Building and Publishing Open Educational Resources in Ethics Education for Engineers: The Ethics Education for Engineers project of 4TU.Ethics

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Abstract

This paper discusses the challenges and obstacles encountered in developing and publishing Open Educational Resources (OER) in engineering ethics education at a higher academic level, in the project *Ethics Education for Engineers* of the 4TU.Centre for Ethics and Technology. The main aim is to contribute to the larger project of providing OER at university level by providing insights gained from the process of gathering and publishing materials. These insights are intended to be suitable for use by other authors and teachers of OER. First, we provide an introduction describing the parties involved and the specific aim of our project. Second, we describe the difficulties that were expected in the proposal phase of the project and explain how we anticipated solving them. Third, we discuss the different problems we encountered once the project was put into practice. We describe in what way we answered to these unexpected challenges. Fourth, an overview is given of valuable lessons learned and some practical take-aways acquired through experience. Here we also discuss the challenges of making ethics modules suitable for empirically trained students and mention some possible blind-spots that 4TU.Ethics might not be able to consider from its sole perspective. Finally, we summarise what we have come to understand are the most important steps in undertaking a project such as this by manner of a blueprint for educators attempting something similar in the future.

Keywords: Ethics education; Case-based exercises; Open Educational Resources; 4TU.Ethics.

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1 Introduction

The aim of the project *Ethics Education for Engineers* discussed in this paper is to collect and open up materials for teaching ethics to engineering students. To introduce it properly, we need to provide some context about the entity that initiated the project, the 4TU.Ethics, and ethics education for engineers in the Netherlands.

1.1 The 4TU.Centre for Ethics and Technology

The Netherlands has four universities of technology, that cooperate through the 4TU Federation [1]. The 4TU Centre for Ethics and Technology [2], 4TU.Ethics for short, was founded by the Federation in 2007, as a centre of excellence linking the philosophy departments of TUDelft (TUD), Eindhoven University of Technology (TU/e) and Twente University (UT). The philosophy group of Wageningen University & Research (WUR) joined the Centre in 2018. With a current size of about 43 senior researchers and 84 junior researchers (PhDs and post-docs), as well as a global network of affiliated researchers, 4TU.Ethics is a world leading centre in the field of ethics of technology. As a community, the Centre aims to:

- Understand ethical issues in the practice of engineering and technology development, and contribute to better practices
- Innovate education in the ethics of technology
- Stimulate and perform research in the field of ethics and technology
- Address societal challenges
- Engage with societal stakeholders and public discussions about technology

At each of the four universities, the local philosophy group provides ethics courses to students of all educational programs. Based on this experience, members of 4TU.Ethics have developed, and continue to develop, new methods and materials, as for instance witnessed by one of the most successful textbooks in ethics in engineering worldwide [3], an accompanying online educational tool, Agora [4], and a Massive Open Online Course on Ethics, Technology and Engineering for professional education developed in cooperation with Royal Netherlands Society of Engineers (KIVI) [5]. Sharing these developments in the form of Open Educational Materials is a natural further step in realising the Centre's educational mission.

1.2 Ethics education at the Dutch universities of technology

The importance of ethics for engineering has been generally recognised, as part of the competences for engineers of the 21th century [6]. All four universities have explicitly included this in the learning outcomes for all their Bachelor's and Master's curricula (see for instance [7]). Currently most students enrolling the four TUs will have taken at

least one course involving ethics during their Bachelor's (either as a dedicated course, or embedded as part of another course), and probably another one as part of their Master's. Combined with a rise in student numbers over the past decade (enrolment in 2021 was 64,591: 34,259 Bachelor's and 30,332 Master's students [8]), this integration of ethics in engineering curricula comes with a huge teaching load for the 4TU.Ethics community.

A cornerstone of the practice of teaching ethics to engineering students is the case-based exercise (CBE), where students learn to tackle ethical questions in context, i.e. as they occur in relation to applications of technologies. In these case-based exercises engineering students learn to apply ethical frameworks and develop competencies such as moral sensibility, moral creativity, and moral argumentation and judgement skills [9]. The CBE-approach of teaching ethics in context arose directly from the teachers' experience, but fits the more general model of so-called 'problem-based learning' [10] which has been increasingly popular in the past decades in higher education [11]. Engineering education in particular relies heavily on problem-based learning, which means that students are familiar with the approach, as it is used throughout their curriculum. Hence, case-based exercises have become a central instrument in ethics teaching in 4TU.Ethics.

1.3 The Ethics Education for Engineers project

Teachers in the 4TU.Ethics community develop CBEs for use in their courses to students in different engineering disciplines, addressing a wide variety of technologies. However, the development of these educational material has so far been largely an individual activity. CBEs are sometimes shared locally among close colleagues, but there are no channels or processes in place for systematically sharing these materials among teachers at the different universities. Both teachers and students could benefit significantly from an efficient way to develop and share up-to date materials for teaching ethics in engineering. The integration of ethics in the campus curriculum requires a lot of tailor-made arrangements with the educational programs. Having a communal collections of CBEs different technology domains (suited for co-teaching with non-ethicists) will support this process. Rather than solving this problem inside the community, 4TU.Ethics decided to broaden the scope and set out to share and produce ethics teaching materials as Open Educational Resources (OER).

Open Educational Resources are materials for teaching, learning and research that are publicly accessible and released under an open license allowing free access, use, adaptation and redistribution by others without any restrictions. This flexible, collective movement of shared information is strongly connected to the belief in the human right to the access of high-quality education. The project of creating OER stands for reducing the general cost of education as well as for broad participation, cooperation and co-creation. As such, OER can be seen to be part of a systemic change in learning and teaching content by engaging educators in new participatory processes and effective technologies in education ([12], [13], [14], [15], [16]).

Given that the local goals of 4TU.Ethics matched the global goals of OER, the Centre initiated the *Ethics Education for Engineers* project, with the aim to collect and publish 60 ethics CBEs created by the 4TU.Ethics community in an unambiguous, structured

and open manner for reuse in all the study programmes of the institutions involved, and beyond. This required improving and updating of existing materials, adding new materials and ensuring that all material is suitable for reuse by fellow lecturers and in co-teaching. Also a process had to be put in place to sustain the publication of CBEs after the project ends. The project ran from September 2019 to March 2022 and was supported by a grant from the Dutch Ministry of Education, Culture and Science, which has an Open and online education incentive scheme [17]. During this time, we have gathered experience and knowledge by developing and distributing materials and answering to different challenges. In this paper we describe how we dealt with both the expected and the unexpected difficulties that were encountered in the process. We hope the answers and solutions that we found will be of use for other practitioners in building their own collections of materials. Of course, we have to keep in mind that the scope of the project is limited to education in English for engineering students in universities comparable to the 4TU institutions. Moreover, the project's main beneficiaries are ethics instructors familiar with case-based exercises (CBEs) and working with Western ethical theories. As such, a further aim of this paper is to address the academic, educational and normative assumptions that underlie our project.

2 Project preparation

The aim of the current section is to describe from our perspective what the main challenges consisted in when developing the outlines of our project. We discuss three problems that were anticipated yet challenging, and explain in what manner we addressed them in the project.

2.1 Making ethics materials available to a wide audience

In developing open educational materials, a first challenge is to design them in a manner suitable for a wide audience. Materials should be as accessible, understandable and useable as possible. Certain theories and ethical concepts that are used self-evidently in one place might not be suitable for direct use in another place. For the materials to be as widely applicable as possible, they must be able to accommodate a variety of perspectives. We had to consider what one assumes about others when developing, what we might accidentally impose and how could we keep development open towards the future.

A first answer we came up with was a bottom-up approach. This means that the primary inspiration for a CBE would consist in an idea provided by an academic expert active in the ethical field. Concretely, we wanted to approach teachers and professors and ask them to share their teaching materials. These texts, papers, presentations and other documents could then be transcribed into a shareable format by editors. This way, rather than imposing a rigid structure from the umbrella body and asking teachers to meet its requirements, the theories and working methods would spring from practice and experience.

Secondly, we decided to focus on case-based exercises (CBEs). For reasons explained above (Section 1.2) CBEs have become a central instrument in the teaching practice of the 4TU.Ethics community. On the highest level of description, they consist of two elements. The *story* (sometimes called "the case") introducing the topic of the exercise, explaining the main features on the technology involved and the most salient aspects of its application in a particular situation, often providing the students with further sources to consult to study the situation at hand in more detail. Traditionally, the story is presented by means of a written text, but one can also use other forms such as documentaries, movies, podcasts, etc. The second element are the *educational instructions*, specifying the ethical issues the students have to address in the situation and the activities they should engage in to do so. CBEs can employ a wide range of activities. Besides writing papers, students can for instance be asked to engage in structured debate, in role play, or in product design.

CBEs come in different sizes, ranging from a short exercise that takes one or two lesson hours in class, to the main assignment of a course, requiring 2-3 ec's of student work. Hence, offering teaching materials in the form of a CBE, allows for modular (re)use. Instructors can pick exercises based on topic (story), or ethical framework or activities used or size (educational instructions). As CBEs share a common structure, they can easily be dismantled, reassembled and appropriated by teachers to fit their specific educational objectives. In this way, we can ensure both the availability of a wide range of topics and a consistent applicability of the materials.

2.2 Covering a wide range of topic in the engineering ethics field

In coming up with a way to develop materials for as broad a range as possible, we started by acknowledging that it is impossible to do so in an all-encompassing manner. The range of existing technologies is too large to be included in full in any single collection of educational materials. Also, new innovations constantly emerge as well as new theories regarding the ethics of these technologies. One way to deal with this is to aim for an abundance of exercises, to increase the probability that an instructor can find something to their liking. Within the scope of the project (aiming for 60 CBEs) this is not feasible and even with a sustained collection effort over time, it will be difficult to keep up with developments.

Eventually, we decided to focus on three large technology domains that are prominent in the research of 4TU.Ethics:

- Digital technologies (Artificial Intelligence, robotics, Internet of Things, social media, blockchain, etc.)
- Bio- and medical technologies (gene editing, synthetic biology, neurotechnology, agricultural and food technologies, etc.)
- Energy and environmental technologies (energy technologies, water technologies, recycling technologies, climate engineering, etc.)

The idea was to structure the development of the collection by using a matrix for ordering the CBEs in the collection according to the technology domain in which they are situated and the ethical concepts/theories they employ.

On the one hand, case-based exercises should inform students about the state of knowledge regarding a certain topic and worldly events. These topics can be highly specialised in scientific disciplines or deeply connected to novel technological advancements of our time. On the other hand, these exercises must provide students with the means to make their own, justified decisions and arguments based on their personal, active ethical reflection. This twofold aim of developing empirically informed exercises that invite performative ethics will remain a major challenge. Staff that is specialised both in ethical philosophy and a specific domain of empirical technoscience is scarce. As the CBE has to be designed in such a way that a certain ethical problem comes forward, the provided information about the concrete state of affairs can never be displayed truly 'neutrally' or objectively. The challenge is to balance normative perspectives with technical knowledge.

We aimed to work with this distinction by separating the informative theory, double-checked by experts in relevant fields, from the practical exercises in each CBE. The informative or empirical framework should present a state of affairs in a neutral and objective way and ruling out possible untruths, while the ethical exercise should enable students to actively shape their own thoughts on the matter. At all four universities focus groups exist that research a specific topic. The aim was to seek out scholars with different specialisations to edit and develop cases, making the most of available specialised knowledge. Cooperation and inviting a multitude of perspectives seem to be key in answering to this challenge.

2.3 Collecting the materials from the four universities

For the collection of materials, we conceived the following approach. Within each of the universities, we wanted to approach groups of experts in the ethics of technology fields who were actively teaching these matters. These expert groups could then share the teaching materials they had developed for their own courses with the 4TU.Ethics umbrella task group. As the focus, topics and theories substantially overlap amongst the four universities, this collection of materials would also lead to the finalisation of the learning objectives and outcomes as well as the structuring of exercises in specific steps. Accordingly, the project aimed to appoint two people from each university, preferably high-profile scholars, to be responsible for building the collection. We assumed these scholars could intermediate the communication with the teachers and obtain their teaching materials.

3 Project implementation

In this section we will describe the pitfalls and challenges encountered in the process of actually building the collection, once the project got underway.

3.1 Defining a format

There is a tension between universality and particularity at stake in defining a format for the publication of OER. Because, although the materials should be fit for worldwide use, they must always be drawn up by specific persons in specific situations. Inevitably, any scholar anywhere is always bound to specific (groups of) academics, courses, interests, topics, media, cultures, and other such variables. Having access to a global community of researchers is something quite novel, as are developments in the direction of efficient interdisciplinarity. A logical way to deal with this differentiated situation is by devising a template, a format. But this means that developers of OER in ethics necessarily have to create openly on the one hand while working in a widely understandable format - i.e. strictly defined and as such not open - on the other hand. A format is in itself both a way to structure and create knowledge and something that reduces or closes off other possibilities of knowledge. Yet, if one wants to create educational materials that are (re)usable, the importance of a clean, instantly transparent format cannot be overestimated.

In ethics of technology, one often encounters ill-structured moral problems. Differences in opinion will always exist in ethics and many debates are still on-going and ethicists continuously work with a plurality of theories. Next to the classical Western theories, virtue ethics, utilitarianism and deontology, a multitude of other frameworks and theories are employed in such as for instance risk ethics, care ethics, value-sensitive design, codes of conduct, responsible research and innovation, and postphenomenology. Moreover, these theories are not mutually exclusive and in continuous, active discussion with each other. The challenge from a pedagogical angle is, therefore, to ensure an exercise enables students to work through the ethical considerations in the most fruitful way possible, i.e. obtaining as many insights and as a wide a reflection as possible.

To allow for this variety in defining a format for CBEs, we drew inspiration from the "Ethical cycle" as developed by van de Poel and Royakkers [19], which is depicted in Figure 3. The ethical cycle views the formulation of a moral problem, of the possible solutions and of the ethical evaluation of these solutions as intertwined aspects of the one, possibly iterative *process*.

From analysing an initial batch of CBEs collected from teachers in the community, we learned that the a more general process definition was needed to capture the variety present in practice. This process is depicted in Figure 1.

We take a case-based exercise to consists of a series of *steps*. A CBE starts with a *story*, which introduces a particular application of technology and provides the relevant contextual factors. The students then go through one or more distinct steps in which they answer a set of coherent questions. Each step has *inputs*, (such as the story for step 1), and an *output*, the answers to the set of coherent questions belonging to the step. If the CBE has multiple steps, the outputs of earlier steps (possibly combined with additional materials) are used as inputs to later steps. With every step comes an *activity* in which students engage to answer the question of the step (e.g. literature study, debate, or role play). Teachers are free to define the kind of steps as well as the

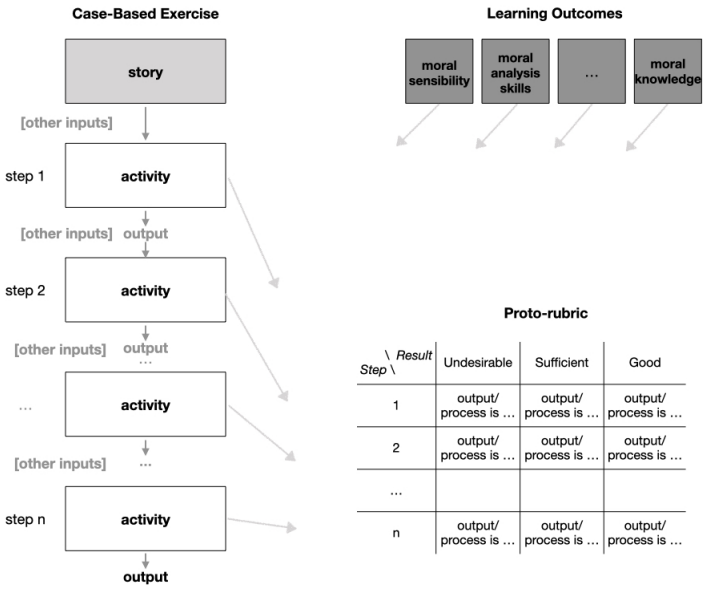

Figure 1: General structure of a case-based exercise.

number of steps in the CBE as long as they stick to this general structure[1]

The activities in the steps contribute to the learning outcomes for CBEs defined in the project, listed in Appendix A. This set of learning outcomes was obtained for an analysis of the first batch of exercises collected from all four institutions. The learning outcomes present in these exercises were identified, restructured and rewritten into a foundational set of learning objectives, and validated with the community. In this way, a general consensus was identified and accordingly condensed into a viable format. To help teachers in monitor the students' progress during the teaching of an exercise, every CBE contains a small proto-rubric in which the authors describe when according to their experience the activity in a step is going well or not so well, based on the process the students are going through or the output they produce in the step (see Section 4.3).

After validating the format, by discussing it with teachers in the community, it was used to create a template for the description of CBEs [20] that was used throughout the project.

3.2 Structuring the collection

Our initial idea was to create a matrix for ordering the CBEs according to the technology domain in which they are situtated and the ethical concepts/theories they employ as the

[1]Formally speaking, a CBE is represented as a directed acyclic graph of steps connected through inputs and outputs. If an exercise contains iterations, these can be accommodated by "unfolding" the loops and adding the repeated steps to the graph.

framework for building the collection. We collected a first batch of CBEs from teachers in 4TU.Ethics to see if this top-down idea would fit the practice of the community. With regards to the technology domains, the proposed categories *Digital & ICT*, *Health and Biotechnologies* and *Energy and Environmental technologies* made sense for the collected materials, but we found a group of CBEs that were less concerned with the specifics of a particular application of technology than with the organisational and political aspects of the engineering profession, such as problems of responsibility. For these we introduced a new category *Engineering Practice*. The ethical concepts and theories found in the collected materials matched our expectations, but it turned that it is quite common for CBEs to address multiple theories, which makes a simple matrix less useful as framework for organizing the collection.

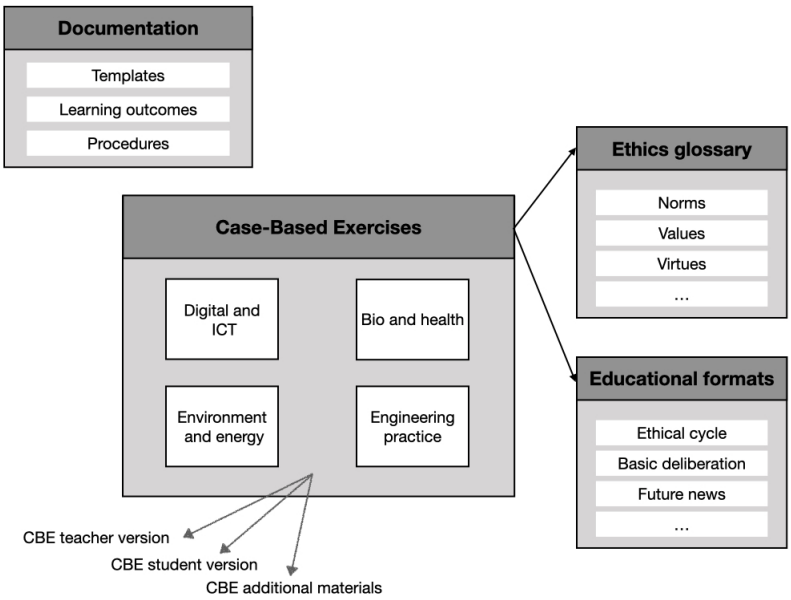

Figure 2: Contents and structure of the Ethics Education for Engineers repository.

By that time, we had chosen edusources as the platform for publishing the CBEs. Using the facilities offered by this platform we settled on a more flexible ordering of CBEs in "collections", where materials are grouped under a common heading, while allowing for links between individual materials in different collections. The materials in the repository are organised in seven collections, accessible from the 4TU.Ethics community page on edusources [21]. Figure 2 depicts this structure. The Case-Based Exercises (CBEs) are divided over 4 collections based on the technology domain in which they are situated: Digital and ICT, Bio and health technologies, Environmental and energy technologies, and Engineering practice. For every CBE a teacher version is provided. CBEs can also have a separate student version that can be handed out, and some have additional materials (like role description in a role playing exercises) are needed to conduct the

CBE in class. The Educational formats collection contains the descriptions of exercises forms that are applicable to a wider variety of technologies, and the collection Ethics glossary contains short introductions of the central concepts and frameworks from ethics occurring in the CBEs, that can be used by students for self-study.The records for case-based exercises in the repository are linked to the entries for the ethical concepts and frameworks occurring in them, and can also be linked to descriptions of the educational formats employed.

This structure fits the community practice. It allowed us to classify all further CBEs developed over the course of the project, and provides teachers with an intuitive way to browse the educational materials. It is also future proof: if needed, further domain categories can be added to cope with the advent of new technologies, and developments in ethics research (such as the current interest in non-Western approaches) that find their way into teaching can be accommodated by extending the ethics glossary.

To make the repository self-documenting, we have added the *Toolkit* collection, which contains reference documents to support the creation of new materials in the vein of the project, such as the developed templates for case-based exercises and educational formats, the set of learning outcomes for CBEs and explanations of procedures for contributing new materials to the repository.

3.3 The missing link: editors

After having determined the CBE-format, the learning outcomes and the structure of the collection, some of the collected materials were developed into CBE descriptions according to the template by the project team and tested in trial-runs. These CBEs proved fairly easy to use, as the preliminary feedback from several teachers showed us. However, we also found that we could not ask teacher to convert their own teaching materials. The main bottleneck was not the absence of teaching materials or ideas, but the effort required to get the materials to the standard where they can be easily be understood and used in class by other teachers. Especially in times of Covid-19, teachers did not have the required time and focus to do this independently.

To fill the gap between the teacher contributing materials and the project group overseeing the publication of CBEs, a new role was introduced, that of *editor*. Editors were trained in each of the four groups to assist teachers in getting their materials to the point where they could be published. The process was as follows: teachers were approached locally to contribute existing CBEs or ideas for new ones to the project. The materials they submitted, in whatever form, were converted into a CBE description according to the template by an editor. The editor and teacher would then discuss this new description to make sure that the editor had correctly captured the teacher's intent and to fill in any missing information required by the template. Once a CBE was complete, it would go to the project group, who would perform a final quality check and publish it on the edusources platform.

In this way the project goal of publishing an initial collection of 60 CBEs as OER was reached. To maintain and grow the collection in future, 4TU.Ethics strives to maintain a certain editing capacity in its community to support publication of further CBEs. We do

think that, now that an initial collection of reusable materials from their community is available and teachers are getting more familiar with the standard formats, the threshold for them to contribute to the collection will become lower.

4 Lessons learned and practical take-aways

The aim of this section is to share some insights acquired during the implementation of the project within 4TU.Ethics. By identifying possible pitfalls and encountered challenges, we hope to inform and prepare those starting similar projects. The more fundamental difficulties that we came across and that helped in obtaining these practical take-aways will be elaborated upon in the following sections.

4.1 Production of individual CBEs

With regards to the existence of teaching materials, there is less scarcity than one might expect. Everywhere in academic institutes, professors and teachers have been passionately giving courses, lessons and engaging tutorials to BA and MA students for years or even decades. Not sharing this experience would be a waste of energy and time. As such, we found that simply asking these teachers to share as much materials as possible was a highly efficient way to obtain verified teaching resources. If just a few people have the means to dedicate themselves to the structuring and organising of these materials, the experience is conserved with relative ease and new generations of teachers will not have to re-invent the wheel each time they build a course.

A strongly related insight concerns the current demand for OER in ethics. As the number of students in technical fields is rising, the need for ethics education rises as well, indicating that OER in ethics will always be welcome. The aim of supplying materials that can be reused and appropriated by teaching staff poses demands different from teaching materials developed for personal or local use. However, teachers are always already under the pressure of a large workload and have hardly any extra time to orient themselves in the fields of available educational modules, especially if the themes therein deviate from their own expertise. Longer term, this situation could be improved by having teachers develop their materials in a specific template by providing them with incentives such as traceable publication of their materials (DOI), exposure on the platform and being part of an active community of OER builders that meet regularly and exchange materials.

Currently, beginning an interdisciplinary, inter-academia (and ideally, international) project like making OER in ethics in first instance will only cost precious time for teachers and scholars that are asked to submit teaching materials. This means additional resources are required to train editors and developers organising the rough materials. In this respect 4TU.Ethics is a privileged position, as a community of qualified scholars that can decide to invest time in common projects.

A third challenge that must be mentioned here consists in dealing with copyright issues. Intellectual property has value and not everyone might be eager to share the

work they spent so much time on. Peer-reviewed research cannot just be attached to OER. Neither is it possible to include every graph, image, table, or document of reference that editors of OER would have initially preferred. The copyrights required for open access publishing are quite narrow and must be checked carefully by someone knowledgeable in the field. We are currently still challenged by the compatibility of differing open licences. Combining materials published under different licences leads to a situation in which the most restrictive one determines the licence of the whole. We are dealing with this issue by using creative commons for all images, rewriting, summarising and referencing relevant research not yet freely available, contacting original authors for permission and by including downloadable open-access files to certain materials. For example, we have changed the files from PDF to docx upon recommendation by library institutions.

Lastly, we found that developing CBEs in workshops with groups of teachers constitutes an engaging exercise from which a lot of wisdom can be obtained. Besides the fact that instructors enjoy working on materials in groups, such cooperation also yields a manifold of valuable insights. Combining different perspectives and areas of expertise provides a view on the richness of the examples at stake in the exercises and offers knowledge on all the different directions in which a lesson can be developed.

4.2 Building the collection

The first insight with regards to the development of the collection is that teachers that are in need of additional educational resources often do not know where to start looking. They will still feel the responsibility to provide their classes with both scientifically accurate information and solid ethical theories. Unlike commercial commodities, educational resources cannot be advertised in a public, market-driven manner. While a number of teachers feel that anything published by other teachers can pose a viable inspiration for colleagues, in a structural project it is also necessary to consider how to establish a certain guarantee of quality. In weighing the role of trust and how to obtain it in the context of the materials at stake, clear design-choices have to be made.

A related challenge consists in coming up with materials that are both specific to the studies in which they are used - which might differ from biology to engineering to social sciences - and useable in the most general sense possible. We consider the availability of both diverse experts and capable editors to be key in answering to this challenge. Also, in order to keep up with developments in technological innovation, educational objectives and pedagogic approaches, it is necessary to consistently and structurally keep expanding, updating and refreshing the collection of materials.

4.3 (Re)use of materials

We have learned how to formulate the instructions for assignments concisely and specifically. Although any instructor should always have the freedom to appropriate and modify all materials, they should be able to teach an exercise directly from its description. For this purpose it is helpful to write out every step involved in the assignment

with examples and overviews. A clear determination of ideal group-sizes can only be beneficial to include. Also when variations are likely, writing out a table with possible group-sizes depending on the size of the total group saves instructors time on preparation. Building exact, unambiguous instructions is needed, even if instructors would opt to take a different approach. Wherever time can be saved for instructors, one should try to do so in the materials.

The development of scoring rubrics also provides some guidance for instructors to anticipate the behaviour and participation of involved students. The design choice of using pre-written rubrics here to enable summative testing is contested, especially in ethics education, where answers are never binary, yet we feel teachers do not have to use these provided instruments if they do not desire so. In terms of editing, it proved entirely feasible to map out the diverse attitudes of engagement to be expected per question in a matrix with a scale of unsatisfactory-satisfactory-excellent. Here is an example of the manner in which we did this:

Step	**Unsatisfactory**	**Satisfactory**	**Excellent**
1	Did not read text Does not raise hand Not paying enough attention	Reads text Pays attention to introduction and video	Displays understanding Helpful input Adds to the conversation
2	Not cooperating Not active in assigned group Copies arguments from text instead of thinking for themselves	Cooperative Works with group Provides useful contribution to strategy or design that has to be made	Pulls group forwards Makes visual model Introduces new ideas and arguments
...	...	...	...

Table 1: Example of a scoring rubric as included in CBE format

There also is a challenge of anticipation involved in the development of OER in ethics. Anticipating all the possible answers, arguments, angles, perspectives and concepts that might come to the fore when teaching about a specific ethical theory or in the context of a specific technology can be hard. This is of course also the beauty of education, that students might come up with original, novel approaches of which instructors can themselves learn in turn. In general, though, it turned out relatively feasible to list and map out the main possible arguments that students tend to come up with in a certain context. For each domain of ethics, and for disruptive technology reflected upon, certain recurring themes can indeed be identified. Making transparent lists of what topics, arguments and answers to expect when teaching an OER-module could prove helpful for instructors working with the materials.

We also found that teachers of ethics might not always feel confident talking about specific empirical domains, about which the engineering students likely have better knowledge. Again, the format in which a short and to-the-point story about the empirical background - verified by the expertise of the original teachers that provided the rough materials for the CBE - constituted our strategy; in general, this focused exposition of

relevant facts suffices for ethics instructors to talk about the moral aspects involved. In our experience a fruitful synergy can be achieved in which students learn to think ethically about their empirical work, while teachers learn new things about the empirical counterparts of their research in ethics.

4.4 Didactical points of departure

A strategy that we wanted to share concerns our model of a procedural approach. Reflecting about ethics is not a rigid process and can take all kinds of shapes and forms. However, embedding the main elements in an encompassing overview can be valuable for the (hermeneutic) insight of an instructor practicing one of the elements. In this manner, teachers have a feeling as to where in the process they find themselves and how they can work towards a comprehensive, plenary outcome. Below in Figure 3 we show the model of the Ethical Cycle [19] which was used as a preliminary inspiration for our procedural approach. However, as we were in need of a more general procedural approach, because not everybody favours the model of the Ethical Cycle, we expanded and appropriated this model in our finalised structure.

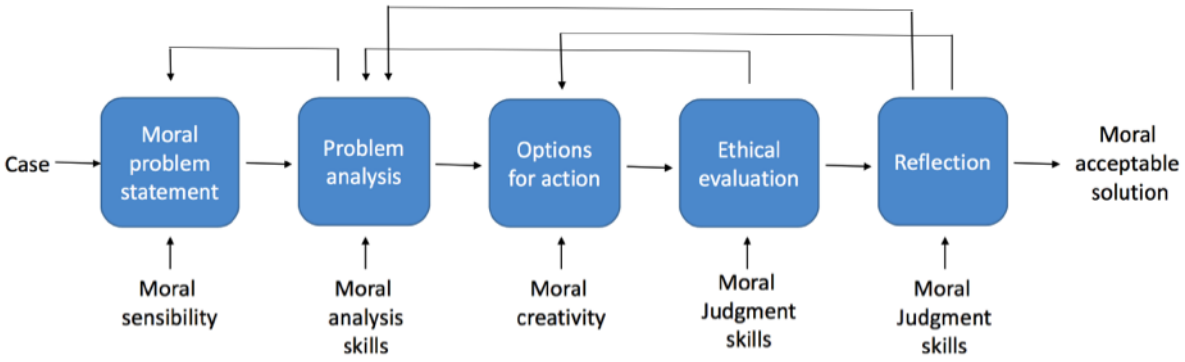

Figure 3: Example of a procedural approach: the Ethical Cycle models structures an exercise in a number of steps (each consisting of a number of questions), addressing specific learning goals.

What we noticed in developing CBEs for ethics education, furthermore, was that students in advanced empirical fields often struggle with comprehending ethics, as the abstract domain of ethics does not have an objective, measurable definition or system of thought to build upon. Ethics are dependent on diverse perspectives and differing situations of application. Our answer was found in the model of the CBE, in which an empirical, concrete and manageable case is presented that students recognise from their own theoretical backgrounds. This helps them to feel informed about their opinions and to come up with ethical arguments relevant to their own fields.

In revising the pedagogic as well as the ethical framework of the CBEs, an aspect that stood out was that all the ethical theories currently used are Western. The specific

methods, theories and perspectives used within 4TU.Ethics might not correspond to the dominant themes and theories used in other places. This challenge can only be truly met by broadening (international) cooperation. For now, 4TU.Ethics sidesteps this issue by only including the main theories supported by its active researchers in the respective fields. Given the current interest in non-Western approaches in the ethics of technology and the widening international cooperation in the field, we have hope that the collection will come to include CBEs drawing on Confucianism, Ubuntu philosophy, Islamic philosophy, indigenous philosophies and Buddhism, among others.

5 Overall blueprint

At the end of this paper we wanted to summarise in chronological order the most valuable insights we have obtained throughout our experience with this project. This roadmap can serve as a checklist of elements that should at the very least be present if somebody would want to undertake a project similar to ours.

1. *Make sure you have enough people on board.* Gathering materials, converting them into a viable format, supervising the general collection are all very time-consuming aspects of such a project. Having an engaged staff that works on it weekly is essential to its success.

2. *Train or hire specialists (editors) for converting the materials into a shareable format.* Teachers often have a great deal of educational resources at their disposal, scarcity is not the problem. The esoteric nature of the texts, presentation and hand-outs only used by one teacher, though, make it so that they are in need of heavy editing.

3. *Put a lot of effort and thought into making the formats for the materials at the beginning.* The format determines the general structure of the collection but can also reduce the need for specific types of information. A clear outline is therefore crucial when beginning and without it a lot of time will be consumed by unnecessary restructuring of materials.

4. *Test your materials with other teachers to make sure that these are actually teachable by others.* We highly recommend running a pilot-phase of at least a year in which materials, the format and the staff can try out their work. Revising the general outset on the basis of these preliminary experiences helps to determine a clear approach in the following years.

5. *Use feedback to improve upon the format.* Education is a field that constantly evolves and develops. Teachers accumulate a lot of specific knowledge through experience. Listening to those active in the fields guarantees the applicability of the materials.

6. *A modular approach helps to keep materials up-to-date.* Building the collection and the materials in it according to a modular structure was a valuable decision in our experience. If a certain component gets outdated, it can easily be replaced by the editors or even by the teachers themselves browsing the collection.

7. *Tie the project to an existing organisational structure* For the longer-term future of an OER project, is important to tie it to existing organisational structures, that can ensure continuity of the production and sharing of the materials.

As will be clear by now, producing OER is ambitious. It requires a lot of effort, and one cannot expect teachers, editors and others to embark on such a project purely out of passion. Asking them to invest their free time, or piling it on top of their other duties does not create sustainable conditions for producing valuable OER. Teachers will need time allocated to the project and support from their university. Hence our last and first advice for undertaking an OER project: *ensure funding.*

6 Conclusion

In this paper, we have described the project of 4TU.Ethics of developing open-access resources for ethics education in empirical domains such as engineering. As the umbrella-institute of ethics for the four Dutch technical universities, we have elaborated upon our specific approaches regarding the diverse challenges met in the undertaking. We have listed the main practical take-aways, supplied insight into the format used to transparently combine ethical and empirical educational information and discusses in more detail some of the fundamental challenges in the background of this development. By displaying these main challenges and describing the main ways in which we dealt with them, we hope to inform and inspire editors, teachers, instructors, librarians and anyone involved in similar projects. Cooperation, clarity, unification and inclusion seem to be the key qualities required for projects like ours to be a success. As such, we hope to extend our transparency to a context beyond 4TU.Ethics and to receive similar insights from comparable undertakings, working towards a global collective of OER-publishers, learning from each other and building towards more accessible, efficient, and complete educational resources for ethics in higher education.

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Appendix A: Learning outcomes for the CBE collection

A. Moral sensibility

i Identify moral values, norms and principles at stake in a given situation

ii Identify risks in a given situation

iii Identify stakeholders and their interests in a given situation

iv Identify responsibilities of actors in the given situation, especially of engineers and designers

v Identify normative claims (both explicit and implicit) about a given situation

vi Identify ethical assumptions in engineering frameworks and assessment tools relevant to the situation

B. Moral analysis skills

i Analyse a given situation in terms of ethical frameworks

ii Analyse a given situation in terms of relevant ethical codes

iii Analyse risks in the given situation in terms of causation, probabilities and damage

iv Validate analyses of the given situation in a discussion with stakeholders

C. Moral creativity & imagination

i Apply ethical frameworks to generate options for action in the situation at hand

ii Apply relevant ethical codes to generate options for action in the situation at hand

iii Translate values, norms and principles into designs for the situation at hand

iv Devise distributions of responsibility for the actors involved in the situation at hand

v Generate options for action in the situation at hand in a discussion with stakeholders

vi Reconceptualise the situation at hand to generate additional options for action

D. Moral judgment skills

i Evaluate proposed actions from different moral perspectives

ii To take into account constraints in terms of technological possibilities, governance and institutional options in evaluating proposed actions

iii Conducts a solution-oriented debate with stakeholders to evaluate options for action

E. Moral decision-making skills

i Decide on a course of action in a given situation, based on a reflection on possible actions in different moral frameworks

ii Shows personal commitment to chosen solutions ? e.g. is able to live by it, not just prescribing for others courses of action

F. Moral argumentation skills

i Analyse normative arguments about the given situation in terms of logical structure

ii Morally justifies one?s actions (in terms of ethical theories or frameworks and a reflection upon them)

G. Moral reflection skills

i Recognizes the situated nature of one's own perspective and some possible biases which might come into play in one's judgment

H. Moral knowledge

i Understands the main ethical frameworks and major concepts associated with them

ii Understands the relevant ethical codes