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A Case Study on Theme-Based Approach in Health Technology Engineering Education: Customer Oriented Software Applications

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***Abstract*—**Metropolia University of Applied Sciences (MUAS) Information and Communication Technology (ICT) Degree Programme provides full-time Bachelor-level undergraduate studies. ICT Degree Programme has seven different major options; this paper focuses on Health Technology. In Health Technology, a significant curriculum change in 2014 enabled transition from fragmented curriculum including dozens of courses to a new integrated curriculum built around three 30 ECTS themes. This paper focuses especially on the second theme called Customer Oriented Software Applications. From students' point of view, the goal of this theme is to get familiar with existing health related ICT solutions and systems, understand business around health technology, recognize social and healthcare operating principles and services, and identify customers and users and their special needs and perspectives. This also acts as a background for health related web application development. Built web application is tested, developed and evaluated with real users utilizing versatile user centred development methods. This paper presents experiences obtained from the first implementation of Customer Oriented Software Applications theme. Student feedback was gathered with two questionnaires, one in the middle of the theme and other at the end of the theme. Questionnaires had qualitative and quantitative parts. Similar questionnaire was implemented in the first theme; this paper evaluates how the theme-based integrated curriculum has progressed in Health Technology major by comparing results between theme 1 and 2. In general, students were satisfied for the implementation, timing and synchronization of the courses, and the amount of work. However there is still room for development. Student feedback and teachers' observations have been and will be used to develop the content and operating principles of the themes and whole curriculum.

***Keywords*—**Engineering education, integrated and theme-based curriculum, learning experience, student centred learning.

I. Introduction

THE working life is changing rapidly. Pace is getting faster, work tasks and projects are changing often, new digital platforms enable novel ways of work. These new needs have to be taken into consideration in engineering education curriculum design and implementation.

Organization of work and working time into simultaneous projects creates multi-level learning networks. Working teams are changing dynamically and therefore the role of transferrable skills, such as co-operative learning has become increasingly important [1].

Future learning environment should enable questioning, testing, applying and carrying out new ideas in ubiquitous environment; the role of a teacher should be an enabler and sparring partner offering tools for learning [1].

Student centred learning is one answer to respond for working life needs. In student centred learning, students need to be active learners already in school, students need to take responsibility for their own learning to be able to be successful in their later career [2]. The role of a teacher is not just transmitting knowledge, but rather activates participants to learn transferable skills such as problem-solving, critical thinking and reflective thinking [3].

Projects are good tools for implementing student centred learning. Project topics from industry have been shown to inspire and motivate students and to enhance their analytical problem solving skills [4]. Projects give students opportunities to build 21st century skills such as collaboration, communication, critical thinking, and the use of technology [5].

In student centred learning, theme-based or integrated curriculum is a valuable tool to combine different subjects, courses and projects into larger units that enable wider perspective and more profound depth to the selected theme. This helps students to understand practical real-world issues related to the selected themes better.

In MUAS' Health Technology engineering education, student centred learning and matching working life needs are the primary curriculum design parameters. Continuous curriculum development is also based on monitoring the learning experience. This paper presents a case example where student feedback is gathered for curriculum development and curriculum implementation purposes.

II. Health Technology Curriculum

MUAS is the largest University of Applied Sciences in Finland. MUAS has around 16.700 students and 1.000 staff members. About half of the students are engineering students. MUAS ICT Degree Programme provides full-time Bachelor-level undergraduate studies for 1000 students at two campuses. It takes four years to complete the studies including 240 ECTS (European Credit Transfer System) credits.

There were significant curriculum changes in ICT Degree Programme in 2014. In the new curriculum all ICT students have common first year studies (60 ECTS). These are

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implemented as four consecutive 15 ECTS integrated modules (Objects, Devices, Networks and Games). Curriculum development including first year studies and experiences are presented in [6].

By the end of the first year, the students can choose and apply for their Major. Major options are: Communication Networks and Applications, Game Applications, Health Technology, Media Technology, Mobile Solutions, Smart Systems, and Software Engineering. This paper focuses on Health Technology.

Health Technology major has a wide curriculum where the focus is on technology, usability and business. The new integrated theme-based curriculum is built around three 30 ECTS thematic parts. These are Physiological Measurement Technology (theme 1), Customer Oriented Software Applications (theme 2), and Health Technology Devices and Solutions (theme 3).

Health Technology major curriculum can be seen as thematic learning approach, where the selected three themes focus their content. The themes last for the semester, although individual courses are implemented in 8 week periods. Same operating principles are applied for consistent learning experience. Weekly timetable includes slots for lectures, practical assignments, independent and guided group work or projects. Students work mainly in small groups. The key is that students work actively, take responsibility of their own learning and are also active towards outside world such as health technology companies. Teachers have ICT, business, social care and healthcare background bringing different point of views for the students. Detailed planning and weekly meetings enable synchronization between different courses inside the themes.

Table I presents the structure and content of Health Technology Major. Each Block is one period (8 weeks) in length and 15 ECTS in size. Each theme includes two one period modules and each theme module includes three 5 ECTS courses. Theme 1 was implemented first time in autumn 2015, theme 2 in spring 2016 and theme 3 in autumn 2016.

TABLE I
STRUCTURE AND CONTENT OF HEALTH TECHNOLOGY

	1st period	2nd period	3rd period	4th period
1st year	Objects Module	Devices Module	Games Module	Networks Module
2nd year	**Theme 1**: Physiological Measurement Technology I	**Theme 1**: Physiological Measurement Technology II	**Theme 2**: Customer Oriented Software Applications I	**Theme 2**: Customer Oriented Software Applications II
3rd year	**Theme 3**: Health Technology Devices and Solutions I	**Theme 3**: Health Technology Devices and Solutions II	Elective ICT/Health Technology studies	Elective ICT/Health Technology studies
4th year	Innovation Studies	Work Placement	Work Placement	Thesis

Health Technology major curriculum development and implementation, and results from the first implementation of the theme 1 are thoroughly presented in [7]. Furthermore, credit points (ECTS) obtained by the students in Health Technology major is analyzed and compared to old curriculum in [8].

This paper focuses on the theme Customer Oriented Software Applications and student feedback gathered from the first implementation.

III. CUSTOMER ORIENTED SOFTWARE APPLICATIONS

Customer Oriented Software Applications theme is introduced in the Health Technology major curriculum as follows: "*Health ICT solutions have diverse utilization opportunities. Spectrum of technological solutions varies between consumer products to extensive social and health care systems. Understanding special characteristics of application environment is essential, when applying and utilizing health ICT solutions. One must be familiar with actors, operating principles and environment, and customers. Customer can be, for example, municipality, private service provider or consumer. Customer and his or her role in value chain defines the foundation to customer oriented product development. When developing products, it is utmost important to take customer tightly into product development or technology utilization project. This is crucial to enable maximal usability and benefit of health ICT solutions to the customer.*" [9]

The learning goals of this theme are as follows. Student knows main health related ICT solutions and systems, and understands technology sales and marketing principles. Student recognizes social and healthcare operating principles and services, and identifies customers and users and their special needs and perspectives. Student understands Web application fundamentals, and builds Web service and client browser application. Student applies user study principles and usability study methods, and utilizes user information in product and service development. Student applies team and project work skills, applies the knowledge and skills learned in this study module in the project work focusing on health related ICT solutions. Student knows project management and financial perspectives and different instruments related to project funding.

Customer Oriented Software Applications theme include following six 5 ECTS courses. Courses and their main content are presented below.

A. Customer Oriented Software Applications I (1st Period)

eHealth Business and Solutions (5 ECTS)

- eHealth ecosystem and business environment
- ICT systems, software and products
- Significance of information in health ICT
- User oriented development
- Sales and marketing of product and services

Customers and Users of eHealth Services (5 ECTS)

- Social and healthcare actors, operating principles and services
- Roles of customer and user
- ICT solutions' customers and users and their special needs
- Customer in product development

- User perspective to technology

Web Application Development 1 (5 ECTS)

- Basic concepts of databases and database management
- Design and creation database structure, and manage content using SQL
- Design and development of a simple Web service
- Database and web service connections
- Development of a database admin application

B. Customer Oriented Software Applications II (2nd Period)

Web Application Development 2 (5 ECTS)

- Basic concepts and technologies related to browser client
- Design and development of simple browser client using HTML5/CSS/JavaScript
- Design and development of interface between web service and browser client
- Applicability of usability and user interface design principles to browser client development

User Oriented Development and User Study (5 ECTS)

- User information in product and service development
- Methods for gathering and modelling user information
- Service design
- Usability and usability evaluation
- Human factors in product and service development

Health Technology Project 2 (5 ECTS)

- Practice-oriented project
- Health ICT solutions
- Project leadership and management
- Project financial management
- Project funding

IV. Data Gathering Methods

To enable continuous development, it is important to gather feedback. Customer Oriented Software Applications theme was implemented first time in January-May 2016. This section presents the survey used to gather student feedback. Feedback was gathered at the halfway and at the end of the theme. Similar survey will also be executed after each period/module in the future. Obviously this survey is only one of our methods to collect feedback. Feedback is also gathered during the courses, tutor discussions etc. Survey includes qualitative and quantitative parts, questions are introduced below.

1. Assignments and timing of returns
2. How good timing and synchronization was in this period
3. How different courses supported each other
4. Amount of work: a) could have been more, b) suitable, c) too much
5. I worked: a) <30 hours, b) 30-40 hours, c) 40-50 hours, d) > 50 hours per week
6. What was good in this period?
7. What should be developed in this period?

V. Feedback from the Implementation

This section presents the results from the student feedback survey gathered from the theme 1. Results are divided into workload (amount of work and working hours), what was good and what should be developed. The structure is similar to earlier study [7] to enable comparison.

A. Workload (Questions 4 and 5)

Fig. 1 presents answers to survey question 4 related to amount of work (Period 1). It can be seen that 92.2% (29.5 out of 32, note that some of the students selected two options: a/b or b/c) of the students estimated that the amount of work was suitable (option b), 4.7% (N=1.5) of the students answered that there could have been more work (option a), and 3.0% (1 student) of the students thought that there was too much work (option c).

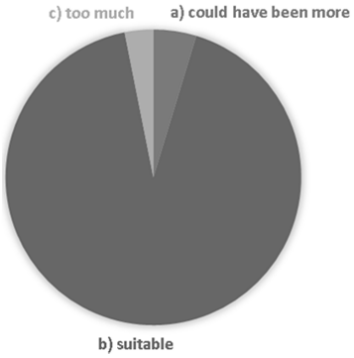

Fig. 1 Amount of work period 1

Fig. 2 presents answers to survey question 4 related to amount of work (Period 2). It can be seen that 91.1% (25.5 out of 28) of the students found the amount of work suitable (option b), 3.6% (1 student) of the students thought that there could have been more work (option a), and 5.4% (1.5 students) of the students answered that there was too much work (option c).

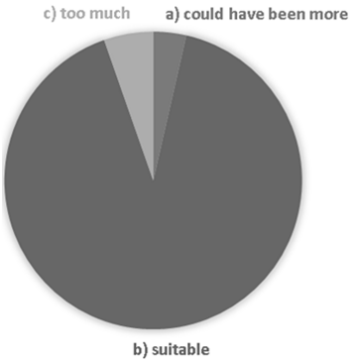

Fig. 2 Amount of work period 2

Fig. 3 presents answers to survey question 5, how much students worked on weekly basis (Period 1). The amount of used hours is based on student self-estimation. It can be seen that 64.1% (20.5 out of 32) of the students worked 30 to 40 hours (option b), 9.4% (3 students) of the students worked under 30 hours (option a), 21.9% (7 students) of the students worked over 40 hours (option c) per week, and 4.7% (1,5 students) worked over 50 hours (option d) per week.

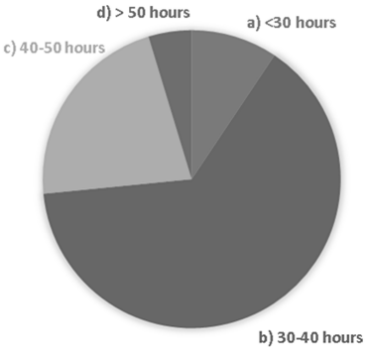

Fig. 3 Working hours per week period 1

Fig. 4 presents answers to survey question 5, how much students worked on weekly basis (Period 2). It can be seen that 57.1% (16 out of 28 students) of the students worked 30 to 40 hours (option b), 12.5% (3.5 students) of the students worked under 30 hours (option a), 28.6% (8 students) of the students worked 40-50 hours (option c) and 1.8% (0.5 students) of the students worked over 50 hours per week (option d).

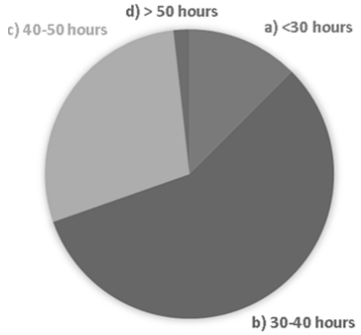

Fig. 4 Working hours per week period 2

B. What Was Good (Questions 1, 2, 3 and 6)

In the first period, practically all the students were satisfied with the timing of the period and the assignment returns. Most of the students were satisfied how different courses supported each other. Students were satisfied with the content and implementation. Web programming course was highlighted in the feedback; they appreciated the practicality of this course. Students made a web application to social or healthcare sector. In this work they used background information gained from the other courses.

In the second period, students were satisfied for timing of the assignment returns. In the second period students were focusing on web application and usability studies related to this. The Web Application Development 2 project topics and working time were allowed to extend into Health Technology Project 2 to allow the learning experience to grow into larger scope, whenever possible. They students especially pleased to integration of different courses and how they supported each other.

C. What Should Be Developed (Questions 1, 2, 3 and 7)

In the first period, there were a couple of comments that the assignments should be clearer. Some overlapping of introductory parts was commented. They were a result of first time implementation of the module with four members of staff. Also, there were single comments that mixing the groups should be fair, timing should be clear from the beginning of the course, more technology should be included, materials should be better, and there were too many reports written.

In the second period students gave feedback on one specific part of the theme. The first issue reflected the challenge of integrating methodological studies into the already multi-disciplinary module, more specifically quantitative analysis. The intended purpose of the module, tool selection and applicability of statistical analysis on the exiting samples of data were questioned. This part was suggested to be relocated to another place of the curriculum for the following implementations. This has now been implemented.

VI. Analysis and Comparison

This section analyses the feedback obtained from the students. Also, comparisons to theme one [7] are made.

A. Amount of Work

Feedback about experienced workload during period 1 indicated that 92.2% of students estimated the load as suitable, continued during period 2 still as 91.1%. In comparison, the results in the first theme (Autumn 2015) were 85.7% and 87.5%. The themes were different but the students were same.

It can be concluded that the students were very satisfied of the amount of work. This was already in good level earlier. On the other hand, there might be still room for additional work.

B. Working Hours

In the period one, 90.6% of the students estimated that they worked over 30 hours per week, and 26.6% worked over 40 hours per week respectively. In the second period 87.5% worked over 30 hours on weekly basis, and 30.4% worked over 40 hours per week.

In the first period of the first theme (Autumn 2015) 75% of the students estimated that they worked over 30 hours per week, and 10.4% worked over 40 hours per week. In the second period of the first theme, 79% of the students self-estimated that they worked over 30 hours on weekly basis, and 26.5% worked over 40 hours per week.

It can be concluded based on the studies that students were working more in the second theme. Still students were more satisfied with the amount of work which is an encouraging sign. Both thematic semesters include an integrative (capstone) project in the second period. Higher level of working hours during both second periods compared to first periods indicate growing motivation to project completion with meaningful results. Therefore, we consider this structure effective and allowing flexible extension of the learning experience even with a number of different real-life project topics.

C. Lessons Learned

When comparing results between themes 1 and 2, students

were satisfied for timing of the assignment returns and they are still willing to do practical assignments and research. Also versatility of the content was appreciated in both themes. They appreciate integration of the courses and understand the value of integrated theme-based curriculum.

In the first theme (Autumn 2015) students gave feedback that the group sizes of four and five were too large. In the second theme, groups' size was limited to three and there were no complaints in this issue in second theme. In the first theme, students hoped for more materials from the teachers and more practical examples about subjects discussed. There was no major feedback related to this in the second theme.

In the second theme, there was a minor curriculum change made where a part of the theme was relocated to another place in the curriculum. According to the students, there were too much overlapping between some courses in theme 2; this was fixed during development workshops before the second implementation in spring 2017.

When comparing results between themes 1 and 2, still the assignments should be clearer, this has been taken into consideration in following implementations.

VII. Conclusions

Dramatic curriculum change is a possibility to make significant adjustments to curriculum. A new Health Technology curriculum implementation was practically started in autumn 2015. Changes were made to content and first of all to the way of implementing the curriculum.

When looking and comparing the first implementations of themes 1 and 2, it can be seen that students were satisfied for the implementations. More results can be gathered and analysed after there has been several implementations of each theme with different students. Systematic feedback collection helps to prioritize the development work. One major target is to integrate theory and practical assignments even better in future implementations.

The goal is to continuously develop the Health Technology curriculum content and implementation based on the industry, student and teacher feedback. Results from the first group indicate that students are willing to take a role as an active learner that is basis for student centred learning and our curriculum. So we believe that we are on the right track.

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