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The impact of Project-Based Learning curriculum on first-year retention, study experiences, and knowledge work competence

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Abstract

Technological and social developments during the past years emphasize the importance of knowledge work competence. Additionally, funding of universities in Finland was changed to be based largely on yearly accumulated credits, therefore improving retention is of critical importance for the institution. In order to improve first-year retention (measured by credit accumulation) and learning of knowledge work practices, Metropolia UAS (University of Applied Sciences) changed the Information technology curriculum by integrating single topic 3-5 credit courses into multidisciplinary 15 credit courses that included substantially more project work where students solve open-ended problems. This study focuses on investigating how the new curriculum influenced first-year retention, students' study experiences and self-evaluated development of knowledge work competence. Research data included study register data on course completion and student feedback collected through online questionnaires after each course. Retention rate was substantially improved compared to previous years. Furthermore, student collaboration and independence were found to increase overall satisfaction and to boost learning in project teams.

Introduction

Student retention in tertiary studies has been a long-standing problem globally. OECD statistics showed that the average share of students who do not complete their first degree was over 30% (OECD 2010). Student retention has been especially challenging in information technology (IT) programs as the labour market attracts students already

during the studies. The phenomenon has been studied since 1970's and there is an understanding of factors contributing to retention, but at the same time it has been shown that understanding the reasons not necessarily helps in finding out measures that would improve retention.

Globalisation and technological advancements are changing the ways we live and work. Competence requirements for software engineering graduates have also changed, which means that education needs to be adopted accordingly. On top of the professional IT skills, software graduates need to learn about knowledge work practices. One must not only master professional tools, but also know how to efficiently work in multi-disciplinary teams and communicate with customers and other stakeholders.

To mitigate the above-mentioned challenges (retention and the learning of knowledge work practices), the curriculum at the School of ICT at the Metropolia UAS was changed completely in 2014: Instead of around 20 one-discipline courses, the new curriculum for the first year was restructured to include four 15 credit multidisciplinary courses employing project-based learning. The target was that the first-year retention would improve and at the same time the students would not only learn about the subject matter but would also start developing industry relevant knowledge work competence including teamwork, open problem solving and communications skills.

In the present study, we examined the implications of the curriculum change to the first-year retention. Moreover, we collected information on how students described their study experiences and evaluated the development of their knowledge work competence during their first study year.

Literature review

Student retention in engineering studies

Student retention has been studied in depth since 1970's (Tinto 1975). It has been examined through multiple different theories including economic, social interaction, adaptation and complex system theories (Tinto 2006). Models for student retention can be divided to models that emphasize integration and models that emphasise adaptation of the institutional practises and teaching practices to student expectations. The best-known model for student retention is the Longitudinal model of individual departure that was introduced by Tinto in 1975 and enhanced by him in 1997. It emphasises the importance of academic and social integration while acknowledging that there are multiple factors affecting the retention. Tinto's model has received also criticism for concentrating on academic integration and not considering external factors like a student's economic situation and family background. Cabrera, Nora, and Castenda (1993) introduced an integrated model that basically integrated Tinto's integration model and Bean's student attrition model (1980) into a more balanced and comprehensive model. Moreover, recent research has studied retention as multifaceted, complex system using system theories. When seen as a complex system, it becomes evident that any attempt to improve retention by addressing a single element are bound to fail and more comprehensive means are needed (Forsman et al. 2015). Even if retention has been studied for decades and understanding on factors impacting it has improved substantially, progress in improving retention in sustainable manner has been somewhat disappointing. It seems that it is one thing to understand the reasons behind retention and another thing to find and implement actions to improve it. Furthermore, even initially successful attempts to improve retention have been reversed in case the persons involved with the educational setting have changed (Tinto 2006).

One way of classifying the factors that may affect retention, is to divide them into 1) social interactions, 2) first year impression, and 3) economic factors. The economic factors such as the need to work while studying, social background and past studying experience are outside of institution's control, whereas there are means to enhance social interactions and the first-year experience. The quality and quantity of student-faculty interaction affects academic integration and thus influences retention. There is also substantial evidence that interaction with peers is a strong determinant of persistence in studies (Pascarella and Terenzi 2005).

According to previous research, students' academic engagement is an important factor in retention (Tinto 1993; French, Immwkus, and Oakes 2005; Noble et al. 2007; Bernold, Spurlin, and Anson 2007; Crosling, Heagney, and Thomas 2009). Furthermore, there is evidence that especially the first year is critical for student retention (Tinto 2006; Upcraft, Gardner, and Barefoot 2005; Harvey, Drew, and Smith 2005, Wilcox, Winn, and Fyvie-Gauld 2005). It also seems that a project-based curriculum may improve retention. For example, at Aalborg University in Denmark which has project-based curriculum in engineering studies, drop-out rate has been between 20 and 25% whereas in traditionally taught similar programs in Denmark the drop-out rate has been around 40% (Creese 1987). Also, at the Metropolia UAS, the retention especially in IT programs has been an issue as the drop-out rate has been in excess of 40% (Vesikivi et al. 2015). High dropout rate is an economical issue, but also a humane and welfare issue from the point of view of students. Pritchard and Wilson (2003) concluded in their study of 218 undergraduate students from a private university in the US that student's emotional health was one factor influencing student's intent of dropping out.

Multiple sources (Tinto 2006; Upcraft, Gardner, and Barefoot 2005; Harvey, Drew, and Smith 2005; Wilcox, Winn, and Fyvie-Gauld 2005) suggest that investing in resourcing and planning the first-year experience would improve academic and social integration resulting in improved retention rates. Especially, effort would need to be put in designing and implementing educational settings that foster faculty-student and peer interaction. Project based learning involving teamwork on cross-disciplinary content have been suggested as one possible way of providing better student-faculty integration than single topic courses (Pascarella and Terenzi 2005). Small group activities have also helped students take more active learning approach while increasing student-faculty interaction and diminishing the possibility of feeling disconnected from the academic setting (Powel 2008, Muukkonen et al. 2013). Harvey, Drew, and Smith (2005) suggested in their review of literature for higher education that even if first-year results are not highly correlated with final grades, they are indicative of future retention: students with successful first-year studies are more likely to persist in their studies that their peers with less successful first-year studies.

The need for IT professionals in companies is high and therefore many IT students are working during their studies. Working in the field of study helps in learning skills and competence needed in the profession, but there is also evidence that extensive working (more than 20 hours a week) may have a negative impact on retention (Hovdhaugen 2015). ICT programmes have substantially more males than females enrolled. Retention rate among female students is known to be higher than among male students (Harvey, Drew, and Smith 2005). Roberts, McGill and Koppi (2011), in their study of reasons for ICT students in Australia leaving their ICT course, concluded that there was no single explaining factor; instead, the decision was influenced by multiple factors including integration to the university environment, the way the ICT course was

taught and difficulties in combining studies with other commitments. Weng, Cheong, and Cheong (2010) examined the reasons behind students' retention in six private Information Systems institutions in Taiwan using a model that was based on Cabrera's (1993) model. They added self-efficacy to Cabrera's model and based on their study found that top three explaining factors for student retention were: self-efficacy, goal commitment and academic integration. Thus, methods promoting development of self-efficacy could improve retention. This idea has received support also from Barker, McDowell, and Kalahar (2009): there is evidence that the use of collaborative learning methods in the classroom may improve retention also in ICT programs. According to Barker, O'Neill, and Kazim (2014), framing the classroom as a challenging place where making and learning from mistakes and co-learning is supported and expected is a powerful tool in improving retention, and one way of supporting co-learning is to use pair programming where two students in turns are coding and actively watching and helping with coding.

Competence requirements in engineering studies

"21st century skills" is an umbrella term for new competence requirements that can be categorised in multiple ways. One possible categorisation is: 1) learning and innovation skills 2) digital literacy skills 3) career and life skills (Trilling and Fadel 2009). However, there seems not to be a single globally adopted categorisation for 21st century skills. In an OECD Organisation for Economic Cooperation and Development report on global evaluation of general learning outcomes, key competences were categorised into three groups: 1) Cognitive competences, 2) Intra- and interpersonal competences and 3) Technological competences. Cognitive key competences include communication, information processing, problem solving, learning and mathematics (OECD 2013).

Institute of Electrical and Electronics Engineers (IEEE) has published curriculum guidelines (Ardis et al. 2014) for software engineering, which define professional practice as one of the ten knowledge areas that should be considered when planning a software engineering curriculum. The guidelines identify teamwork, communication, analytical skills and ethical skills. NACE (National Association of Colleges and Employers) conducted in the US a study among its employer members about importance of skills for recruitment of software professionals. Top three skills found were internal and external communication, teamwork and problem solving (NACE 2016). Holzman and Kraft (2011) studied employers' requirements in the US and concluded that they would like to increase the emphasis on new technological advancements in technology and science, teamwork skills in diverse teams, communication skills, analysis and critical reasoning and thinking skills, future implications of global issues and development, capabilities to find, merge and analyse information from multiple sources, complex problem solving skills as well as understanding statistics and working with numbers.

Besides profession-specific knowledge and competence, research has identified generic knowledge work competence as one direction to examine competence development in higher education (Lakkala et al. 2015; Muukkonen et al. 2017).

The concept of knowledge work competence refers to knowledge, skills and disposition to act, study and work intentionally and effectively both individually and together with others in various contexts. Knowledge work competence enables solving complex problems and taking part in creating knowledge and novel solutions by using the community's collective, technology-mediated efforts (Muukkonen et al., in press). Here competence is not understood as a specific skill or activity (e.g., "is able to plan project work") that can be assessed as an acquired skill. It is defined similarly to Mulder

(2012) and Marin-Garcia et al. (2013) as being able to take part in, advance and monitor both individual and collective activities during knowledge work in progressively more expert ways. Taking part in teamwork in a project is one way to learn such competence.

This viewpoint is based on the knowledge creation approach on learning (Paavola and Hakkarainen 2005), which emphasises collaborative interaction and object-oriented development to work on some shared outcomes of collaborative knowledge work. More specific identification and measurement of the development of related competence is relevant from the engineering education point of view particularly regarding teamwork, communication and collaboration skills as well as complex problem-solving skills around authentic knowledge-intensive problems. Although generic competence development is predominantly understood as an individual's competence development (e.g., Strijbos, Engels, and Struyen 2015), present day knowledge work involves various activities where the individual must coordinate both the regulative and epistemic aspect of collaboration with other team members or participants. The present study utilized a questionnaire on collaborative knowledge work practices (Muukkonen et al. 2017) to investigate students self-assessed competence development.

Terron-Lopez et al. (2017) studied the impact of a university-wide adoption of project-based learning at The School of Engineering at Universidad Europea de Madrid in 2012-2013. They concluded that in the new set-up, the motivation of both students and teachers increased as students experienced that they acquired more relevant skills through projects they did with real companies. More importantly, students regarded the projects as a way to learn more deeply and uniformly as opposed to learning isolated islands of knowledge.

Aims and research questions

One aim of this study was to investigate how a curriculum, which is based on project-based learning, impacts first-year retention. Another aim was to examine how students describe their learning experiences and outcomes regarding knowledge work competence. The questions addressed in this study are the following:

(1) How did the introduction of new project-based curriculum impact the student first-year retention?
(2) How did the students in the new curriculum evaluate their learning of knowledge work competence?
(3) How did the students in the new curriculum evaluate the benefits and challenges of the course practices?

Design and methods

The general research approach followed a mixed-method strategy (Johnson and Onwuegbuzie 2004; Tashakkori and Teddlie 2010), including both quantitative and qualitative data collection and analysis methods. Mixing methods allowed us to get information of both the students' experiences of competence learning and studying, and the retention rates in the renewed first year studies. As first-year study success is one substantial factor effecting retention (Tinto 2006; Upcraft, Gardner, and Barefoot 2005; Harvey, Drew, and Smith; Wilcos and Fyvie 2005), we decided to measure retention by credit accumulation and collect also information about the grades.

Context

At the Metropolia UAS, the studies in IT were previously loosely structured. First year studies included around 20 courses in mathematics, physics, and the basics of

information and media technology. Most courses were 3 to 5 credits consisting of lectures to a large audience and laboratory practice for groups of 24 students. Students were allowed to repeat failed courses, and the completion sequence was not strict. Unfortunately, this freedom and independence did not result in good retention: nearly 40 % interrupted their studies already after the first year and only 40-49 % graduated in 5 years (Vesikivi et al. 2015)

The institution has information technology programs in Finnish and international programs in English for the first study year. Most students of the international programs are from abroad, whereas in the Finnish program the students are mostly from Finland. Furthermore, the first-year curriculum differs slightly between the Finnish and international programs.

The Metropolia UAS revised its pedagogical vision and strategy to be student centred and aiming at promoting working life skills, learning by inquiry, interdisciplinary learning and internationality. The revised curriculum was implemented in 2014: The Finnish IT programmes had 233 students and the international programme had 55 students. Students were divided into groups of approximately 30 students and altogether 10 groups in two campus locations were formed. Each group studied one course during each period instructed by a team of lecturers representing different professional disciplines such as communication skills, mathematics, physics, programming and electronics. A dedicated classroom was used for each course.

Starting from autumn 2014, first year studies were divided into four 15 credit courses: Orientation (for international programs), Networks, Robots, Games and Objects (for Finnish programs). Each course lasted for eight weeks out of which the last week was reserved for resits and getting unfinished assignments completed. The student groups took all the courses, except for the Orientation course, in a varied order. Because

of this, the courses were generally designed as independent courses that did not rely on students having previous knowledge about the course topics. Mathematics and physics were taught integrated into the 15 credit courses, but in a systematic order throughout the academic year.

Students in the Finnish programs were divided into eight groups. The international programme was split into two groups that both started with the orientation course. The orientation course in the very first study period aimed at giving international students a good understanding of information technology basics as well as enhancing independent learning skills and adopting academic practices. In addition, the students learned teamwork skills and project management while completing course assignments. Learning objectives and working practices of the courses are outlined in Table 1. All courses included physics and maths as well as media related topics (web development, video production, photography, 3D modelling) and either Finnish language or English communication.

[Table 1 near here]

Participants

During academic years 2012-2013 and 2013-2014, the School of IT at the Metropolia UAS had four study programmes: international and Finnish IT programmes as well as international and Finnish media programmes. During academic year 2014-2015 there was just two study programs: international and Finnish IT. Due to the differences in curriculum, we decided to collect and analyse the data separately for international and Finnish programs. Thus, in the final data set we had six datasets: 2012-2014 international study programmes, and 2012-2014 Finnish study programmes. Table 2 summarises the participant information. Students in the study programmes came from different backgrounds: a few of them had already a bachelor's degree in some other

field and some had completed a vocational school. However, the largest part had completed high school. It is worth noting that student composition in the international program in the year 2014 differs from years 2012 and 2013 as the share of Vietnamese students is high and, on the other hand, there are only few Finnish students. In 2012 the international students came from 21, 2013 from 25 and 2014 from 12 different countries (see Appendix).

[Table 2 near here]

Data collection

Data used in the research consisted of two parts: 1) course completion and grades data for study years 2012, 2013 and 2014, and 2) responses to student questionnaire from first two study periods in 2014. With the first part of the study we aimed to examine the impact of the curriculum change to retention rates and study success whereas the second part was used to gain understanding on the students' perceptions and experiences during their first study year.

First-year retention

Course completion data (credits, grade) were fetched on 20 December 2017 as an excel-file from the study register for students who started their studies autumn 2014, ECTS credits registered by 1 October 2015. A similar time window was used for students who started their studies in 2012 and 2013.

Student questionnaire

To examine students' learning of collaborative knowledge work competence and their experiences of the courses, a questionnaire with scaled items and open-ended questions was presented to students at the end of their course in the first two periods of the study

year. The Collaborative Knowledge Practices questionnaire (Muukkonen et al. 2017) includes seven scales: Learning to collaborate on shared objects, integrating individual and collaborative working, Development through feedback, Persistent development of knowledge-objects, understanding various disciplines and practices, Interdisciplinary collaboration and communication, and Learning to exploit technology. Students evaluated how each statement (27) corresponded to their competence learning. “During the course I have learned…”, e.g., “to develop ideas further together with others”. The statements were on a five-point Likert-scale (1 = not at all – 5 = very much). The two open-ended questions asked about the positive and impressive or challenging and disturbing aspects in the course.

A link to the online questionnaire was sent by a teacher to the students of the course. Students were provided with information about the aims of the research and were asked for their informed consent to use the questionnaire data for feedback and research purposes. Students who provided their consent were included in the data. Further, courses with less than nine respondents were excluded from the analysis to maintain a moderate representation of self-evaluations from respondents. The data consisted of 192 responses from thirteen courses (Table 3). Responses may include data from same students given in a consecutive course. An overall response rate is not possible to define since we did not register student identity. However, as there were altogether 40 given courses during the academic year, our data represents approximately a third of the courses. In these courses, one of the teachers volunteered to forward the questionnaire to the students.

Data Analysis

Analysis of first-year retention

The data were filtered to include only enrolled students who had completed at least 1 credit during the study year, and identification information was removed from the data. Credits gained from eventual previous work placements were also removed. Descriptive statistics were calculated for all six data sets.

A one-way between subjects ANOVA was conducted to compare the effect of first year curriculum on credit accumulation for groups FI2012, FI2013 and FI2014. Similar ANOVA test was performed also for the international student groups: INT2012, INT2013 and INT2014. Grades of FI2012, FI2013 and FI2014 were analysed using one-way between subjects ANOVA test. Similar ANOVA test was performed also for grade data of international program for the groups INT2012, INT2013 and INT2014.

Analysis of collaborative knowledge practices scaled items

Students' responses to the collaborative knowledge work competence learning items of the questionnaire were grouped according to the seven scales (Muukkonen et al., 2017). Mean scores and standard deviation were calculated and a t-test was used to analyse the differences between programmes.

Analysis of students' open answers about course experiences

Students' free-text answers of the questionnaire were analysed combining data-driven thematic analysis (Braun and Clarke 2006) and qualitative content analysis including quantification of data (Chi 1997). First, student answers were segmented into propositions, each of which was considered to represent a separate idea describing positive or successful and challenging or disturbing aspects of the course. In all, 452

propositions were selected and coded from the student answers. The following main content categories were constructed and used in the final analysis for categorizing both positive and negative aspects of the courses mentioned by the participants: Facilities (study premises and equipment), Organisation (practical arrangements, timetable, workload, integration of subjects), Content (usefulness, attraction, difficulty), Teaching and guidance (quality of teaching and teachers, instructions, amount and quality of support), Working methods (experiences of various ways of working), and Outcomes (what was produced and learnt). The final categories were constructed iteratively moving back and forth between the whole data set, the coded propositions, and the categories produced, combining categories or creating new ones based on the increased understanding of the data (Braun and Clarke 2006). One author carried out the first coding, which was then examined together with other researchers, discussing disagreements and making changes if needed.

Results

First-year retention

Target for first year credit accumulation is 60 credits i.e. completion of four 15 credit courses. Table 3 presents the descriptive statistics credits and grades for Finnish and international IT programs. It seems that the average credit and median credit for the Finnish study group increased substantially on study year 2014 when compared to year 2012 and 2013. Based on the descriptive statistics, credits earned by the international student did increase, but not to the same extent. Figure 1 illustrates the credit accumulation during the first study year. The data sets included only the students who had accumulated at least 1 credit during the study year. In the Finnish programs there were 40 students in 2012, 57 students in 2013 and 33 students in 2014 who were

enrolled but did not earn any credits. In the international program there were 25 students in 2012 13 students in 2013 and 15 students in 2014 who were enrolled but did not complete any studies during the respective study year.

[Table 3 near here]

[Figure 1 here]

Figure 1. Credit accumulation during the first study year

Student groups FI2012 and FI2013 had a similar first year curriculum whereas for FI2014 the curriculum was different. There was a statistically significant effect of curriculum on credit accumulation for the three conditions [$F(2, 724) = 3.01$, $p < 0.01$]. Post hoc comparison using the Scheffe test indicated that there was a significant difference between groups FI2012 and FI2014 [CV = 6.02, FS = 30.66]. Similarly, the difference between groups FI2013 and FI2014 was statistically significant [CV = 6.02, FS = 32.68] whereas the difference between the groups that both had the old curriculum was not significant [CV = 6.02, FS = 0.02]. The analysis suggests that there was a significant increase in the amount of accumulated credits between the year when the new curriculum was introduced and the two previous years.

For the international programs IN2012, INT2013 and INT2014, there was no statistically significant effect of the curriculum on credit accumulation for the three conditions [$F(2,212) = 3$, $p = 0.20$].

The grades were analysed with one-way ANOVA test. There was a statistically significant difference for the three conditions [$F(2,7075) = 3.00$, $p < 0.01$]. Post hoc comparison using Scheffe test indicated that there was a statistically significant difference between groups FI2012 and FI2014 [CV = 0.10 , FS = 46.98] and between groups FI2013 and FI2014 [CV =0.09, FS = 40.90] whereas the difference between

groups FI2012 and FI2013 was not significant [CV = 0.001, FS = 0.45]. The test implies that the change of curriculum has potentially an effect on the grades for the Finnish courses. For the international programs, there was a statistically significant difference for the three conditions [F(2,2169) = 3.00, p < 0.01]. Scheffe's post hoc comparison test indicated that there was a significant difference between INT2012 and INT2013 as well as between 2013 and 2014. The difference between 2012 and 2014 was not statistically significant. The test implies that change of curriculum possibly did not significantly change the grades of international students. Mean grade was lowest for the year 2012 and highest for 2013.

In 2014, a mixture of exams and evaluation of the project process and project achievements was used in the grading of the courses whereas the grading in the old curriculum was based almost solely on exams. Teacher teams evaluated the project process and achievements and gave a grade for the project teams. Individual grade for the project work was adjusted based on peer evaluation and teachers' evaluation of each individual's contribution to the project.

Students' self-reported learning of knowledge work competence

Students answered to the Collaborative Knowledge Practices (CKP) questionnaire after completing a course. Responses of students in the Finnish programme are presented in Table 4 and the international programme in Table 5. The tables show that there is variation in the self-assessed competence learning between the courses. A t-test compared the mean grades between the two programmes on the CKP scales. Students in the Finnish programme courses (M = 3.98, SD = 0.71) (t (42) = 2.54, $P < 0.015$, equal variance not assumed, $d = 0.51$) rated their competence learning in the scale Persistent development of shared object higher than the international programme courses (M =

3.47, SD = 1.19). Conversely, the international programme students rated their Learning interdisciplinary collaboration higher (M = 3.32, SD = 1.10) (t (190) = -3.99, $P < 0.001$, $d = 0.78$) than in the Finnish programme (M = 2.36, SD = 1.36), although both of these means are rather low. On other scales there were no statistically significant differences, but student reported quite high means especially on Learning to collaborate on shared objects and Integrating efforts.

[Table 4 near here]

[Table 5 near here]

Students' self-reported course experiences

Student questionnaire included two open questions about 1) the positive or successful and 2) challenging or disturbing aspects in the study experiences. Figure 2 presents an overview of positive and negative issues mentioned in the answers, distributed in the main content categories.

[Figure 2 here]

Figure 2. Students' evaluation of the positive or successful and challenging or disturbing issues in the courses.

Positive aspects (f=242) were mentioned somewhat more often than negative aspects (f=212), and they focussed on different issues. The largest number of positive evaluations related to the working methods in the courses, especially team working, practical working as well as community practices in the class; for example: *"Teamwork has also raised the quality of projects to higher levels. I would not have been able to carry out similar projects alone", "A lot of actual practice which is great"*, or *"Interaction between teachers and students as well as among students are good."* Features regarded as positive in the teaching and guidance practices included, e.g.,

praising teachers and their competence *("Teachers are very knowledgeable")*, teachers' attitude *("Compared to earlier study experiences, teachers seemed to be more committed to the success of the course and student learning"*) or quality of guidance received *("It was nice to see how they provided individual support to those in need besides general teaching"*). Organization of the course (good entity in general, appropriate timing, or good integration of subjects), course content, and outcomes (learning of new things, or successful project work results) were mentioned in positive terms equally often.

Most often mentioned issue experienced as disturbing or challenging concerned the organization of the courses; especially the tight timetable and heavy workload ("*Too little time was allocated for many projects*"), but also confusing arrangements ("*Teachers' mutual lack of understanding of the progress of projects and the lack of common schedules*"), poor communication practices ("*Failed communication: changing timetables, actual task instructions missing (with requirements)"*), uneven workload, and poor integration of subjects. The working methods also received quite many critical comments, related to problems in group working ("*The absence of other members of group from class*"), too much self-study, challenging tasks ("*Exercises were challenging without coding background*"), high amount of teamwork, restless classroom, small amount of practical working, and compulsory attendance. Course content was addressed, especially, related to the challenges of learning new difficult issues ("*A next to nothing knowledge of some of the languages used in CSS and html*"), but some comments also included criticism about uninteresting or poorly covered topics. In the negative opinions about teaching and guidance practices, criticism focussed on specific teachers or subjects, not the quality of teaching in general.

Discussion

The aim of this study was to find out how did the introduction of the new curriculum with project-based multi-disciplinary courses impact the first-year retention in comparison to the traditional curriculum as well as how students evaluate their learning and describe the benefits and challenges of the new study practises. The results suggest that there was a significant change in average number of credits accumulated in the Finnish programs during the first study year. More importantly, the share of students who earned 60 credits or more during their first study year, increased in the Finnish program from 30% in 2012 and 32% in 2013 to 79% in 2014, which represents approximately a 155% increase in the number of students that are fully on track with their studies. In the international programs, the change in the average credits earned proved by the analysis not to be statistically significant, but when comparing the share of students who earned 60 credits or more during the study year, we can see that the number increased from 41% in 2012 and 40% in 2013 to 67% in 2014 i.e. approximately a 48 % increase. These numbers suggest that the curriculum change seems to have the desired effect of improving first-year retention i.e. increasing the number of students who are on track with their studies.

Even if the change in credit accumulation in Finnish and international programmes is to the same direction, the analysis reveals that the increase has been more profound in the Finnish programmes than in the international. Possible cause for this could be that international students coming from various countries and cultures have bonded together also in the previous years and, therefore, the change in curriculum did not have as substantial an effect on retention. In the Finnish programs, the relative number of students with zero credits dropped slightly whereas in the international programs the percentage did not change. Furthermore, in the international programmes

the credit accumulation was already higher in 2012 and 2013 than in Finnish programmes and thus there was less room for improvement in credit accumulation.

Course grades have improved considerably more in the Finnish program when compared to the international program. Prior experience in project-based learning could be an explaining factor for significant improvement of the average grade for the Finnish programs. Another factor is that the average grade in the international programs is already relatively high (over 4 in the 1-5) scale. One could also argue that the average grade improvement is due to grade inflation caused by the change from traditional curriculum to the project-based curriculum. This may not be the case because most of the courses actually had individual exams and the individual contribution evaluated by peers and teachers was also considered in each students' individual grade. However, students did assess their competence development rather high in the scales based on questionnaire answers that can be seen as targeted by these courses through project-based teamwork (collaboration around shared objects, integration of efforts, feedback practices, persistent development and exploiting technology for collaboration). Nevertheless, we have data only from about a third of the courses in the study year, so there could be more variation if all courses had been involved.

At the same time the results from the student questionnaires indicate that students reported learning various aspects of collaborative knowledge work competence during the courses involved in the study. The level of experienced competence learning was in a relatively high level, about the same level as in another study from university studies in agricultural sciences where students completed challenging project assignments for external clients (Kymäläinen et al. 2018). The results of the Finnish and international programme courses showed few differences, notably that persistent development was highlighted in the former and interdisciplinary collaboration on the

latter. The heterogeneity of the interdisciplinary programme might provide more opportunities for learning about interdisciplinary collaboration and it could be easier to carry out persistent development in more homogenous groups, but this needs to be addressed in further studies.

According to the answers to the open questions in the questionnaire, students evaluated as positive in the study practices many of those aspects that also previous studies have suggested as important in promoting student commitment and retention (Pascarella and Terenzi 2005; Powel 2008): working methods based on teamwork, collaboration and practical assignments as well as support from and interaction with teachers. Many critical comments about the study methods related to poor organization of the courses and working methods, which might relate to the fact that the first two courses of the study year, from which the questionnaire data were collected, were also the first courses for the teachers to implement the new type of curriculum and project-based multidisciplinary approach.

Conclusions

The new curriculum with project-based approach substantially improved first-year retention i.e. increased the number of students on track with their first-year studies. Thus, it is plausible that project based pedagogical approach that integrated several subjects, when compared to the older approach (numerous one subject matter courses), helps students in achieving the targeted amount of credits during their first year.

Results of this study suggest that the first study year credit accumulation was improved, which could imply that retention would improve going forward. Further study would be needed to examine whether the positive results attained in the first year will reflect to better credit accumulation in further studies and, finally, to increased number of graduations from the IT programmes.

New curriculum produces new skills and competence, and therefore also changes in the evaluation methods of the courses are needed. However, data collected for this study did not include data concerning course assessment. Thus, grade improvement in the first-year studies is a phenomenon that would require further research. Especially, understanding both the basis and process of assessment would help in developing course assessment further.

Summing up, based on the results of the study, we are ready to recommend this approach of multidisciplinary project-based courses that include challenging projects and create a multitude of opportunities for team work and teacher student interaction, which improves first-year retention and enable students to develop their knowledge work competence.

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APPENDIX

Nationality of students in the international programmes

	2012	2013	2014
Ethiopian	12 %	10 %	7 %
National	14 %	12 %	2 %
Nepalese	17 %	16 %	18 %
Russian	15 %	8 %	13 %
Vietnamese	13 %	16 %	40 %
Other countries	29 %	37 %	20 %
Sum	100 %	100 %	100 %