Upscaling Challenge Based Learning in an Ethics Course at TU/e

Ethics via Challenge Based Learning

TU Eindhoven starts with USE-courses (non-technical courses focusing on User-, Society- and Enterprise aspects of technology) in the first two years to stress that this is an indispensable part of engineering education. In a traditional format of lectures, tutorials and a multiple-choice exam at the end, first and second year's students overall are only little motivated.

After intensive research, TU/e decided to fundamentally redesign the basic course on ethics using flipped-classroom and challenge-based learning for a group of 180 students.

Gunter Bombaerts (Philosophy and Ethics group, department IE&IS, TU/e) led this pilot as part of his *AUTIQ* program and the '*Leergang Onderwijskundig Leiderschap'*. Inspiration was taken from Nottingham Trent's SCALE-UP. The pilot was also part of the H2020 project SCALINGS on scaling of co-creation.

External partners with ethical challenges

External partners (called clients in this course) are central in challenge-based learning. They provide the open-ended exercise the students are faced with. Here (some) examples of the ethical challenges of the 6 clients:

- **Jouw Licht op 040**: is a public procurement-based project consisting of the municipality of Eindhoven, Heijmans and Signify, and the Eindhoven University of Technology's Lighthouse. *How can JLO040 design a neighbourhood Eindhoven is "prettier, safer, and more interesting" through lighting?*
- **TU/e's Student team CASA**: designs "comfortable, affordable, sustainable, and alternative" living accommodation. *How can CASA use sensors in such a way that it respects privacy and ensures security? What design principles would students recommend CASA to build a better "smart" house?*
- **WijZijnIn architecture – Brainport District**: In 2016, TU/e and the municipality of Helmond decided that they would build the "smartest neighborhood in the world". *How should BSD select the future inhabitants of the houses? How can the technologies be optimized to answer future inhabitants' values?"*
- **TU/e's Student team RED**: develops a smart innovation guiding platform on which users can run simulations to demonstrate the impact that different technologies have on the grid, and work to optimize the system or compare different alternatives. *How should Team Red organize the process for people on TU/e campus to voice their opinion and for the feedback to be addressed sufficiently?*
- **Community Based Virtual Power Plant Loenen:** is a software-based solution that aggregates distributed energy resources into one coordinated portfolio. *How can citizens*

in a community share their energy mutually, distribute the revenue fairly, fight poverty and reach all people (also young people) in the community with co-creation?

- **TU/e's Student team SOLID**: realized the proof of concept how iron powder can be a viable source of energy. SOLID is now working towards developing the metal cycle process further. *How can the team make its technology and process a commercial success, contribute to sustainability goals and have strict guidelines on working conditions for iron suppliers in Brazil and elsewhere in the world?*

Design principles and key concepts

180 students were divided in 3 tutorial groups of 60, each containing 12 assignment groups of 5 students. In a flipped classroom approach, students prepared a certain ethical theory before the tutorial group session. In the session, they first discussed how the theory would fit to their case, they summarized this in a poster and then explained it to groups also working on this case. As such, they learned to formulate their ideas, learned from others, and could use the output of their discussions in their assignments.
Students also met a second time during a week, either in a 15 minutes tutor meeting to discuss progress and group dynamics or in a 45 minutes client meeting with two other groups treating the same challenge and getting feedback from the client.
This results in 6 contact hours per week per tutor.

Assignment 1 asked for making a research proposal, assignment 2 to do the ethical cycle, assignment 3 to design a final product that answers the challenge for the client.

Table: Course overview

W	Topic	Rationale
W1	Design own dystopia and values	No case yet, getting used to method
W2	"Co-Creation" and "Ethical Cycle"	Sketch core topic + methodology
W3	Apply utilitarianism + Kant	Flipped classroom – focus on application
W4	Apply happiness + Virtue Ethics	Flipped classroom – focus on application
	+ assignment1	*Finish W1-2, doing entire exercises first time*
W5	Apply democracy + Justice	Flipped classroom – focus on application
W6	Apply Capabilities & eco-philosophy	Flipped classroom – focus on application
	+ assignment2	*Finish W3-6 – first application theory - case*
W7	Wrap-up, prepare end event	Focus on finishing, link ethics-product
W8	End event	Recognition – contribute to real process
	+ assignment3	*Product + Ethical Justification*

Results

The study analyzed motivation and competencies.

Self-determination theory (SDT) describes several gradual forms of motivation. Intrinsic motivation is the highest form and means someone does something for the mere pleasure. A second level is called identified regulation, which refers to motivation that someone has because the action is considered as personally important. SDT further states that people have basic needs autonomy, relatedness and competence. If these basic needs are fulfilled, people are more motivated. (For more info, see **here**)

The study also analyzed students' self-assessment of competencies with the **ACQA framework** and asked for 7 competencies, such as "the student is able to reformulate ill-structured research problems, takes account of the system boundaries in this, and is able to defend the new interpretation against involved parties. (ACQA_USE)"

Table: Overall evaluation via Likert [1-10], others [1-5], number (N), mean (M), standard deviation (SD), mean difference (ΔM) and effect size Pearson's d.

	CC-case			Distant-case			Difference	
	N	M	SD	N	M	SD	ΔM(sign)	d
Overall w9	56	7.48	1.22	56	6.54	1.74	0.95**	0.63
Autonomy	55	4.27	0.63	55	3.99	0.64	0.28*	0.45
Competence	55	3.85	0.82	55	3.24	0.88	0.62***	0.73
Relatedness	55	4.01	0.63	55	4.02	0.76	-0.01	-0.02
Intrinsic motivation	54	3.38	0.77	54	2.76	0.97	0.62***	0.71
Identified regulation	*54*	*2.06*	*0.97*	*54*	*2.93*	*1.07*	*-0.87****	*-0.85*
ACQA USE	53	3.91	0.58	54	3.63	0.71	0.28**	0.44

Results show that intrinsic motivation, autonomy and competence are significantly higher in the co-creation case compared to the other approach not using challenge-based learning. Although we expected that relatedness would also differ significantly because of the increased contact with students, tutors and clients, this was not the case. From 7 competences, one (ACQA_USE) was significantly different.

Lessons Learned

Challenge-based

It is very important to define the challenge as precisely as possible. This is the case for technical challenges, but more so for ethics challenges. Clients need guidance how to formulate their problem in such a way that students can start working on the ethical issues.

Process evaluation

Students came up with creative solutions. Nevertheless, it will be a next version's challenge to make students' work more 'technical'. Too often, they shifted to 'communication' issues as the main (or only) ethical issues. An extra result is that students were so motivated that they asked to treat other philosophers that were not discussed (which was, of course, further stimulated!)

Stakeholders liked the approach and expressed that the time they spend on it was worth the effort. Key here was that in every meeting with the client the question "How can we do something for you?" was central.

PhD students felt very autonomous and responsible and could link the cases immediately to their research.

Scaling-up

The challenge-based learning was scaled-up to 180 students. It is as intensive as a 'normal' project course and PhD's can coach one group of 60 students for the entire course period on their own. It could in principle be scalable to the larger group of 2000 students of the USE basic course.

More information

For more information on this project, please contact Gunter Bombaerts at: g.bombaerts@tue.nl.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 788359.

SCALINGS