

Project CREaTE — Challenge-based Learning for Robotics Students by Engaging Start-Ups in Technology Ethics

Report

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Description of the teaching innovation

At the University of Lübeck, a new course in “ethics of technology” was established using the challenge-based learning (CBL) principle, which rests on four main pillars:

- (i) In terms of CBL, students are strongly co-responsible for the identification of the challenge and are oriented towards overall societal issues, cf. (Nichols & Cator, 2008). In addition, normative ethical principles are taught as overarching idea drivers.
- (ii) Challenges are jointly identified in consultation with regional and national partner companies (stakeholders) in multidisciplinary collaboration, resulting in actual real-world examples for which students develop solutions, cf. (Johnson et al., 2009).
- (iii) In line with the flipped classroom approach, cf. (Flaherty & Phillips, 2015), students independently engage with course content during the semester, the relevance of which in relation to the projects can be discussed in course meetings and debated in prepared tutor and stakeholder meetings.
- (iv) Project outcomes are presented in a public way to further increase student engagement, cf. (EDUCAUSE Learning Initiative, 2012).

In summary, students are tasked with identifying, analyzing and solving (at least conceptually) ethical challenges in relation to a (local) start-up. They apply concepts and insights from the course’s lectures and regularly discuss these with supervisors and stakeholders of the respective start-up. Students work in groups and there are opportunities to learn from and exchange with the other project groups. Final presentations and reports document the insights, which are made available to the start-ups.

At the Technical University Eindhoven, the existing challenge-based learning course has been developed. The original course was a 5ECTS ethics course. It has been made interdisciplinary. It was made a 10 ECTS course, with 5ECTS data-analytics and 5ECTS ethics. Students worked on brain-on-chip case. They received data and had to provide the stakeholder with data-analytical and ethical advice.

Video 1 original course: <https://www.youtube.com/watch?v=IIPRcz7-Wxg&t=68s>

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Video 2 interdisciplinary brain-on-chip course:
<https://www.youtube.com/watch?v=08pTD1a03CY>

To what extent were the goals pursued with the teaching innovation achieved?

There were two major goals to be achieved within project CREaTE:

1. Establishment of a scalable and practice-relevant concept for teaching ethical and societal aspects in technology development as part of the compulsory course " Ethics of Technology" of the degree program "Robotics and Autonomous Systems" at the University of Lübeck.
2. Joint expansion and improvement of the teaching concept by focusing on students of computer science, robotics and artificial intelligence.

Both goals have been achieved as the CBL-style course at the University of Lübeck has now passed its third instalment and is receiving good to very good reviews by students.

Furthermore, the exchange between both project partners is documented by common publications that have been published:

- Herzog, C., Breyer, S., Leinweber, N.-A., Preiß, R., Sonar, A., & Bombaerts, G. (2022). Everything you Want to Know and Never Dared to ask – A Practical Approach to Employing Challenge-Based Learning in Engineering Ethics. *SEFI Annual Conference*. SEFI Annual Conference, Barcelona, Spain.
- Herzog, C., Breyer, S., Sonar, A., & Bombaerts, G. (2021). Challenge-based Learning for Robotics Students by Engaging Start-Ups in Technology Ethics. *Reflecting Technology in Academic Teaching. Workshop on Teaching Environmental, Societal, and Ethical Dimensions of Technological Change*.
- Martin, D., Herzog, C., Papageorgiou, K., & Bombaerts, G. (2022). Three European experiences of co-creating ethical solutions to real-world problems through Challenge Based Learning. In *Emerald Handbook on Challenge-Based Learning*.

Teaching materials have been produced at the University of Lübeck, which — albeit in written in German — can be easily made available also to other groups. These materials heavily focus on the current topics associated with algorithms and artificial intelligence and can be quickly adopted to support CBL-like teaching (or even other forms) with an emphasis on ethical challenges in computer science.

What problems led to the fact that the goals were not achieved as planned?

In essence, the goals were achieved. However, in some ways, certain details have been modified as opposed to the proposed project. For instance, in the last instance of the course, no flipped classroom mode was adopted for the main reason that during the pandemic and when using the flipped classroom mode during the initial instances, it became clear that students also wanted to discuss broader issues beyond a pure focus on the challenges relevant to the start-up. Accordingly, materials for both a presentation-style lecture as well as script-like reading materials have now been generated.

The pandemic also prevented the project partners from fully elaborating all modes of exchange, e.g., student visiting groups and an in-person final event. Instead, a final event

was held fully virtually, featuring Prof. Armin Grunwald, head of the Institute of System Analysis and Technology Assessment at Karlsruhe Institute of Technology. Prof. Karena Kalmbach from TU Eindhoven (now head of strategy at the Futurium, Berlin) also joined in on the discussion which also featured contributions from an outstanding student of the “ethics of technology” course.

The pandemic also made it necessary to reallocate significant amounts of funds towards making possible hybrid modes for both lectures and seminar sessions. These have been found to be sustainable investments for post-pandemic teaching, as well, as several students still expect — and indeed need — remote access to the sessions.

What are the "lessons learned" (unintended positive/negative effects, indispensable prerequisites, etc.)?

Much more than an exchange in terms of the topics used to adopt the Eindhoven CBL course to computer science and artificial intelligence students, the project partners have discussed course design issues at the micro- and meso-level. This culminated into a publication about practical implications and considerations relevant for teachers interested in establishing a CBL course in engineering ethics of their own:

- Herzog, C., Breyer, S., Leinweber, N.-A., Preiß, R., Sonar, A., & Bombaerts, G. (2022). Everything you Want to Know and Never Dared to ask – A Practical Approach to Employing Challenge-Based Learning in Engineering Ethics. *SEFI Annual Conference*. SEFI Annual Conference, Barcelona, Spain.

To what extent has the teaching innovation been perpetuated?

The course „ethics of technology“ at University of Lübeck is now fully established as a mandatory course and the integration into the local ecosystem is tried and proven to support the CBL approach nicely. The efforts are considerable, but due to the local protagonists that remain in full support, they are also manageable.

The course on Brain-on-Chip in Eindhoven is now further developed. This year, the study will compare strong- and shared regulatory approaches in challenge-based learning. This could not be realized with the innovation of the previous years.

Other courses at TU/e follow the example of the brain-on-chip course.

To which soft teaching/learning situations - also in other disciplines - can the teaching innovation be transferred?

At the University of Lübeck, Christian Herzog has already pitched ideas to combine the CBL approach of “ethics of technology” with a subsequent internship, seminar or project course that is more firmly rooted in computer science and AI-based implementation. This way, ethically motivated conceptual solutions could be brought to the level of proof of concept within a unified teaching framework that considers ethics from inception to implementation.

To what extent have the department/faculty and the university supported you in the implementation of the teaching project (e.g. invited to report on it)?

Christian Herzog has been asked to report on the CBL course in an inofficial capacity several times. He remains in regular exchange with a group of peers interested in innovative didactics at the University of Lübeck and beyond. The following is a sample from presentations and talks held by Christian Herzog with topics involving or tangential to the CBL course:

- 12. Oct. 2022 **Lehrveranstaltung „Technikethik“ • 4ING-Workshop „Ethik in den Ingenieurwissenschaften und der Informatik“**
- 22. Aug. 2022 **Ethische Aspekte der KI in der Medizin • COPICOH Research Camp, PASBADIA Project Workshop. Universität zu Lübeck**
- 15. Sep. 2022 **Echte Herausforderungen für echt verantwortungsbewusste Ingenieur*innen – Challenge-based Learning in der Lehre zur Technikethik • Tag der Lehre. Universität zu Lübeck**
- 28. Mar. 2022 **“Teaching a Constructive Approach to the Ethics of Technology by Partnering with Start-ups as Real Case Studies” • SEFI@Work: Teaching societal responsibility through real life projects and challenge-based learning**
- 28. Jul. 2021 **“Challenge-Based Learning for Robotics Students by Engaging Start-Ups in Technology Ethics“ • Reflecting Technology in Academic Teaching. Workshop on teaching environmental, societal, and ethical dimensions of technological change • KIT**

How did you benefit from the fellow meetings and teaching/learning conferences?

Due to the pandemic and personal childcare duties, Christian Herzog was not able to regularly participate. However, an initial exchange was clearly inspiring, given the breadth of projects that are supported by the foundation. In summary, Christian Herzog was forced to concentrate on exchanging with Gunter Bombaerts as his more direct project partner.