

3TU. CENTRE FOR

ENGINEERING EDUCATION

Progress Report



TU Delft Delft University of Technology

TU/e Technische Universiteit Eindhoven University of Technology

UNIVERSITY OF TWENTE.

'Innovating engineering education for tomorrow's engineer'



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Word of welcome

A good start and more to come

We proudly present our progress report. In the two years since our formal kick-off much has been achieved. In this report we provide an overview of these achievements and activities that were organised. Our network setup with a combination of both joint and local projects works well, and the progress we have made has culminated in a very successful European conference on engineering education, held in Delft on 24 - 26 January 2016. Four keynotes addressed the theme 'Inventing tomorrow's engineering education' from different perspectives, while over 160 engineering education experts and teachers contributed actively in the workshops, making it clear that the subjects we work on are shared by many.

While much has been achieved, we still see sufficient challenges ahead of us in which we want to make a difference:

- Inspiring the teaching staff with seminars about teaching and learning of, for instance, creativity and innovation skills, intercultural learning, etc.
- Supporting our departments in upgrading their curricula with new pedagogical methods or new learning outcomes to meet 21st century needs and possibilities.
- Developing and incorporating interdisciplinary education in engineering curricula with specialist staff.
- Designing and testing new blends of learning in the area of mathematics for engineers, working closely with our 3TU.AMI partners.
- Helping the teaching staff to handle the large numbers of students while maintaining quality standards and active learning elements in their course design.
- Rewarding teaching excellence and offering staff educational challenges beyond the basic teaching qualifications.
- Supporting our staff in finding access to research and exchange grants in the area of engineering education.
- Identify which professional skills will help prepare engineers for entrepreneurship, and how to integrate them to some extent already in the curriculum.
- Visualisation can support learning in many ways. Virtual labs is a promising direction of which we will explore the potential.

To maintain our momentum it is important to set our horizon beyond 2018. We aim to change our sector plan project status into an institutional one. At the same time we are seeking synergy with educational research and support units at each of the TUs.

Kind regards,

Executive Board 3TU.Centre for Engineering Education

3TU.CEE Executive Board and Coordinators



Jan van der Veen



Lisa Gommer

UNIVERSITY OF TWENTE.



Aldert Kamp



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Technology



Perry den Brok



Chantal Brans

TU/e Technische Universiteit
Eindhoven
University of Technology

Introduction

The world is in need of more and differently trained engineers who are able to tackle the major societal challenges in the fields of energy, safety and security, health, mobility and the environment.

The 3TU.Centre for Engineering Education (3TU.CEE) contributes to the provision of inspiring and effective engineering education that will prepare engineers for these challenges by facilitating innovations in education programmes within and beyond the Netherlands. 3TU.Centre for Engineering Education was founded by the 3TU.Federation, an alliance between Delft University of Technology (TU Delft), Eindhoven University of Technology (TU/e) and Twente University (UT).

The goal of 3TU.CEE is to ‘jointly inspire, stimulate, support and disseminate effective and high quality engineering education through research and application of evidence-based innovations.’ 3TU.CEE is the place for teachers and scientists with questions and ambitions in the domain of Engineering Education.



Aims of 3TU.CEE

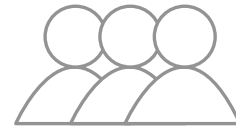
1. To create/contribute knowledge and expertise on innovative engineering education by conducting joint in-depth studies and local projects close to daily practice.



2. To disseminate research, good practices and tools for innovative engineering education to teachers, educational managers and researchers.



3. To stimulate the professional development of teachers in engineering education by organising meetings, providing information and through other activities.



This report provides an overview of the centre's activities in the first period of its existence, starting with the official 3TU.CEE Kick Off on 23 September 2014 in Delft up until April 2016.

The focus of 3TU.CEE on innovation in engineering education in order to stimulate design-based, sustainable and interdisciplinary engineering education is what distinguishes the centre from other cooperative activities between universities in the Netherlands.

In this report, 3TU.CEE shows what progress has been made in achieving its goal. Projects and activities have been clustered on three different levels: 1) university, 2) programme and 3) course level. A selection of the results is discussed briefly, as are their impact and a preview of what is yet to come. The icons behind the project title refer to the main aim(s) of the different projects. A more extensive activity overview can be found on our website: www.3tu.nl/cee.



1. University level

Comparing Bachelor Curriculum Innovations

To gain more insight in educational practice within the 3TU universities, an exploratory study was conducted on the intended curriculum innovations at Bachelor level. The innovation plans for these Bachelor's programmes at the 3TUs were described and compared with respect to their goals, curricular structure and educational design. It was for example interesting to see that Twente and Eindhoven had the same drivers for change, but they chose a different approach for implementing the curriculum innovation. A report with outcomes of the study is available.

Next, the implemented curriculum (Van den Akker, 2003) was explored by a new research team. The focus was the uniqueness of developing and implementing engineering course programmes. The findings show no real differences between disciplines; the university and the individual circumstances of the programmes have a higher influence on the implementation of the innovation. The study showed that problem- and project-based learning are teaching methods often used in engineering education. Curriculum innovation in a STEM setting is being approached as a large design assignment. When looking at the processes in the case studies, it can be concluded that the analysis phase of the design phase is often skipped and that there is little attention for the social aspect of the innovation to avoid too much fuss.

Impact

Outcomes of the first study can be found in the report: 'Comparing Bachelor Curriculum Innovations at the Three Technical Universities' (Gommer, Klaassen & Brans, 2015). A paper was presented at the SEFI conference to an audience of education experts and a workshop was given at the 3TU.CEE/CDIO conference. The report, paper and workshop presentation are available on the 3TU.CEE website (<https://www.3tu.nl/cee/en/publications>).



Henk Schellen
(Associate Professor at TU/e)

”

“From my research for 3TU.CEE I learned an important management rule. If a small minority of the people in charge of an important change in e.g. curriculum does not agree, or has an opposite opinion, there are two ways to go: convince them of the necessity of change or release them from their duties. On the other hand, if a vast majority has another opinion than the Executive Board in charge, the Executive Board should reconsider the change or come to its own conclusion.”

Preview

At Civil Engineering (UT), Built Environment (TU/e) and Electrical Engineering, Mathematics and Computer Science and the Faculty of Architecture and the Built Environment at TU Delft, a smaller research project will focus on the third phase, the attained curriculum. This research will focus on the question of whether the implemented curriculum innovation has led to the desired results at programme level (e.g. improvement in study rate).

People involved

UNIVERSITY OF TWENTE.

TU/e Technische Universiteit
Eindhoven
University of Technology

TU Delft Delft
University of
Technology

Lisa Gommer

Chantal Brans

Renate Klaassen

Charlotte
Oude Alink

Henk Schellen

Maartje van den
Bogaard

Marie-José
Verkroost

Ruth Graham



On March 25, 2015, Ruth Graham visited TU/e for the evaluation of the TU/e curriculum redesign. She also gave a lecture to a group of educational innovators during this visit. In this lecture, she talked about the challenges and opportunities universities face in creating engineers that are fit for the 21st century. The group of 20 people consisted of both teaching and support staff. To educate the engineers of the future, Graham's advice is to include 25% project-based experiences, including first-year team projects, and scenario-based experiences throughout the curriculum, and 60% engineering fundamentals including common subjects taught across disciplines.



Rewarding Teaching Excellence



Many universities are struggling with the issue of how to balance research and education in career paths. Partly this is caused by a strong focus on research. The lack of good measures for educational achievements is also a reason why education efforts are not valued as much. A snapshot needs-analysis of the University of Twente based on a number of interviews was presented on 30 November 2015 by Ruth Graham. The analysis showed that staff do not see teaching efforts appreciated as much as they would like. Options how to move forward were then discussed. Ruth Graham developed a template for the Royal Academy of Engineering using international examples and literature. The four-level model for the educational career side was received well, in particular because measures were included. Starting an Academy for Teaching & Learning like the University of Lund is another option that will be investigated. Ed Brinksma (Rector Magnificus) concluded that we now have tools to take the next steps in creating rewarding teaching.

Impact

Two faculties of the University of Twente decided to run a pilot in which education is emphasised in annual appraisals and promotion interviews. All three universities of technology are now looking at what comes next after basic teaching qualification trajectories.

Preview

Via the Royal Academy of Engineering, a network of international universities, including 3TU.CEE, is now working together on the topic of rewarding teaching excellence, see also: www.evaluatingteaching.com. Teachers will be challenged to go beyond the basic teaching qualifications. The results of their endeavours will be shared across TUs and internationally.



Dr. Ruth Graham
(Consultant in engineering
Education)



“The Royal Academy of Engineering study is now working with 14 top-ranked universities from across the world to pilot and review a new approach to evaluating and rewarding teaching achievement. While most of these partnerships are institution-specific, working with the 3TU.CEE has allowed the study to consider the needs of Dutch universities from a national perspective. Through targeted networking activities by the 3TU.CEE – including conversations with the national government and universities from across the country – considerable potential exists for the Netherlands to develop a coordinated national approach to tackling an issue that is of increasing concern to universities across the world.”

PhD network

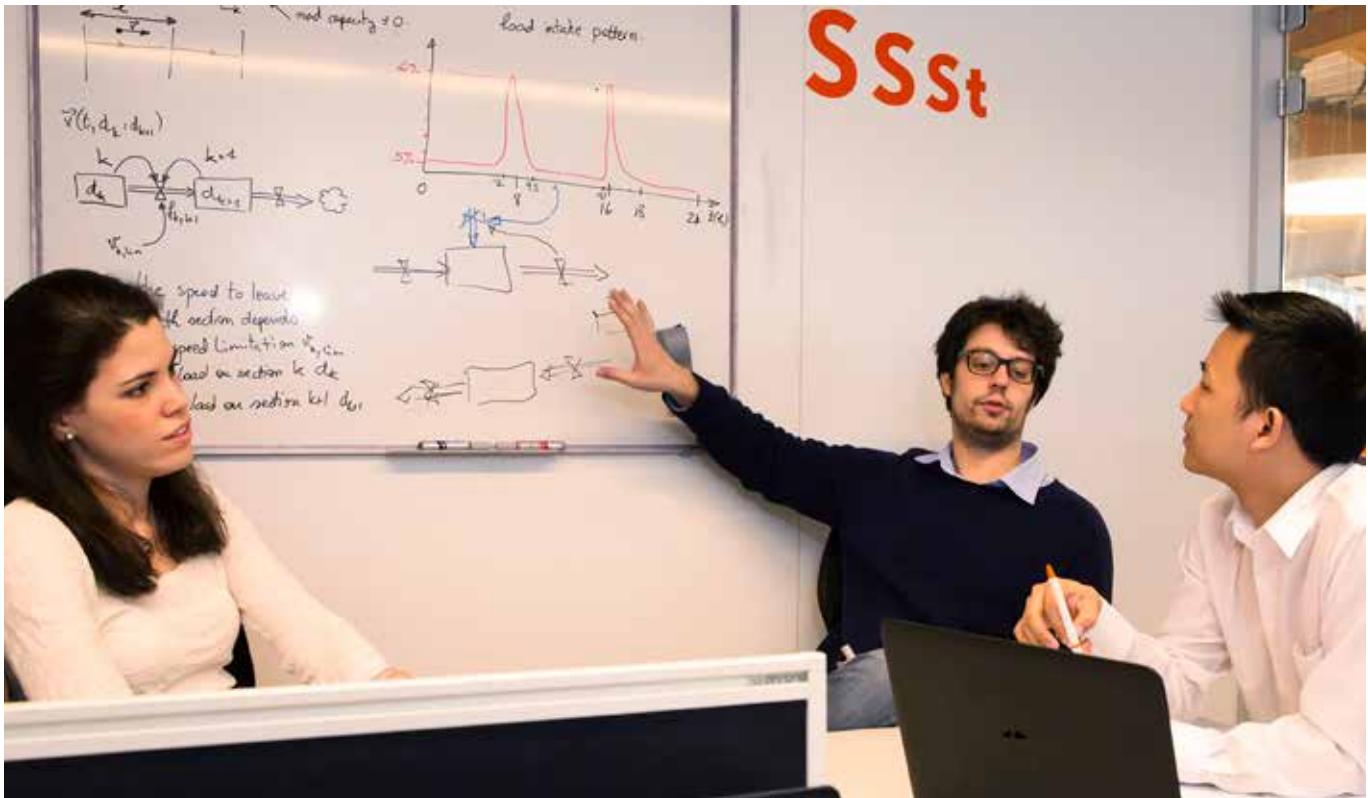
PhD research on higher education is limited, and even scarcer with respect to higher engineering education in particular. However, a growing number of studies is in progress. Within 3TU.CEE, projects started for example at Twente and Eindhoven (see next paragraphs). At the 3TUs, PhD studies have also been conducted within the engineering departments or within the teacher education institutes. In a similar fashion, engineering education research is being conducted in international partner institutes, such as Chalmers, KTH and Aalborg. 3TU.CEE started an inventory of PhD studies (ongoing and past work) and makes this available via its website (http://www.3tu.nl/cee/en/about_us/promovendi/).

Impact

The network of PhD studies and stimulating research in higher engineering education is important. During the 2016 CDIO meeting in Delft, a workshop was held on Engineering Education Research, hosted by Kristina Edström. This workshop had approximately 20 international participants, who were eager to follow up with a PhD network.

Preview

The next step is to flesh out this list into an international and live network of PhDs that meets at conferences and/or exchanges information in several ways.



PhD project on frequent assessment in engineering education



At TU/e more emphasis is being put on frequent assessment within engineering courses, on the one hand to stimulate learning and organise feedback, and on the other hand to increase student outcomes. How to organise such assessment in the most efficient and effective way is, however, an unanswered question, and little knowledge is available regarding this issue. Therefore, this PhD project will investigate different configurations of frequent assessment and factors involved in this design, such as course characteristics, grading, motivation of students, perceptions of assessment of teachers and students, and assessment characteristics and their interrelationships. A pilot study was conducted in the context of a Bachelor's mathematics course. The results showed that students liked the frequent tests, but that only half of them experienced these as providing useful feedback for their own learning.

Impact

An article on the pilot study has been submitted to the Higher Education journal. A presentation was given at the TU/e educational innovation day.

Preview

In 2016, the aim is to finish a literature synthesis, construct instruments for mapping frequent assessment practices and investigate a series of engineering courses in this respect. Also, presentations will be given at the TU/e educational innovation day organised by 3TU.CEE and at an international conference.

People involved



Bram Vaessen



Lex Lemmens (Dean BC, TU/e)

”

“Frequent interim assessments increased the group of students at TU/e studying nominally after year two from 16 to 41%. However, the system of frequent assessment is not popular with all students and staff. Bram Vaessen’s research will help us improve the system so that this spectacular success is not jeopardised.”



PhD project on teacher professional development



In her PhD research, Inken Gast is working on the topic of teacher professional development in teams in higher education. Her research focuses on individual teacher learning and teacher attitudes in the context of Twents Onderwijsmodel (Twente Educational Model, TEM). For her first study, she conducted a systematic literature review which provides an overview of the effects of working in teacher teams in higher education on teacher learning and teacher attitudes. Furthermore, she identified several factors at individual teacher level, at team level and at organisational level that influence teacher learning and teacher attitudes in a team context. For her second study, she conducted a UT wide survey among TEM module team members to further study the effects of individual, team and organisational level variables on both individual teacher learning in TEM module teams and teachers' attitudes towards TEM. Finally, to further study teachers' attitudes towards TEM as well as how and what teachers learn while participating in TEM module teams, she has followed several UT module teams intensively by recording and observing their team meetings and interviewing all team members.

Impact

The research has so far resulted in two conference papers and presentations at the EARLI 2015 and SEFI 2015. First results were shared with directors of education, educational support staff and educational researchers stressing the importance of considering the module teacher teams as key to successful innovation of education.

Preview

A review article has been submitted filling the gap of expertise that was found in literature on team-based professional development in higher education. Articles that connect to the specifics of the Twente Educational Model setting are prepared.

People involved

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Inken Gast



PhD project on collaborative learning

At universities, teaching has mostly been an autonomous and individual task. With the introduction of the 'Twente Onderwijsmodel' (Twente Educational Model, TEM), teachers at the University of Twente became collectively responsible for teaching 15 ECTS modules. This has led teachers to collaborate in module teams in order to design and teach their module. By adopting a team learning perspective, we aim to shed light on the communication and decision making processes occurring in the teacher teams, and relate them to different measures of team effectiveness. Such measures are perceived team performance and viability, and student satisfaction. We distinguish team learning processes within the team and between the team and external parties, and investigate how these emerge from team interaction and how they influence team decisions and effectiveness. The data consists of a team learning questionnaire, filled in by 440 teachers from 129 teams working on module design, and about 100 videotaped meetings of different teams designing and teaching their module.

Impact

The research has already resulted in two conference papers and presentations at the IURE and EARLI 2015.

Preview

The outcomes of this study will be used to formulate guidelines for (supporting) effective team learning. A series of articles and a thesis will be published.

People involved

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Rike Bron



Irene Visser-Voerman
(Head of Centre of Expertise
in Learning and Teaching,
at UT)



“Working with the 3TU.CEE has given us the opportunity to ask two PhD-students to study the design and implementation processes of several teacher design teams. It provides us with deep inside knowledge on the relationship between the way teams operate and the outcomes of team work, as well as on team-learning and individual learning. Also 3TU.CEE allows for a few educational advisors to study, compare, and contrast elements of our innovation to those of the two other technical universities. This not only enriches our knowledge on curriculum innovation in general, but is also motivating for the advisors involved, who can incorporate their experiences in a better advice to teachers and directors of education.”

2. Programme level

3TU.Study – Collecting and defining innovations at programme and course level



Besides Bachelor curriculum innovations, innovations on a smaller scale continuously take place as well. Each of the three institutions constantly innovates its educational programmes and courses. Engineering education projects that are very relevant to teaching staff and programme management are often inaccessible for others outside one's own department or institution. A 3TU.CEE project group is cooperating to collect examples of successful innovations in engineering education, which are then shared on the 3TU.CEE website.

Innovation has been defined in many ways, in the current study, the research team looked at it as the idea, the process and the product or outcome of the process. The question whether an innovation is successful or not is not easily answered. The team indicated success and fail factors by doing a literature review and by examining innovations in the innovation map. This resulted in a long list of success factors. This tool may help teachers in the future to check whether an innovation has a chance to become successful. It may serve as a guide in the implementation phase, but it can also help teachers enhance the sustainability and diffusion of an innovation.

Impact

Currently many innovations within our universities remain isolated because teachers lack the time and/or need to disseminate the innovation. 3TU.CEE plays an essential role in this process by detecting and disseminating the innovations in the digital innovation map.

Preview

The innovation map is currently being redeveloped with the knowledge and expertise of the research project and in dialogue with teaching staff. In September 2016 the new and more user-friendly innovation map will be available. The research team proposed a workshop for the 2016 SEFI conference and will have the full results on the research ready in the summer of 2016.

People involved

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Hans van den Berg Chantal Brans

Dury Jacobs

Kim Zunderdorp

Dury Jacobs (Post doc researcher, TU Delft):

“Having a PhD in educational sciences and post-doc in science education, I have an interest in researching education innovations in higher engineering education. I think education innovations play a key role in preparing future engineers, who will be building our future. I am keen to find out the key variables and success factors for education innovations in higher engineering education, as to stimulate successful education innovations.”

Workshop Kristina Edström



On 2 February 2015, Kristina Edström visited the University of Twente and provided a workshop on Engineering Education Research for educational management and teaching staff. 26 people attended the workshop. A discussion was held on the topics relevant to engineering education research, the effect it should have

on curricula and what distinguishes engineering education research from general higher education research.

Impact

A total of 26 participants, including teaching staff, programme directors and policy advisors from different departments were informed about engineering education research. Innovations are now being implemented in several courses in Twente.

Preview

In different departments at UT, four projects have been initiated in which an engineering lecturer/researcher implements an innovation into his/her own course and carries out research on the educational effects. A researcher with expertise on educational design research (Prof. Susan McKenney) is available for support.

“



Lisette Woud (Programme coordinator Civil Engineering currently seconded to the Strategy & Policy department of the UT)

“It was inspiring to see that this is also educational research and fascinating that it is still such a new and small discipline. What also interested me is that the research methodology partly resembles the research methodology in engineering (and engineering education).”



3TU.Study - Investigating Interdisciplinary Engineering Education

The engineer of the future should be able to collaborate in interdisciplinary teams. There is a need for experts specialised in working on the juncture between domains. Yet true interdisciplinary engineering education is a challenging task: can we create courses and tasks that are truly interdisciplinary? How can we assess interdisciplinary learning and learning outcomes, when teachers are experts on a particular (sub)domain? To answer these and other questions a team of researchers from 3TU has conducted a literature review on interdisciplinary education and interdisciplinary collaboration in higher engineering education. This resulted in a framework and tools for curricular analysis. A variety of interdisciplinary engineering courses from the different universities is currently being analysed, including Built Environment, Automotive and Technical Medicine. Preliminary results suggest that in many cases a culture for interdisciplinary collaboration is lacking: people have difficulties in crossing boundaries, creating new languages and tools, and in taking new perspectives. Also, there are signs that the goals may often be interdisciplinary in nature, yet the content and assignments of students, as well as the way in which they are graded, are more multidisciplinary in nature. The challenge is to strive for interdisciplinary learning goals with a multidisciplinary team. Well-chosen tasks and experts in charge with an interdisciplinary background are key factors for success.

Impact

Results were presented at the TU/e Educational Innovation Day and at the CDIO conference in Delft. At the CDIO conference, a workshop was also conducted. A report was published on the course of Technical Medicine from UT. In the next stage, course teams will be supported in their redesign efforts while using the outcomes of this study.

Preview

In 2016, the literature review, an analysis framework, and



Maarten Steinbuch (Professor at TU/e):

“Introduction to ‘system thinking’ should be standard for engineering students, so that students are able to think outside of their own discipline, make connections and cooperate with experts from different fields.”

tools for redesigning interdisciplinary engineering courses will be completed. These will be made widely available through the 3TU.CEE Innovation Map. Also, presentations will be given at international conferences and reports on the project will be submitted to international peer reviewed journals in the form of articles. Based on the analyses, individual courses and their teachers will receive feedback. With a small group of motivated teachers, courses will be redesigned using the tools and framework for interdisciplinary engineering education.

People involved

 Technische Universiteit
Eindhoven
University of Technology

UNIVERSITY OF TWENTE.

 TU Delft
Delft University of Technology

Antoine van den Beemt

Jan van der Veen

Marco Lub

Anne van de Ven

Sophie van Baalen

Renate Klaassen

Perry den Brok

Mieke Boon

Miles Macleod

TU Delft FREE SPIRITS Think Tank

To be able to stay in the top 100 of technical institutions in the world, TU Delft is continuously innovating its educational programmes to prepare students for the rapidly changing world. In the FREE SPIRITS Think Tank, TU Delft directors are looking ahead to the year 2030 and to the capacities students need in the anticipated near future without losing core strengths. Five meetings were held with a representative group of 12 academic staff members from the faculties, the Valorisation Centre and student bodies. The key question was: 'What will our students need to learn in 2030?' Options were explored via Design Thinking, a method known for its effective creation of out-of-the-box solutions for new ways of working. Establishing the biggest needs at present, ideation based on possible future worlds and the building of a concept are all elements of the 'What' question. The meetings were fuelled by survey data on trends in science, numerous small informal workshops and a FREE SPIRITS Facebook page on which progress was shared with the TU Delft Community.

The exploration points into the direction of differentiation in engineering roles during the study, the reframing of societal problems into engineering cases for authentic and multidisciplinary learning and the creation of common engineering languages to realise mutual understanding of Engineering.

Impact

The provisional Think Tank outcomes were presented to and discussed with various audiences at TU Delft (e.g. Directors of Education meetings, faculty education days, faculty professor conferences, MT retreats, Advisory Council meetings). The outcomes were discussed in industrial partner meetings (Airbus Group University Partnership (meeting in Paris, June 2015), Royal HaskoningDHV (November 2015), and in workshops at the CDIO Meetings in Belfast (November 2015) and Delft (January 2016). The outcomes will also be

presented at the CDIO Annual Conference in Turku in June 2016 and discussed with academics and industries in a workshop at the Hannover Messe in April 2016. Consultation with industrial and academic stakeholders will tell us whether the Think Tank ideas make sense. These ideas are: common engineering language across all disciplines, profiling on top of disciplinary specialisation, and the exploitation of hubs as pockets of knowledge for interdisciplinary learning. The TU Delft's Think Tank project, organised under the umbrella of 3TU.CEE, has a high visibility and is expected to have significant impact on the future of engineering education in Delft.

Technical Review Committee CDIO Conference June 2016:

"This is a masterly wide-ranging review of the future at TU Delft (and, I hope, elsewhere). The authors and their colleagues are to be commended on presenting such a stimulating analysis. This deserves to be highlighted as a plenary presentation."

Preview

In consultation with the Directors of Education, one or two implementation pilot scenarios will be implemented in 2016. The pilots will run at the Delft Infrastructure & Mobility Institute and probably at the Faculty of Technology, Policy & Management. The objective is to validate, test and evaluate the new ideas. Parallel to this process a working group will establish an educational vision and policy document for the university. This will be done in consultation with all Deans and Directors of Education, taking the Think Tank outcomes as major source of information and way of thinking. This new vision will be an important chapter in the report for the Institutional Quality Assurance Assessment (InstellingsToets Kwaliteitszorg, ITK) in 2016 and outline the future development of education at TU Delft.

3. Lecturer / course level

Multidisciplinary course assessment with multiple assessors



A challenge in the theme of multi-disciplinary education is the assessment of the work of students. Students have



to apply theories and concepts from different academic disciplines but safeguarding their educational and assessment quality is difficult, because the assessors are typically specialists, not generalists. In an integrative course (IE Quick scan), students have to apply theories and concepts from five different academic fields and perspectives: Accounting and Finance, Human Performance Management, Information Management, Operations Management, and Innovation Management. Many staff members are specialist in one discipline and lack expertise to grade the students' multidisciplinary work. This project investigates what this means for the accuracy and validity of the assessments and how and whether this procedure can be redesigned.

Impact

The goal of this project was to examine the requirements and design of multidisciplinary assessment. The results of this project (expected summer 2016) provide information on the accuracy of (partial and overall) grades accounting for assessor expertise. The findings allow to conclude which approach, analytic or holistic, is preferred to assess assignments in the multidisciplinary course IE Quick Scan, resulting in reliable, valid assessments, irrespective of the assessors' expertise.

Kelly Meusen (PhD researcher at TU/e):

"The accuracy of multidisciplinary assessment: is the whole the sum of the parts? That is what we want to find out."

Preview

A literature review was used to gain insight into the effectiveness of multidisciplinary assessment and its conditions. Interviews with assessors and students generated insights into the actual assessment process in the IE Quick Scan. Also, data from a quantitative study are currently being analysed to examine whether lower expertise on a subject impairs the reliability of assessments and affects grading decisions negatively. The need for further research is emphasised to explore whether holistic or analytic approaches are preferred within the multidisciplinary course IE Quick Scan.

People involved



Kelly Meusen
Ad Kleingeld
Jeroen Schepers

UT experiment on student engagement

Student engagement is an important aspect and a reason for innovation on curriculum, department, programme and course level.

Based on theories presented and applied in the course 'Designing for Student Engagement' at Olin College in Boston, a third-year Bachelor's course at the University of Twente was redesigned to enhance student engagement. In the first year of the Bachelor's programme in Mechanical Engineering, maths education was taught in a new 'flipped classroom setup' to offer students more flexibility and stimulate active learning. The new setup was evaluated and student motivation was measured during the course using a SIMS1 questionnaire. In addition, a panel evaluation was held amongst first and second year mechanical engineering students in which they were asked to come up with ideas to stimulate student motivation and to rank ideas derived from motivational theory. Ideas that received a high score from students included:

- Contact with alumni to see application of theory in practice.
- Choose your own project group.
- Receiving individual feedback.
- Seeing connections between subjects and courses.
- Choose your own theme to elaborate on in more depth.

Impact

Based on the findings and theory on student motivation and study success, a programme for enhancing student engagement was implemented in the 1st semester, including a study support programme (Leren Studeren WB), student mentor groups and redesign of one of the courses in the first quarter. The results will be documented in a paper. A 'recipe' for motivating students hasn't been found yet, but doing these experiments in different educational settings has increased our understanding of student motivation and provided us with some information on what works and what not. Also, these experiments have contributed to the

awareness of and interest in student engagement. At UT, the educational day was organised around this theme.

Lisa Gommer (Educational advisor at the department of Engineering Technology and UT coordinator for 3TU.CEE):

"Once students take up ownership of their project or assignment and become inspired by it, it is great to see how they cooperate and bring about creative and high quality end results."

Preview

At the Department of Mechanical Engineering both the flipped classroom and the study support programme will be evaluated. Based on the evaluation outcomes and our experiences improvements will be made and the pilots will be repeated. Afterwards, results will be compared. Also, a 3TU.CEE research project on the use of a digital portfolio to stimulate active and self-directed learning behaviour was initiated at the Engineering Technology department.

People involved

UNIVERSITY OF TWENTE.

Lisa Gommer



Visit Eric Mazur

In November 2015, Eric Mazur, Professor of Physics at Harvard University and educationalist, visited several universities in the Netherlands. On 25 November, Professor Mazur attended the University of Twente at the invitation of 3TU.CEE and shared his ideas on education and assessment. He also gave two fully booked workshops on team-based learning for lecturers from the engineering programmes and the science programmes.



During these workshops, teaching staff from 3TU had the opportunity to exchange ideas with Eric Mazur and work on further improvement of their education. Participants prepared for the workshop by bringing in a case or problem from their own educational practice.

In total 90 people participated in the workshops.

The lunch lecture was also made available for remote viewing through streaming video.

To raise interest for the lunch lecture and the workshops and to make 3TU.CEE known to a broader public, a website was set up in cooperation with Leiden, Delft and Groningen. To raise awareness an article was also published in the



November issue of the UT news magazine with information about Eric Mazur and 3TU.CEE: www.utnieuws.nl/magazines.

Impact

Afterwards, the lunch lecture was made available on the 3TU.CEE website. A workshop report and testimonials from workshop participants were also disseminated through the website.

Eric Mazur's keynote presentation and workshops have inspired many lecturers and educational advisors to experiment with new educational methods. Some have implemented Perusall in their courses to stimulate active preparation of classes, others have tried team-based teaching methods or started using peer instruction during lectures. The keynote also led to discussions about meaningful assessment methods.

“

Andreas Hartmann
(Associate Professor at
Construction Management
& Engineering (UT), interim
Programme Director of the 3TU
CME master)



“It was a very inspiring workshop providing a couple of fresh ideas for teaching. I have already successfully tested one of them – a group approach for examination – in my classes.”

Preview

A follow-up workshop was organised on 31 March, allowing participants to work on their own courses and develop a ready-to-use idea. Lecturers who had already implemented some of Mazur’s ideas in their courses were invited to share their experiences. Eric Mazur himself participated through Skype to provide the participants with feedback.

New workshops and keynotes with other educational innovators (e.g. Carpenter, Kristina Edström) are being planned for ongoing stimulation of educational innovation.



Kristina Edström's Teaching Trick

On 10 December, Kristina Edström provided an inspiring workshop on her Teaching Tricks for 22 TU/e teachers in which she explained how to improve student learning with a given level of teaching resources. Edström: "Teachers are often under time pressure. It pays off to do less of that what doesn't contribute to improving student learning and do more of what does". An important observation was that letting go of the old, ineffective patterns is very hard. We tend to keep doing things that are less effective for learning because we don't know what the new will bring. One insight Edström provided was to spend less time on finishing student work for them by giving feedback in a different manner. She also showed that an oral exam can be just as time efficient as a paper exam, up to a maximum of 60 students. While generally it is thought that oral exams cost much more time.

Impact

The workshop inspired the individual teachers and put them in a positive mood. Kristina also spoke with educational directors and policy advisors and the topic of efficient and qualitative education is now on the agenda.

Preview

Kristina Edström's Teaching Trick tour will visit the three universities on 2 – 5 October 2016. Kristina will be accompanied by a teacher who has brought her design principles into practice. The principles will also be applied to the courses of the participating teachers during the lectures and workshops to put inspiration into practice.



Jan Smits (Professor at TU/e)

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“Driven by her passion for educating engineers Ms Edström gave me insights for easy applicable educational tools that already allowed me to save a great deal of time while increasing student involvement. I would like to learn more from her experiences through a follow-up presentation or literature on this subject.”



TU Delft - Creating Adaptive and Innovative Questions

In order to be able to educate the more diverse engineering student population and cater to more diverse study programmes, digital tests are increasingly being used. Generally, these digital tests are at best a literal implementation of the paper-based test, which take away the opportunity for students to clarify any process steps normally taken during a paper-based test. As established by evaluation results among 1556 students at TU Delft, these 'default' digital tests are unfair and not always appropriate for the type of courses they need to assess.

New software allowing for adaptive and innovative digital testing (matching maple TA software) is showing great promise for overcoming the difficulties students are experiencing with the digitalisation of paper-based tests. It is assumed that innovative digital testing will lead to better and improved tests, not as compared to paper-based tests, but as tests in their own right. Therefore, it is hypothesised that the digital innovative item type main/sub questions as used in this research project will create added value in reliable and valid (as in construct validity) digital test constructions. The hypothesis is studied using two main research questions:

1. What is the added value and underpinning of the innovative item formats main/sub questions regarding construct representation in the Engineering domain?
Six lecturers have converted their paper-based questions according to protocol into digital innovation questions. The converted items are analysed with students via stimulated recall sessions, to study whether learning objectives are reliably and validly covered.
2. What factors of the innovative item formats main/sub and underpinning decrease validity by introducing construct irrelevant variance in the Engineering domain?
A perception questionnaire prior and post intervention



Erik Offerman
(Associate Professor Materials
Sciences 3mE-TUD)

”

“These sessions on converting my exam questions from a written test into a digital test, really made me think deeper on my learning goals and how to evaluate these goals. I believe this digital test is a better version.”

are used, besides focused student interviews to study irrelevant variance factors in the test environment.

Impact

A well-attended workshop at the ETALEE conference (DTU-Denmark) was held in November 2015 on the redesign of exam questions, using technology enhanced item types in adaptive scenarios. This workshop was repeated in the spring of 2016 at TU Delft. A proposal has been submitted for the European ATP Conference.

Preview

Locally, several coaching sessions have been held with the relevant staff from three different courses, resulting in digitalised exam questions using technology-enhanced item types in adaptive scenarios. For two more courses, material science and civil engineering, the created sample questions are currently being tested among the student population.

An official exam version will follow after the testing period. The tested methodology will be used to help other teachers create a valid and reliable digital exam with innovative questions. We expect that the involved teachers will serve as ambassadors for the rest of the institution.

People involved



Celine Goedee
Meta Keijzer-de Ruijter



TU/e Innovation Projects



Being aware of what you know and what you don't know gives direction to students' learning. Students therefore benefit from adequate feedback when performing their tasks. In 2014, the theme of the TU/e CEE innovation fund was feedback. Lecturers were encouraged to use educationally innovative forms of feedback within their own educational setting to improve the feasibility of the study programs. This resulted in an experiment with concept mapping as an educational form, a study to be able to provide efficient feedback, an evaluation of a frequently used feedback method, a tool to make students better at asking for feedback, a tool to improve direct feedback, an experiment with peer feedback on study progress and a method in which students are able to test their prior knowledge on a course.

In 2015 the theme of the innovation fund was 'Realising small-group or individual education with an increasing student population'. Nine projects implemented innovation on this topic and many of the projects have a blended learning component. Realising personal education within an increasing student population was a follow-up on the 2014 project Mining and Visualising, which resulted in a further tested and developed feedback tool named FEEDBACK.CAMP. The 2016 theme of the innovation fund was 'Blended learning and new ways to supervise education'. In this call projects with blended learning and/or where supervision takes place (one or a few students), such as (final) projects, internship or graduation research. With the increasing numbers of students, a decreasing time for supervision, efficiency / innovation in this form of education is a necessity.

Impact

The end results of all of the projects have been distributed on the 3TU.CEE innovation map and were also presented at several conferences and at the TU/e Innovation Day. The teachers continued to use it. One project has also already been put into daily practice in Delft. The 2016 projects are still in progress. An overview of projects can be found in the table on the next page.

Preview

The teachers involved in the projects are educational frontrunners and are well known in the wider university community. The projects are being published in the innovation maps, but are also presented on different education days, within the departments and the TU/e wide Innovation Day.



Project title	Innovator
Enriched Skeleton Concept Mapping and student feedback	Frank Delbressine, Ton Marée & Marieke Thurlings
Organising and providing effective feedback to students	Carry van Weert
More and better feedback through Carrousel evaluations	Faas Moonen, Tom Veeger
Asking for feedback	Ruurd Taconis, Marieke Thurlings & Migchiel van Diggelen
Mining and Visualising a Database to Assess and Improve Quality of Teacher Feedback in Industrial Design Education	Mathias Funk & Migchiel van Diggelen
Supporting 2nd year Bachelor's students by providing online peer feedback on study progress	Sonia Gomez Puente
Getting a heads up on prior knowledge	Bianca
Efficient creation and sharing of educational content via internet media	Jean-Paul Linnartz & Peter Baltus
Blended learning in Technology Entrepreneurship education @TU/e	Isabelle Reymen & Myriam Cloodt
Realising personal education within an increasing student population: scaling up high-quality feedback and assessment in Industrial Design and the Bachelor College	Migchiel van Diggelen & Mathias Funk
Improving students' writing skills through effective small-group peer feedback	Sonia Gomez
BASIC - Boosting the Activity of Students in Between Contacts	Erik de Vink
Research projects in a 'studio setting'	Arjan Habraken
Taste your Future	Jolanda Vogelsangs
Integrating blended learning in physics courses: dealing with diversity in classrooms	Sonia Gomez
Instructing the right study effort in OSEUBO 'Patents, Design and Rights'	Gunter Bombaerts
Effective Teaching and supervision of students through the support of blended-learning tools	Sonia Gomez Puente
Towards a Blended Approach to Teach and Supervise Electrical Engineering Students	Sonia Gomez Puente
Efficient and Reliable Online Homologation Recommendation	Bas Luttk
Expedition Energy Transition: Educational Innovation for Building Tomorrow's Energy System	Boukje Huijben
FEedback on Exam for Students and Teachers (FEEST)	Hans Cuypers
Intermittent Quizzes in Video Lectures: Making Sure they Work	Daniel Lakens
Online Communication Platform for Mathematics Instructions	Rik Kaasschieter
Reducing teacher' Classroom Anxiety through a Virtual Internship	Anoine van den Beemt
Underpinned Scenarios and Good Practices for Teacher Coaching	Migchiel van Diggelen
EXCTRA - Exploiting the Click-TRAI. Assessing the benefits of Learning Analytics	Uwe Matzat
Blended learning improved tutorials, feedback and students' intrinsic motivation in OSABO USE Basic Course	Gunter Bombaerts

TU/e Innovation Day



The first TU/e Educational Innovation Day was organised on 1 October 2015. Over 20 innovations were presented on the Innovation Market. Prof. Marc the Vries provided an inspiring keynote and colleagues shared ideas on course redesign, blended learning and guided self-study during three workshops. Almost 100 TU/e employees attended the event, most of whom were teachers. The slides and video of the keynote are available via the CEE website and intranet. For more information, see: <https://intranet.tue.nl/en/education/3tucee/>.

Preview

The second TU/e Educational Innovation Day will take place on 5 October 2016.



Peter Baltus
(Professor at TU/e)



“The Innovation Day was truly inspiring with many new and very exciting ideas, several of which I would like to try myself. For example, next month I will already be doing my first exam using the carousel method.”

CDIO conference



More than 160 education professionals from 41 technical universities from all over the world gathered to exchange knowledge and experience about innovations in engineering education at the CDIO conference on 25 – 26 January. The theme was ‘Inventing tomorrow’s engineering education’. 3TU.CEE, the event organiser, looks back on a very successful conference with enthusiastic participants. Innovations in engineering education are badly needed to prepare the new generation of students for the rapidly changing needs of the 21st century, as was stressed by all four keynote speakers. More attention must be paid to multi- and interdisciplinary thinking, cross-sectoral collaboration, creativity and innovation skills in both Bachelor’s and Master’s degree programmes. Participants worked intensely with these themes in fully booked interactive workshops. The conference took place at the Faculty of Aerospace Engineering at TU Delft, member of the CDIO network.

Impact

Anka Mulder, Vice-President Education and Operations at TU Delft has shown her interest in the CDIO network for the whole university and hinted that full membership for the whole institution was being explored. The conference inspired UT, TU/e and the Idea League to further investigate CDIO membership. The Faculty of Electrical Engineering, Mathematics and Computer Sciences at TU Delft decided to join the CDIO as an active member.

Hester Bijl, Dean of the Faculty of Aerospace Engineering at TU Delft, booked keynote speaker Sabina Jeschke to come and speak to the team of full and associate professors about the rapidly changing needs in engineering education and inspire them to think about possible modernisation of the Master’s programme.

The conference provided high visibility: Twitter hash tag #cdiodelft; article in Delta, article in ScienceGuide and a 3TU.CEE Newsletter CDIO special.

Preview

3TU.CEE will make use of the CDIO network as international specialist platform of engineering educators and researchers for dissemination of results and inspiration for new initiatives. Furthermore two papers will be presented at the Annual

CDIO Conference by TU Delft, and Twente University in Turku, Finland in June 2016. 3TU.CEE will take the lead in establishing a European PhD network in Engineering Education Research (EER).



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Paul Hermon (Senior Lecturer and Programme Director - Product Design Engineering School of Mechanical and Aerospace Engineering, Queen's University Belfast)

“I really enjoyed the CDIO meeting at Delft. You put together a great programme. So much so that I had difficulty choosing which track to attend; a problem I don't usually have at conferences. CEE has raised the bar of what a CDIO EU meeting should be.”



4. Direct and indirect impact of 3TU.CEE

In only a short period of time, from September 2014 onwards, 3TU.CEE's core team managed to instigate many projects that contribute to the much needed innovation of engineering education. Besides publications, ranging from reports to conference contributions, activities such as workshops and meetings both large and small scale have been organised. This enabled education staff to learn about innovations, exchange ideas and actively participate. 3TU.CEE's activities, the 3TU.CEE website, and particularly the networks of 3TU.CEE staff at the universities, are

contributing to the increasing visibility of 3TU.CEE amongst education staff at the three universities of technology. Appendix 1 shows some data with respect to the direct and indirect impact of 3TU.CEE's activities.

An activity plan was set up shortly after 3TU.CEE was founded. In this plan, 3TU.CEE identified in-depth projects and smaller activities on several themes relevant to achieving its main goal. Appendix 2 shows an overview of the achievements and indicators that 3TU.CEE set itself when it first started.



Appendix 1

Impact (Direct)

One important measure for success and impact is the involvement of people in various 3TU.CEE activities. The following table shows the direct impact of 3TU.CEE on different indicators.

People involved in 3TU.CEE activities (Intended 100 a year¹)

Project Bachelor Curriculum Innovations 7 researchers 35 respondents	Project Innovation Map 4 researchers 45 respondents	Project Interdisciplinary Education 8 researchers 18 respondents
Project TU/e Innovation Fund 1 researcher 53 educational innovators 156 followers	Project Building the future of TU Delft 5 researchers 140 respondents 240 followers ²	Project Designing Engineering Education@UT 4 researchers 45 respondents

3TU meetings (including CDIO³) (Intended 200 per meeting)

3TU.CEE Kickoff TU Delft 22-09-2014 221 participants	CDIO regional meeting TU Delft 25-01-2016 More than 160 participants
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TU Meetings (Intended 100 per meeting)

TU/e Educational Innovation Day TU/e 01-10-2015 ± 100 participants	Eric Mazur keynote UT week of inspiration ⁴ UT 25-11-2015 ± 300 participants	Eric Mazur TU Delft 24-11-2015 ± 150 participants
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Seminars (Intended 20 per seminar)

Kristina Edström UT 02-02-2015 26 participants	Ruth Graham TU/e 25-03-2015 20 participants	Eric Mazur workshops UT 25-11-2015 78 participants
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Kristina Edström TU/e 10-12-2015 22 participants	Ruth Graham UT 30-11-2015 62 participants
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Innovation fund - Meet & Greet TU/e 06-03-2015 ± 20 participants	Think Tank TU Delft Jan - June 2015 ⁵ 15 participants
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¹ work packages 1-6, either as researcher, teacher, respondent or other

² of the Think Tank Facebook page

³ CDIO (Conceive, Design, Implement, Operate) is an international network on contemporary Engineering Education, that organises international meetings, see <http://www.cdio.org/>

⁴ Streaming of the lunch lecture was watched by 76 people.

⁵ 5 sessions during this period

Impact (Indirect)

Next to the involvement of people in our activities, we have sent out a newsletter and a website.

Activity	Intended	Realised
Blog / newsletter	200 recipients	UT: 945 TU Delft: 1590 TU/e: ± 1100
Hits / visitors of the 3TU.CEE websites	2400 a year	3004 unique users 5583 sessions 49.8% returning visitors ⁶

⁶Visitors on the 3TU.CEE Homepage. Period: October 2014 - March 2016



Appendix 2

Indicators for achievement of 3TU.CEE aims

From the different work packages mentioned in the activity plan, a series of products or outcomes have been formulated that serve as indicators for the achievement of the 3TU.CEE aims.

Publications	4 published internal (research) reports
	Gommer, E.M., Klaassen, R.G., Brans, C.H.T.A. (2015). Comparing Bachelor Curriculum Innovations at the Three Technical Universities.
	5-8 scientific articles or book contributions ⁷
	Diggelen, van, M.R., Thurlings, M.C.G., Weert, van, C., Morgan, C.M. & Tops, A. (2016). Opvattingen van docenten over leren, doceren en feedback in het Hoger Onderwijs. Tijdschrift voor Hoger Onderwijs.
	Diggelen, van, M.R., Morgan, C.M., Funk, M. & Bruns Alonso, M. (2016). Formative Assessment. Eindhoven: Eindhoven University of Technology.
	Vaessen, B.E., Beemt, van den, A.A.J., Watering, van de, G., Meeuwen, van, L.W., Vinke, D., Lemmens, L.M.C., Brok, den, P.J. (2016). Students' Perceptions of Graded Frequent Assessment, Intrinsic Motivation, and Grades. Submitted for publication.
	5-8 (international) conference contributions ⁸
	Klaassen, R.G., Brans, C.H.T.A., Gommer, E.M. (2015). Cross Institutional Comparison of Curricular Change in Dutch Engineering Bachelor Programmes. Paper presented at SEFI annual Conference 2015, Orléans.
	Boogaard, M.E.D. van den, Verkroost, M.J., Oude Alink, C., Schellen, H.L. (2015). A heuristic to understand curriculum change: towards comparing 3 course programme overhauls within the Dutch 3TU coalition. Paper presented at SEFI annual Conference 2015, Orléans.
	Gast, I., Veen, J.T. van der, Schildkamp, K. (2015). Team-based professional development in Higher Education. Paper presented at SEFI annual Conference 2015, Orléans.
	Bron, R., Endedijk, M. D., & Slegers, P. J. C. (2015). Team learning for innovation in higher education: A mixed methods study. Poster presented at the EARLI conference, Limassol, Cyprus.
	Veen, J.T. van der, Blume-Bos, A. (2015). Engineering in Dutch Schools: Impact on Study Choice. Paper presented at SEFI annual Conference 2015, Orléans.
	Diggelen, M.R. van, Funk, M. (2015). Stimulating feedback conversations: Evaluation of a Textual Feedback Tool for Industrial Design Education. Paper presented at SEFI annual Conference 2015, Orléans.
Gast, I., Schildkamp, K. & van der Veen, J. (2015) Professional development in the context of a higher education curriculum innovation. In: 16th Biennial conference, EARLI 2015 'Towards a reflective society: synergies between learning, teaching and research', 25-08-2015 - 29-08-2015, Limassol, Cyprus.	
Klaassen, R.G., Luising, A. (2015). Design Thinking as a tool for the design of Engineering Education. Interactive session at ETALLEE 2015, Copenhagen.	
Keijzer, M.A., Goedee, C. (2015). Method for constructing test questions of a new innovative item format. Interactive session at ETALLEE 2015, Copenhagen.	

⁷ published, in press or submitted

⁸ paper presentations, posters, round tables

Grant	1 grant or participation in a (EU) grant
	EXChange – UT (NRO Grant)
Products	3 frameworks (for engineering education innovation success; interdisciplinary education)
	Framework on Interdisciplinary Education (expected) Framework on Bachelor Curriculum Innovations Framework on Engineering Education Innovations (expected)
	3 checklists
	Checklist on Engineering Education Innovations (expected)
	Audio-visual materials on the Bachelor innovations
	Will not be realised
	5 redesigned courses
	Eindhoven: Innovation Fund 2014: 3 redesigned courses Eindhoven: Innovation Fund 2015: 8 redesigned courses Twente: 4 redesigned courses (flipped classroom / student engagement) TU Delft: 5 redesign courses (adaptive testing)
Activities	3TU.CEE Kick-off meeting
	Appendix 1
	6 local annual meetings / conferences and seminars
	Appendix 1
	Several project meetings for the local work packages
	2 project meetings innovation call 2014 – TU/e 3 project meetings Innovation Call 2015 – TU/e 5 project meetings Think Tank – TU Delft
	Hosting of and participation in the international CDIO conference/meeting
	Appendix 1

Network	Site visits at other international engineering universities
	Study trips by 3TU.CEE board Sweden Chalmers University of Technology (Göteborg) and KTH Royal Institute of Technology (Stockholm) 29-31 March 2015 Scotland University of Edinburgh and Strathclyde University (Glasgow) 20 - 22 March 2016
	Site visits by international scholars
	Kristina Edström (UT, TU/e) Ruth Graham (UT, TU/e) Eric Mazur (UT, TU Delft)
Communication	A corporate brochure explaining 3TU.CEE and its focus and purposes
	A blog/newsletter to regularly inform teachers and others interested
	A website containing tools, products and reports
Policy outcome	Participation in workshops or procedures for innovation management, sko, etc.

