INTRODUCTION TO NEXT-GENERATION ENGINEERING: BEING HUMAN IN THE INFORMATION SOCIETY

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ABSTRACT

While adopting Information Technology (IT) may have been a goal in itself in the past, during the last decade the emphasis has shifted, and IT has instead become a tool that enables us to realize other needs. This also sets new requirements for IT education: skills in software engineering and computer science alone do not provide students with the professional abilities they will need after graduation. To answer this call, the University of Jyväskylä launched in autumn 2021 a new engineering B.Sc. and M.Sc. degree program in Information and Software Engineering with close ties to the Humanities. The degree program was established on three cornerstones: 1) the ability to implement IT systems, 2) comprehension of the expectations and needs set on technology, and 3) mathematical-logical reasoning. As an introduction to the multidisciplinary studies, the students take a course called Being Human in the Information Society at the very beginning of their B.Sc. studies. This course aims at providing an understanding of the multidisciplinary context in which technology will be developed and applied when addressing the complex challenges of the future. In this paper, we will present the planning process of the new course, and describe the intended learning outcomes, contents, and learning methods of the course. In addition, faculty experiences and student feedback of the first implementation are discussed and reflected upon.

KEYWORDS

Information Technology, Humanities, Social Sciences, Multidisciplinarity,
CDIO Standards: 1, 2, 4

INTRODUCTION

The future roles of engineering professionals are changing with societal and technological development. To be able to respond to the future challenges, the traditional 20th century 'how-to-do it' approach should be moving towards 'what-to-do' and 'why-to-do' engineering functions, addressing the needs of the digital, global, diverse, and rapidly changing society (Kamp, 2019; Sorby, Fortenberry & Bertoline, 2021). Accordingly, while adopting Information Technology (IT) may have been a goal in itself in the past, during the last decade the emphasis has shifted, and IT has instead become a tool that enables us to realize other needs. This also sets new

requirements for IT education: skills in software engineering and computer science alone do not provide students with the professional abilities they will need after graduation.

It is widely recognized that graduate engineers need to understand the interaction between users, systems, and machines, and to be able to envision in multidisciplinary teams how novel solutions will outperform existing solutions. In addition, the future society calls for technology that can be widely applied and adapted to its fundamental needs. Bucciarelli & Drew (2015), Lantada (2020), Kamp (2021), and others discuss the importance of human literacy as an engineering competence. Engineering studies need to become more socially relevant, including topics in Ethics, Humanities, and Social Sciences. Empathy, communication skills, agency, and emotional intelligence should be guiding engineering graduates when solving complex societal problems together with experts of other fields.

To answer this call, the University of Jyväskylä launched in autumn 2021 a new engineering B.Sc. and M.Sc. degree program in Information and Software Engineering with close ties to the Humanities. To establish a broader view on technology, all students in the program choose their minor from a wide spectrum of other studies, such as education, psychology, communication, sports sciences, arts and humanities, and business & economy. The multidisciplinary research of the university as well as its Humboldtian tradition originating from the first Finnish-speaking Teacher Training College founded in 1863 sets a solid foundation for the chosen educational approach.

As an introduction to the multidisciplinary studies, the students take a course called Being Human in the Information Society at the very beginning of their B.Sc. studies. The course aims at providing an understanding of the multidisciplinary context in which technology will be developed and applied when addressing the complex challenges of the society of the future. This course alone does not cover all the aspects of the Introduction to Engineering course outlined by the CDIO Standard #4 (CDIO Initiative, 2021; Malmqvist et. al, 2019). Yet, it aims to stimulate students' interest in, and strengthen their motivation for, the field of engineering by offering insights into the impact of digitalization in human interaction and involvement, as well as the long-term individual, societal, and cultural effects of technological innovations.

In this paper, we will present the multidisciplinary planning process of the new course, and describe the intended learning outcomes, contents, and learning methods of the course. In addition, faculty experiences and student feedback of the first implementation are discussed and reflected upon. Based on our findings, it seems that while the concepts discussed on the course were unfamiliar to the students at the beginning, they were able to quickly grasp their importance for both the developers and users of technology. In their final assignment, the students were also able to critically evaluate the multifaceted and evolving impact of technology on society.

PLANNING THE COURSE

The Information and Software Engineering education at the University of Jyväskylä was established on three cornerstones: 1) the ability to implement IT systems, 2) comprehension of the expectations and needs set on technology, and 3) mathematical-logical reasoning. An essential element in reaching these goals is that the students gain an understanding of the fundamental principles and functions of the information society. To make this happen, they must be exposed to the multidisciplinary context in which technology will be developed and applied.

Many initiatives in introducing multidisciplinary elements to engineering studies include different project-based activities. For example, MIT (U.S.) initiated an interdepartmental project-centric academic program in 2016 (Crawley, Hosoi & Mitra, 2018). Enelund and Henricson Briggs (2020) discuss the Tracks initiative that creates pathways between degree programs by offering project-centered learning supplemented with short courses, online learning, self-study, and mentoring at Chalmers University of Technology (Sweden). The curriculum of the Information and Software Engineering degree program at the University of Jyväskylä also includes several phases during which the students work in multidisciplinary teams addressing different assignments and projects. However, it was considered important that the students also get an orientation to the Humanities at the very beginning of their studies and the development of their professional identities both as individuals and as a group of engineering students.

Designing the goals and learning outcomes of the Being Human in the Information Society course was a multidisciplinary, creative process, where participants from the different departments of the Faculty of Humanities and Social Sciences approached the topic from their own perspectives. The faculty has four departments with undergraduate degree programs, and representatives from each department took part in the planning process:

- Department of History and Ethnology
- Department of Language and Communication Studies
- Department of Music, Art and Culture Studies
- Department of Social Sciences and Philosophy

The aim was to ensure that each department would contribute in a way that would enable the students to catch a glimpse of the essence of the discipline, while also adhering to the common theme of the course. In the process of developing the course content, each department formulated a brief description of how their specific discipline approaches different aspects of technology. For example, the Department of Social Sciences and Philosophy wished to bring in the theme of digital life and approach it through age and aging, life trajectories, and intergenerational relations, as well as consumption and well-being. The common thread in their theme was the equal distribution of the benefits and challenges of digitalization. The different descriptions were then discussed together to fill in gaps and avoid overlaps. In the end, five learning outcomes were formulated. These were related to understanding the role of arts, culture, and communication in technological environments and their development over time, as well as the ability to critically examine the effects of digitalization in people's activities and possibilities of participation in society. The course contents and intended learning outcomes are presented in Appendix 1.

COURSE IMPLEMENTATION

The course took place in the first period of the autumn term; the idea was to expose the first-year engineering students to topics in the Humanities from the beginning of their studies. There were two class meetings each week – on Thursday afternoon and Friday morning – and each week was devoted to a different topic. This made the course rather intensive. The course ran for seven weeks and had the following overall contents:

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Week 1: Orientation and practicalities; social justice and cognitive accessibility
Week 2: Designing inclusive digital services; digitalization of consumption and lifestyles
Week 3: Technology-mediated interaction
Week 4: Music, art, and technology; digital culture and digital art
Week 5: The history of communications and technology
Week 6: Social anthropology of technology; digital ethnography
Week 7: Wrap-up and feedback; learning diary workshop

For each topic, there was a visiting expert lecturer from the relevant department. There was also a coordinating lecturer present in all class sessions, who took care of the online participants (Zoom) and assisted with lecture hall equipment, such as wireless microphones: the course was carried out in full hybrid mode, meaning that the students could decide whether they wanted to join in person or online via Zoom. All classroom activities were designed so that they could be done in class as well as remotely: we used, for example, breakout rooms on Zoom for group assignments. In addition, we used digital collaborative tools, such as Flinga, to collect the results of group assignments in class. To make full use of the hybrid setup, we also recorded each class to enable asynchronous participation. Each classroom meeting contained a lecture part as well as an activity or multiple activities on the topic. The activities were not recorded for later viewing.

The online learning environment Moodle was the digital backbone of the course: the Moodle workspace contained the course schedule, assignments, lecture recordings, background materials, a discussion area, and assignment return boxes. To pass the course, the students needed to actively participate in classroom activities, write a short essay on each week's topic, and produce a learning diary as the final assignment. The essays were graded pass/fail and the course grade (1-5) was given based on the final assignment. The final assignment instructions contained a set of questions for the students to guide their analysis of the course contents. The grading was based on the level of critical reflection, application of course contents, logical argumentation, and use of examples. For example, for a grade 3, the students had to show they had mainly understood the course contents, were able to critically evaluate at least some of the contents, and were able to connect the contents to the outside world using relevant examples.

Out of the 30 people who had enrolled on the course, 27 completed it. Out of the 27 students who completed the course, 24 gave consent for their learning diary to be used as data for this paper. We randomly selected 10 learning diaries to be analyzed. The diaries were anonymized prior to the analysis.

STUDENT AND FACULTY EXPERIENCES

To investigate the experiences of the students on the course, we used thematic analysis (Braun & Clarke, 2012) to analyze the learning diaries the participants turned in as part of their coursework. This method allowed us to systematically search for, interpret, and organize the threads of meaning we found in the diaries and use them to form broader themes. Our approach was mainly inductive and data-driven: we searched for the themes from the data rather than from a particular theoretical premise (Braun & Clarke, 2012, p. 58). Our aim was to discover how the students responded to and reflected on the course contents and whether

they were able to connect the contents to their other studies and their everyday experiences as members of the information society, and whether there were any indications of change in their thinking.

We used Braun and Clarke's (2012) six-step model to conduct the analysis. According to Braun and Clarke, the steps of thematic analysis are: 1) exploring the data, 2) coding the data, i.e., marking points of interest, 3) searching for broader themes, 4) evaluating and making a final selection of themes, 5) defining and naming themes, and 6) writing the research report. We carried out steps 1-3 individually and 4-6 collectively. The examples from the learning diaries presented below have been translated from Finnish into English by the first author.

In our analysis, we found two main themes: 1) new perspectives into the digitalization of our society and 2) software development as the enabler of accessible and equitable society.

As to the first theme, many of the students mentioned that the course provided them with new insights into digitalization, their own backgrounds as users of technology, and the multifaceted impact of technology on society:

> **Excerpt 1**: Frankly, I was surprised at the number of different perspectives you can examine technology and its development from. For example, I hadn't previously considered that technology could impact culture, or that you could compose music using artificial intelligence.

Excerpt 1 shows that the course provided students with new or newly discovered old approaches to technology. Music is certainly familiar to all, but the course was able to open students' eyes to novel possibilities to connect technology and music.

Accessibility was a theme that many students brough up in their diaries. It was apparently something that many had not previously explicitly connected to technology. Excerpt 2 illustrates these views:

> **Excerpt 2**: I didn't think earlier that access to digital tools offered by public services could play such an important role in the equal treatment of citizens. It may be difficult to for a handicapped person, for example, to get information of public matters and social services concerning themselves. This problem could be mended with good planning and testing. This way one could ease the burden of public service personnel with matters that could be handled independently.

Excerpt 2 shows that the student had realized how certain groups may be marginalized in society when they do not have proper access to public services. The student also sees technology as one solution to the problem, as better planning and testing could save resources.

In the following excerpt, the student connects accessibility to broader issues of democracy and human rights, which shows how deeply some students reflected on the contents of the course:

> **Excerpt 3**: I was surprised to learn who much the accessibility of, for example, internet services affects democracy and human rights.

The students also recognized the importance of looking at the world through a wider lens, connecting technology and societal issues, and were able to position themselves within this wider framework in the future:

> **Excerpt 4**: The course brilliantly presented the side of things that is outside of working with computers. The reason why we learn to write code in the first place, or why new innovations

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make the world a better place. The course gave me new, very interesting perspectives on real-world situations and things to reflect on in my own behavior.

The second theme that we discovered in the data was related to the role of software developers in making society more accessible and equitable. Although the students had only just started their studies, they were very aware of their responsibilities as future technology developers and saw the need to take all types of users into consideration when developing software products:

> **Excerpt 5**: I felt that digital inclusion, digitalization, and developing digital services were particularly important topics, because as future engineers, programmers, and web designers we need to understand the impact of digital technologies on society and be able to look at the digital products we develop from the viewpoint of regular people and consumers.

In the student as well as faculty feedback – which will be discussed next – one of the improvement suggestions was that the different topics on the course could have a clearer connecting theme. Nevertheless, the overall human perspective on technology seemed to come across clearly for the participants, as the following two excerpts show:

> **Excerpt 6**: This course taught me, above all, the importance of empathy, sympathy, and tolerance in the development of technology as well as the logic behind the development.
> **Excerpt 7**: The whole course of Being Human in the Information Society was a very eye-opening course.

To collect faculty feedback, we arranged two meetings with the faculty members that had taken part in the planning and carrying out the course. In the meetings, we discussed our work process and the teachers' experiences in planning and teaching the course. We also collected any suggestions for developing the course further. In general, developing the course had been a positive experience and each of the participants was willing to participate in the future, too. The participants felt that the hybrid system, with a coordinating teacher as a teaching assistant, worked well and that the amount of work associated with the course was feasible. Our aim is to develop the course iteratively, based on our own experiences as well as student feedback, and the improvement suggestions we collected after the first implementation include the following:

- A clearer common theme between the different topics on the course; for example, technological determinism or technological stratification
- Diversity in the weekly assignments – now, they were all short essays based on background reading
- Clearer picture of the other courses and activities taking place simultaneously for the first-year students, to increase cohesion.

In the spring term of 2022, we will arrange workshops to respond to these improvement suggestions and develop the course further.

CONCLUSIONS

Multidisciplinarity is a much-discussed topic, and its importance is widely acknowledged. It requires some effort – all participants must step out of their comfort zone – but it is necessary

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for the development of an inclusive information society. It is also evident that the society of the future places extensive expectations on technology: it must be widely applicable, accessible, and respond to the needs of the people. With the Being Human in the Information Society course, our aim was to answer this call.

For graduate engineers to develop technology in an efficient and usable direction, they need to understand the way society functions and be aware of the real-life contexts in which technology will be applied. Based on the feedback we received, the themes on the course were thought-provoking and gave the students new perspectives on everyday technology use. The feedback from both students and faculty will also allow us to develop the course further.

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BIOGRAPHICAL INFORMATION

Lauri Kettunen is Professor of Computational Sciences at the University of Jyväskylä, Finland. He is also the Vice Dean responsible for education at the Faculty of Information Technology and has been in charge of the planning and implementation of the new engineering degree program at the university. His scientific research activities have focused on the intersecting field of technology, mathematics, and IT.

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APPENDIX 1 – COURSE DECRIPTION

The course description translated from Finnish to English from the Study Guide (Curricula 2020-2023) of the University of Jyväskylä (available at: https://studyguide.jyu.fi/2021/en/).

Direct link to the original document: https://opinto-opas.jyu.fi/2021/fi/opintojakso/hytp5000/

BEING HUMAN IN THE INFORMATION SOCIETY

Course Level: Basic Studies (B.Sc. in Information and Software Engineering)
Extent: 5 ECTS Credits
Grading Scale: 0 (failed) – 5 (excellent)

Summary

Human activity in the digitalized society from the perspectives of digital service systems, working life, communications, arts, culture, and history.

Learning Outcomes

After completing the course, the student:

- can critically examine the impact of digitalization on human activity and participation in different environments from the perspective of the distribution of well-being
- understands the importance of communication and interaction in changing technological environments
- understands the role of art and culture in identity and community building
- is familiar with the social and cultural implications of technological innovations
- understands long-term changes and continuities and their implications for individuals, communities and societies.

Contents

The course examines human activity in the digitalised society from the perspectives of digital service systems, working life, communication, art and culture, and history.

Digital everyday life is approached from the perspectives of age and ageing, the life cycle and intergenerational relations, consumption, and well-being. A cross-cutting theme is the fair distribution of the benefits and drawbacks of digitalization.

Regarding work life, the focus will be on digital interaction, intercultural communication, and multilingualism, as well as the links between these and organisational practices and, more generally, accessibility, inclusion, and well-being in today's society.

Music, art, and culture are approached as part of time, society, and humanity. Technology will be addressed from a cultural studies perspective, with a particular focus on the social and cultural implications of technological innovation. Games, music, images, and written expression are seen as key environments for learning, information processing, interaction, emotions, and social influence. The focus is on how art and cultural products are used to build identity and community, how art generates well-being, and how digital environments shape creative activity.

To understand today's digitalized society, it is also necessary to look at long-term changes and continuities from a historical perspective. This requires the adoption of a critical approach to historical sources and an analysis of the relationship between the present and the past. The aim is to understand why and how communities and societies have been formed as part of historical, often long-term, temporal processes.

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