answered the theme interview questions in writing because they were already familiar to them, and it was easy for them to answer them in writing.

4.1.3 Haaga-Helia University of Applied Sciences

Haaga-Helia is also a University of applied sciences operating in Finland. A project-based study module aimed at third-year students was chosen as the study unit, where software projects for project clients are developed. The study module consisted of Haaga-Helia's computer science students and staff.

Four lecturers participated in Haaga-Helia's study module and were interviewed separately via remote connection. Haaga-Helia's study module included four client organisations, of which three project clients participated in the interviews.

5 RESULTS & DISCUSSION

5.1 Interviews of lecturers

The research data from lecturers were collected through thematic interviews. Eight lecturers were to be interviewed: three from Laurea, one from RGU and four from Haaga-Helia. All lecturers were interviewed separately. The research aimed to determine how suitable LbD is for the teaching and learning method in the software development study module, which contains real customer projects. In addition, the researcher wanted to find out how the students' skills developed during the study module from the lecturers' point of view. The thematic interviews were conducted remotely and transcribed so the answers could be analysed in more detail. The language of the interviews corresponded to the main language used in each institution; therefore, in Laurea and Haaga-Helia, interviews were carried out in Finnish, and in RGU, the interview language was English. The Finnish interviews were translated into English for analysis.

All lecturers were given the interview questions in advance. The interviews were conducted remotely and recorded so that they could be transcribed for further analysis. All interviews were conducted after the end of the study modules, and all lecturers were interviewed separately:

1. *Before starting the study module, were you familiar with the Learning by Developing (LbD) action model?*
2. *How well the LbD model fits your organisation, in your opinion (Laurea/Haaga-Helia/RGU)?*
3. *Do you think the LbD model is suitable for all study modules?*
4. *What studies or situations is the LbD best suited for, in your opinion?*
5. *What were your roles in this study module implementation in which you were involved?*
6. *How well does LbD fit into the study module you teach, in your opinion?*
7. *What strengths do you think the LbD model has?*
8. *What are the weaknesses or shortcomings of the LbD model, in your opinion?*
9. *What are the opportunities in the LbD model, in your opinion?*
10. *What kind of threats do you think the LbD model includes?*
11. *Do you have something in mind that should be developed in the LbD model to make it work better?*
12. *How well did the students' skills develop during the study module?*

5.2 Lecturers result

First, all lecturers were asked how well they knew the LbD action model before starting the study module. Table 1 shows all three institutions' lecturers' knowledge of the LbD action model before the study module. Two of Laurea's lecturers knew LbD very well because they had worked there for a long time, and the LbD model has been in use at Laurea since 2006. One of Laurea's lecturers was relatively new to Laurea, so this lecturer did not know the LbD model as profoundly as the others. The RGU lecturer understood the principles of the LbD model quite well because the lecturer had previously read about LbD pedagogy and participated in the study twice. The name of the LbD action model was unfamiliar to Haaga-Helia's lecturers, although they recognised the development-based learning model very well.

Table 1. Knowledge of the LbD Action Model before the study module.

	No prior knowlegde	Basics under-standing	Good knowlegde	In-depth knowledge
Institution 1				
Lecturer 1		X		
Lecturer 2				X
Lecturer 3				X
Institution 2				
Lecturer 1	X			
Lecturer 2	X			
Lecturer 3	X			
Lecturer 4	X			
Institution 3				
Lecturer 1			X	

To the second question, asked if the LbD model fits their organisation, all Laurea and Haaga-Helia lecturers answered that it fits very well. RGU lecturer thinks the LbD model is suitable for some study modules but demands a lot from all parties. According to the RGU lecturer, it requires a new way of thinking from lecturers about how things are taught or how students learn. It needs students to be more active in their learning. It also requires a strong commitment from all parties to work well. The third question asked if the LbD model is suitable for all studies according to the lecturers. To this question, all the lecturers answered that LbD might not fit very well with some basic studies of beginning students, such as the basics of programming or some very theoretical subjects. To the fourth question, which asked what kind of study modules LbD is best suited for, all the lecturers answered that it fits best for the study modules where projects are done and where a working life partner is involved.

The lecturers were also asked how well they think the LbD suits computer science studies and the study module they teach. According to the lecturers, LbD is well suited to study modules with a real customer project. All the lecturers answered that LbD fits well or at least reasonably well into the study module they teach. According to one lecturer's answer, it is even the only right and reasonable way. LbD is explicitly designed for study modules that combine theory and things already learned and deepened knowledge in practice, states one lecturer in his answer. According to one Finnish lecturer, LbD is particularly suitable as a pedagogical model for universities of applied sciences because their principle combines practical research and development and renews working life.

According to the LbD model pedagogy, lecturers usually have several different roles. According to all the lecturers' answers, they had many different roles. Of course, everyone had the role of a teacher, but in addition to this, the lecturers said their roles were as preparer, planner, mentor, organiser, implementer and evaluator.

The lecturers were also asked how well the students' skills developed during the study module. In the opinion of all the lecturers, the student's competencies grew well during the study module. The students learned many different skills and could apply what they learned in customer projects. The RGU student group was more diverse than usual because they were studying while working and were already used to communicating professionally. According to the RGU lecturer, the competencies developed well from an academic point of view because the students learned to use the skills they already had and applied them in an academic environment. Although the students' competence

developed well during the study module, according to one of Haaga-Helia's lecturers, some students could have achieved an even deeper level of competence.

The lecturers' answers to questions 7, 8, 9 and 10 have been compiled into a SWOT analysis (Figure 2). Based on the answers of the lecturers, they saw the good aspects and strengths of LbD, especially the fact that students get to cooperate with working life partners already during their studies. In work experience projects, students' skills and what they learn also deepen in practice. Cooperation with project clients also motivates students to try their best, and many can create working-life connections already during their studies, which further increases their motivation. The lecturers thought it was good that their skills stayed up to date while working on real customer projects.

Weaknesses and threats are also included in using the LbD model. Many lecturers needed more precise and practical instructions to help them in different situations. Before starting the study modules, a good knowledge of the LbD model was also perceived as challenging. Suppose the participant does not know it well and has not internalised the pedagogical thinking about LbD. There may be many misunderstandings, and the results will not be good enough. The LbD model requires a strong commitment from all parties; if it does not work, it usually causes problems. The evaluation of course performance can also cause problems if the evaluation criteria and aspects related to the assessment are not known to the students and clients before the start of the study module. A weakness can also be that the skills of all students participating in the projects are insufficient before the projects start. One threat was also seen as the fact that if the final results of client projects are not satisfactory, it can negatively affect the educational institution's reputation.

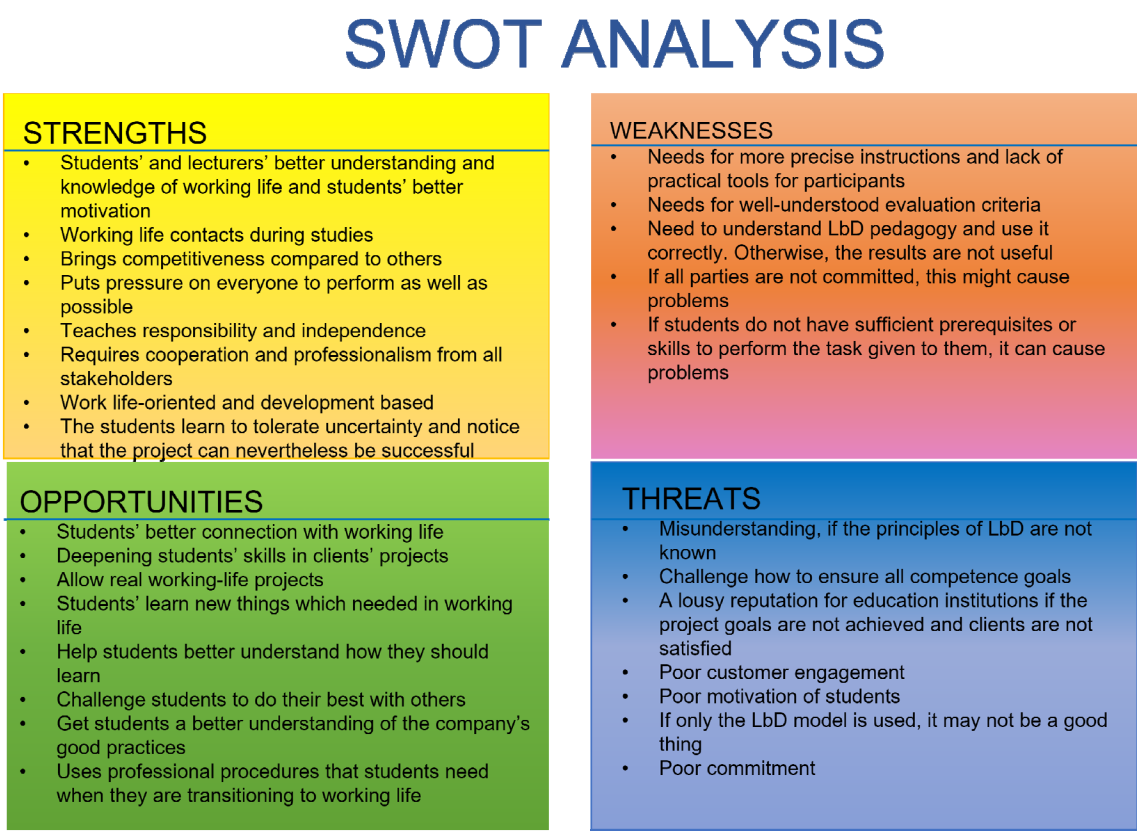

Figure 2. Lecturer's SWOT analysis.

A few lecturers could not answer how the LbD model should be developed to make it work better. The lecturers who responded to this question agreed that there should have clear and practical instructions for using LbD. Concrete instructions and examples were needed for different stages and situations of the study module so that LbD pedagogy could be implemented best. A good introduction of the students to the principles of the LbD action model should also be well-planned. There should also be a practical guide for them to familiarise themselves with it so that they can better evaluate the

development of their skills in different areas and better understand their learning style. The customers' understanding of LbD was also felt important because it would help them better commit the customer to such joint projects with educational institutions.

5.3 Interviews of project clients

Eight project clients who participated in the study modules were interviewed. Four of the eight organisations in the theme interviews participated in the study module at Laurea, three at Haaga-Helia and one at RGU. The study module at Laurea had six project groups, each with slightly different project topics. At RGU, the theme interview was held twice, in the fall of 2020 and 2021. Both times the client was the same organisation and the same representative of working life, but the projects were slightly different each time. Four project clients participated in the study module at Haaga-Helia, of which three participated in the interviews. Two of these project clients participated in the interviews and were interviewed together.

All clients were given the interview questions in advance. The interviews were conducted remotely and recorded so that they could be transcribed for further analysis. All interviews were conducted after the end of the study modules:

1. *How well did the students succeed in the project?*
2. *How well do you think the cooperation between students and teachers worked?*
3. *Did everyone have clear roles during the project?*
4. *Were the project goals mutually agreed upon, and were they clear?*
5. *How well did the practical matters related to the project go?*
6. *Were there any challenges or problems during the project, and if so, were they resolved, and if so, how?*
7. *How well were the goals achieved?*
8. *How beneficial was the result of the project for your organisation?*
9. *Did the project's outcome produce new operating methods or other reforms for your organisation?*
10. *How well did you know the LbD model before starting the study module?*
11. *What do you think about collaboration according to the LbD model, and do you think it is suitable for such student customer projects?*

5.4 Project clients results

The project clients were asked how well they thought the students succeeded in the projects. According to all project clients (Table 2), the students performed either excellently, well or at least satisfactorily. A few clients' projects were implemented in two teams, and the teams differed in success. However, the clients often had poor visibility into the project groups' internal activities, so they would have been able to assess the success of individual students sufficiently. As a whole, however, the project groups managed the projects relatively well. When asked how well the cooperation between students and lecturers went, the customers generally answered that they lacked visibility. Still, in their opinion, the collaboration went well.

Table 2. The project clients' assessment of the project's results.

	Weak	Satisfactory	Well	Excellent
Institution 1				
Client 1, project 1				X
Client 1, project 2		X		
Client 2, project 1				X
Client 2, project 2			X	
Client 3				X
Client 4			X	
Institution 2				
Client 1			X	
Client 2			X	
Client 3			X	
Institution 3				
Client 1, year 2020			X	
Client 1, year 2021				X

When asked if everyone had clear roles during the project, three customers answered that the roles were clear. Two clients responded that they did not know the internal roles of the student groups, but the cooperation went well because they had an agreed contact person from the student group. Four customers answered that the roles were not completely clear at the beginning of the project, but as the project progressed, they became more precise.

The fourth question was related to how well the clients thought the project's goals were achieved. The customers were generally satisfied with how well the project goals were achieved in the project groups. The goals were achieved excellently for a few groups, and other groups reached at least the minimum goals. If all the set goals were not completed, there were a few equal factors regardless of the customers. The project work was carried out in connection with the study module, and the schedule of the study module was the reason that not all goals were completed in some projects. Some customers also said that not all objectives were achieved because their goals changed during the project, and they lacked participation due to the customers' busy schedules.

The fifth question was related to how well the customers thought the practical things went. In the opinion of five respondents, operational issues during the project went very well. The rest of the respondents were also relatively satisfied with how practical things went, even though some customers had some challenges initially, and some customers would have liked more active contact from student groups.

According to most customers, there were no significant problems during the projects, but the cooperation went well. If any technical or other minor issues arose, they were resolved quickly and well, and the project work was not jeopardised. Two clients had challenges related to communication or finding a common understanding at the beginning of the project. These problems were solved in joint discussions, after which the cooperation went well.

The customers' opinions about the project's results ranged from very useful to partially usable. All customers said that the final results were as expected or some even better than expected. However, none of the final results could be used directly, but all of them still need to be further worked on or developed. The customers said that proof-of-concept assignments are best for such projects. According to the customers, one of the best aspects of involving the students was getting a new vision and the so-called out-of-the-box thinking through them.

The LbD model was not very familiar to any customer before the start of the study module. Some clients had heard about the LbD action model. Most clients became familiar with it when it was introduced, either before or at the beginning of the study module. The last question was, what do the customers think about cooperation according to the LbD model or whether it suits such customer projects made by students? In the opinion of all customers, the LbD model is a suitable method for collaborative projects with students if a relevant project is found and the students are self-initiative, know how to communicate well with the customer and commit to joint project work. Customers think this is a good model from the student's point of view because it is a meaningful way to be involved in real working-life projects. LbD pedagogy is a different learning method that offers students good practical work in customer projects that deepens their knowledge in addition to traditional learning.

6 CONCLUSIONS

The LbD pedagogical model was evaluated according to lecturers and clients. According to the lecturers, LbD is suitable as a pedagogical method for computer science students' project-based study modules, and their experiences were primarily positive. However, there were challenges in some projects. Even it has been noted that for LbD to work well and be helpful, it requires all parties to be thoroughly familiarised with the principles of LbD. In addition, all parties must be committed to performing their tasks well throughout the project and the entire study module to make the result good and valuable. LbD also requires students to have many initiatives and an active approach to developing and developing their skills. It also requires lecturers to have an open mind and a new way of thinking compared to the most traditional teaching methods. Lecturers typically have different roles and tasks with study implementations according to the LbD model. Lecturers still have the vital job of teaching, planning and evaluating results. In addition, lecturers usually have many other roles on a project-specific basis, such as mentor, implementer, and organiser. In many projects, lecturers often find themselves outside their expertise area and comfort zone because work-oriented projects often involve tasks that are not necessarily familiar to the lecturers. Using LbD means that lecturers must

also tolerate uncertainty about the adequacy of their skills in different situations. Then the lecturers also have to learn new skills themselves. This aspect can be a challenge for many lecturers. It can even be an obstacle to not adopting such a method. Using LbD also requires continuous and close cooperation with project clients in educational institutions to make work-life projects suitable for studies available. Building such close cooperation in educational institutions requires a systematic approach and constant dialogue with companies and other organisations.

Project clients' experiences of collaborative projects with computer science students were primarily positive. In some projects, the results benefited the clients more than others. The clients felt they got valuable results from the projects and appreciated the students' new views and fresh ways of thinking. The final products of some projects were also ones that the customers could use in their production, either directly or slightly modified. Some of the end products of the projects were such that they needed to be further developed. Some customers also regretted not having enough time to collaborate due to busy work. However, all clients felt that having students participate in their projects added value to their business development. According to the customers, the LbD model is also a meaningful way to learn from the student's point of view.

The research results are also used as background information to create a new kind of practical guide for the needs of teachers, students and customers. The planning and mapping work of the new guide has already started. According to preliminary plans, three Finnish universities of applied sciences will be involved in defining, designing and producing the guide in the first phase.

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