How to coach students that work on complex design challenges of a multi-disciplinary nature?

# Applicants

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* Angela Tops BSc, coordinator of the TEACH Training program

# Introduction

In this resubmitted proposal we processed the comments of the review committee to our best knowledge. In our view the main changes are:

* Decreasing the focus on Industrial Design both in the set-up and the text of the proposal;
* Increasing the attention for the actual implementation by including two courses, that are part of use learning lines, and using a promising and dedicated professional learning approach;
* Including more departments by including a course provided by teachers from five departments and the inclusion of a member of DPO-teach in the project team; - Including a plan for dissemination.

A more detailed overview of how we processed the comments can be found in Appendix A. In the following we present our rewritten project-proposal. First, we outline the problem definition and objectives and provide you with a visual overview of the studies. Next, we will describe the project design and management. Per study we will address the research question, outline the different activities to be undertaken to answer the research question and provide the planning. Following, we will explain the fitness between the project proposal, the TU/e vision and the innovation call. Then, we will mention the deliverables and dissemination activities. As the final sections of this proposal we provide the budget and the references.

# Problem-statement

In the long run, the aim of the Eindhoven University of Technology is to educate the engineer of the future who deals with complex design challenges which are multidisciplinary by nature (CDCM) requiring creative and innovative thinking and making skills (source: website TU/e). Dealing with this kind of challenges asks for a non-traditional design engineering approach and a different way of educating students to deal with such challenges (Buchanon, 1992; Hummels and Frens, 2009). Although there is a lot of practical knowledge and experience available about how to coach CDCM, across the departments, there is little empirical evidence available to inform policy makers, curriculum developers and teachers about how students that work on CDCM should be coached (Razzouk and Shute, 2012).

# Objectives

This project aims to derive insight and understanding into what coaching students that work on CDCM entails and will result in elements for a blended training module to support teachers in mastering the necessary competencies pertaining to coaching students that work on CDCM. For these purposes we will undertake different studies (in parallel). Figure 1 gives an overview of these studies and the envisioned end product.

*Figure 1. Overview of the studies*

*1*

Study 4

Creating

elements for of

a

blended BKO

module

about

coaching CDCM

As becomes clear from visual 1, this project approaches coaching CDCM from different angles to explicate what good coaching of CDCM entails and to translate these findings into concrete elements for a professional development module about coaching CDCM.

* Study 1: Interviewing teachers to explicate their implicit knowledge about how to coach students while working on CDCM explicit
* Study 2: Observing students while working on CDCM in USE design thinking course to provide more ‘objective’ information about how both students and teachers coaching CDCM situations and the challenges they are both facing
* Study 3: Intervening and stimulating and professional learning of teachers using the data team approach within the course ‘Project Robots Everywhere’
* Study 4: Creating elements of a blended BKO module about coaching CDCM

# Project design and management

## Study 1. Interviewing teachers to explicate their implicit knowledge about how to coach students while working on CDCM

*Planning: February-April 2017*

Research question: What entails good coaching of students working on CDCM according to ID teachers?

Rationale

There are several coaching models available in the educational literature. A well-known model is the cognitive apprenticeship model of Collins, Brown and Newman (1987). The latter is emphasized in the TU/e vision on Education in 2030 (Meijers and den Brok, 2013) as well. In most definitions, coaching is defined as deliberately making use of interventions as modeling, instructing and providing feedback. The literature on coaching and feedback is mainly focused on ‘closed learning processes’ with clear defined outcomes instead of open-ended problems like coaching on CDCM. Therefore, the insights of the literature on feedback and coaching cannot be transferred that easily to the context of coaching students that work on CDCM. Let us explain this.

In essence, learning and instruction boil down to answering where a learner is, where s/he wants/needs to go and how the learner can get there. In coaching these questions also need to be addressed by the coach, student or jointly (Black and William, 2007; Hattie and Timperley, 2007; Van Diggelen, Morgan, Funk and Bruns-Alonso, 2016). It is easy to imagine that these questions can be answered easily in learning situations where the focus is on closed learning processes and where the environment is largely teacher centered. Another picture emerges when learning processes are open and the learning environment is (more) student-centered and when students work on CDCM. . In these instances, it is difficult to answer the questions of where the learner wants/needs to go and how to get there that straightforward. There are multiple potential answers to both questions. Consequently, coaching needs to focus on different aspects. To highlight just a few examples:: many students will need to learn to deal with more uncertainty,, students need to learn to understand that there is no right answer but only the best option to be chosen, and that it is important for them to learn to explicate why they made a certain choice and which alternatives were considered. So, there are many differences between coaching students working on closed learning processes and students working on open and complex CDCM. Since the literature offers limited opportunities and insight we turn to the practical knowledge of teachers frequently dealing with coaching on CDCM is an important source of information. In this project, we focus on the practical knowledge of ID.

Approach

To explicate ID teachers’ practical knowledge, Student-teachers from the master Science Education and Communication, track ‘Design’ (ESOE[[1]](#footnote-1)) will interview teachers from Industrial Design during the Industrial Design Education Day. The goal of these group interviews is to make their knowledge and beliefs about design processes, methods and approaches and how to coach students that work on CDCM more explicit. More particularly, we would like to find out what ID teachers consider to be best practices of coaching students that work on CDCM and how to deal with different perspectives on design processes and outcomes teacher have. For the interview we will make use of the characteristics of coaching we composed which we will translate in an interview protocol. This protocol will be based on principles of effective feedback, coaching and mentoring. This list will be composed by extracting characteristics from deliverables gained by previous projects about feedback and coaching of the CEE. E.g. projects about feedback.camp (Diggelen, Funk and Bruns, 2013; 2014; 2015) and a project about feedback in higher education performed with researchers from ESOE, teacher trainers from DPO / professional development and the fourth researcher (Van Weert, Tops, Morgan, Thurlings and Van Diggelen, 2014). Furthermore, we will use the six coaching methods of the cognitive apprenticeship model (Collins, Brown and Newman, 1986) and the MERID model for mentoring of Hennisen & Crasborn (2008), also referred to in the TU/e position paper written for mentoring?

We will divide the teachers into groups. Each group will be led by a student-teacher. The studentteacher follows the protocol and asks the questions. Group answers will be summarized on a flip over. During a break, the student-teachers analyze the flip overs of the groups and come up with a consensus list of requirements for coaching student working on CDCM. This list will be presented and discussed in a short plenary session.

## Study-2 Observing students while working on CDCM

Planning: quartile 3

Research question: What requirements for good coaching of students that work on CDCM can be formulated after observing a teacher coaching students working on CDCM?

Rationale

It is important not only to base requirements for coaching of students that work on CDCM on what teachers mention as important, but also on what teachers actually do when they coach. In this smallscale study we focus on observing a teacher while coaching students that work on CDCM.

Approach

In the course Technologies for Connectivity, part of the USE learning line design thinking, we will extract requirements for coaching students that work on CDCM. The third author will attend three situations wherein students are coached while working on CDCM. These moments will be picked in close consultation with the teacher. Based on this observation, requirements will be formulated. The teacher then, will be provided with the list of requirements and be asked to indicate the relevance of the requirements and whether requirements should be removed from the list or added. Obviously, suggestions for reformulation or sharpening the requirements will also be processed. If needed, and time permits, we will approach the responsible teacher of the third course of this learning line as well to validate the requirements derived in this study (this teacher has not been approached yet).

After composing a list of requirements based on interviews and a list of requirements based on observation we will turn to stimulating teachers’ professional learning with respect to coaching students that work on CDCM.

## Study-3. Intervening and stimulating and professional learning of teachers using the data team approach

Planning: Q3-Q4 and Q1-Q2 (2017-2018)

Research questions:

1. What measures can be undertaken to improve the quality of coaching of students that work on CDCM during Project Robots Everywhere?
2. How can the effects of these measures for improvement be measured?

Rationale

Professional learning of teachers is most effective when the content of learning is connected to the course they are providing and is well embedded within their own teaching practice (Van Veen et al., 2012). Furthermore, teachers need to be actively involved and study the problem and goals in interaction with their colleagues. However, processes of teacher learning are only valuable if teachers are sufficiently motivated and view the benefits as outweighing the costs in terms of time and resources (Day, 1999). This means that careful decisions need to be made about when to involve teachers, for what purpose and for how much time. A promising method that seems to fulfill all conditions for professional learning of teachers is the data-team method (Schildkamp, Handelzalts, & Poortman, 2016).

We have opted for the course Project Robots Everywhere. In this course, teachers of five departments are involved. It provides an opportunity to collect data based on the problems and challenges teachers experience with respect to coaching students while working on CDCM, to design methods for improvement and to evaluate the effects. Collaborating with teachers provides the project team with valuable insights and the teachers with sustainable measures for improvement.

*Approach: Data-team method*

In the data-team method, teachers responsible for a course and a quality assurance employee or educational scientist work as a team in a systematic and evidence-based way to improve the course (Schildkamp, Handelzalts, & Poortman, 2016). To assure that the needs and expectations of the teaching staff of project Robots everywhere align with the project team we already completed several steps in the data team approach. In the table below we outline the different steps in the procedure (colon 1), describe the different steps (colon 2), describe who is doing what, and when (colon 3).

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| --- | --- | --- |
| **Steps in the procedure**  | **Description**  | **Whom is doing what Planning**  |
| 1. Problem definition  | decides on which educational problem and goals they want to focus their efforts  | After interviews with three participating teachers we made a preliminary problem definition consisting of several elements. Firstly, the teachers indicated that there is a mismatch between the student satisfaction rates and the students’ learning gains as observed by teachers. What are explanations for this mismatch and what measures can be undertaken to improve this? How can the effects of these measures for improvement be evaluated? In this respect, all consulted teachers mentioned that balancing ‘expectation management’ on the one hand and coaching students without prescribing them where to go and how to get there on the other hand was an important dilemma. Secondly, teachers were wondering how to scale up their coaching of students that work on CDCM. Thirdly, the teachers expressed their need for an observation instrument/questionnaire that actually measures what happens during coaching and what students learn instead of how satisfied students are.   |

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| 2. Formulating hypotheses  | develops hypotheses  | Develop these hypotheses with the team  | Quartile 3  |
| 3. Data collection  | collects data to test the hypotheses  | Project leader and fourth researcher will observe during three occasions  | Quartile 3  |
| 4. Data quality check  | Are the collected data reliable and valid  | Project-leader  | Exam week Q3  |
| 5. Data analysis  | This can involve simple data analyses (e.g., descriptive analyses, summarizing interview data) as well as more sophisticated analyses (e.g., correlational and regression analyses).  | Project leader and fourth researcher make a short observation report and based on these observations, interpretations of the problem and possible measures for improvement are formulated.  | Exam week of Q3  |
| 6. Interpretation and conclusions  | If hypotheses turn out to be false, new hypotheses need to be tested. The data team needs to collect additional data (back to step 2). If the hypotheses are correct, the team draws conclusions based on the collected data.  | The observation report with its interpretation and measures for improvement are discussed with the teaching staff of the Project Robots Everywhere. It is decided if the interpretations make sense, if alternative interpretations can be formulated and whether the proposed measures are the right measures to undertake. If not, other measures will be proposed.  | Exam week of Q3  |
|  7. Implementing improvement measures  | Describe what it takes to implement the measures for improvement in terms of actual coaching behavior, organization and set-up of the course etc. Furthermore, actual goals are formulated.   | Project leader makes a plan to evaluate, to collect data and analyze the data to evaluate the measures for improvement.  | Final at the end of Q3. In Q4 the measures will be implemented.  |
| 8. Evaluation  | Are the actions effective? Are the goals met? Are the problems  | Project leader writes a short evaluation  | End of Quartile 4  |
|  | solved, and is the team satisfied? To evaluate the actions, new data need to be collected.  |  |  |
| A new cycle of the data team approach will be started in Q1 and Q2 with an emphasis on intervening to make the quality of coaching better.  |

# Study 4 Creating elements for (elements) of a blended BKO module about coaching CDCM

Planning: see table above, colon 3

Research question

1. What competencies do teachers need to possess in order to coach students that work on CDCM?
2. What tools can be used to stimulate these competencies via a blended BKO module?

The outcomes of study 1, 2, and 3 will be summarized and presented to the project team. The project-team, then will discuss the implications of the findings for what teachers should know and be able to do when coaching students that work on CDCM. As a result of the discussion, a hand-out with lessons learned, nice to knows and need to knows with respect to coaching students that work on CDCM will be composed. Furthermore, a list of competencies for coaching students that work on CDCM will be formulated. A competence is only included on the list if consensus reached by the project team. For transparency purposes, the meeting will be recorded. The list of competencies then, is input to the next step: developing online content for the module for DPO teach focused on online content.

For that we will work closely together with the TEACH staff of DPO and in particular, with the fifth project member, Angela Tops. DPO is working on an online training program for TU/e teacher training. Our project will aim at providing on-line content that can be used to professionalize staff in the coaching of complex multidisciplinary projects. For the online content, we will process the list with competencies pertaining to coaching students that work on CDCM in, for example, a selfassessment tool and a peer-observation tool. The exact tools to be developed depend on the outcomes of the previous studies and the wishes of DPO. The tools will be developed in Quartile 1 of the academic year 2017-2018.

To disseminate the findings we will set-up a dissemination committee and organize a meeting in Q2.

# Fitness between the project proposal, TU/e vision, and the innovation call

To educate the engineer of the future it is important that students are prepared to deal complex design challenge that is multidisciplinary in nature. This proposal builds on the literature and the knowledge and experience of ID teachers to define what good coaching of students that work on CDCM entails. Doing so, we start with the following core elements of the TU/e vision as formulated by Meijers and den Brok (2013):

* Small-scale education and master-apprentice interaction as key components of academic education.
* Teaching that is driven by student demand, with a stronger tutoring role for the teaching staff.
* Greater emphasis on multidisciplinary and diversity of students

With this proposal we try to make these trends more concrete. So, this project aligns well with the core elements of the TU/e vision on education. We aim for a flywheel effect for:

* Student-teachers who need to develop a vision on design education on secondary education
* Industrial Design to formulate a vision on design (education) and guiding students while learning to design
* Design pedagogy and in particular coaching students while working on complex design challenges that are multidisciplinary in nature
* Create knowledge and ideas about how to coach CDCM for TU/e staff who will be confronted more and more with the kind of issues
* Provide input for the development of a vision for the innovation space.

# Deliverables

* A hand-out with lessons learned, nice to knows and need to knows with respect to coaching students that work on CDCM.
* A list of competencies pertaining to coaching students that work on CDCM
* On-line materials (e.g. self-assessment form, observation form, peer-assessment tool) that is part of a professional development module on how to coach CDCM for TU/e staff
* Summaries of the literature with denominated what useful ideas can be found within for coaches
* A questionnaire to measure effects of coaching students that work on CDCM
* Contribution to a Conference (e.g. ORD, Surf, ECENT, ESERA) and/or paper for a practical journal about what good coaching of CDCM entails when viewed from a practical perspective
* Assignments for the course ‘Teacher competencies for innovative Science subjects’

## Dissemination

The goal of the project is to provide useful deliverables. We will disseminate products via the 4TU.CEE website, during presentations at conferences and via the DPO website/intranet. Obviously, we will also present at the TU/e Education Innovation Day. . Furthermore, The Eindhoven School of education will incorporate the outcomes of their program for future Technasium teachers and on their wiki. Finally, we will try to set-up a dissemination committee and organize a meeting to come up with a more defined plan for dissemination.

Signing

All participants, and Managing directors have approved the proposal via mail.

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# Appendix A – Response to the comments of the review committee

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| Your project proposal “How to coach students that work on complex design challenges of a multi-disciplinary nature” has not yet been granted in the current status. Recommended is to write a new proposal that incorporates more faculties, is more concrete and proposes dissemination.  | We have rewritten the proposal and included a course provided in the context of a USE learning line. The course is offered by teachers from 5 departments. We also included a course of the new ID USE Trajectory. Furthermore, we have added a member of DPO teach in the proposal. We have tried to make the proposal more concrete. However, we deliberately defined the project in an open way, leading to less concrete activities and less clear defined outcomes. In this way, we can adhere to the beliefs and needs of teachers. Furthermore, we have included a dissemination plan.  |
| The proposal refers to a problem that is acknowledged by the committee: coaching of students in a multidisciplinary context. The submitted proposal however, is designed very specific on the situation within Industrial Design and on the on Complex Multidisciplinary Design Challenges. The committee would like to receive a new proposal with emphasis on research questions 3 and 4.  | In the resubmitted proposal we did not exclude the first research questions because we believe these questions to be a valid addition to the proposal. We did considerably elaborate on research question 3 and 4.       |
| Besides, it is important regarding dissemination, that project participants are not just within Industrial Design but with true multidisciplinary teams. The committee suggests involvement of for example Built Environment, OGO or for example the new ID USE Trajectory.   | As stated above, we included two additional courses. A course, part of a use learning line, provided by teachers from 5 different departments and a course part of the new ID USE Learning trajectory.  |
| Lastly, DPO can be a valuable addition, which also helps with the dissemination through for example training sessions by DPO.  | A member of DPO teach is included in the proposal.  |
| The committee would like to see a proper dissemination plan within the new proposal which clearly states how the results and the products of the project will be sustained within the TU/e organization.  | We have included a dissemination plan that explicates how we will make the results sustainable  |
| The Advisory Committee would like to receive the adjusted proposal before the 5th of December, 2016. Once timely received, the committee can guarantee the projects approval for the TU/e Innovation Fund before the start of the new year.   I hope to have informed you sufficiently based on this e-mail and we are looking forward to the adjusted proposal. If you have any further questions, please do not hesitate to ask.  | Unfortunately, it took considerably more time to resubmit this proposal. This is caused by several reasons. Firstly, the project leader was on a two-weeks leave. This time coincided with the deadline for resubmitting the proposal. Secondly, it took us considerable time to find a useful course, convince teachers to participate and formulate a clear question that fits the goals of the project and fulfills the needs of the teachers as well. We hope the Advisory committee is willing to take this project proposal into consideration.  |

1. For the teachers of the Master SEC, the interviews will be part of their course ‘Teacher competencies for innovative Science subjects. These teachers are trained to work in Technasium schools, a type of Dutch secondary schools where student work in teams on authentic design and research problems. [↑](#footnote-ref-1)