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# EXPERIENCES OF PILOTING THE LEARNING BY DEVELOPING ACTION MODEL IN A COMPUTING SCIENCE CONTEXT

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## Abstract

This article describes the piloting of the Learning by Developing (LbD) action model in the UK. The purpose of the pilot is to study how a pedagogical method based on the LbD can be introduced in computing students in the UK. The LbD action model has long been used in Finland at Laurea University of Applied Sciences (Laurea), but now the LbD has been piloted in a UK-based institution in a project-based study module. The main purpose was to study, through self-assessment, how the competence of computing students develops during the study module. In addition, the study reviews an action research analysis of the responses of lecturers and the project client. In addition, the pedagogical expert of the institution has been interviewed as background research to obtain sufficient information about the initial situation at Robert Gordon University (RGU).

Keywords: Learning, teaching, Learning by Developing, computing, learning outcomes.

## 1 INTRODUCTION

This action research second cycle aimed to pilot the LbD action model in RGU. The first cycle of the study has been carried out in Finland, at Laurea, where the LbD action model has been used for a long time and where it is continuously developed [1]. The LbD approach has been developed at Laurea, which studied teaching and learning at the University of Applied Sciences [2]. The LbD approach was introduced in Laurea as early as 2004 and is a successful way of teaching new things in higher education [3].

This article discusses the research phase that was conducted in the UK at RGU. The pilot had been agreed with the lecturer of the chosen study module and the lecturer had good background knowledge of the LbD before the start of the study module. To gather background information on RGU's pedagogical possibilities, a thematic interview was conducted with RGU's pedagogical expert. Discussions with RGU pedagogical expert about the LbD had already taken place before the interview and the expert had been provided with written material relating to the LbD action model. In addition to this, thematic interviews were conducted with the client and the lecturer of the study module. A questionnaire was sent to the students at the end of the study module.

## 2 METHODOLOGY

The strategy of this research is action research. Action research is well suited to development-based research, where the researcher is himself or herself part of the organization being developed. The purpose of action research is to obtain information and, based on the information received, to change its practices in the future, and it requires discipline-based research conducted by the teacher. [4]. Participants carefully and systematically review their teaching practices using research methods in this process [5]. Action research can only involve one teacher, a group of teachers with a common problem, or the whole school faculty and is well suited for educational research [6].

The researcher first analyses the current state and, based on that, designs the target state. The researcher goes through the situation with other participants and participates in the development process itself and further develops it. The first cycle of the study was carried out in Laurea in the autumn of 2019 and the second cycle was carried out in the autumn of 2020 at RGU. The second cycle was planned with staff from a university in the UK. The aim is to obtain information on whether the LbD approach is also suitable for computing students outside Laurea. In this study, method triangulation is used as the main research method. For example, method triangulation uses several different data acquisition methods in the acquisition of research material, as in this study [7]. The data collection

methods used in this study were a survey of students and a thematic interview with an expert, lecturers, and clients.

In narrative research, the meanings of human activities and phenomena are seen to be constructed in various narratives, which are therefore important to study. Narrative can also be utilized in conducting interviews. Narrative analysis has been used to analyze the results of the interviews. The narrative perspective helps to outline entities structured from individual meanings and interpretations at both the individual and community levels. Narrative analysis is suitable as a way of analyzing research, because the object of research is changing in one way or another, and at the same time cultural backgrounds are also studied. In narrative research, background information can be essential, as the researcher may be interested in relating texts to their narrators and also to the contexts of narration. In this case, the narrator can be thought of as playing the main role as the weaver of the narrator and the creator of the plot. In the narrative examination, kind of type reports is often formed - not always - which are called e.g. content reports, abstracts, and plot summaries. In this study, all interviewees participated in the study in different roles and therefore their "stories" have their kind of content that has been analyzed in the form of a narrative. [8].

### **3 RESULTS**

The subject of the study was a software engineering study module with a genuine customer. The participating students were also full-time employees, for whom project-based work was already quite familiar. Due to the situation in COVID-19, this study module was conducted as distance learning, as going to campus could have posed a risk of exposure. This fact posed one additional challenge to piloting the LbD, as the intention would have been to implement this study module as contact teaching, where it will be easier to communicate with previously unknown individuals.

12 students participated in this study module. At the beginning of the module, the researcher was involved remotely and introduced students to the LbD action model and the research, where students will be sent a questionnaire at the end of the study module. The researcher introduced the students to the principles of the LbD action model and explained what it means in practice and how the LbD is intended to develop students' competencies.

At the end of the study module, the researcher sent the lecturer a link to the questionnaire, which the lecturer forwarded to the students. Students were reminded to answer the survey a few times, but as a result, only one student responded to the survey. This fact complicates the analysis of the results of the study because no comprehensive conclusions can be drawn from the responses of one student. However, student responses have been analyzed and are included in this article because they provide additional information about the research from the student's perspective. Three thematic interviews were conducted in the study and they are summarized from different perspectives because the interviewees have different perspectives on the study.

#### **3.1 Expert interview**

The purpose of the interview with the pedagogical expert was to obtain information about the pedagogical models used in RGU to mirror the suitability of the LbD action model for RGU. The expert was first asked to explain the pedagogical models that are currently used in RGU. RGU is a vocationally focused university that is committed to developing students' employability skills during tertiary education. According to the expert, RGU uses many different pedagogical models which actively involve students in learning and participation. In addition to this, they also use genuine work-based pedagogy. The teaching aims to simulate work environments through case studies or projects. At RGU, several courses cooperate with placement and a set of courses is fully based on workplace learning. The expert also said in an interview that this is like the blended learning model where students are supported to reflect their work through academic theory and to develop their skills and competencies in that way. The expert thinks that authentic learning is a possible key term that might cover words such as work-based learning, project-based learning, active learning and community learning. The expert had read the LbD in advance and found it interesting. According to the expert, the LbD has many similar elements to the pedagogical models already used in RGU. This indicates that there are similarities in several pedagogical models, even though they are called by different names.

According to the expert, the LbD action model, where students, business representatives, and lecturers work together to develop software in a real business project and at the same time develop their skills in many areas, is a good way and will benefit all parties. However, in the expert's opinion, not everything

can be taught with the pedagogical model like the LbD. Very theoretical topics are those where, in the opinion of the expert, it is appropriate to use some more traditional teaching methods. The challenge or even a barrier to using the LbD may be that it requires the university and its lecturers to have a lot of good relationships with different companies. Companies can offer students either internships or business projects in which students can participate. Creating such well-established business partnerships is a long-term job and requires a lot of time and interest from everyone to continually develop it. It also requires the cooperation and understanding of all parties so that everyone benefits from it. Another challenge is that business representatives should have sufficient knowledge and experience of what the academic quality requirements are and how this can be ensured in business projects. The requirements for higher education institutions in the UK are strictly defined and this places certain demands on the quality assurance of teaching.

The expert was also asked whether there are any cultural and/or social challenges for the introduction of the LbD at RGU. The expert said there have been discussions in the Scottish sector that social disparities may have an impact on recruitment. This can affect students' learning experiences because not everyone has equal employment opportunities. The LbD action model could be good to facilitate this, as it would give all students an equal opportunity to participate in business projects before completing their studies.

The expert was also asked for what studies or situations the LbD would be suitable, and whether it would be particularly suitable for any specific area of education. According to the expert, the LbD is well suited for many different industries, such as commercial business, healthcare, and even education, where the significance of innovation has become increasingly important. According to the expert, it is ideal for many multidisciplinary projects that require different expertise in different areas where problems can be solved together. The LbD can be used when looking at larger entities and there is a need to address issues and problems related to the needs of real working life together. According to the expert, the LbD action model is broadly suitable for teaching all types of disciplines, except perhaps really highly theoretical subjects, such as theoretical physics or mathematics, there might also be a way to use it for these subjects as well.

### **3.2 Client interview**

The client who participated in the study module was asked questions related to students' success, the cooperation with the client, and the usefulness of the project result. According to the client, students performed quite well on the project. The client had no computing background and thought it was good because the students gained experience in what it is like to commit to a genuine business client's problem that is not tied to just the computed technical aspect. The client thought this was a good experience for the students and they learnt, how they can get IT-related information from a client who has limited knowledge about these things. In the beginning, the students used a lot of technical vocabulary and were amazed when a client asked them what they meant. However, as the project progressed, students realized that they needed to be able to ask questions and explain things to the client in a different way so that the client would understand what they meant. One of the challenges was that, due to COVID-19, the study module was implemented as distance learning, although it was intended to be considered as contact teaching. Despite this, the client felt that the communication between the client and the students went 'pretty well' because the lecturer had taught them and helped the students.

The client was also asked how well they thought the cooperation between the students and the lecturer went. The client replied that there was not very high visibility for this because the client was usually in contact only with the students. However, according to the client observations and understanding, the cooperation between the students and the lecturer worked well and the students received sufficient support from the lecturer. The client was also asked if the students had clear roles in the project and whether the objectives of the project were sufficiently clear and jointly agreed. According to the client, the role of the project was very clear right at the beginning of the project because the lecturer had taken care of this before the start of the project. In terms of project goals, the client felt that, at the beginning of the project, not all students were fully aware of what the project should achieve as a result. As the project progressed, discussions with the client and the students' understanding increased and the goal of the project became clear to them.

The client was also asked if there were any problems during the project and, if so, whether they were resolved. The client replied that perhaps the biggest problem was that the students did not have a clear picture at the beginning of what should be achieved. As a result, they felt that they did not receive clear enough instructions on what they should do. The client had to explain to the students that often at the

beginning of the project, there is no exact picture of what to expect from results. The problem may be because, in traditional university studies, lecturers usually instruct exactly what students have to do with the so-called step by step, but at the beginning of customer projects, it is usually not yet known exactly what needs to be completed, but things become more clear as the project progresses. According to the client, the goals of the project were achieved quite well and some of the results of the project were ones that the client would not have even been able to think about in advance. However, some of the output of the project still requires additional work to be implemented, but the aim was not to obtain final outputs that could be used directly as such in the company. The client thought the results were positive and the results were helpful.

The client found this collaborative project very useful for the students as it gave them an idea of how to do project work with the real client. There are many stages in a collaborative project and students realized that technical skill alone is not enough, they need to be able to effectively communicate with the client and change plans as needed. In such client projects, changes are normal and students need to be able to acquire information themselves to resolve future issues. Customer projects combine both technical skills and social skills to achieve the best outcome. In this way, students increase their competencies in practical projects and at the same time acquire theoretical knowledge related to the issues to be solved. The client was also asked whether the LbD is a suitable way of learning to develop students' competencies in such client projects. The client thinks this model is a good way because it combines theory and practice. The client thinks the LbD is good also because it is a different way to learn and some students benefit considerably from doing things in practice because then they internalise things much better. Computing students are usually quite shy and quiet and in this kind of teaching model they also learn to communicate with others and that is the skill they need in working life.

### **3.3 Lecturer interview**

The lecturer of the study module knew the LbD action model before the start of this study module. The researcher had introduced the principles of the LbD to the lecturer and the piloting of the LbD has been jointly agreed. The lecturer was asked how well the LbD suited for RGU. The lecturer opinion was that it fits well, depending on the context. For some study modules, it fits better than for others. In the opinion of the lecturer, it fits well for the piloted study module. However, the lecturer suspects that the LbD is not suitable for all study modules, as for some traditional theoretical courses. In the lecturer's opinion, the LbD is well suited for project-based study modules or study modules that involve stakeholders other than just students and lecturers.

In addition to the lecturer normal responsibility, the piloted study module was also responsible for the presentation of the LbD, responsibility for the curriculum, and responsibility for meeting the learning outcomes and the aims of the study module. In designing the study module, especially this software engineering study module, which involved an external client, it was very important to find a way that meets the students' competence needs, and for this purpose, the LbD is well suited. There are many things to consider when building a partnership between students and a client in such a study module, and this approach is part of the core of the LbD. The lecturer considers this is what will be useful for them in the future when working with students, the client, and the lecturer.

The lecturer was asked how suitable the LbD was in the piloted study module. According to the lecturer, this study module existed before the lecturer was aware of the LbD, but due to the nature of the LbD, it was easy for the lecturer to reorganise the teaching so that the LbD was successfully piloted in that module. The participated students in the course were full-time employees, which helped to introduce the LbD, as it combines work- and university-based learning.

The lecturer was also asked what is good about the LbD. The LbD requires a lot from everyone involved. It requires lecturers to have a new way of thinking about how things can be produced, but it also requires students to commit to their learning. Students need to be much more active themselves, as they are responsible for developing their competencies. The lecturer believes that the good thing in the LbD is that students learn things more deeply when students understand the meaning of the LbD and commit to developing their competencies. The LbD action model works in the study modules in this way and can be a really rewarding experience for the students as long as the study module fits into it.

The lecturer was also asked to consider the weaknesses or shortcomings, strengths or threats in the LbD. According to the lecturer, there are weaknesses and shortcomings in all pedagogical models. Pedagogical models are useless if pedagogical models are not used correctly or their users do not understand why the model is used. The strength of the LbD is that it imposes responsibilities on all stakeholders and requires everyone to commit to professional cooperation. The biggest threat a lecturer

sees in the LbD is that if it is used without understanding what the LbD is all about, students' skills will not develop as intended. Students learning outcomes are best when the LbD is used in a suitable environment and situation. The lecturer was also asked what changes should be made to the LbD to making it work better. The lecturer believes that the LbD works well in a current way as long as it can be used properly. The lecturer finds it difficult for students to understand because it is called an action model, which is why they expect rapid change. Usually, students are not told anything about pedagogical models or the teaching or learning methods used in teaching. Students also do not know the constructive background of the LbD, and when they are told that now the LbD approach is in use, it makes them think about how they are learning. However, students are not used to being told in what pedagogical way they are taught, so this confuses them a bit. The lecturer wonders whether it would be a change in the LbD to think about how students are taught, or whether students should first understand how they should learn at all.

As a final question, the lecturer was asked how well students' competencies developed during the study module. According to the lecturer, the students' competencies developed well, but the starting point for these students was that they are also full-time employees who are used to communicating professionally. From an academic point of view, the skills did develop well as the students learned to use the skills they already had and they were able to apply them in an academic setting.

### **3.4 Student survey**

Students were sent a questionnaire with both questions to be assessed on the Likert scale and answer fields, which they were asked to answer freely in their own words. Although students were reminded several times about the survey and answering it, only one student responded to the survey. Because of this, no comprehensive conclusions can be drawn from the students' responses in one direction or another, but the responses of this one student are nonetheless going through a bit here to get even some insight from the students' perspective in this study. In the questionnaire, the student was asked to evaluate the development of his or her competence by assessing what his or her level of competence was at the beginning and the end of the study module. The areas of expertise assessed are the same as those used in the study of Laurea's IT students and are based on the general skills needed in working life was taken from Laurea's 2030 strategy [1].

At Laurea, the competencies need of working life, has been strongly identified alongside the degree's substantive skills, and for those who have completed applied sciences higher education, they are perceived as increasingly important skills. Laurea's general working life skills are common to all degrees and consist of six competencies: self-management and an entrepreneurial attitude, critical thinking and problem-solving skills, anticipation, and innovation skills, communication and interaction skills, global skills, and responsibility skills. These competencies and their development are important in all degrees and are therefore taken as the basis for the student survey in this study. Below these sets of competencies are three or four more detailed sections. Students were asked to rate the development of competencies for each of these detailed sections in the survey. In the survey, students conducted a self-assessment of what their level of competence was in each section before the start of the study module and what they thought was their competence at the end of the study module. Students were asked to rate their competence in each subject area on a scale of 1 ("no competence") to 5 ("expert"). [1].

Figure 1 summarizes the student's answers in which he/she assesses that his / her competence has increased during the study unit. There were a total of 20 areas of competence to be assessed, of which 10 areas of competence were those in which the student felt that his or her competence had developed. Based on the student's self-assessment, his / her competence had increased the most in the field of ethics and empathy, whose level of competence had risen from level 1 to level 4. Co-development and service planning skills, own learning and skills, and life management and well-being had risen from Level 2 to Level 4. Ethical engagement in a global media and technology environment, and networking skills had risen from Level 1 to Level 3. Four other competencies, namely: analytical thinking and debate, ability to change, equality and fairness, and impressive oral and written communication skills, have grown by only one level. Figure 1 shows a summary diagram of these.

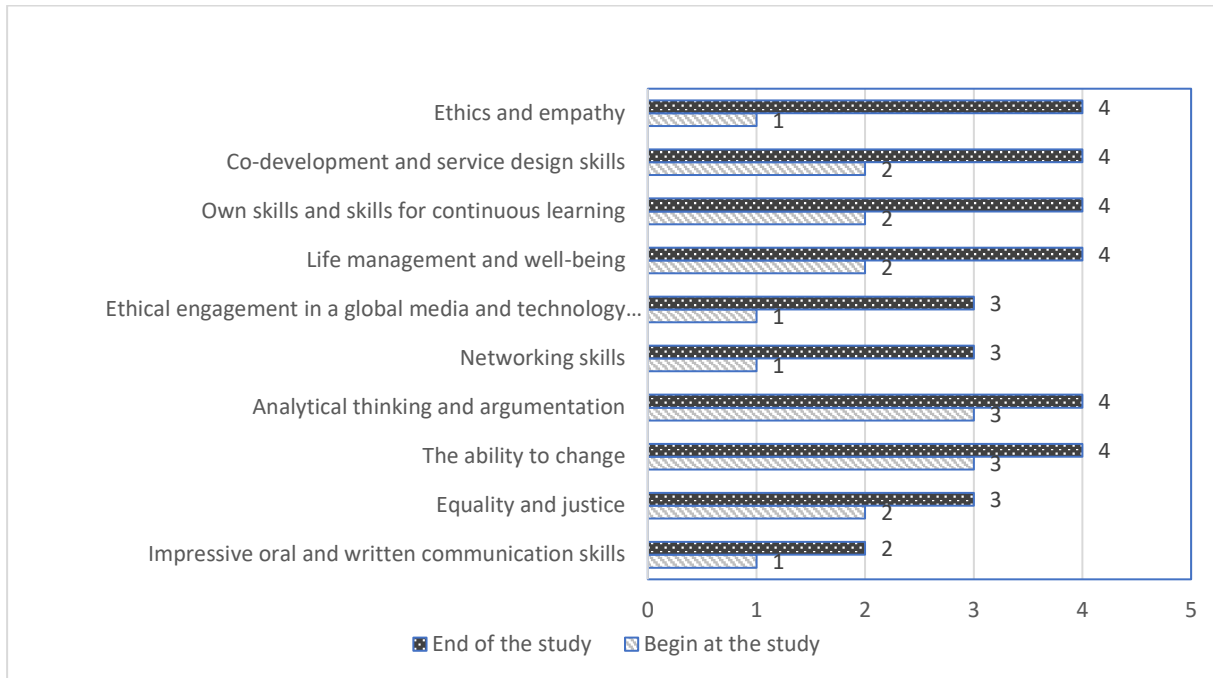


Figure 1. Student competence developments.

In free-form questions, students were asked what new knowledge or skills they learn during the study module. The student responded to this as follows: “*How to work as a team to develop a piece of software. Team working skills. Planning skills. Presentation skills*”. Students were also asked how well they understood what the LbD meant in practice and to this, the student replied that not very well. However, the student replied that during the pilot study module student was able to develop the application and learn something new and it helped when at the same time being able to apply the learned issues in the development of the application. The student thought the LbD was well suited for computing studies and the student also thought the lecturer was very familiar with the LbD. The student, on the other hand, felt that the customer was not familiar with the LbD.

## 4 CONCLUSIONS

In summary of this research cycle, it can be stated that the results of the student survey were not sufficient because only one student who participated in the course responded to the survey. However, the result of this provides valuable information on how to survey students in the next round of research data collection. Students need to be committed to the research survey from the very beginning and emphasise its importance in the development of pedagogical methods at the university. The study module participated only 12 students and due to COVID-19, the study module had to be implemented completely remotely, which could also affect participation in the study. However, the answers of the student who responded to the survey show that the student estimates increased competencies in the areas of collaboration, development, personal competence, and lifelong learning. Ethical values and empathy developed the most in the student's opinion and this is well in line with what the client had noticed. The client's experience of the pilot study module was positive and in the client opinion, the LbD is a suitable way for such study modules that involve a genuine client project. In addition to theory, the study is combined with practical work in a client project, and during the project, in addition to technical issues, students also learn communication with the client, which is an important skill in working life.

The expert interview provided valuable information that the LbD action model could be one suitable pedagogical model that could be used in RGU, as RGU is a highly professional-oriented university and committed to developing students' working life skills during their studies. It can also be seen from the lecturer's answers that the LbD was well suited for the chosen study module and it supported the development of students' competencies well. However, the responses from both the expert and the lecturer also revealed that they did not consider the LbD to be appropriate for all teaching. If the LbD is

to be used in the teaching of RGU, then the study modules must fit the purpose and the lecturers must be familiar with the LbD to be able to use it correctly. The wider introduction of the LbD would therefore require well-planned familiarization and support throughout the organization, as it requires lecturers to think in a new way to develop students' competencies and to commit to working with students and working life. It also requires a new way of thinking from students as well as an active approach to developing their competencies.

This research cycle provided useful information on the piloting of the LbD in RGU. The results of the study will help in planning the next research cycle, which will also be carried out at RGU. The research results provided valuable information on what needs to be changed with the implementation of the next research cycle and how tasks should be prepared before collecting research data.

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