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Rooij, Remon; Klaassen, Renate; Cavallo, Roberto; Arts, Jos A.

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Architecture and built environment design education: disciplinary and pedagogical developments

Remon Rooij¹ · Renate Klaassen² · Roberto Cavallo¹ · Jos A. Arts³

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Introduction

The Dutch 4TU Centre for Engineering Education (CEE)¹ has the mission to inspire, stimulate, support and disseminate effective and high-quality Engineering Education through research and the application of evidence-based innovations. It realises these goals by engineering education research, innovation and inspiration. Since 2 years the 4TU Centre for Engineering Education has joined forces with the departments of architecture and the built environment (A&BE) at the universities of technology in the Netherlands, and particularly at Delft University of Technology. In Delft, the ambition has been set to develop a portfolio for research-on-education innovation. The Delft A&BE faculty has chosen to create a research agenda for engineering education research, in which evidence-based working is becoming a standard practice.² It aims to support and inspire teachers to innovate, monitor and systematically evaluate and improve their education. The 4TU CEE wholeheartedly supports this endeavour as it highly relates to the CEE mission of capacity building of engineering educators in higher education. Moreover, it integrates the three CEE primary pillars: engineering education research, innovation and dissemination. The A&BE faculty has become an experimental lab for sustainable change in engineering education with possibly long term impact on the quality of the (process of) educational innovation.

¹ In order to boost engineering education, the Board of the 4TU.Federation-TU Delft, TU Eindhoven, University Twente, Wageningen University and Research—work together in the Centre for Engineering Education. 4TU.CEE collaborates with (inter)national educational communities such as SEFI and CDIO. 4TU.CEE is funded by the universities themselves and by external sponsoring such as the Ministry of Education and Sciences (OCW, 4TU. Sectorplan Technologie 2014–2015).

² See <https://www.tudelft.nl/en/architecture-and-the-built-environment/research/research-at-bk-bouwkunde/education-innovation/>; accessed 27 March 2019.

✉ Remon Rooij
r.m.rooij@tudelft.nl

¹ Faculty Architecture and the Built Environment, Delft University of Technology, Julianalaan 134, 2628 BL Delft, The Netherlands

² 4TU Centre for Engineering Education, Delft University of Technology, Delft, The Netherlands

³ Department of the Built Environment, Eindhoven University of Technology, Eindhoven, The Netherlands

A number of experiences from Delft education practice makes the heart of this special issue on *Architecture and Built Environment Design Education: Disciplinary and Pedagogical Developments*. This introductory chapter explains the context and motivation of this special issue in more detail. It presents in the next section a discussion on the future of engineering education, the field of architecture and the built environment, and the role of design education within. Additionally we argue the important role of initiatives like this—writing education based scientific articles by (A&BE) academics—for university teaching professionalization on the job. Finally, we present and reflect on all contributions (both abstracts and final articles) which were sent to us as guest editors of this special issue of the *International Journal of Technology and Design Education*.

Engineering education, architecture and the built environment, design education

A&BE entails various disciplines and fields of expertise. Technology, history, design, planning, management, to name but a few, are all disciplines characterized by their own field of knowledge. In contrast to (hard science) mono-disciplines, A&BE is characterized by an *epistemic culture* (Knorr Cetina 1999). According to Knorr Cetina, an *epistemic culture* includes diverse scientific fields, each one of them characterized by own methods, instruments and tools of inquiry, as well as their own way of reasoning and establishing evidence. In other words, it implies specific knowledge which is defined in each field in terms of knowledge content and its production (Kurath 2015). When it comes to educational aspects, each of these disciplines caters specific learning pathways connected to the type of skills that have to be acquired. The different natures and traditions of the various disciplines involved make A&BE a very rich and intriguing subject too. However, and particularly from the perspective of learning to design, this variety does not deliver a straightforward way of gaining knowledge and skills.

These epistemic cultures of learning to design in context have become the subject of more studies in the last years particularly due to the increasing attention for design as pivotal vehicle to tackle with the wicked challenges of society today. These wicked challenges are difficult to be faced only with a systems engineering driven approach. The recurring problem is that due to the involvement of many variables and factors, the development of systems and processes, typical of a ‘traditional’ engineering approach, have to comply with a much higher degree of uncertainty. As changes cannot be predicted, the contribution of other disciplines and expertise is then needed in order to uncover the complexity in the different stages of engineering projects.

Extending the discourse to engineering in general, research and education at universities (of technology) have to consider this new condition, reflecting on its implications while deploying activities. The main challenge is on how to relate engineering knowledge to an increasingly complex and unpredictable reality. According to the authors of the *Cambridge handbook of engineering education research*, the ‘... three most common kinds of problems that practicing engineers solve include decision making, troubleshooting, and design’ (Jonassen 2014). In any case, the emphasis on problem solving is an important issue in a ‘traditional’ engineering approach. Nevertheless, in the light of this new condition, and particularly when dealing with education, establishing that engineering students must become aware of the complex nature of nowadays problems may not be enough. Next to learning the hard core of their discipline, in the course of their studies students must be triggered to develop the right attitudes in order to cope with ‘...authentic, complex

problems' (Jonassen 2014). To do so, they need to be able to incorporate perspectives and insights of other disciplines and stakeholders into the problem-solving process.

So, being acquainted with other disciplines and working methods becomes more and more a basic requirement when dealing with complex problems, and with collaborative, inter- or multidisciplinary settings. Therefore, participants need appropriate communication strategies enabling the exchange of concepts, materials, findings, data or tools coming from the various disciplines (Kamp 2016). In short, next to the uncontested trend of disciplinary specialisation in research and education, the complexity of nowadays problems calls for engineers able to integrate simultaneously multiple and diverse types of input with a high degree of synthesis. This is the reason why the 'design driven' approach is increasingly gaining interest; design is *par excellence* a synthetic way of communicating and can be an important vehicle of communication when working with different disciplines in cross-disciplinary projects.

It is therefore not a coincidence that understanding the natures of design and the ways design can be learned and thought are front running themes for the professionalization of education at the faculties of A&BE in The Netherlands. Design is an open-ended, creative but complex act for which skills can be learned only by doing it, reflecting upon it and understanding how to do it. At the same time, the act of doing a design is also linked to the tacit knowledge of the designer, remaining somehow a personal and implicit activity difficult to objectify. In the attempt of making the design process explicit for both teachers and students, a conceptual framework has been developed by Elise van Dooren, lecturer at the Faculty of A&BE, Delft University of Technology. Five generic elements that are always present in the design process are depicted: (1) experimenting or exploring and deciding, (2) guiding theme or qualities, (3) domains,³ (4) frame of reference or library, (5) laboratory or (visual) language (Van Dooren et al. 2014).

The research and approach of Van Dooren are a consistent help, for being a contribution to the disciplinary knowledge as well as a benchmark work supporting the professionalization of teachers in A&BE. Research and teaching practice experiences of Van Dooren have been the base for the shaping of the architectural design pedagogy course offered to design tutors at the Faculty of A&BE of TU Delft. This course elaborates on the main components of design education as well as on issues like assessment, appraisal and feedback. The fact that many of our colleagues have followed Van Dooren's course increased the awareness of the educational personnel in looking at the learning and teaching of architectural design as an academic activity.

University professionalization on the job: an engineering educators GROW model

An important challenge related to the endeavour of this special issue on A&BE design education has been to pave the way for academic teaching staff to become more proficient in educational research. The faculty colleagues contributing to this journal, but also the ones who submitted abstracts, face the challenging transition from 'standard' course evaluation approaches (supported or executed by faculty Quality Assurance

³ Domains differ per design discipline. For architectural design Van Dooren distinguishes five domains: (1) form and space, (2) material, (3) function, (4) physical context, and (5) social, cultural, historical and philosophical context.

departments) towards educational research on their teaching and on the learning of their students. In transitions studies, the impact of sustainable change is often ascribed to what extent the experiments are embedded in existing, local structures (Wirth et al. 2018). Yet the ambition is to have an impact beyond the local boundaries of the embedded experiment. This can be done with a focus on the possibility of a wider implementation of experiments within the specific 4TU/faculty/departmental context (horizontal diffusion) or upscaling of experiments to other faculties (vertical diffusion) (Wirth et al. 2018).

The cases from educational practice presented in the articles to come, can be characterised as learning by doing and doing by learning, and as an iterative process within the faculty process of educational renewal and innovation (Ansell and Bartenberger 2016). The transition process as a whole is built upon informal learning or social learning activities in the work environment, which comprise of talking and collaborating with colleagues, consulting each other on a regular basis, learning through feedback, sharing resources, observing, imitating, and/or mentoring others (Kwakman 2003; Lohman 2006). It has been demonstrated that this kind of informal learning leads to improved performance (Froehlich et al. 2015). In innovation processes the social learning process is further strengthened by shared mutual goals, reframing, and commitment (Rijst et al. 2018). One of the key points is that a shift in cognition and/or behavior occurs, which leads to a more permanent basis for innovations (Rijst et al. 2018).

Research on creative networks tells us that sustainable transitions can best be realized by value creation (Wenger et al. 2011), in which employees can continuously shift between changing demands in the environment. Value creation is realized in cycles (see Table 1). The first cycle is the *immediate value* of meeting someone else to discuss a case, get a good tip or realizing a small research project. The second cycle is the *potential value* of building and exchanging knowledge, which leads to potential opportunities, collaborations and learning. The third cycle is the *applied value*; it is the follow up of the created knowledge with a focus on the reapplication (by trial and error) and on the reflection in new situations. Applying knowledge in different contexts may lead to innovation and may be an important leverage to continuous improvement and innovation. The fourth cycle is the *realized value*, when the new innovation is institutionalized in new processes that matter to the involved stakeholders. During this cycle a joint narrative is created around the realization, which further strengthens the network. The fifth cycle refers to the *reframing of value*, when the results in previous rounds lead to a long term and profound change in the organization, redefining the definition of success. Different stakeholders might assess the (level of) success of and the value creation via an activity differently (Wenger et al. 2011).

Thus, the success criterion for this special issue pilot is the stimulation of networked collaboration, in which learning can take place. Innovation and improvement of educational quality are desirable outcomes for the A&BE faculties in particular. But we see this endeavor also from an institutional point of view, as a model for growth across different faculties. To support the Delft A&BE faculty in its ambition to set up engineering education research in the field of architecture and the built environment, the idea has been to create a knowledge exchange among the teaching staff and to present results which both meet the educational scientific research standards and the architectural engineering research standards. By definition the authors who have contributed to this issue have worked in an interdisciplinary way; they all had to learn how to meet the educational scientific research standards.

The momentum of this special issue has created an optimal condition for informal networked learning and value creation. The teachers involved did not only have to delve into

Table 1 Value creation core indicators per cycle (based on Wenger et al. 2011)

Immediate value	Potential value	Applied value	Realized value	Reframing value
Level of participation	Skills acquired	Implementation of advice	Personal performance	Community aspirations for new vision
Level of activity	Information received	Innovation in practice	Organizational performance	New assessment metrics
Level of engagement	Change in perspective	(Re)use of tools, document, products	Organizational reputation	New relations with and new expectations for (new) stakeholders
Quality of interactions	Inspiration	Use of social connections	Knowledge products as performance	Institutional changes
Value of participation	Confidence	Innovation in systems		New contexts: social, institutional, legal, political
Value of network, connections and co-laborations	Types and intensity of social relations	Transferring learning practices		

educational literature on what works and does not work in education, but were also challenged to:

- review why they are doing what they are doing (GOALS);
- review and evaluate what the current results are and why they work in practice (RESULTS);
- review what the obstacles were and how they have overcome these, making in some cases substantial changes to their education (OBSTACLES);
- and assess what they have learned, what the world can learn from them and redefine the way forward in terms of research and educational innovation (WAY FORWARD).

It has been a long and iterative process of submissions, assessments, feedbacks and resubmissions. Initially, more than 20 abstracts were submitted and five articles have been accepted in the journal. To establish whether the criteria for sustainable change are met, we have conducted a small scale survey among the first authors of the accepted articles (on behalf of their author team), on the basis of the GROW model (Alexander 2010) and the model of value creation with its different cycles and levels of impact (Table 1). The questionnaire focused on (1) the extent to which there is an immediate value for the article that has been written and the collaboration between peers, (2) the potential value for personal growth, (3) the applied value for the learning contexts and improvement, (4) the realised value: does this project have impact on personal or organisational performance? Are authors doing better now? And finally, (5) the questionnaire focused on the reframing value: is there a new way of looking, which stimulates the framing of educational engineering problems in a different way?

Results: GROWing

In this part we show the results of the evaluation and weigh the added value of this activity based on the feedback of the participants, who have gone through the entire process from submitting a first abstract until the final publication. Four first authors responded to our questionnaire on behalf of their author team. The G of GROW refers to the goal or the intentions with which the teams started to write. Two teams convincingly expressed the content wise relevance of their innovation and the importance of sharing this with the world. Our goal is "...to present to the wider architectural education audience a methodology we developed to address a very important need in contemporary design education, that of dealing with values in the existing built environment." The R in GROW focuses on the results in reality in terms of learning about education. One author team nicely phrased that "we were stimulated to formally assess the success of our new methodology through questionnaires. This has led to a refining of our teaching practice in distinguishing the various steps to be taken during analysis and also highlighted where students required additional support."

On the O, the obstacles encountered during the writing of the article, the authors responded to have felt somewhat lost every now and then. One author team says that "...we struggled to identify theories of education practice for adaptive reuse of valorised built fabric with which to relate our innovative methodology." And another team shares their experience that "...operating in a lacuna meant that we could not compare our methodology against others." For a third author team the main obstacle was "...

that we at first started from our perspective and it was difficult to find a method that created a kind of equal level playing field for all design disciplines.” Another kind of obstacle that was mentioned, relates to the (long) submission, resubmission and feedback process. One author team explicitly referred to “the not always clear comments of the reviewers” as an obstacle. As editorial board we (also) observed that a number of author teams (also the ones who submitted or resubmitted abstracts, but in the end were not accepted) had difficulties implementing the comments from an educational scientific perspective. But other author teams did this actually quite quickly and smoothly, which resulted in varying durations of submission-feedback-resubmission trajectories.

For the way forward (W) teams were firstly asked about their discoveries while working as a research and writing team. Answers relate not only to teaching contents, but in particular to communication and co-operation issues. One team shares their experience “...that it remains difficult to pass the ideas and experience from one group of tutors to a next one.” Another team said that “...the process brought us into contact with the 4TU Centre which otherwise would not have easily happened.” On the question ‘What will be your next step in educational research?’, one author presented a new educational scientific project: “Taking part in a(n educational scientific) research (project) from the Open University (on giving feedback).” A final question referred to the author team’s needs in the future for more educational research (support 4TU-CEE). Answers refer to both the facilitating role of the CEE (for organization, support and dissemination) and the enthusiasm needed from CEE to motivate staff by continuously showing the relevance and value of endeavours like this one.

Results: value creation

We also asked the author teams (via the first author) to respond to a number of questions related to the value creation framework (see Table 2). The numbers being very few give an impression of what it did for the author (teams). The immediate value table shows that each respondent was very much involved in the writing process and at least enjoyed the writing process. Most of them became more involved in doing educational research in education of the faculty and most have reflected on their role as educators. With respect to the potential value the writers felt inspired through their own team writing process and through meeting (some new) people as a result of that. Writing in itself was not a skill to be learned. The applied value mainly has an impact on innovating education, and even more after having discussed the article with the co-authors and/or editorial board.

With respect to the realised value, most writers recommend other faculty staff to go through this process to professionalise, and expect to have more exposure by reaching a wider audience and make more connections for their work. As organisational impact, the majority of the writers felt that it would potentially improve the quality in education, and improve their personal way of working; they have acquired a new strategy for educational change. The authors assess that all of this will be good for the reputation of their institute. For the reframing value, authors were most hesitant. They tell us that the writing exercise did not change fundamentally their perspectives on education, educational research, assessing educational quality, and institutional changes.

Table 2 Results value creation cycles (1 = fully disagree–5 = fully agree)

	1	2	3	4	5
Immediate value					
I engaged as primary writer /feedback giver					4x
I became more involved in educational research for architecture and the built environment				3x	1x
As a result of co-writing I have reflected more on my role as educator in the domain of engineering and design		1x		2x	1x
I have enjoyed this collaborative writing process on education				1x	3x
Potential value					
I have acquired new skills/knowledge during the process of writing			3x		1x
I felt inspired by debating and talking amongst each other about education			1x	2x	1x
I made different/new social connections as a results of writing this article			1x	2x	1x
Applied Value					
I can offer tools of analysis to other colleagues in the department for researching their education		1x		1x	2x
I have acquired a new perspective to look at education within the department			2x	1x	1x
I have innovated my education even further on the basis of our discussions				3x	1x
Realised Value					
My personal performance has improved as a result of our participation in this process				3x	
I would recommend anyone to go through this process to professionalise				3x	1x
I would recommend anyone to go through this process to improve educational innovations		1x	1x	1x	1x
I hope to reach a wider audience with the article				1x	3x
I wish to make more connections related to our work				2x	2x
Organisational impact					
The organisations' quality in education is likely to improve as a result of our participation			1x	3x	
The organisational reputation will improve as this will be our way of working in the future			1x	1x	2x
We have found a new, additional strategy to go about educational change			1x	1x	2x
Reframing Value					
The writing of this article changed the team's perspective on educational research			2x	2x	
The writing of this article changed the team's perspective on education in the faculty			2x	2x	
The writing of the article provided us with new metrics to weigh the quality of our education		1x	3x		
Eventually I believe these kinds of (research on education innovation) activities will lead to institutional change			3x	1x	

Calling for papers

In 2017 we, as editors, launched the call for abstracts 'Latest Developments in Architecture & the Built Environment Design Education'. It stated among others that...

... Design education is one of the strong fundamentals of academic curriculums in the fields of Architecture, Landscape Architecture, Urbanism and Building Technology. Also curricula such as Management in the Built Environment, Spatial Planning, Environmental Sciences and others have design components in their programmes. We (the editors) observe a lot of interesting developments and growing teaching expertise in design education, which are worthwhile presenting to and sharing with our international academic community. More particular, we look for contributions which present research findings on courses, curriculums and student work focusing on:

- Teaching Design Approaches and Processes.
- On-line Design Education.
- Academic Skills for Design Oriented Engineering Curricula.
- Inter- and Transdisciplinarity in Design Education.
- Geo Information in Design Education.

- Students in Charge of Their Design Education.
- Supervision Strategies in Design Education.
- Entrepreneurship in Design Education.
- The Faculty Research Portfolio as Fundament for Design Education Themes.
- Automation, Digitalisation, Virtual Reality and 3D Manufacturing Processes in Design Education.
- Teaching Ethics in Design and Engineering Education.
- Teaching Sustainability in Design Education.

Initially we got over 20 submitted abstracts that could be grouped in five thematic fields. These themes made a lot of sense to us as we recognised them as themes that have been important for education innovation over the last years in the Dutch A&BE faculties.

1. Learning and teaching to design for *sustainability*. The contributions showed that designing for sustainability in the A&BE context relates to (1) the understanding of the notion of sustainability and (2) how that materializes in (landscape) architectural, urban and building technological design.
2. Learning and teaching *academic skills* for design. The contributions focused on the question(s) which academic skills in particular support designing, researching for design, and studying by design.
3. Learning and teaching to use *history and heritage* in design education. The value of history goes without saying in a design field such as architecture and the built environment; one can learn a lot from design problems, design situations and design strategies and solutions from the past. And history has regained 'new' interest since the reuse of buildings, building components, and urban structures have become more prominent in A&BE practice, because of the large, outdated building stocks, for which redevelopment strategies are needed.
4. Learning and teaching the *design process and design approaches*. In many studies from the last decades on design processes and design approaches, the idea of design being a big black box has been demystified to a large extent. From the contributions we see many experiments on making explicit to students (and teachers) certain steps and modes of operation within design processes, such as: different kinds of analysis and research activities, formats for creativity and conceptualisation, cyclic iterative steps of exploring and deciding (analysis-synthesis-reflection), and designing as team work.
5. Learning and teaching to *integrate* various subdisciplines and topics when designing. Many contributions focused on working in and between domains, and working at and across a variety of spatial levels.

Some topics unfortunately were not addressed in the submitted abstracts, although we know that educational innovations do take place at the moment, e.g. learning to design in an online and/or VR/AR environment, (big) data based/supported design approaches (BIM, geo based urban design), automation and/or 3D manufacturing driven design. Perhaps it has to do with the relative novelty of these themes, but perhaps also with the transition challenge to come from 'regular' educational innovation and course evaluation towards educational scientific research on education.

This transition challenge was actually one of the major obstacles we as editors encountered when realizing this special issue; and in particular the interdisciplinary nature of this

challenge. Educational research and writing about it require a somewhat different approach from disciplinary research and writing in the fields of architecture, urbanism and the building sciences. With limited guidance available for authors on this aspect of integrating educational scientific knowledge with A&BE professional knowledge, it proved to be quite a challenge to get the articles in a format to be accepted by the educational journal. This has been the most important issue also for the editorial team. For nearly all contributions the editors had repeatedly point out to the authors to come up with scientific evidence and to explicitly write about the educational research aspects that were addressed in their papers. In this respect the author teams did a great job in tenacity and perseverance, besides innovating their perspectives towards education.

Therefore, we would like to plea for more (possibilities for) networked learning among teachers, as it seems to directly contribute to education innovation at the immediate, potential and realised levels of the value creation model. For long term sustainable transformations and further professionalization of staff, joint research, writing or network activities we assume there should be an iterative occurrence across a wider audience of participants, focusing on knowledge building within the area of architecture and the built environment education. This special issue presents five articles on A&BE design education and can be seen as such an iteration step within the A&BE community, which nicely fits in the ambitions of the CEE to inspire, stimulate, support and disseminate high quality engineering education. Design thinking as crucial element in engineering education (Kamp 2016), is in the genes of our schools of architecture. The TUD A&BE faculty has taken up the challenge to become a living lab for design oriented educational innovation and research. The faculty definitely looks forward to show their next developments in this regard.

What follows

The five contributions which follow this introductory chapter focus on five important themes within A&BE design education: history, values, reflection, team work, and integration.

Teaching history for design (Hein, Van Dooren)

This article explores the question “what and how do design students learn about architectural history and how do they translate this knowledge into their design practice?” It builds on the generic framework of Van Dooren et al. (2014) to argue that ‘history’ refers not only to background information, but to socio-cultural knowledge that designers can actively use in developing their projects; the context *domain* in terms of the generic framework.

Embedding built heritage values in architectural design education (Clarke, Kuipers, Stroux)

In this article, the authors argue that “...embedding built heritage values into studio-based design education is a daunting new challenge that demands new didactic perspectives and tools.” The redevelopment and regeneration of the built environment have become important design assignments for cities all over the world. Using the built

heritage values approach as *guiding theme* (Van Dooren et al. 2014) thus becomes a pivotal approach for architects and urbanists.

Reflection in design education (Lousberg, Rooij, Jansen, Van Dooren, Heintz, Van der Zaag)

This article discusses the (development of) design reflection skills of undergraduate students. When *experimenting*, or *exploring* (Van Dooren et al. 2014), designers tend to continuously—and very often implicitly—reflect on the back and forth process of analysis—synthesis. In the third year course ‘Academic Design Reflection’ students are asked to explicitly reflect on an architectural design project: on the definition of the brief, on a specific design theme, on the design process and on the relation between design and research.

Cultivating the next generation designers (Qu, Chen, Rooij, De Jong)

This article focuses on the discussion about learning from group methods in urban and regional design education. It advocates the relevance and importance to co-operate during design processes as an important professional skill. Four approaches to learn to design in teams are described, compared and reflected upon.

Interdisciplinary learning and practice-theory integration (Chen, Daamen, Heurkens, Verheul)

This article discusses several pedagogical insights to improve interdisciplinary teaching in urban planning, design, and management courses. It shows the relevance of integrative skills for an increasingly diverse professional and societal setting, in which urban designers, planners and managers operate. It presents, arguments and evaluates an urban management game in which students simulate a concrete urban redevelopment assignment via role playing.

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