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The Ethical Matrix in Digital Innovation Projects in Higher Education

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Abstract Higher educational institutions incorporate projects into their curricula, in which students, together with educators, researchers and professionals from practice, try to find solutions for real, societal problems, to develop relevant skills. Because such solutions are increasingly digital with high impact on society, ethical responsibility is an important part of these skills. In this study, we analyze two cases of digital innovation projects in higher education in which the concept of the Ethical Matrix is adapted and integrated in a Value Sensitive Design approach and applied by educators (case 1) and by students (case 2). We find that an adapted version of the Ethical Matrix supports educators and students in taking values of different types of stakeholders into account which leads to different design choices.

Keywords: value sensitive design, ethical matrix, digital innovation, projects, higher education.

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1 Introduction

Innovation is at the core of higher education. Researchers and educators prepare students for an uncertain future in which innovative skills are indispensable. An increasing number of higher educational institutions (HEIs) incorporate multi-disciplinary projects into their curricula in which solutions are sought for complex societal problems. During projects like these, students develop necessary skills such as innovation skills, analytical skills and interpersonal skills (Hero & Lindfors, 2019). In professional practice and research, the rise of the field of Digital Ethics signals the increased importance of ethical skills for innovation. In the overarching Framework for Qualifications for the European Higher Education Area (EHEA, 2018), making ethical judgements and professional ethical responsibility are prominent aspects. Approaches and instruments that stimulate and facilitate ethical design have been subject of study, such as Value Sensitive Design (Friedman, Kahn, & Borning, 2006) and the Ethical Matrix (Mepham, 2000; Mepham, Kaiser, Thorstensen, Tomkins, & Millar, 2006).

In this study, we discuss two cases of digital innovation projects in higher education in which the Ethical Matrix was applied as an instrument facilitating ethical reflection by educators (case 1) and by students (case 2). In both cases, the usage of the Ethical Matrix was performed by non-ethicists within a larger Value Sensitive Design approach. We aim to answer the following research question: "How can the Ethical Matrix augment the Value Sensitive Design approach for digital innovation projects in practice-based research?". After giving an overview of the theoretical background of this study, we describe the methodology and the characteristics of the two cases and present the results of our analysis. Finally, we give our conclusions and discussion and give suggestions for future research.

2 Theoretical Background

In this section, we discuss relevant theory on innovation in higher education and practice-based research, and on Value Sensitive Design and the Ethical Matrix.

Societal challenges need practice-based research in order to obtain innovative solutions to these challenges. This type of research is often performed by universities of applied sciences (UAS). The research questions that underly practice-based research emerge from professional practice and research results have impact both on practice and on the scientific knowledge base. The impact of practice-based research can be described in four types of development (Greven & Andriessen, 2019): development of the knowledge (researching), the system (changing), the product (designing), and of the persons (learning) involved. In this study, we focus on the dimensions of product development (through Value Sensitive Design; see Section 2.1) and personal development (of the ethical skills of the participants).

An increasing number of higher educational institutions (HEIs) incorporate multi-disciplinary projects seeking innovative solutions to societal problems into their curricula. To be successful in such projects, a wide range of skills is needed: innovation skills (such as entrepreneurship and creative problem solving), research skills (such as reflective, analytical and critical thinking), interpersonal skills (such as communication and collaboration) (Hero & Lindfors, 2019) and increasingly, ethical skills. HEIs need to facilitate both educators and students in the development of these skills.

2.1 Digital Ethics and VSD

Nowadays, many innovation projects have a digital core. Digital innovation comes with an increased ethical responsibility of those involved in the innovation process, e.g. in the form of awareness of privacy and inclusion aspects of the technological solution space. The use of a technological artefact can both realize and hinder values. VSD is "a theoretically grounded approach to the design of technology that accounts for human values in a principled and comprehensive manner throughout the design process" (Friedman et al., 2006, p. 349). Human value is defined as "what is important to people in their lives, with a focus on ethics and morality" (Friedman & Hendry, 2019, p. 4). VSD goes beyond instrumental aspects such as functionality,

reliability and ease of use, taking into account also moral values of individuals and societies (Flanagan, Howe, & Nissenbaum, 2008). It not only considers the values of direct stakeholders, but also of stakeholders who may indirectly be impacted by the innovation. For example, future generations or individuals who cannot or will not use a service. The values of all stakeholders, as well as potential tensions between them, are iteratively investigated from a conceptual, empirical and technical perspective. At the conceptual level the relevant stakeholders and values are identified and defined, based on existing literature and knowledge. At the empirical level the perception of these values by the various types of stakeholders is studied by employing methods such as interviews, focus groups or experiments, leading to elaboration of the values into norms. At the technical level values and norms are translated into technical design.

2.2 Ethical Matrix

To lower the threshold for non-ethicists to engage in rational ethical evaluation of biotechnological innovations in agriculture and food production, Mepham developed the Ethical Matrix (Mepham, 2000). Since its conception the matrix has been applied, often in an adapted version, in various settings, such as workshops (Mepham, Kaiser, Thorstensen, Tomkins, & Millar, 2006), research teams (Jensen, Forsberg, Gamborg, Millar, & Sandøe, 2011) and individuals (Kermisch & Depaus, 2018) and in various areas, such as fishery (Kaiser, Millar, Thorstensen, & Tomkins, 2007), waste management (Kermisch & Depaus, 2018) and medicine (Chatfield, 2018). The Ethical Matrix aims to provide an ethically neutral evaluation tool for use by non-ethicists to conduct a comprehensive evaluation of a technological innovation, taking the interests of all relevant stakeholders into account, without specialist ethical training (Schroeder & Palmer, 2003).

The original Ethical Matrix is a 3x4 matrix with stakeholder groups on one dimension and ethical principles on the other (Mepham et al., 2006). The default stakeholder groups are producers, consumers, treated organisms and biota. The ethical principles are based on three main ethical streams: well-being (utilitarianism), autonomy (deontology) and fairness (Rawls). This generic Ethical Matrix can be adapted to the specifics of a particular application area. The cells of the matrix contain the impact, negative or positive, of the technological innovation under consideration on each of the stakeholder groups with regard to the ethical principles.

This impact can be described factually, but how it is weighted in the ethical evaluation depends largely on the values of the participants in the discussion. Over the years, adaptations have been suggested. Vinnari, Vinnari & Kupsala (2017) propose giving more voice to non-human stakeholders. Schroeder & Palmer (2003) suggest adding future generations to the list of stakeholders and replacing the principle of justice (fairness) with the principle of solidarity.

To use the Ethical Matrix in a VSD approach, we made some adaptations. The stakeholders in the original matrix are geared towards biotechnical innovation, leading to other stakeholder groups than encountered in the field of education. As for the dimension of ethical principles, we decided to expand this dimension to all values that emerge from the conceptual investigation step in VSD. The original ethical principles, based on three ethical streams and expressed as the values of well-being, autonomy and fairness, is too limited from a VSD perspective (Friedman et al., 2006). Stakeholders may consider other values as (even more) important. The Ethical Matrix's intended use is evaluation of a proposed technological innovation. Integrating the matrix into a VSD approach opens up the opportunity to also use the matrix during design, for instance to consider various design alternatives within an overall design, or even usage, to evaluate whether the implemented innovation does indeed respect the values it was expected to respect. This adds a third dimension to the matrix, i.e. the design alternative it is applied to (see Figure 1).

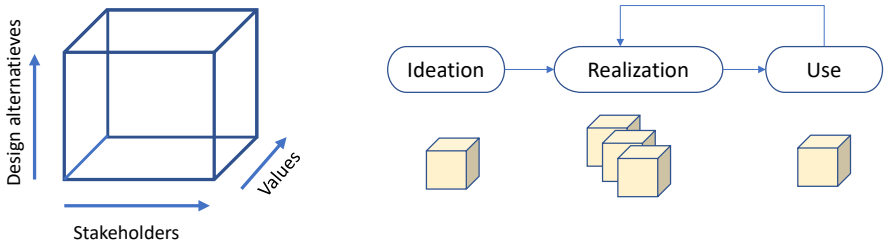

Figure 1: Application of the adapted Ethical Matrix in a VSD approach

The present study shows how our VSD-inspired adaptation of the Ethical Matrix is used by educational professionals (case 1) and students (case 2) in the context of a VSD approach to the design of two apps for students in higher education.

3 Method

For our study, we adopt a qualitative methodology. We analyse two cases (Table 1). We perform the analysis by comparing the two cases on their characteristics along two dimensions: process and product.

Process. We analyze in what way the Ethical Matrix was used in each of the cases in the innovation project: what was the goal of its use and in what way the results of using the matrix have been applied in the innovation process. Furthermore, we analyze who were the users of the Ethical Matrix, what were the instructions and guidance given to them, and how did they evaluate their usage.

Product. Based on the dimensions Product development and Person development of the PRIME-framework (Greven & Andriessen, 2019, we analyze the impact of the usage of the Ethical Matrix. First, we describe the actual data entered in the Ethical Matrix by the participants. Next, we discuss in what way the Ethical Matrix influenced the final products and deliverables of the project. Finally, we touch upon the personal development of the involved users of the Ethical Matrix. In the next two sections, we describe the professional and educational context of the two cases in more detail.

Table 1: Characteristics of the two analyzed cases.

Case	Participants	Role	Domain	Innovation Result
1	4	Educators	Health	Health Check App
2	5	Students	Education	Internship App

3.1 Case 1: Health Check App

HU Clinics, which is part of the HU University of Applied Sciences Utrecht, is a learning environment for allied health students. Under supervision, students deliver care to citizens in the areas of dental care, skin therapy, eye care and speech and language therapy. To create more awareness of 'public health' and prevention (for both citizens and students), an initiative was started to perform Preventive Health Checks in the neighborhood. This entails the presence for a day of students and educators of HU Clinics in a library or neighborhood center where passersby can have a preventive health check performed, without charge and without appointment. After being asked a short list of questions about their basic health and functioning in daily life, citizens can have tests performed from one or more of the disciplines mentioned above. Based on the outcomes the citizen receives an advice, for instance about healthier eating habits, dental care or to go visit an optician. Advices are preventive, the students do not perform a medical diagnosis. To support students in their task of performing the Health Check, the idea arose to develop an assisting app. Besides supporting students in their task, the Health Check App also aims to enable students and educators to work multidisciplinary. It should support all steps in the process, from intake questions, to routing to the relevant disciplines, to performing tests and finally, providing an integrated advice.

3.2 Case 2: Online Internship Coaching

Many HEIs have integrated workplace learning (e.g. internships) into their curricula. The rationale is that graduates with prior work experience are generally considered to have a higher 'employability' (Andrews & Higson, 2008), because they have practiced job-specific functions, such as socialization, innovation and job performance (Nijhof, Nieuwenhuis, & (Eds.), 2008). Learning in the workplace is mostly implicit and unconscious in nature and leads to tacit knowledge (Eraut, 2000). Only few studies aim to design, develop and evaluate technologies that specifically support workplace learning (Siadaty et al., 2012). Recently, a web application was developed to support such learning processes (van der Stappen & Zitter, 2017). This open-source web application provides students with an interface to register their working and learning activities in the workplace in an easy-to-use way, which in turn allows for analytics (a dashboard with charts) and automated feedback, thus giving them insight into their learning process.

To support the internship coaching process performed by higher education professionals, it was decided to add new functionality to this application aimed at partly digitizing the internship coaching process. The new functionality that was developed in this case project, targeted both students learning in the workplace and their coaching educators.

4 Results

In this section, we present the findings of the analysis of the two cases.

4.1 Case 1: Health Check App

The design of the Health Check App was undertaken by four educators involved in the Health Check, during a series of workshops. The workshops were moderated by a research team led by one of the authors. The creation of the ethical matrix, i.e. the identification of relevant values and stakeholders was done in two steps. First, from the literature on preventive health, the research team identified five relevant values: Privacy, Transparency, Trust, Distributive Justice, Informed Consent and Health. This is the conceptual perspective in VSD. Next a philosophical dialogue was held between the four educators, to further elaborate on these values in the context of the Health Check (empirical perspective). Dividing the participants in pairs, each participant was questioned by a moderator about their understanding of and personal norms regarding each of the values. The other participants made notes on post-its, which were clustered per value and discussed by all participants together. In this way a shared meaning was generated. Five additional values emerged from the discussion: Helpfulness, Responsibility, Sustainability, Autonomy and Security. The stakeholders identified by the participants were Students, Educators, Citizens, the Municipality and Employers (the latter three are indirect stakeholders). The resulting matrix was used throughout the design process of the Health Check App.

After a brainstorming workshop, the educators were presented with an overall mockup of the app in a next workshop. Discussing the mockup, they identified potential impacts on the values of the stakeholders, which they wrote down in the cells of the matrix. From this exercise it emerged that the way the advice to the citizen was generated, either automatically by the app or manually by the student, or a combination of the two, would have considerable impact on the values

transparency, autonomy, responsibility and security. The research team designed four alternative mockups for generating advice, varying from the advice being drafted completely by the student to the advice being generated completely by the app. During a following workshop the participants completed an ethical matrix for each of these alternatives, writing down in the cells the impact each alternative would have on the values of the stakeholders.

	Transparancy	**Responsibility**	**Security**	**Autonomy**
Citizen	Orginin of advice is not		May cause sence of insecurity when student heistate a lot a about advice	
Student		High responsibility for student they may not yet be ready for that	May couse sence of insecurtity abaut the soindness of their advice	Much autonomy for students, who formualte advice entirely by thmselves
Lecturer	Process towards advice is not cleat	Requires close monitoring for student	May couse sence of insecurity abaut whether all advices will be sounf	

Figure 2: Part of the Ethical Matrix of one of the design alternatives.

Figure 2 illustrates part of the matrix for the design alternative in which the advice is generated entirely by the student (we only show part of the matrix for brevity reasons). Some cells in the matrix are empty because not every value is impacted for every stakeholder. Comparison of the four matrices showed that a combination between design alternatives 2 and 3, with the app first suggesting relevant pieces of advice, followed by showing other potentially valid advices, represented the best balance between values. As this was the first time the educators worked with the Ethical Matrix, we asked them how they experienced its use, in an informal evaluation. They indicated that working with the matrix enriched their discussions, not only about the app, but also in other work contexts.

4.2 Case 2: Online Internship Coaching

Case 2 was executed by five third-year IT Bachelor students under supervision of one of the authors. Weekly progress meetings were held in which they received feedback on their process and products. The students were instructed to use a VSD approach to develop the new technology and use the Ethical Matrix to obtain a well-thought-out design of the new functionality. The general concept of the Ethical Matrix was explained as a matrix with values as columns and stakeholders as rows which could support them in the design process. First, they consulted VSD literature and they identified four phases for their project: Value Discovery, Value Conceptualization, Empirical Value Investigation and Technical Value Investigation (Spiekermann, 2015). To create the Ethical Matrix, they read VSD literature and interviewed an expert on ethics of digital innovation in education. The stakeholders they identified were Students, Internship Coaches (Educators), Internship Coordinators, App Administrators, and the HEI in general (the last two as indirect stakeholders). The identified values were Privacy, Autonomy, Insight, Efficiency, Support, Responsibility and Usability. The students used the Ethical Matrix for the assessment of design alternatives by students and educators. Because of time constraints, they could not collect direct input from the other identified stakeholders, and they tried to incorporate their values indirectly, mostly by making assumptions.

Design workshops were organized with five internship coaches to complete the Ethical Matrix for seven alternative designs (mockups) for the teacher functionality. The students used the matrix to code stakeholders' opinions in these workshops, by color coding the cells of the matrix: a positive impact was coded as green, a neutral impact as orange, and a negative as red. Next, they invited six students to assess three different designs (online mockups) and coded the review comments with colors in the Ethical Matrix. Based on all gathered information, they reviewed the designs and combined the positively assessed aspects of several design alternatives into final design requirements for the new functionality. The final design facilitated the value Support and Efficiency, while respecting the Autonomy of students.

Interestingly, the students changed the structure of the Ethical Matrix to values as rows and design alternatives as columns, making a separate matrix for each stakeholder. This is probably because they were gathering information from specific stakeholders directly, thus multiple rows for stakeholders were not relevant at that time. This adaptation of the matrix fits with their goal of comparing design alternatives and made it easier for them to incorporate values in the design process, thus easily adapting a design methodology familiar to them into a value sensitive one.

4.3 Comparison of the two cases

As a summary of the above and based on observation and interviews, we compare the two cases on the aspects mentioned in Section 3 in Table 2. The aspects in the shaded rows are similar for both cases; for the other aspects, the two cases differ.

Table 2: Comparison of the two cases on eight aspects.

	Aspect	Case 1	Case 2
Process	Goal	Evaluate and compare design options with regard to values of stakeholders	Evaluate and compare design options with regard to values of stakeholders
	Integration in process	(1) Identifying stakeholders and values in conceptual phase, (2) completing matrix for each design choice.	(1) Identifying stakeholders and values in conceptual phase, (2) completing matrix for each design choice.
	Users	Educators	Students
	Instructions	Moderated workshops	Instructions beforehand
	Usage evaluation	Richer dialogue about design choices	Easily integrated within familiar design process
Product	Data	Impacts on various stakeholder groups as envisioned by educators	Impacts on educators and on students derived from focus groups
	Product influence	Combination of design options that represents best balance of values	Combination of design options that represents best balance of values
	Personal development	Richer, value-sensitive dialogue in other settings as well	Awareness of ethical considerations in design processes

5 Conclusion

Using the Ethical Matrix in a VSD approach to designing innovative apps for higher education, we expanded both the matrix itself and its use: we added more values to the matrix, i.e. all values identified in the conceptual phase of VSD, and we extended its use to all design phases. Our experiences with using the Ethical Matrix in the context of a VSD design project in the two cases described here suggest that the matrix is a valuable addition to VSD. It makes the considerations of the impact of design choices on the stakeholder values tangible and traceable. Furthermore, it provides structure and support to those involved in the design process who have no formal ethical training. Having the participants identify the relevant stakeholders and values themselves, instead of providing them with a pre-structured matrix, made them more aware of the values of different stakeholders. The primary contribution of our study is that it presents one way to operationalize part of VSD accessible to non-ethicists. Our analysis of its application in an educational context indicates that it can be used by both educators and students.

The differences in the way the Ethical Matrix is used in the two cases shows its versatility as an instrument. Of course, comparing merely two cases with a small number of participants has limitations with respect to generalizability. Our next step is to use these experiences to further tune the use of the matrix and try and make it into a generically useful instrument in the performance of Value Sensitive Design.

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