

Information Sciences Education for a Digital Society and Sustainability

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Abstract—Sustainability and social responsibility have become hot topics in Informatics, with more enterprises and organizations looking at their and others’ digital technology through this lens. At the Vrije Universiteit Amsterdam, we have experience in education on these perspectives in the Computer Science and Information Sciences Master’s programs, connecting well to our university’s educational principles. Specifically, Information Sciences as an education program and professional discipline is well-suited to approach and assess information technology from a sustainability- and societal perspective. In this paper, we describe how sustainability and digital society are embedded in the curriculum and reflect on our experience by synthesizing five lessons learned. We also present the preliminary design of a Master’s program Information Sciences, which will start in 2020/2021 with a special focus on the *Digital Society and Sustainability*.

Keywords—sustainability, education, information sciences, digital society.

I. INTRODUCTION

Information Sciences (IS) has been one of the three pillars of Informatics education at Vrije Universiteit Amsterdam (VUA) for many years. In addition to the other pillars - Artificial Intelligence and Computer Science - IS education is taught at both bachelor’s and master’s levels. In our perspective, Computer Science primarily teaches students the fine competences of the underlying digital technology and Artificial Intelligence has a more crosscutting approach by introducing students to intelligent and/or social systems. In turn, our IS is a multidisciplinary program that prepares students to fulfill a bridging function between IT and society. It combines knowledge and expertise from computer science, organizational science, information- and knowledge management. Given the pervasive role of ICT in modern society, like Eriksson [1] we believe that “*within CS education, sustainability will become only more important in the coming years*”.

The IS master at VUA is a one-year master of 60 ECTS. This distinguishes it from other Masters in Informatics that are typically two-year Master programs. Specifically, its aim is to enable students to acquire knowledge, skills and insight in the IS field as well

as auxiliary disciplines for professional practice at an academic level, hence preparing them for a possible academic career.

The following describes the building blocks underlying our new IS Master, which will start in 2020/2021 with a special focus on the *Digital Society and Sustainability (DSS)*.

A. Embedding

To date, our IS Master was embedded in the ACM domain-specific framework “Model Curriculum and Guidelines for Graduate Degree Programs in Information Systems” (MIS2006, [2]). This framework describes the increasing need for information-based knowledge and experts, training “*talented people with advanced knowledge for managing information systems*”. It should be noted that both MIS2006 and the VUA embedding to date emphasizes the business context of information systems.

A more generic interpretation is given by, among others, Saracevic [3]: “*[...] Information Sciences is a field of professional practice and scientific inquiry addressing the effective communication of information and information objects, particularly knowledge records, among humans in the context of social, organizational, and individual need for and use of information.*” This interpretation emphasizes the relationship between the management of information (and systems), and the human- and organizational context. This generic interpretation has inspired the revision of our IS program, which will carry less emphasis on business aspects, and bring forward the societal context.

B. Digital Society

Our ambitions also tie in with VSNU¹ Digital Societies program (www.thedigitalsociety.info). The ambition of this program is to give the Netherlands a leading role in “*[...] the creation of effective connections between digital technology and people and their societies*”. This requires investment in research and

¹VSNU is the Association of Universities in the Netherlands.

education, and in the years ahead, Dutch universities will work together towards this common goal.

The focus of the IS Master on the *digital society* also reflects one of the four VUA profile themes strengthening the link between science and society, the *Connected World*.

C. Digital sustainability

Sustainability has become an important global theme, which brought in many education fields new programs, tracks or courses that touch upon it. In Informatics, however, this has resulted in too few concrete programs, among which our CS Master Track in Software Engineering and Green IT² [4] is a notable leader. With this successful experience, we plan to evolve the IS Master in two directions: (i) we extend the focus of sustainability-related competencies and skills from the underlying digital technology (in the CS Master track) to the needs of a digital society; and (ii) we apply the principles of community of learners [5] where students and educators are partners in a cycle of *inquiry learning* consisting of applying the theory, sharing the results, reflecting and learning, and reapplying the lessons learned.

The focus of the IS Master on the *digital sustainability* also reflects one of the four VUA profile themes strengthening the link between science and society, the *Science for Sustainability*.

D. VUA Education Vision

The IS Master will reflect the education vision of the VUA [6] based on three core values³:

Personally engaged - Students are encouraged to take their own responsibility in their education, under the supervision of competent teachers. Organized as a community of learners, students will be able to reflect in peer groups on courses taken during their studies. Coming from various Bachelor's study programs and personal backgrounds, exchanging diverse experiences and reflections with their peers will lead to an enrichment of the overall learning process.

Open - The IS Master will - even more than before - have an interdisciplinary character and stimulate an open relationship with other degree programs and domains within VUA and beyond. In various courses, IS students will experience that (societal) problems can be approached from different angles and that they can make a contribution to a multidisciplinary analysis with their IS expertise.

Responsible - The IS Master connects the university and the society at large. She will focus on concrete IT challenges that emerge from practice, with the active engagement of VUA partners from the private and public sectors. At the same time, the program will pay attention to the social responsibility that VUA alumni bear: sustainability, ethics, privacy will be addressed repeatedly in the various courses, hence triggering critical reflection and awareness of the ethical principles and social values that digital technology plays in modern society.

The IS Master will give substance to the official mission of the VUA: "...to improve the world by educating students to become responsible, critical and committed academics that want to develop themselves continuously."

E. Community Service Learning

In the VUA education vision, special attention is given to Community Service Learning (CSL) [7], through the program "A Broader Mind". This aims to challenge the students to look beyond their own discipline and into societal issues. In other words, "[...] use their knowledge and skills for society and learn from it" [6]. With its focus on digital society and digital sustainability, the new IS Master will naturally realize this vision. Section II will report on courses that already realize the CSL principles.

F. Portfolio

We want to pay specific attention to so-called 'longitudinal mentoring' and 'social learning' of students [8]. To establish this and to increase constructive coherence of the program, students meet in peer groups throughout the year to discuss and reflect, guided by mentors. We introduce a course-transcending portfolio assignment used by students to monitor and reflect on their own learning progress with regard to the learning objectives of the curriculum as a whole and throughout the year.

II. REFLECTION ON CURRENT EXPERIENCE

In redesigning the IS Master, we reflected on the experience gained in the courses we teach for both the CS Master Track in Software Engineering and Green IT (and in particular 'Green Lab' and 'Service Oriented Design') and other DSS-relevant courses ('Software Architecture', 'ICT for Development', 'ICT4D in the Field').

A. Green Lab

The course Green Lab focuses on how to design and carry out successful software engineering experiments to understand and measure the impact of software on

²<https://tinyurl.com/yx6xg7j>

³<https://vu.nl/en/about-vu-amsterdam/mission-and-profile/mission>

energy consumption and other software quality properties. The students work in teams, learn how to operate in a lab environment, and develop their critical thinking skills and Green IT competences.

Lesson #1: The sustainability impact of digital technology can and should be quantified. Quality requirements like performance and security are customary in software engineering and in general ICT. With the increasing digitalization of modern society, the students (aka the next generation of ICT professionals) learn that sustainability impacts like energy consumption must be treated in a similar way, hence defined, linked to their influencing technology, quantified and monitored.

B. Service Oriented Design and Software Architecture

Service Oriented Design and Software Architecture are long-lasting and relatively traditional courses in our Informatics curricula. The first teaches the students how to design complex software solutions according to a service oriented paradigm. The second focuses on architecture design in complex systems, and the techniques for a.o. collaborative design decision making, documentation, quality assessment.

In both courses, the students work in teams to apply the theory into a real-world project proposed each year by a different partner organization from the private or public sector. The students incrementally develop understanding of the pervasive role of software in a digital society, and how software-intensive systems can be designed to achieve sustainability goals [9]. They experience the fact that no solution is optimal in absolute terms, and that trade-offs must be made.

These two courses are so-called *project-based* courses [4] providing traditional Informatics competencies, then put into practice by means of DSS-related projects.

Lesson #2: Digital solutions are the result of compromises. It is well-known that digital technology is the result of trade-offs between functionality, quality and concerns coming from different and often competing stakeholders. By including sustainability into the picture, however, students learn that digital solutions are not neutral, and that there are some values that should not be compromised. They understand the importance of ethics in the profession, the role that IS plays in organizations and digital society, and that digital sustainability can coexist with business goals.

C. ICT for Development

ICT for Development (ICT4D) is an elective course attended by students from various Informatics programs (CS, AI and IS). While other universities offer courses

on ICT4D, these are mostly taught at Sociology or Economics departments and target these types of students. Our course is unique in that it takes a Computer Science approach to the topic and exclusively targets Informatics students. These learn about “Development Informatics”, the importance of social context and user-centered design methodologies, the gap between our highly-digitalized and hyper-connected society, and other realities which are resource-scarce and with different needs (e.g. for sustainable ICT infrastructures) and challenges (e.g. to create User Interfaces for low-literate users). Through a group project, the students gain hands-on experience with real-world ICT4D cases, mostly from a West-African rural context, making this a good example of a CSL course.

Similar to the Green Lab, ICT4D (and ICT4D in the Field) is a so-called *centralized* course [4] providing dedicated specific competencies for DSS.

Lesson #3: Students value societal relevance, learn thinking outside the box. Started out small, ICT4D has since grown into a stable and consistent part of the Informatics curricula, drawing up to 50 students each year. Students showed enthusiasm for real-world cases that force them to re-think some basic assumptions when creating digital solutions. They experience that there is no one-fits-all solution, that user-centric design and appreciation for contextual and cultural issues are of the utmost importance. They learn that operating in resource-scarce environments does not mean that ICT or information sharing needs to be restricted or that it leads to ‘uninteresting’ solutions but that innovative solutions are possible, and impactful.

Lesson #4: Awareness of the own learning progress is especially important in inter-disciplinary programs. Finally, we have experienced that the use of portfolios is a very helpful instrument for the students to reflect on their own learning activities and outcomes. Students come with different backgrounds, skills and reasons for choosing this course, and the course itself approaches ICT4D from multiple angles. The portfolio is one way in which this diversity can be harnessed and consolidated, so that the students reflect on their progress, with respect to both the course and how it relates to the rest of their studies.

D. ICT for Development in the Field

As a follow-up to the ICT4D course, the course ‘ICT4D in the Field’ is an elective that brings ICT4D CSL more directly to the communities [10]. In this course, the students carry out case-based field research in a rural resource-scarce location abroad. The course takes 4 weeks for field research and designing, modeling, engineering, testing and deploying an information system that must serve a local community’s need. In

2018 and 2019, the course was co-organized with a UNIMAS university in Sarawak, Malaysia and involved collaborative projects with local students.

Lesson #5: There is great value in having in-depth follow-up co-creation courses for passionate students in the field of ICT for societal good. The pilot of this course was a big success, with highly motivated students who collaborated with local students, co-creating real-world examples of ICT for Development for local communities. Through the hands-on project, the students also showed deepened understanding of ICT aspects learned in earlier courses.

III. TOWARDS A NEW DESIGN OF THE IS MASTER

In the new design, the main learning objectives of the IS Master remain the same as in previous years. Accordingly, it is a multidisciplinary program that prepares students to act as a bridge between IT and society; it combines knowledge and expertise from the field of CS, organizational science, and information and knowledge management. We also retain the one-year duration (equivalent to 60 ECTS) to position it differently from other existing two-year masters. In this way, we are attracting the students interested to specialize in specific IS competencies without compromising on quality. In our experience, with a clear and compact structure we are able to target the learning objectives of the master in a one-year period.

Differently, our proposed new design adds the focus on *Digital Society and Sustainability*. This thematic choice distinguishes it from other IS Master programs in the Netherlands, which typically are more oriented towards Business Information Systems or Data Science. The proposed focus aims at realizing the aforementioned education vision of the VUA and builds upon the lessons learned as synthesized in Section II.

Figure 1 provides the overview of the new curriculum. This fits the structure of the VUA academic year consisting of six periods of 2-2-1-2-2-1 months, respectively, and where the students follow two 6-ECTS courses in the 2-month periods and one such course in the 1-month period. The redesign of our IS Master is based on the following design principles.

The program will be a one-year Information Sciences Master with a distinctive focus on *Digital Society and Sustainability*. There will be a single track with two separate but connected “learning lines”: *Digital Society* and *Digital Sustainability*. The decision to start from a single track is partly based on increasing the coherence of the program and cohort formation. By applying two clear learning lines, it becomes clear how individual subjects are inter-related, and linked to the broader goals of the study program.

In the (8 weeks-long) Periods 1 and 2, four mandatory core courses will be given along the two learning lines. These courses create a solid shared basis that enables us to formulate a clear outflow profile for the study program and to shape it through the learning lines and courses.

In Periods 4 and 5, in addition to the Master project, a limited number of electives will be available. These courses give the students the opportunity to specialize in one of the topics of the curriculum, to broaden their profile or, for example, to explore entrepreneurship.

In Period 3, students start preparation of their Master project through a course “Research Methods and Thesis Design”, which will introduce students to a variety of IS research methods and develop a concrete research plan for their own Master project. This which can be done either internally within a research group, or externally in the context of a social- or business organization. The remainder of the Master project takes up 18 ECTS during Periods 4, 5 and 6.

Throughout the year, the students maintain a portfolio (cf. *Portfolio DSS* in Figure 1) in which they reflect on the education followed in relation to the principles and practice of the two learning lines. In the portfolio, students identify and analyze information challenges and solutions related to the digital society and digital sustainability. In addition, students form peer groups, in which they meet once per period (6 times in total), to discuss progress. The portfolios are monitored by mentors who can keep track of progress. Ultimately, the portfolio is submitted together with the Master Thesis.

For the interested reader, Table I shows the proposed exit qualifications based on Dublin Descriptors. It is based on the pre-existing exit qualifications, with the addition (in red) of specific elements related to the DSS learning lines.

IV. CONCLUSIONS AND FURTHER WORK

With the ongoing digitalization of society and the growing concerns related to sustainability and climate change, it comes a growing need for professionals and academics able to assess the impact of ICT on society and sustainability and to adapt or design appropriate technologies fulfilling sustainability requirements and societal needs. By building on the experience of our teaching staff in both these domains, this paper illustrated our lessons learned and presented our plans for the Master Information Sciences at the Vrije Universiteit Amsterdam with a special focus on Digital Society and Sustainability. Through this Master program, we expect to imbue the next generation of Information Scientists with the knowledge and know-how to address the 21st Century challenges and build a more sustainable society.

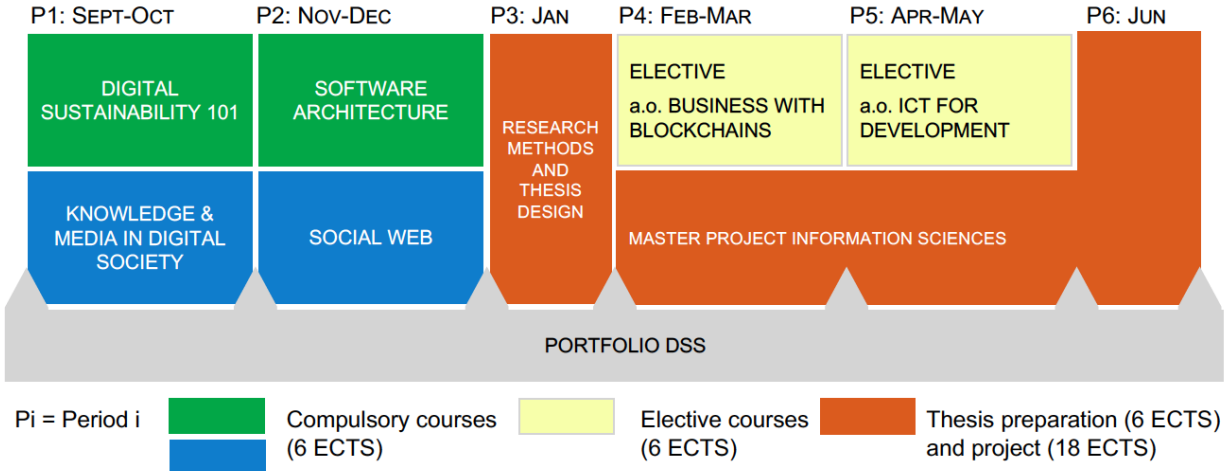


Figure 1: Academic structure of the redesigned IS Master

<p>A. Knowledge and Insight</p> <ul style="list-style-type: none"> - Knowledge and understanding of the latest developments and key themes in the field of Information Science and knowledge of research that is relevant to ongoing efforts to solve problems related to those themes, which include: (1) knowledge management, (2) software services and architecture, and (3) user-centric data science. - Knowledge of the interaction of ICT and various types of sustainability (economic, environmental, etc). - Knowledge of theory and frameworks regarding the impact of ICT on society.
<p>B. Application knowledge and insight</p> <ul style="list-style-type: none"> - The ability to use the acquired knowledge and understanding from the Bachelor's and Master's courses to define a problem and the objective of a research project, and to independently initiate and carry out an advanced research project. - The ability to analyze the sustainability of IT solutions and to identify IT solutions for sustainability challenges. - The ability to analyze the impact of IT design (including web technologies) and architecture on social processes and vice versa.
<p>C. Judgment</p> <ul style="list-style-type: none"> - The ability to give an informed opinion and adopt a critical scientific attitude. - The ability to make (ethical) judgments in the design and analysis of IT solutions with regards to sustainability and social impact.
<p>D. Communication</p> <ul style="list-style-type: none"> - The ability to report, both orally and in writing, on an advanced research project. - The ability to function as a liaison between IT professionals and domain experts in IS related professional environments.
<p>E. Learning skills</p> <ul style="list-style-type: none"> - The ability to discover and use new information in the field of information science and related, relevant area

Table I: Exit qualifications i.t.o. Dublin Descriptors

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