Teaching Architecture

Insights from TU Delft – Research on Education Innovation in Architecture & the Built Environment

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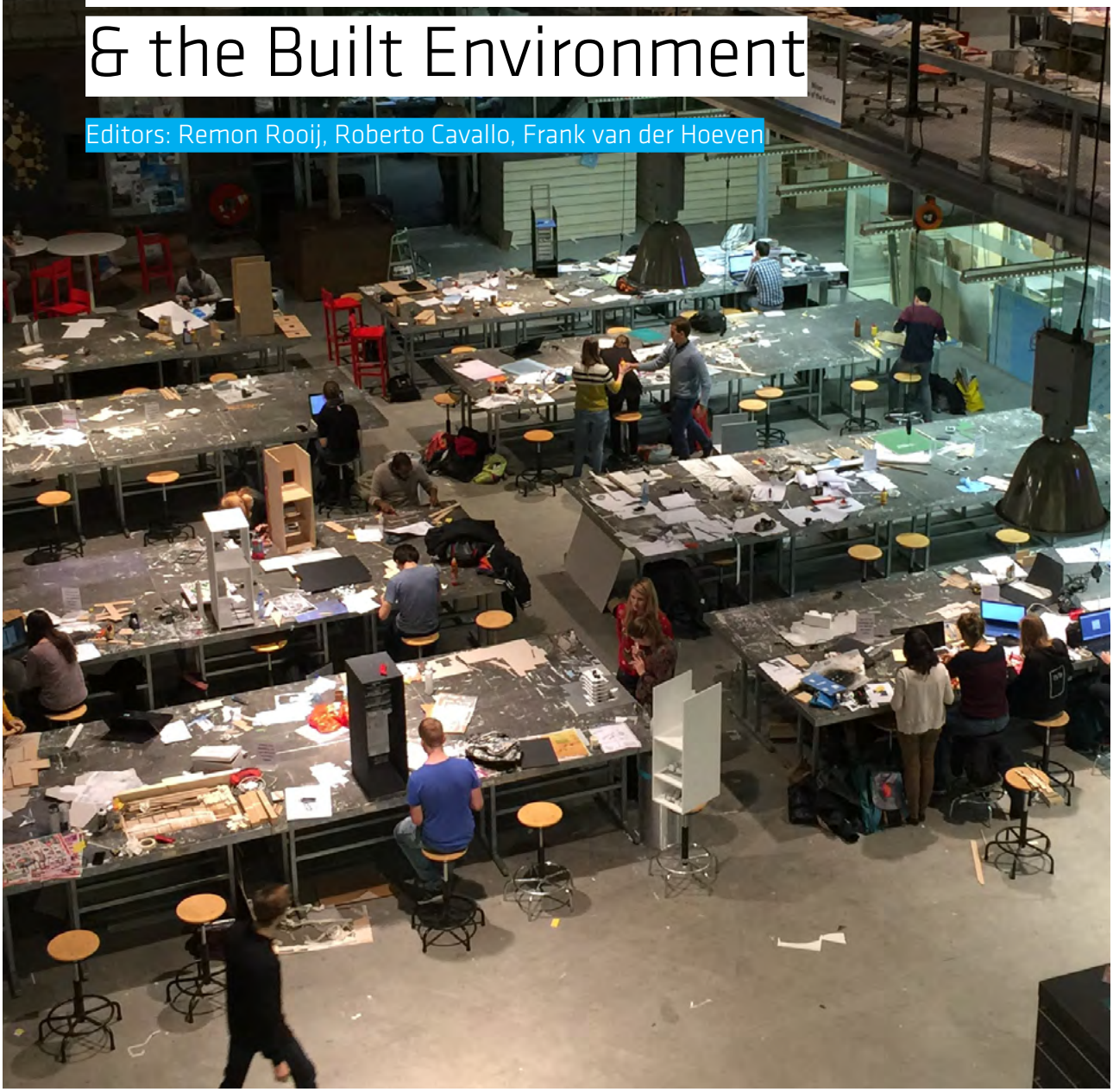
Editors: Remon Rooij, Roberto Cavallo, Frank van der Hoeven



Teaching Architecture

Insights from TU Delft – Research on Education Innovation in Architecture & the Built Environment

Editorial

Process, Approach & (Dis-)Position

Curriculum, evaluation & assessment

Introduction

Remon Rooij [1], Roberto Cavallo [1], and Frank van der Hoeven [1]

[1] *Delft University of Technology (The Netherlands)*

This book marks the commencement of a series of projects and initiatives initiated by the Research-on-Education-Innovation programme at the Faculty of Architecture & the Built Environment, Delft University of Technology, at the conclusion of the 2010s. These initiatives, including the call for contributions to this volume, sought to address pertinent questions that would engage the interests of our colleagues.

The primary objectives of these inquiries were to foster innovative, cross-disciplinary approaches in architecture and built environment education. We sought to bridge the gap between theory and practice, encouraging students to engage with both historical contexts and contemporary challenges. Additionally, we explored the potential of educational settings as laboratories for spatial and societal transformation. Furthermore, we examined the development of technical skills and academic skills, such as critical thinking and reflection, among design students. Finally, we addressed the challenges posed by the COVID-19 pandemic, including the need for flexible and collaborative learning frameworks and learning environments.

Many colleagues responded positively to the call for contributions. After several rounds of review and feedback by the book editors, the submitted papers have been organized into two thematic parts of this volume.

We extend our sincere gratitude to all contributing authors for their support and patience, and to the 4TU Centre for Engineering Education, which warmly supports our Faculty's Research-on-Education-Innovation programme and this book project.

Contextualizing Architecture & the Built Environment Research on Education

Remon Rooij [1], Roberto Cavallo [1], and Frank van der Hoeven [1]

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A Glimpse into the European Context

Our disciplinary field is uniquely positioned at the intersection of art, science, engineering, and social responsibility. Architecture in Delft—*Bouwkunde* in Dutch—refers to the disciplines of architectural design, building technology, urbanism, landscape architecture, geomatics, and management in the built environment. According to the European Association for Architectural Education (EAAE, 2022), architecture extends beyond designing buildings and cities; it is a field dedicated to interpreting and shaping the built environment in response to cultural, ethical, and environmental conditions. In this context, professionals must navigate the complexities posed by climate change, globalization, and rapid urbanization simultaneously. Education innovation and pedagogical research are therefore indispensable for preparing future built environment professionals to address these ever-evolving challenges effectively.

The EAAE emphasizes that a solid education foundation should equip students to engage in critical inquiry, cultivate spatial understanding, and develop a capacity for synthesis—skills that are essential for problem-setting and problem-solving in today's multifaceted societal landscapes. While grounded in its own body of knowledge, this inquiry into education should also benefit from interdisciplinary collaboration, integrating insights from other disciplinary fields. To facilitate a broader dialogue on public understanding and policy regarding the built environment, greater cohesion is needed between theoretical research and practice-based inquiry. This will foster collaboration between academia and the profession, contributing to a dynamic and expansive architectural knowledge base.

In this regard, the New European Bauhaus (NEB, 2021) initiative further strengthens the mission of architectural education by promoting an approach that aligns beauty, sustainability, and inclusivity with architectural practice. Rooted in principles of collaboration and societal impact, NEB emphasizes the importance of integrating cultural heritage with forward-looking innovation. This approach calls for a balanced education of built environment students that prioritizes ecological sensitivity, social equity, and aesthetic appreciation. By aligning with NEB principles, architectural education in Europe should prepare students to become not only skilled designers but also changemakers who contribute to more livable, sustainable communities. NEB promotes an education that is both reflective and responsive to the challenges of our time, working to redefine architecture's role within broader environmental and social contexts. The initiative encourages architectural programs to develop curricula that foster critical thinking,

community engagement, and a commitment to ethical practice. In essence, the New European Bauhaus offers an aspirational framework, urging architecture schools to educate graduates who are not only professionals but also responsible stewards of the built environment.

The Design Studio Revisited

Educating architecture and design pedagogies are not new, of course. The pedagogical model of the design studio has been with us for quite some time (Lawson & Dorst, 2009; Van Dooren, 2020). However, the changing, challenging, interdisciplinary, and complex socio-spatial urgencies of today and the rapidly developing design, research, and learning technologies (e.g., XR, AI) position architecture education in continuously changing spotlights. What are the core values of the studio model? Six principles of today's design studio stand out for us:

1 Seeing the (un)built environment as a multiscale, interdisciplinary research object

To intervene wisely, buildings and cities need to be understood from various perspectives simultaneously in terms of time (past-present-future), scale (local-urban-regional-(inter)national), stakeholders (private, public, civil society), and perspectives (spatial, technical, social, economic, political, cultural).

2 Gaining a theoretical understanding of design and improving frame creation

Designers must understand what they do as professionals to convincingly argue their approaches, methods, and processes, and frame their ambitions, concepts, and intervention proposals (Cardoso et al., 2016).

3 Dealing with unpredictability via design

A design is a proposal for a desirable, possible future (De Jong, 2012). A design is a future in the making. Exploring and developing plans for an uncertain future is only partly based on or informed by hard, empirical evidence. It is much more based on interpretations of current situations, design explorations, narratives, imagination, envisioning, and vision and strategy making.

4 Working at and across various spatial and temporal scales by visual thinking

Visualization shows the conditions and effects of design choices through space and time. It is pivotal not only for designers as 'language' (Van Dooren, 2020) to explore and experiment but also for audiences who need to understand, assess, and decide about spatial plans.

5 Exploring the various relations between research and design

Students need to understand the relationship between scientific research and academic design and develop their problem-solving skills for ambiguous contexts. Simply put, one can do research for design, on design, and through design (Rooij & Lousberg, 2022; Nijhuis & De Vries, 2019).

6 Boundary-crossing skills

To realize the spatial integration of diverse bodies of knowledge, continuous communication across disciplinary boundaries and societal positions is needed to recognize, seek, and appreciate friction arising from different perspectives (Fortuin et al., 2020; Leung, 2020).

Design assignments tend to be open-ended, and the design process is not prescribed, leaving freedom of purpose and choice. Students are typically asked to reinterpret their assignment based on thorough research and design experiments, consecutively defining a position and process steps themselves (Van Dooren, 2020). Schön (1983) refers to such a professional as a 'reflective practitioner', who learns via reflection on, in, and for (design) action. This open process comes with many uncertainties and personal challenges for design students. A question might be, how should we guide students in a healthy, challenging way (Rooij & Mooij, 2022)? The role of educators is pivotal.

Educators

There are no simple (design) solutions for complex challenges, and there is also no simple way to teach architecture. Educators' roles vary from experts, specialists, and assessors to coaches, feedback givers, facilitators, and many others. The pedagogical-didactic qualities for educators matter a lot as knowledge about complex and uncertain systems is not 'hard' and 'objective' but socially constructed to a very large extent: in a design-oriented curriculum, the community is the curriculum! Being explicit and self-reflective toward one's teaching practice is a very good starting point for improving education quality and developing one's pedagogical understanding. That is an important value. Educators should critically look at their course design and teaching practice, looking for data, theory, or educational knowledge to support their pedagogical position or methods to scholarly evaluate their teaching practice. And share!

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Part 1

Process, Approach & (Dis-)Position


EVIDENCE OF THINGS UNSEEN
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Cultural Centre, Remchingen (Germany)
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Addressing the design process in architectural design education

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Abstract

Although students must learn to design in the architectural design studio, this process is barely addressed during tutoring sessions in TU Delft's architectural design education. Students learn by doing, and teachers mainly discuss the design product(s). Based on a body of knowledge of the design process and tested in interviews with expert designers, five elements have been defined to address the basic skills designers need: domains, laboratory, experimenting, frame of reference, and guiding theme. In two educational interventions, the framework was tested in design education.
The initial experiences are positive. The framework may help teachers shift from designing products to designing processes. Addressing the design process increases students' understanding and self-efficacy. Knowledge of the basic skills in the design process may also be helpful in other situations, such as setting up a design studio and curriculum, communication with designers in other disciplines and the designerly aspects of research and policy-making.

Keywords

Design process, generic elements, design education, making explicit

COVER FIGURE Frame of Reference. Anchoring the design process, E.J.G.C. van Dooren [2020], by Luuk Kramer. Reprinted with permission.

1 A journey into the unknown

Learning to design is a double journey in the unknown. Learning a new skill is always a challenge: students have to find out what it means and how to perform. On top of that, the 'designerly way of thinking' (Cross, 2007) is probably one of the most complex and amorphous skills. Traditionally, architectural students learn to design in the studio. They practice designing through a series of integrative and progressively difficult design projects. In the design studio, teachers and students discuss the provisional product, with the main goal of teaching students to think like a designer. Therefore, it seems evident that the design process is addressed there. However, observing dialogues between teacher and student shows that the discussion is mostly on the design product, which may confuse students, leaving them to discover what designers do independently.

As expert designers, it may be difficult for teachers to make the design process explicit, particularly because they perform their skill for a large part implicitly. As design teachers, they seem to discuss the design product as they would with their colleagues or as they remember from their own studies. To make learning to design more accessible, it should involve a combination of design projects and explanations of the design process (see Figure 1). In short, following Dewey (Logister, 2005), knowing supports action. Thus, understanding the relationship between actions and consequences leads to better focus and more thoughtfulness or intelligence, in particular in new and unknown situations, such as students during their studies.

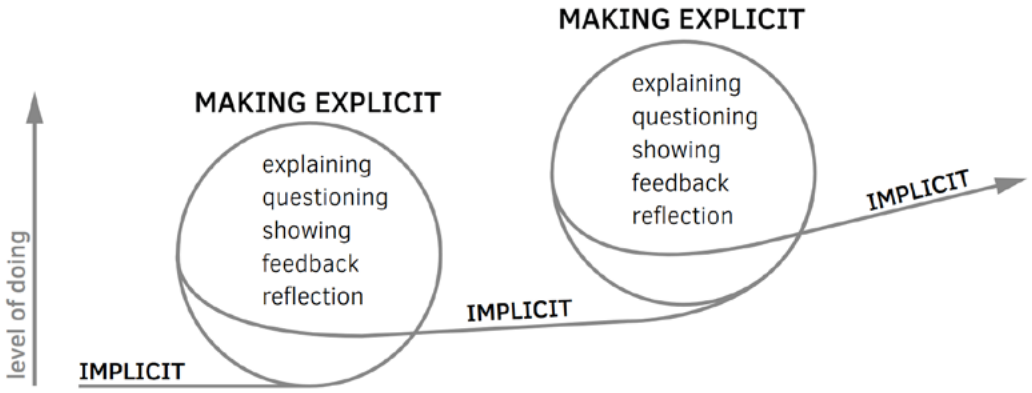

FIGURE 1 Learning, doing, and making explicit, by van Dooren, 2020.

2 Research on design education

I previously addressed the importance of the design process in architectural design education as part of my PhD research (van Dooren, 2020). To improve the quality of (architectural) design education, this project provides a framework to articulate the 'designerly' way of thinking in design education. It asks three fundamental questions:

1 What should and might be discussed in reference to the design process?
2 Do teachers address the design process, and if so, to what extent?
3 Is learning to design less confusing for students if the design process is explicitly addressed?

To answer the first question, the research suggests a design proposal for a vocabulary that addresses the design process in the design studio. Five generic elements or anchor points were defined (see Table 1 and Figure 2), each representing an essential design skill. To validate these elements, they were tested in interviews with a variety of expert designers. All designers used different names for the elements, but they recognised them as basic skills in the design process.

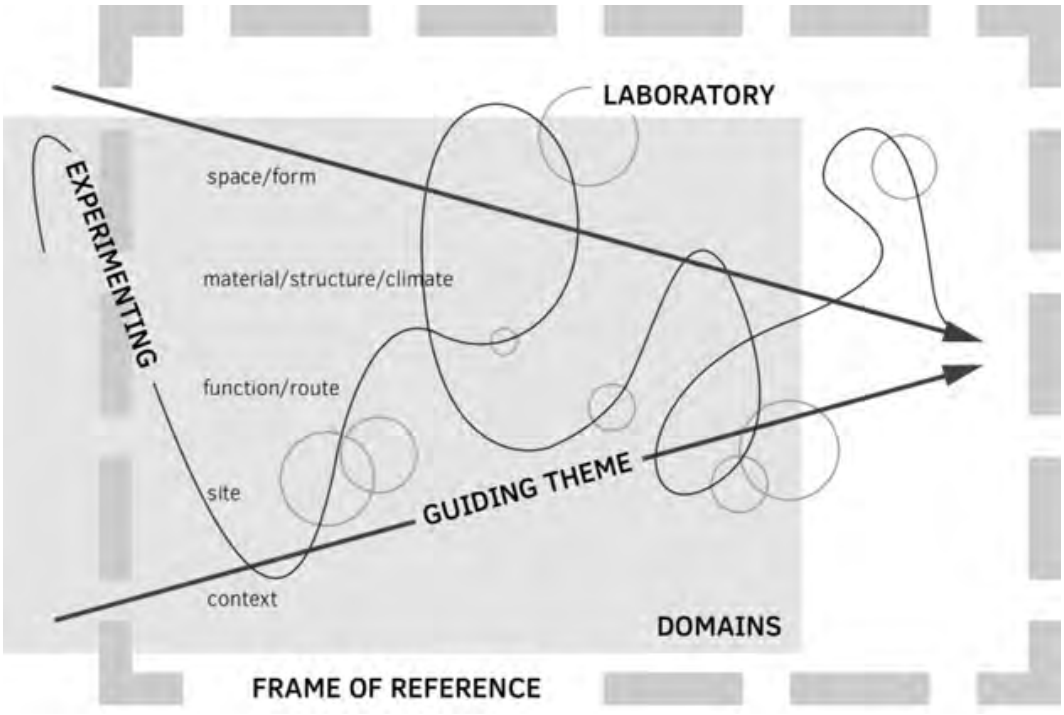

FIGURE 2 Learning, doing, and making explicit, by van Dooren, 2020.

Once these anchor points were established, two other tests were done. Dialogues in the design studio were observed to validate the assumption that teachers barely address the design process. It was found that teachers use implicit examples without mentioning or explaining the design process and that they reference 'between the lines'. For example, they use sentences like 'you have to do some research here'; 'can it be done differently?'; and 'just sketching!'.

Finally, to answer the third question, two additional interventions focus on the design process. The outcome of these interventions is positive. They show a change in students' design concepts towards more expert ones and increased self-efficacy. The teachers involved perceived the framework as helpful in providing an overview of the relevant design process items and helping students in their attempts to understand the design process.

Domains	The main aspects of the design process are summarised in four domains: form, material, function, and context. For architectural design, this can be more specific: space, material, function, and two kinds of context: the site and the socio-cultural context. Choices in one domain influence aspects in other domains, and the aspects have to fit into the design as pieces in a jigsaw puzzle. One could say that the domains form the playing field of the designer.
Experimenting	Designing is experimenting – it is a process of exploration and reflection. Instead of coming up with 'the solution', students have to learn to come up with alternatives and options and to reflect on them by comparing and looking at consequences. The main question is: 'What happens if …?' Experimentation is often an intuitive process, particularly for expert designers. However, in new and unknown situations, such as learning to design and research-by-design, it might be helpful to experiment more rationally.
Laboratory	Experimentation is closely related to what the framework refers to as the laboratory. Designers sketch and model, exploring and testing their thoughts by making them physical. Open and vague sketches or exact and precise drawings that change from one visual means to another illustrate the (un)intended implications of an experiment, and the design process unfolds. Students have to discover that sketching and modelling are processes of experimentation.
Frame of reference	Designing is knowledge-based. Designers have a frame of reference, a professional library of knowledge, and experience. Students must develop their personal library, a collection of design projects and abstractions. To a certain extent, designers 'see' the new design situation via existing knowledge. They experiment with 'images', ideas, rules of thumb, principles, and patterns. In the process of experimentation – combining and transforming – new patterns may emerge.
Guiding theme	Designing is value-based – it is about developing an inspiring direction, a guiding theme, or some qualities in an almost endless field of possibilities. It is the designer's choice and culturally influenced 'answer' to a design situation. As a dynamic process, the qualities develop from vague and abstract towards a concrete, elaborated solution for the situation at hand. Students have to learn what values and qualities could apply to the design situation, and they have to learn to work with the theme concretely.

TABLE 1 Five elements of the design process, by van Dooren, 2020.

3 A framework to clarify the design process

The framework is a construction to make basic design skills explicit. The five elements are anchor points to articulate the 'designerly' process. They are not a prescription or recipe for design but are meant as a vocabulary to discuss the design process in the design studio via a mix of explanation, questioning, and instructions related to the present, provisional design. For example, instead of coming up with 'the solution', students have to learn to come up with alternatives and options and to reflect on them by comparing and looking for consequences.

If a teacher asks a student without design experience, 'Why is it as it is?', it is unclear to the student that designing is experimenting, conceptualising and playing with options, and reflecting on them. It may help students if teachers explain the experimental character and repeatedly reiterate the main (mostly implicit) question for a designer: 'What happens if …?' They may instruct students to come up with three to five options and ask them questions such as: 'What are the similarities and differences of these options?'

and 'What are implications of these options?'. If teachers explain and instruct students accordingly, they demonstrate the process of experimentation on a more abstract level *and* in direct relation to the present design situation.

Obviously, in discussions during the design tutoring session, the elements come together in different combinations, depending on the design product. For example, students have to learn that designing is much more than coming up with (original) ideas; they must understand how design ideas emerge, how to work with them, and how to reflect on them. Design ideas may emerge in 'a chain' of sketching and model making (laboratory). They may be inspired by reference projects or based on 'embedded' knowledge (frame of reference). They concern aspects such as space, material, and function (domains) and values or overall qualities of the design project (guiding theme). In combination with this exploration of ideas, designing also reflects on and tests ideas (experimenting). Ideas must be tested in relation to the overall qualities or values (guiding theme) and in connection to the other ideas and aspects (domains), such as testing a spatial idea for function and location.

By doing experiments, students learn how to work with commonly known and proven knowledge, gradually choosing one or a few values or qualities. In the end, coherent and significant design results may 'emerge'. It may help students if teachers explain and indicate this process regularly, asking questions like the following: Do these ideas fit with other ideas and aspects in the design so far? Advantages and disadvantages? What happens if you elaborate on this idea? What is the (still vague) main idea or quality? Do these ideas fit the main quality? What kind of knowledge do you need?

The framework may also help in other situations between teachers and students in the design studio. First, it may help to organise actions in the context of group work. If students have to jointly develop a design, mutual agreements such as doing experiments, defining and developing a guiding theme, and studying references, principles, and patterns may be helpful actions to structure and focus the design process. Second, the framework may help set up a design studio as a learning environment in itself and in relation to the overall design curriculum. With the help of certain elements, the design projects may be ordered and have a specific focus that differs between projects, allowing students to experience explicitly different approaches and views on designing.

Third, following this framework may help in the design of more complex courses in the design curriculum that deal with the relationships between design projects and other fields – for example, the relationship between history, frame of reference, and guiding theme. Visions, principles, and patterns are developed over time, and they may originate in a specific socio-cultural context that developed into more 'timeless' types and visions. Besides analysing and studying this knowledge, students have to learn to work with it. Similarly, the elements can also be useful in finding our way into the discussion of (scientific) research and design. What are the similarities and differences? For example, general knowledge is the goal of (scientific) research versus searching for knowledge for a specific design project (study). How can we develop research by design?

From an interdisciplinary perspective, the framework can help compare different design disciplines and increase mutual understanding. There are indications that the elements can be part of the overall design process. If so, an interesting dialogue between design disciplines can enrich the specific design processes. The framework can also be helpful for all kinds of design processes beyond the well-known professional design disciplines. For example, it can clarify the design aspects of political research. After all, design is the process of arriving at a new vision of the future. Therefore, it is part of the human experience. In other words, designerly thinking relates to all thought.

4 Conclusion

To conclude, the design process can be made explicit to a more considerable extent than practitioners and teachers relay to students, helping them better understand the developmental process. However, as with all research, this project had limitations, such as relatively small groups and a short period. So, one of the next steps should be a research study that includes a larger number of BSc students, control groups, a longer research period, and specifically trained teachers.

For now, the first experiences are positive, and five elements are proposed as a vocabulary to address the design process. The framework may help teachers to shift from design product to design process and to develop the design studio and curriculum. Addressing the design process may help students understand it better and increase their self-efficacy. In the meantime, the elements have also been used to help formulate learning objectives in the design projects. Position (guiding theme), knowledge (frame of reference) and study (experimentation) are part of the explanation of the learning objective 'learning to design'. In this way, the essential design activities or skills will be repeated, allowing students to experience and practice an experimental attitude, as well as the knowledge-based and value-based way of designing directly.

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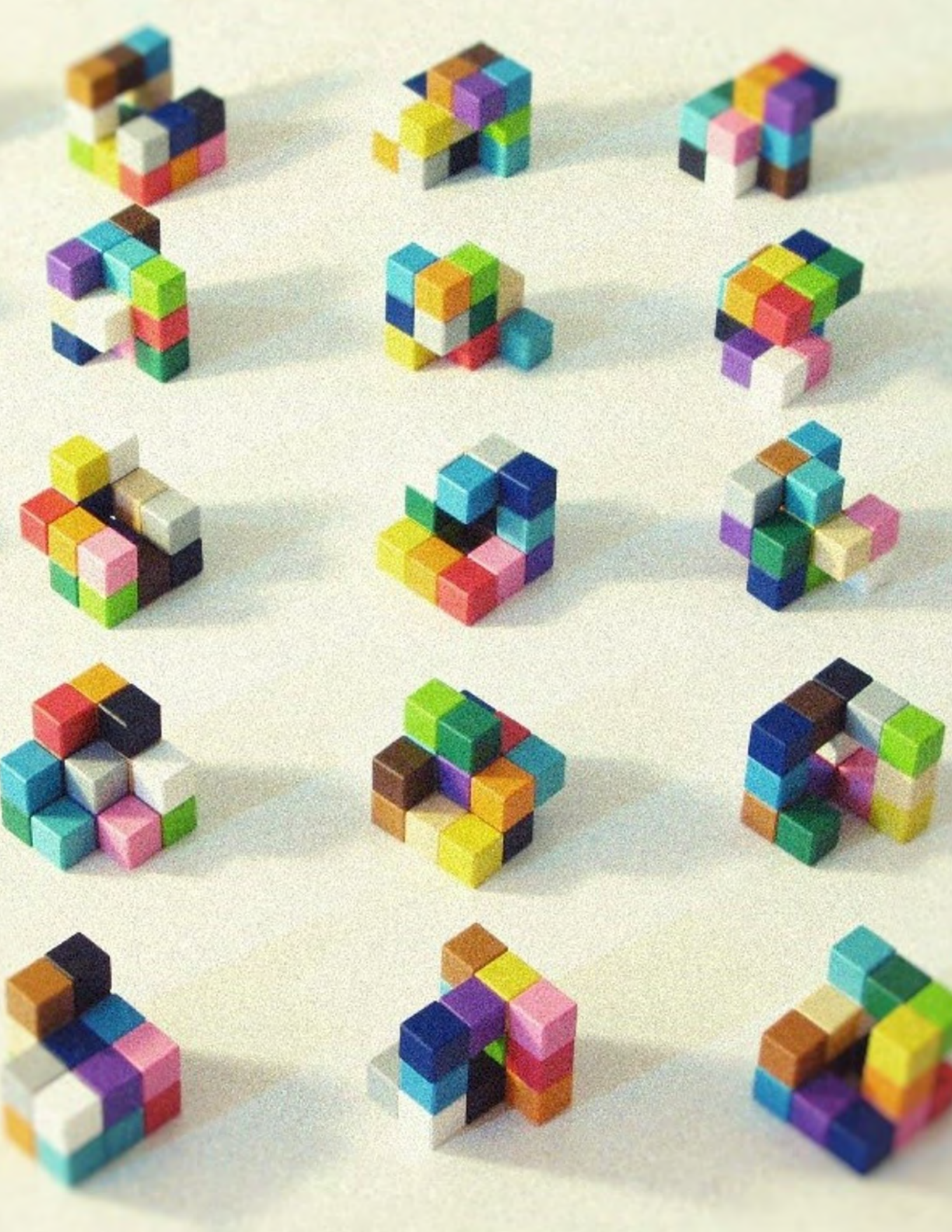

Participatory generative design education

On cultivating collective intelligence in design and planning

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Abstract

This chapter presents a pedagogical approach to generative design education for promoting participatory and transparent decision-making in design and planning processes. Generative design processes range from completely automated methods for the mathematical derivation and optimisation of designs to completely exploratory design grammars for the mass-customisation of designs. In the middle of this spectrum lie interactive gamified design processes that enable participatory mechanisms and the formal representation of design rules and provide for the emergence of collective intelligence through gamification. This chapter articulates a position on digital design education from a participatory design and digital-skills development perspective; provides a pedagogical vision rooted in curriculum development and teaching experiences from two courses on generative design; and explains how discretisation, topological modelling, and modularity facilitate participatory generative design education.

Keywords

Generative design, collective intelligence, gamification of design, combinatorial design, topological design, modular design

COVER FIGURE 16/27 Genesis voxel configurations made in PIXIO blocks, by Pirouz Nourian and Shervin Azadi, 2020.

1 Introduction

The future generation of architects and built environment specialists will face environmental, social, and economic challenges, especially the depletion of natural resources, housing shortages, waste accumulation, and urban inequality. In addition to these contemporary challenges, the combination of inherent physical and human complexities of spatial design problems make them particularly daunting (see Figure 2), so much so that they have been previously dubbed 'wicked problems' (Rittel & Webber, 1973). To avoid oversimplification and reductionism, we articulate the specifics of the complexities of design problems.

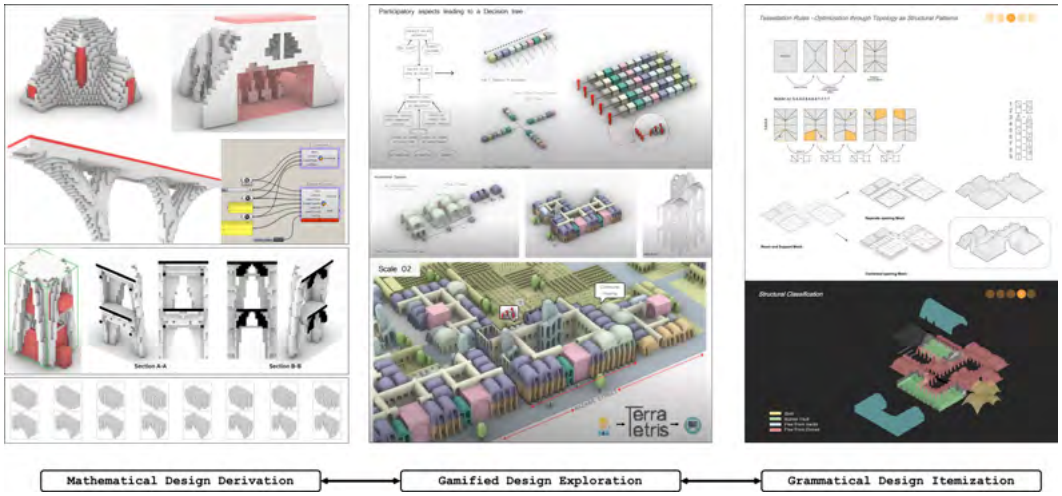

FIGURE 1 Student work within the spectrum of Generative Design Approaches: Mathematical Derivation, Interactive Design Gamification, and Grammatical Itemisation. left-top, MSc thesis project, by Rick van Dijk, 2020. left-middle, MSc thesis project, by Ivan Avdić, 2019 .left-bottom, MSc thesis project, Idil Gümrük, 2019. Middle, Earthy group design project, by Aditya Soman, Vicente Blanes Carpio, Christina Koukelli, Neha Gupta, Dion van Vlarken, 2020, (Azadi & Nourian, 2020c). Right, Earthy group design project, by Aditya Parulekar, Andrea Fumagalli, Divyae Mittal, Filip Zielinski, Prateek Wahi, Tarang Gupta, 2020, (Azadi & Nourian, 2020b); (https://genesis-lab.dev/courses/earthy/)

Without considering so-called human factors, design problems and purely physics-related problems would be indistinguishable. Many engineering design problems, e.g. in mechanical engineering or electrical engineering, pertain to the design of components that serve a larger system of physical components without any direct human interaction and hence no connection to human factors like ergonomics (Azadi et al., 2024). Consequently, design processes should have an adequate level of mathematical sophistication to tackle physical complexity and a sufficient level of communicative sophistication to address the human complexity of design problems. In this chapter, we elaborate on how participatory generative design approaches provide a didactic context for learning how to develop such sophisticated participatory design processes.

The following sections will elaborate on the background and the necessity of generative design education (Motivation), the definition and the framework of our approach (Generative design), the innovative aspects of this approach in design education (Innovation in education), its implementation in the target master's and bachelor's degree programmes (Graduate and undergraduate education), reflections on the results of three consecutive years of conducting these generative design courses (Reflections and experiences), and finally, concluding with the outlook of how this approach fosters research-oriented design education (Conclusion and outlook).

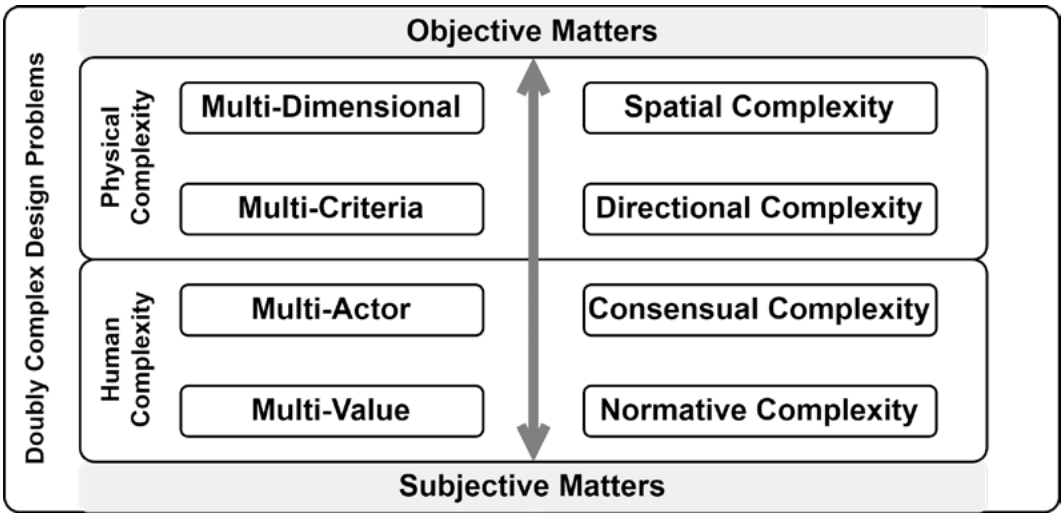

FIGURE 2 Wicked problems of Rittel and Webber (1973) revisited as doubly complex problems. The starting point of participatory generative design processes is to formulate design problems embracing all these aspects of complexity, by authors, 2024.

In design education, students face extreme challenges in learning design skills (Dorst, 2008) due to the absence of transparent design evaluation frameworks, particularly those involving and balancing societal, economic, and environmental values. In addition, fostering digital-skills development and human-centric design education often seem incompatible, particularly if digital design focuses only on creating shapes rather than decision-making. Instead, we suggest explicitly integrating these goals and values into digital design education and ensuring the transparency of goals, their evaluation, and the decision-making mechanisms that connect design decisions to the goals in question.

We argue that using digital means without understanding their fundamental principles is no longer an option, as this consumerist approach creates a culture of accepting decisions from black boxes without critical thinking. In addition, the excessive focus of curriculums on 'using digital tools for drafting design decisions' instead of the fundamental mathematical and computer scientific bases of such technologies will eventually hinder the adaptability of the students within the labour market (European Commission, 2019) concerning disruptive digitalisation and digital transformation (Bloomberg, n.d.; OCW, 2019a), especially with the rise of artificial intelligence (NWO, 2019).

In the spirit of demystifying design processes and avoiding reliance on natural and artificial black boxes,[1] we aim to promote collective intelligence and facilitate participation through gamification, playful situated learning, and methodical open-source design in built-environment education and research. To this end, we advocate using the modern interactive media of open-source scientific computing and the transparent language of mathematics for spatial design. Generative systems manifest emergent yet explainable collective intelligence amongst agents possessing various degrees of natural or artificial intelligence. Generative sciences utilise such emergent collective intelligence for the complex modelling of human-physical systems and processes. Focusing on collective intelligence in 'generative systems and sciences' categorically promotes critical thinking and participation while allowing for the non-reductionist mathematical formulation of real-world problems and an ideal context for learning methodological skills by providing a transparent platform for understanding, devising, and customising digital tools.

1 Unexplainable decision processes performed by humans or machines, based on the so-called tacit or inexplicable knowledge models.

2 Generative design

Generative design (Figure 3) is an umbrella term denoting scientific methods for deducing or discovering spatial configurations based on required spatial functionalities within a discrete design space (Nourian et al., 2023). Such scientific computational methods can be categorised as mathematical derivation, grammatical itemisation, or gamified exploration methodologies for synthesising schemata, configurations, and forms (Nourian, 2020b). The common traits of these three approaches are that they provide a gradual transition from abstract configurational decisions to concrete geometric decisions; that they are combinatorial in their nature, explainable, and reproducible; and that they provide a structured and navigable catalogue of design alternatives (Azadi & Nourian, 2021a).

While the so-called parametric design approach to computational design is relatively well-known and even associated with a design style referred to as 'parametricism',[2] generative design is often confused with parametric design in an architectural context. Naturally, these two paradigms have a lot in common, especially regarding their underlying technologies, and are even sometimes combined in computational design projects. However, to avoid such confusion, we itemise the differences between these two approaches within the computational design field as the two poles of a spectrum (Table 1).

"DESIGN AS A REFLECTIVE PRACTICE" (SCHÖN, 1983)	DESIGN AS RATIONAL PROBLEM SOLVING" (SIMON, 1996)
Design paradigms, design problems, and design procedures (Dorst, 1997), (Dorst, 2003), (Dorst, 1996)	
Procedural design	
Computational design	
Creative design	Generative design
Parametric design	Combinatorial design
Continuous variations	Discrete variations
Geometric variation / evolution	Topological variation / evolution

TABLE 1 : Creative parametric design versus generative combinatorial design (Nourian, 2020b)

The overarching objective of participatory generative design processes is to contribute to balancing equity, inclusion, and operational efficacy with sustainability and circularity as societal objectives (cf. Nourian et al., 2023). The modus operandi of such design processes is to mathematically explicate and break them down into small logical decision-making steps. As a result, the process can be revised not only in terms of the shape of the outcomes but also in relation to their configurations and the underlying goals and assumptions that lead to a design decision. In this framework, the educational purpose is to methodically bridge the so-called 'logical leap in design' (Kroes, 2009; Nourian, 2023), i.e. jumping to concrete conclusions from abstract design goals. We have explained our educational praxis in a previous study (Nourian, 2020c).

2 https://www.architectsjournal.co.uk/practice/culture/patrik-schumacher-on-parametricism-let-the-style-wars-begin

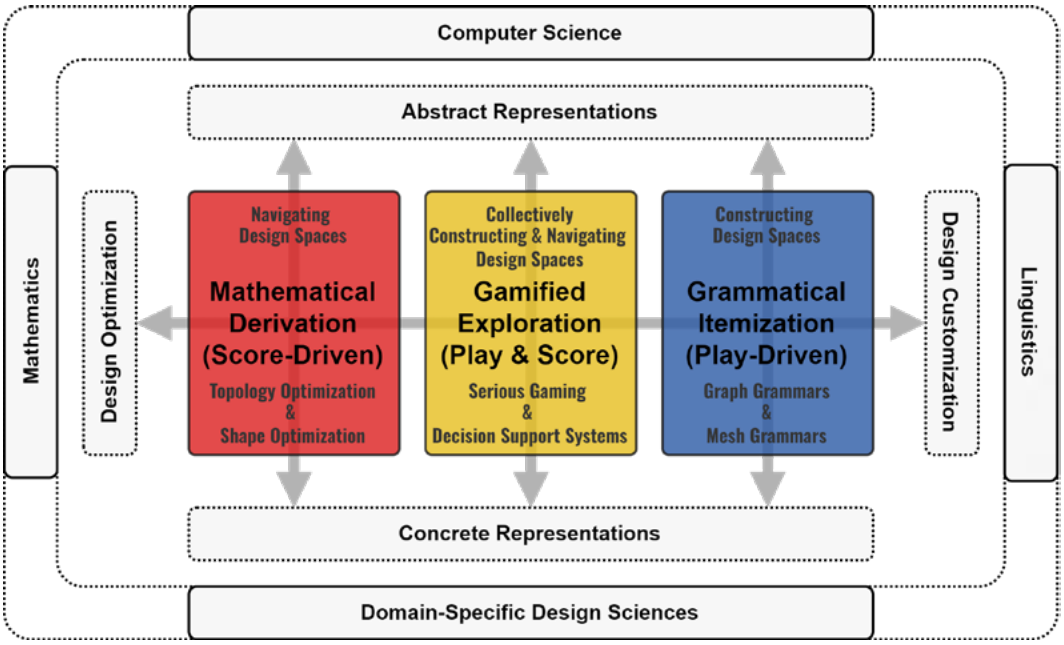

FIGURE 3 The spectrum of generative design methods, by authors, 2024.

3 Innovation in education

We have created an open platform for *situated learning* in the context of open-source software to bring this collective intelligence into the day-to-day experience of design education, symbiotically interlinking research and education both in the sense of extracting educational tools from our ongoing research projects[3] as well as advocating research-oriented design within design studio projects. In this framework, students are introduced to cutting-edge open-source software development, immersed in real-world problems, and asked to reformulate design problems and solve them methodically. Thus, they interactively learn applied mathematics and computer science through the gamification of design (Harteveld, 2011; Kortmann & Harteveld, 2009).

Real-world problem-solving requires experience in *problem formulation*, especially in the face of ill-defined (Epstein, 2008; Simon, 1996) or 'wicked problems' (Rittel & Webber, 1973), specifically applied mathematical knowledge, e.g. concerning spatial configurations, forms, and their functionalities (Cross, 1999; Simon, 1996). Our educational approach has four innovative aspects:

1 **Situated learning**: Situated learning brings about an interactive social environment for students to participate and immerse in a real-world problem (B & Seuchter, 2019, Dorst, 2003; Herrington & Oliver, 1991), thus promoting Learning by Doing, i.e. formulating and solving a problem (Dorst, 2003; Hung, 2002). Students are continuously asked to make decisions and justify them with critical reasoning. This approach will take learning objectives beyond **remembering** and **understanding** to **apply**, **analyse**,

3 See the open-source library topoGenesis (Azadi & Nourian, 2020a) developed in the context of the research projects GoDesign and EquiCity. More information is available at https://genesis-lab.dev/.

evaluate, and **create** (Bloom & Krathwohl, 1956; Cross, 2010; Lawson & Dorst, 2013; Shabatura, 2022; Shapiro, 2010). The trending **challenge-based learning** paradigm aligns closely with this approach (Gallagher & Savage, 2023).

2 **Gamification**: We propose utilising gamified generative approaches in design education so that interactive game media makes complex problems more approachable for students. Doing so allows them to quickly develop an understanding of participatory design processes, providing for playful learning of mathematical and computational underpinnings. Subsequently, students can customise, test, and develop the methods collectively (Kortmann & Harteveld, 2009).

3 **Open-source**: We promote collaboration among students and instructors and allow students to adapt the toolsets and methodologies to the particular needs of their projects. These necessity-driven customisations by students are thus valuable contributions to the research project. Beyond the sense of value, these contributions will pave the way for the students to bypass the black box culture and become competitive professionals with hands-on skills in advanced technologies. Moreover, the open-source strategy reinforces the flipped classroom (Abeysekera & Dawson, 2015; B & Seuchter, 2019) methodology by allowing students to learn to apply methods directly.

4 **Progression**: To ensure continuous progress, we keep the context of the design problem constant, not only to warrant the principle of '*ceteris paribus*' for educational research but also to let the students build upon each other's work and ensure continued progress. This approach strengthens their peer relations and enables them to contribute to a growing body of work, adding to the educational momentum.

4 Graduate education

EARTHY is a master's level design studio about designing and engineering earth/masonry buildings[4] intended for mid-term accommodation of displaced communities. Notably, the prospective inhabitants can participate in the design and construction of these buildings. A prior study thoroughly explains the course (Nourian et al., 2020).

4.1 Learning goal

The use of earthen materials necessitates the knowledge of complex geometry for designing and constructing vaults, domes, and arches in optimal shapes. Furthermore, the multifaceted relations of configuration and structure that manifest complex geometries for the shape of such buildings also necessitate intricate topologies for their layouts. By adopting a modular design process, we can contain the complexity within the design process and simplify the construction into a systematic low-tech process closer to LEGO® assembly than conventional construction.

4 https://genesis-lab.dev/courses/earthy/

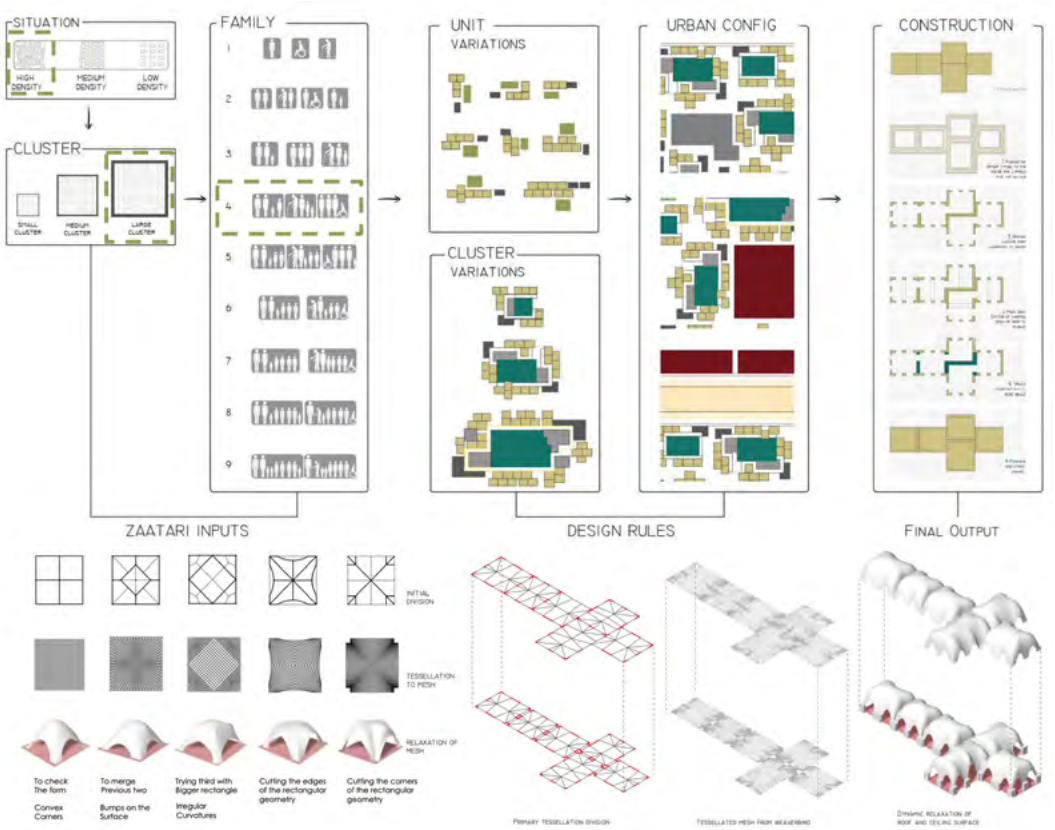

FIGURE 4 Student work sample from Earthy 2019, project Bustan, a farm-housing complex; by Akash Changlani, Shasan Chokshi, Kazi Fahriba Mustafa, Thai Wannasawang, Yarai Z. Montemayor, Elisa Vintimilla Salas, 2020 (Azadi & Nourian, 2020c). The team proposed a game for the participatory design of multi-scalar spatial configurations.

4.2 Didactic approach

Low-tech construction guided by high-tech design necessitates shifting focus from the object to the configuration processes. This approach mathematically shifts the focus from geometry to topology, thus ensuring generalizability (q.v. Azadi & Nourian, 2021b). Thus, the relations between the elements and their configuration become the primary concern rather than those elements in isolation. This approach also transforms design processes into participatory games, thus enabling the inclusion of intersubjective and social requirements in the design process. Furthermore, the same approach provides a fundamentally systematic and digital way of ensuring optimality in fulfilling objective and physical design requirements.

In EARTHY, students are situated in the context of a design by facing a societal goal to include prospective inhabitants in design decision-making and two major constraints in their design process: 1) use of compression-only earthen materials and 2) low-tech construction processes. In addition to these constraints and the design goals, the students are tasked with developing reusable computational workflows in a quest for mathematical elegance (*venustas*) in terms of matching complex configurations and shapes that possess not only operational utility (*utilitas*) but also structural soundness (*firmitas*). To provide for participation, we nudge the students to formulate 'design games' to test the logic, interactivity dynamics, and customisation level that participants would experience (for more details, see Nourian, 2020a).

5 Undergraduate education

The course Computational Design Studio is part of the minor degree programme Spatial Computing in Architectural Design,[5] which is offered as a collaboration between the TU Delft faculties of Architecture and Built Environment (ABE), Civil Engineering and Geosciences (CEG), and Electrical Engineering, Mathematics, and Computer Science (EEMCS).

5.1 Learning goal

The goal of the Computational Design Studio course is to introduce a participatory, generative approach to architectural design. In doing so, the course also introduces basic mathematical and computational skills, especially in geometry, topology, and graph theory (spatial mathematics), which are necessary for systematic analysis, synthesis, simulation, decision-making, and optimisation in architectural design. We propose generative design as a feed-forward design method in which the form is systematically derived from functional requirements.

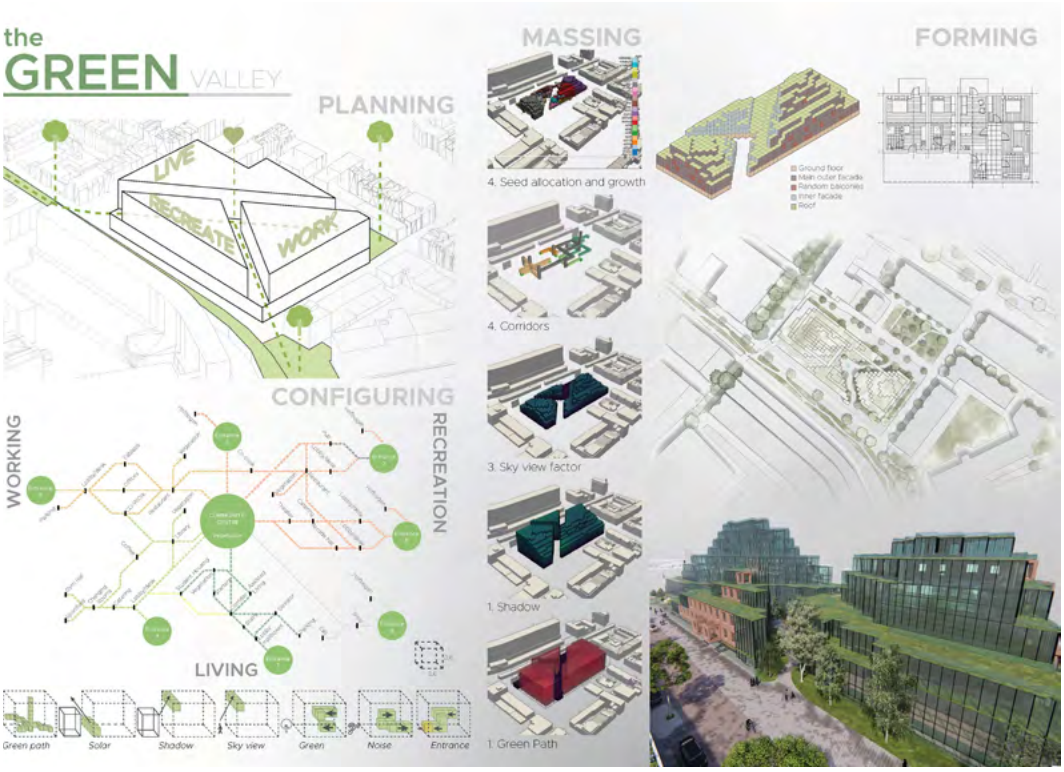

FIGURE 5 Student work sample from Spatial Computing Design Studio (BK7083, 2020), by Xam Adan, Frank Vahstal, Lotte Zwolsman, 2020 (Pirouz Nourian et al., 2020f); the team has adopted a generative design framework and created a system for deducing the final design in procedural steps from design requirements and the environmental goals with respect to the context.

5 https://genesis-lab.dev/courses/spatialcomputing/

5.2 Didactic approach

The goal of this studio was to learn how to develop computational design workflows. Therefore, the focus of the course is to formulate design problems in such a way that they could be solved using participatory generative design methods. Based on the nature of these decision-making problems, students should address them with mathematical derivation, grammatical itemisation, or combinations of these methods. Thus, the primary deliverable will be a demonstration of an operational workflow showing the transformation of a site, a programme of requirements, key performance indicators, and the preferences of the prospective inhabitants of a building.

By utilising such a didactic approach, we ensure that the students are not black-boxing available tools to create a design. They must understand the nature of design problems and be capable of methodically developing a workflow that solves them. Consequently, the outcomes are explainable systems that generate spatial designs with various configurations.

Moreover, students are asked to create computational prototypes of these systems and test their methodical understanding of them. In some cases, a purely computational implementation is insufficient to incorporate human decision-making aspects of the workflow. Therefore, in those cases, they are asked to create a gamified embodiment of the workflow capable of simulating the subjective and intersubjective aspects of the logic (for more on this, see Nourian, 2020e).

6 Reflections and experiences

Although the students in our generative design studios typically lack the essential background in mathematics and computer science to cope with the abstraction and complexity of the subject, after finishing these courses, most students successfully bridge this gap and learn new digital skills. Furthermore, introducing the decision-making perspective on the design process poses challenges for students at the beginning of the course. However, the effective adoption of this new perspective is evident in the final results – students use it to formulate their design arguments based on objective criteria and as a sequence of explainable and reproducible decisions.

7 Conclusion and outlook

The problem formulation within the context of generative design is limited by the physical constraints of economic and environmental sustainability, circular constructability, and the reusability of products, as well as consideration of human factors and ergonomics conventions and standards. Instead of only solving problems with fixed formulations that have only one correct answer, the students leave their intellectual traces in their proposed solutions by how they frame and formulate the problems and the technical solutions they propose to solve them.

It is time to bridge the assumed chasm between architecture and computational methods, look scientifically at spatial design problems previously known as wicked problems, embrace their double-complexity (human/physical complexity), and devise methods sophisticated enough to surpass reductionist understandings of contemporary spatial design. To be prepared for the future, students must be equipped to go beyond consuming technologies and participate in developing human-centred technologies and explainable AI. To achieve this, we propose to revise learning objectives to situate digital-skills learning in the context of challenge-based design education.

This approach strongly resonates with the concept of *learning by doing* (García-Peñalvo et al., n.d.; Hey & Payne, 2015; OCW, 2019b; Toelch & Ostwald, 2018) and entails sharing open, reusable, reproducible, or explainable research methods and didactic materials. These materials are available in multiple public repositories for open-source methods, tools, data, and the proceedings of the courses (see Nourian, 2020d).

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Heritage-related design workshops model

Educational research on design-driven participation models for heritage design charrettes: Southern Waterline case study

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Abstract

Design workshops, design charettes, and student hubs are increasingly used to generate innovative solutions for complex spatial problems or to define (heritage) values as a form of knowledge creation and research-by-design. Due to the increasing focus on participation and co-creation, design workshops should be adapted to strengthen local involvement and commitment to transformation processes. This article delineates a Participatory Transformation Design Workshop model, combining research-by-design with (participatory) action research as the base for design workshops in heritage management. This participatory heritage design workshop (PTW) was developed and elaborated for the Southern Waterline lab (Zuiderwaterlinie lab) at the National Manifestation Landscape Triennale 2020 and is now regularly applied in landscape architecture education to strengthen the relationship between academia and practice on heritage issues. This chapter starts with an overview of different formats in design charrettes (design workshops) and an explanation of the increasing attention of participation in heritage management. In the second part, the most important topics of a PTW are described: the content, the involved parties, and the organisation. All three aspects are connected to the three most important phases of a PTW.

Keywords

Heritage, student workshop, design charrette, Zuiderwaterlinie, research-by-design, action research, participation

COVER FIGURE Photos by Jan Janse, 2020, with permission.

1 Introduction: literature review

1.1 Design workshops or design charettes

Practical and academic cooperation has resulted in formats like design workshops or design charrettes, student hubs, living labs, sketching sessions, graduation atlases, atelier designs, and so on. This cooperation is beneficial for students to learn from practitioners, for local experts to obtain new insights, and for stakeholders to envision a new future for their living environment. From a didactical point of view, students should combine education on campus with training in real-life issues in collaboration with practice. Students should be empowered to engage critically and creatively with the public and local stakeholders in transformations on concrete sites beyond the campus as part of their academic training.

Accordingly, design workshops or design charrettes can be defined as a type of codesign to develop creative solutions to a specific design problem within a limited time frame (e.g. Girling et al., 2006; Howard & Sommerville, 2014, p. 48; Mara, 2006). Kelbaugh (2010, p. 29) emphasises the role of creativity and the designerly part when stated that design charrettes are the best way to develop creative proposals for the most challenging problems by talented and accomplished designers in the shortest period. A design workshop or design charrettes is a relatively low-cost, low-time investment and an active method to create design options and to confront students with practice (Verschuure, 2021). Designing can be considered an active way of creating and visualising knowledge (research-by-design). The Dutch state has advocated for this so-called *design power* since the 1990s (CRA, 2019). Roggema (2014b, p. 23) states that the differences between design charrettes are defined by length, range of participants, and type of objective.

Since their introduction to students at the *Écoles des beaux-arts*, design charrettes or design workshops have been used for various purposes, and roughly, the three most common are (Roggema, 2014b):

- Design schools use design charrettes or masterclasses as a form of *design-driven co-learning* where large student groups led by distinguished professors come up with various design plans (Kelbaugh, 2010). This form of work is widespread in the United States, e.g. the National Charrette Institute at Michigan State University (website).
- Design workshops and design charrettes may be used to facilitate cooperation between a variety of experts or involved partners to come up with *design-driven solutions creation* (Howard & Sommerville, 2014; Roggema, 2014a, 2014b). This approach can lead to one particular engaged design proposal or to differentiate among possible solutions as a form of research-by-design. The Government Service for Land and Water Management (Dienst Landelijk Gebied, DLG) used this model to combine various expert inputs in Sketch sessions. Wageningen University uses this format in *science shop* projects where a design workshop was part of this trajectory (e.g. During & Van der Jagt, 2015; During & Van Dam, 2019; Verschuure-Stuip et al., 2017). This approach focuses on the process and less on the spatial design processes in heritage, urbanism, and landscape architecture.
- Design workshops or design charrettes as *participatory action workshops.* Experts, non-experts, and local stakeholders can discuss future situations in *participatory action research* (PAR; Bilandzic & Venable, 2011). PAR aims to produce 'knowledge and action directly useful to people, and also to empower people through the process of constructing and using their knowledge' (Shortall, 2003, p. 225). The focus is on the process of exchanging knowledge and not specifically on heritage issues or spatial design.

A participatory transformation design workshop (PTW) is a fourth addition to balance participation and action research with problem-solving by designing and visualising. During a PTW, the contribution and commitment of various participants are needed for commitment and a feeling of ownership, explaining spatial dilemmas, giving historical background information, or organising the workshop. These different aspects can help increase awareness, commitment, and local involvement in the process. The role of a multidisciplinary group of students is crucial because they serve as unbiased translators of opinions, adding new and innovative proposals.

1.2 Participation in heritage management

Over the past 50 years, heritage management has shifted from object-oriented conservation to change management to re-use and transformation, with growing attention to experience and participation in the cultural-driven use of tangible and intangible heritage (i.e. Janssen, 2014; Patiwael et al., 2018). Two lines can be distinguished. From the mid-20th century, heritage has focused on historical (built) elements describing historical, aesthetic, and scientific values, all defined by experts who emphasise physical aspects.

Since the start of the 21st century, societal changes, like migration, digitalisation, and climate change, have altered longstanding ideas on heritage values. This shift has resulted in the adaptive, active re-use of our built past, focusing on the future with the motto 'heritage through development' ('Belvedere idea'). Heritage is increasingly considered important for our future as part of the management of change, transformation, and renewal. Janssen (2014) describes this as the active heritage from *sector* to *factor* approach. When heritage becomes the leading theme in planning, he refers to it as the *vector* approach (see Figure 1).
All these approaches are used in heritage management today.

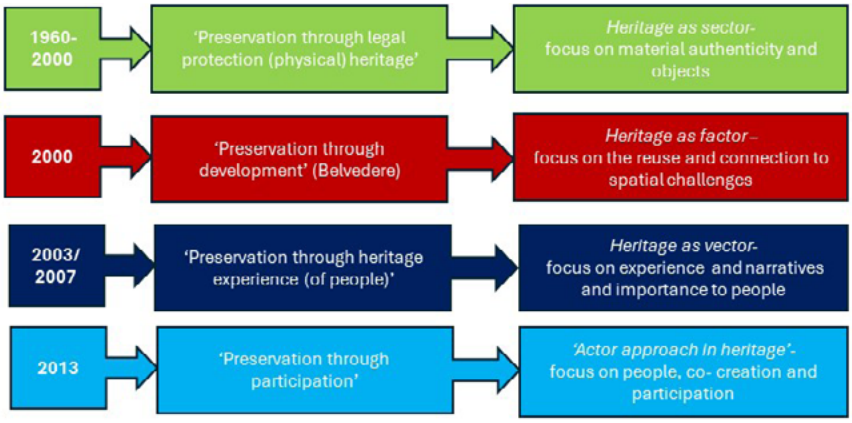

FIGURE 1 Four stages of heritage management in the last 50 years in The Netherlands, by Gerdy Verschuure-Stuip, 2024.

Another significant change in heritage management is the democratisation of heritage and the role of humans in heritage preservation. Since the last quarter of the 20th century, the *social and cultural values* of heritage have become an explicit component of conservation policy and practice. The Burra Charter by ICOMOS Australia (International Council on Monuments and Sites) was considered the keystone document (Burra Charter, 1979). Similar to this, ICCROM (International Centre for the Study of the Preservation and Restoration of Cultural Property) presented Living Heritage sites, focusing on the intangible values of

heritage in 2003 (Wijesuriy, 2014). This focus on cultural and social elements in heritage has resulted in growing attention to participatory processes, storytelling, and place attachment of people with their living environment.

The role of experiencing heritage by citizens grew rapidly. In Dutch heritage management, this process eventually led to the focus on public participation in transformation processes, described in the implementation of the European Convention on the Value of Cultural Heritage for Society (2005) and the 2024 Faro Convention in The Netherlands. These ideas were already described in the National Heritage White Paper Heritage Counts (2018) and the Implementation Agenda Faro (2022), next to the integration and cooperation in state-funded projects organised as 'heritage deals' (Verhoeks, 2020). These agreements have led to changes in the transformation process in which the participation of local stakeholders should be part of design decisions (Verschuure-Stuip, 2024).

This change in focus from object to people demands new methods and approaches to make new plans in which citizens are fully taken into account, leading to four phases in Dutch heritage management, described in four different mottos: preservation through legal protection (start of heritage management), preservation through development ('Belvedere idea'), preservation through heritage experience, and preservation through participation. These mottos reveal a shift from object preservation to the re-use of objects (physical heritage) and the focus from object to people (democratisation). The attention to the intangible aspects of heritage coincides with increasing attention to broader, non-expert perceptions, heritage experience, and participation in spatial planning. To facilitate new alliances in knowledge creation in heritage management, a PTW helps to find solutions with 'design power' (CRA, 2019). The upcoming step is the role of empowerment and commitment in heritage preservation as a fifth, upcoming phase.

1.3 Transdisciplinary cooperation for valorisation

The Rathenau Institute (2020, p. 6) stipulates increased cooperation between municipalities and higher education. This growing attention to cultural participation, local involvement, and cultural aspects is the consequence of the decentralisation of national tasks to municipalities and growing attention to integrated solutions in spatial planning. In academia, this growing attention to new ways of knowledge creation is part of a research valorisation strategy – the third mission of Dutch universities. The City Deal Kennis Maken (CDKM) programme is funding research into practitioner–academic (education) collaborations.

2 Preparation of a participatory transformation design workshop

The second part of this chapter describes how the PTW of the Southern Waterline workshop (Breda) was designed in 2020 and funded and presented for the CDKM programme (Verschuure-Stuip, Jansen et al., 2020) based on knowledge of action research. Every PTW has at least three essential topics: content, involved parties, and organisation (Figure 2). In each topic, citizens' engagement and commitment can be organised into various levels of participation. These three topics are spread out over all three phases in

the design workshop: the preparation, the workshop itself, and the finalisation of the PTW (A, B, and C). The preparation phase is about exploring, framing, and reframing the workshop. The workshop phase deals with the analysis and solutions, and the finalisation phase connects outcomes to a broader audience. De Lille and Overdiek (2021) underline the same three phases in the organisation of a living lab.

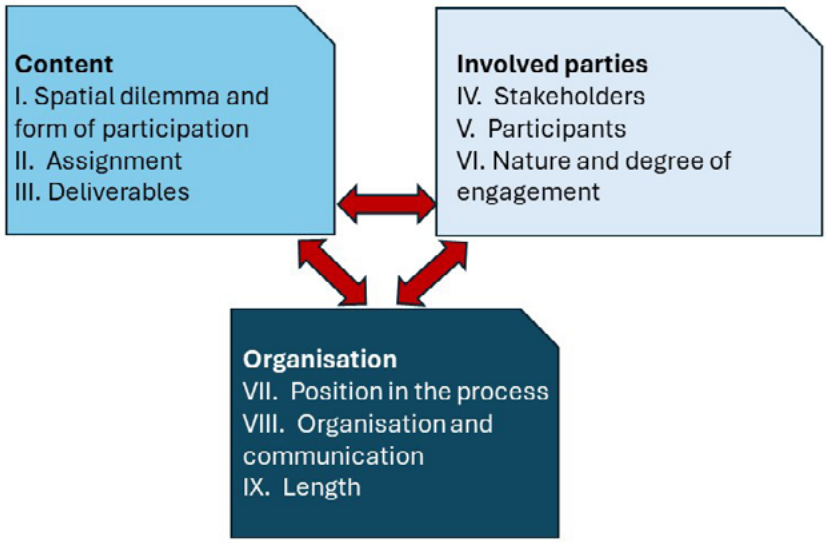

FIGURE 2 Main organisational aspects in the preparation of a PTW, by Gerdy Verschuure-Stuip, 2024.

2.1 Content

1 **Spatial dilemma and form of participation:** The first important aspect is a clear description of the spatial dilemma and the outline of the site, both visual and textual (starting point). The organisation, group, or person who starts the workshop defines the type of participation. If the research-by-design question starts from a citizen's or owner's initiative, it entails a bottom-up approach to participation, called 'citizen participation'. The main design question can be set by stakeholders or governmental organisations (municipality, waterboard province) as top-down 'stakeholder participation' (Wagenaar & Rodenberg, 2023). A participation project can start with a group of citizens called a 'participation by governing the common pool' as a top-down and more closed approach or with a group of citizens 'governing the public good' as an open approach. Citizens, local owners, groups of citizens, or even governmental bodies can start a PDW.

2 **Assignment:** The second pivotal aspect is a common idea on the type of research and desired deliverables. The outcome of a workshop can be an exploration of a wide range of future possibilities, a series of shared (part) solutions, a definition of the essence or (heritage) values, a series of drawings to attract public attention, or a participatory exhibition to increase awareness, among other options.

3 **Deliverables:** The third aspect is the deliverables because they define the proposed research question and the topic of the PTW. Next to this, it is vital to discuss how the outcomes are presented and to whom, and an analysis of the outcome can lead to a series of approaches (research-by-design). The content and type of needed outcome should lead to the set-up of the design workshop and should define the presentation of the outcome, which can be a presentation, an exhibition, a debate, or a film.

2.2 Involved parties

4 **Stakeholders:** Participation thrives on involvement during the workshop. Therefore, a clear overview of involved parties, stakeholders, societal organisations, businesses, and governmental bodies, like municipalities, water boards, and provinces (Quadruple helix), is essential. During the workshop, the role of the stakeholder should be balanced to avoid overburdening the participants during the workshop with too many ideas. This goal can be achieved by starting the workshop with numerous short presentations (with a maximum of 15 minutes) to make a point.

5 **Participants**: In design workshops, students from different fields, their tutors, and the parties involved in establishing the research question should limit the number of ideas. During the workshop, specific moments invite local experts to make the outcome more realistic. To design interdisciplinary solutions, participants should come from different knowledge fields to ensure a wide diversity of ideas.

6 **Nature and degree participation:** Participation is essential, but not everyone can or would want to engage at the same level during the entire project. The degree of participation should be clear and communicated to all involved parties, including noting the level of influence they have on the outcome. Stakeholders can be involved in all parts of the workshop, for example, in collecting historical and other forms of knowledge and in its organisation. However, not all stakeholders should be involved at the highest level of the participation ladder. Instead, a ladder of commitment can be introduced to stipulate that everyone's involvement is important but has limits and different forms. A PDW and the possibilities of reaching out to the public on-site are critically important. Public attention is needed in local newspapers or social media.

2.3 Organisation

7 **Position in the process:** A proper phasing of the workshop is crucial because PDW can inspire and stimulate owners, stakeholders, and the public in case of a contested situation. It can function as a catalyst in a transformation phase when it is organised well. When the process is at a stage in which ideas already exist, the originator or expert may have difficulties when new ideas do not build upon those that were already proposed. Working on-site helps to increase visibility for interested citizens and local newspapers.

8 **Organisation and communication:** The organisation of the location of the workshop, the creation of needed information in interviews (i.e. short films), maps, and other data can create a feeling of ownership of the workshop and show local experts the importance of a site. Storytelling is important in all phases – from historical research to presenting the outcome. Communicating with the right partners is pivotal.

9 **Length**: Another aspect is the length of the workshop. To manage the energy and attention of all involved parties, the timespan of a workshop should not be too long but should have enough time to conduct the three most important phases. Most common are three to five days.

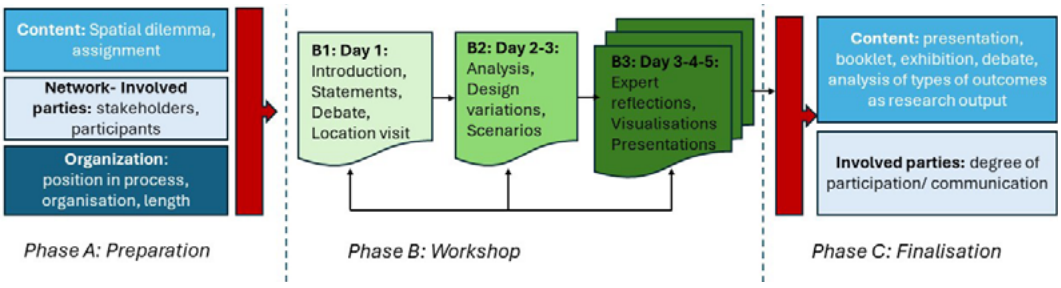

FIGURE 3 The PTW model with the most important phases and main aspects, by Gerdy Verschuure-Stuip, 2024.

2.4 The model

A PTW contains three main phases (Figure 3):

A **Phase A: Preparation.** During the first phase, the content, assignment, stakeholders, participants, and the organisation need to be involved and committed. In a participation process, the public should receive a lot of attention in this phase, discussing future needs, and in a PTW, all types of roles are possible.

B **Phase B: Workshop.** The second phase is the workshop, which has three essential sub-phases.
Phase B1: Explanation and understanding of the context, design problem, and defining the main problem per group and ideas for solutions (day one)
Phase B2: Concept proposal, comparison, and evolution in an iterative process (days two and three)
Phase B3: Refinement of plan and presentation (days three, four, and five)

C **Phase C: Finalisation.** In the third phase, the various designs are published and discussed with the involved public, local owners, and experts in presentations, publications, websites, exhibitions, pop-up exhibitions, and other forms of presentations.

2.5 Case study: Southern Waterline

For the Landscape Triennale 2020 (2021), the Dutch Schools of Landscape Architecture (DSL) organised several design activities and two PTWs for different parts of the Southern Waterline Zuiderwaterlinie). A waterline is an inundation landscape designed for times of war and this line was first developed in the 16th century. The PTW Breda was a collaboration between the LDE Centre for Global Heritage and Development, the project bureau Zuiderwaterlinie, Breda municipality, and the State Forestry Service, the landowner, which provided the network of local participants. During the workshop, involved stakeholders debated the future of this agriculture-dominated area, which is suffering from drought and a loss of biodiversity, with no functional military use of the Zuiderwaterlinie. For the future of this old defence line, the inundation fields can be used for retention in times of climate change (vector approach in heritage management). The moment was well-timed because the experts did not have a solution in mind.

FIGURE 4 Plans were made for specific locations, like a camping site for the Spinola fortress (Breda). Water was reintroduced into the former inundation fields. The strength of the outcomes of these workshops is the visualisation of the future and students are challenged to show their ability to visualise a new future in a plan understandable for residents, by Ioanna Kokkona, Maaike Tenhagen, Willemijn Schreurs, 2020.

The students came from the Universities of Leiden, Delft, and Rotterdam (LDE Centre for Global Heritage and Development, student hub Zuiderwaterlinie, 2020). The PTW took three days and included a presentation for the aldermen of Breda on the last afternoon, which is important for the feeling of 'ownership' and commitment of local politicians to do something with the plans.

The stakeholder analysis showed three 'groups' of involved parties: the public, the landowners and local experts, and the municipality, Water Board, and other experts. The initial idea was to involve the public through their stories and values in the area through interviews and joint-sketching moments, with presentations on a boat that would pass by the different sites. Local parties and experts were invited to discuss the spatial issues due to drought, agriculture, and heritage, and local newspapers would invite participants. During the workshop, the public and local experts were asked to present their ideas and experts were invited later.

Then, Covid-19 changed our way of life and influenced the proposed model because public involvement was physically limited due to national regulations. The workshop was organised as a blended exercise, combining online and on-site design activities with the least amount of contact. Students only visited the area once and could not stay overnight. Therefore, the focus shifted towards the local experts and landowners, diminishing the possibilities of participation. Because some local experts might not be able to join due to Covid-19 risks for older people, a series of YouTube films were made to explain the history and note current concerns. This event marked the start of a 'digital library', and these films can be seen on the *Zuiderwaterlinie.nl* website.

Three main focal themes were defined – tourism, water, and agriculture – with several deliverables. Two or three groups worked on each theme. Joint discussions about more extreme possibilities were not possible in our 1.5-metre society, which resulted in less varied outcomes than originally hoped.

When a joint debate on design proposals at the end of the first day was possible, supervisors could choose to direct certain groups to more outspoken outcomes. The drawings are critically important to show the public and local experts how the future may look (Figures 4 and 5). This model results in local involvement during every phase, which is time-consuming but may result in a more easy-going transformation process in the long run.

The results helped start the discussion and showed various solutions to explore different options through a series of drawings – part of the research-by-design approach. The outcomes were presented at several national and international conferences, and an exhibition with artists, and they were published in a special issue of a national magazine on landscape architecture and urbanism. This PTW was presented as a case study of the Faro approach to participation, created by the National Heritage Agency (Rijksdienst voor het Cultureel Erfgoed). In the later versions of this workshop, the participatory parts operated more smoothly.

FIGURE 5 The former inundation field of the Zuiderwaterlinie: here, the lower parts of this landscape were transformed into wet, nature-based agriculture as a clear visualisation of local ideas, by Dorien Tulp, Suxin Liaw, Yun Sun, Emmanouela Armoutaki, 2020.

3 Conclusions and reflections

In a time of growing cooperation between practitioners and higher education professionals in terms of research and valorisation, there is a growing need to make the transformation processes in heritage management increasingly participatory. This process demands a growing need for methods to discuss spatial transformation with a wider range of people than the heritage expert. Design charrettes or design workshops can be transformed into participatory transformation design workshops (PTWs), allowing involved parties (e.g. stakeholders, the public, owners) more room to express their needs and thoughts for the future. A PTW combines research-by-design with knowledge of action research, design, and participation. A PTW can contribute to speeding up transformation processes because it catalyses and visualises different future perspectives actively without major investments or for an extended period and helps create academic knowledge. For students, working in multidisciplinary teams can be inspiring, and students benefit from learning how different fields of knowledge operate.

The most important aspects of a PTW are the content (spatial dilemma, assignment, deliverables), the involved parties (participants, stakeholders, nature and degree of engagement), and the organisation (position, organisation, and length). All aspects need to be addressed in all three phases of a PTW (preparation, workshop, finalisation) to obtain the best results. Doing so leads to a model which can be implemented in the transformation process of other heritage sites.

Another crucial element is to create and expand in a good network with local stakeholders. The involvement and feeling of ownership by local organisations is critical, and all parties should participate according to their level of commitment and ownership over the project, which should be more clearly addressed at the beginning of the PTW. Participation is a generic term, but defining who is going to invest what in terms of effort, time, and knowledge is critical during the design process. These kinds of workshops or design charrettes can be used to define public demand and connect it to the academic realm.

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Group work in design education amid the pandemic

Observation and reflection

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Abstract

Group work has been used in design-related education programs to train students in handling the complexity of the design process in the built environment through co-operation. Education activities moved on-line when the COVID-19 pandemic started. Students have worked in groups remotely through digital platforms instead of face-to-face on campus. How did design education programs incorporating group work adapt to these changes during the pandemic, and how did the virtual environment influence the design process and outcomes of group work? This paper addresses these questions by examining two master education courses provided at the Faculty of Architecture and the Built Environment, Delft University of Technology. It explores how the group work can be managed online with higher exploitation of digital tools helping interaction and data sharing among group members. The conclusions highlight the distinction between content development via on-line education (and how it can meet certain standards) and the communication dynamics during group work (for example how vocal remarks, separated from body language and shared context, can impact the quality and effectiveness of online group interactions). These findings underscore the importance of considering both aspects when developing group work for online education.

Keywords

Design education, COVID-19 pandemic, group work, on-line education, communication

COVER FIGURE Illustration of the proposal on the redevelopment of Fellenoord at bird's eye level - an end product of the Urban Redevelopment course, by Olga Surogina, 2024.

1 Introduction

Planners, architects, engineers, property developers and city managers are all partially responsible for delivering well-performing good quality buildings and urban districts. They deal with multiple requirements to design and develop sustainable, resilient, circular, eco, low-carbon and inclusive buildings and places. Professional knowledge from specialists is needed together with knowledge and skills to integrate different disciplinary perspectives. At the same time, designers, planners, and city managers should have a better understanding of the interrelations among technology, society, environment, economy and design, and be able to combine and synthesize a variety of academic and professional knowledge. Creativity is needed in such an integration process to make connections and integrate knowledge across fields of expertise and uncertainty (Campbell, 2014). Interdisciplinary education has become an important approach in design education (Chen et al., 2019). To develop interdisciplinary mindset and skills, group work, often chosen as a suitable education approach, fosters the ability to explore complex problems from different perspectives. It also prepares (future) professionals from different disciplinary background to communicate and collaborate in the design process. The differences in culture and education backgrounds, as well as the various disciplinary priorities during design, can create tensions in the collaboration process, a challenge frequently encountered by practitioners.

The unprecedented COVID-19 pandemic has necessitated sudden measures to avoid group gatherings and ensure social distance. As a result, group work in design education had to be executed remotely in virtual environments. The on-line setting has posed challenges to traditional group work, where personal face-to-face interaction is typically crucial. This article examines two design courses at the Faculty of Architecture and the Built Environment, Delft University of Technology - the Urban Redevelopment Game: Integrating planning, property development and design (URG), and MEGA: Integral design and engineering of a tall/large building. Both are design courses that incorporate group work and were forced to transition to on-line mode in April 2020. Based on background studies and empirical observations, this paper reflects on:

1. How was the group work in the design education programs in the on-campus setting transitioned to an on-line education during the pandemic?
2. What feedback have students and teachers provided regarding the learning process, group dynamics and group collaboration in an on-line setting?

This paper introduces background studies on group work in the context of design education and implications in on-line setting. It then examines how the two TU Delft design courses embraced the on-line setting and whether it affected group interaction and results. Discussion follows on pro and cons of group work on-line and how some changes should be incorporated in future design education.

2 Background studies: Group work in interdisciplinary design education: on-campus vs on-line

2.1 Group work in design education

Group work is an essential instrumental method in design education. It emphasizes interdisciplinary and pluralistic perspectives. In real life, the members of design teams or the stakeholders in urban projects embrace different perspectives. Using an interdisciplinary approach, students learn the value of each discipline and recognize their own competence to each expert in the team. Group work benefits students to handle the dynamics of group interaction when collaborating for the interdisciplinary design assignment. During the process, students gain experience in interdisciplinary communication, develop social skills, work more productively and know self-better through peer review and feedback on performance in group assignments (Michaelsen, 1992). They experience different types of meetings and workshops to formulate shared visons, exchange knowledge, develop creative solutions or team-building (Qu et al., 2019).

Group dynamics plays a vital role in forming an effective, high-performance team. The group work may experience different stages like forming, storming, norming and performing (Tuckman & Jensen, 1977), as is in table 1. Participation, communication, collaboration, influence, trust, cohesion, empowerment, and satisfaction are key components of group dynamics in shaping collective learning and action during the different stages (Greenlee & Karanxha, 2010). Students discover how to share, respect and contribute to (new) ideas and learn from critical feedback. Group work requires students to adopt collaborative attitudes to gain trust from each other, such as "open-mindedness, cultural awareness and awareness of own biases when dealing with data" (De Greef et al., 2017). It can facilitate feelings of belonging, empower team members and develop satisfaction if individuals sense their influence and contribution on group goals and decisions. Effective leadership may stimulate team members to influence decision-making processes and be satisfied with personal growth (Greenlee & Karanxha, 2010).

Stage 1	Forming	Learning about each other	Group of people	Orientation
Stage 2	Storming	Challenging each other	Potential team	Dissatisfaction
Stage 3	Norming	Working with each other	Team	Integration
Stage 4	Performing	Working as one	High performance team	Productivity

TABLE 1 the FSNP model, by L. Qu et al., 2019; Tuckman & Jenssen, 1977.

2.2 Group dynamics & interaction: on-campus vs on-line setting

On-line environments imply differences as compared to on-campus environments for group work. Rooij et al. (2020) suggest a complete virtual learning environment may impose numerous challenges. In the on-campus setting, group members can use subtle hints and body language to decide whether extra chats are necessary for communication; the creation of empathy in the on-line setting depends on more formal ways. The quality of interpersonal interaction in on-line courses (e.g. frequent and effective interaction encourages commitment and higher academic performance) relates positively and significantly to student success (Jaggars & Xu, 2016).

Interactions also relate to on-line digital tools. Information and communication technology (ICT) are acknowledged to play a substantial role in enabling remote design collaboration and have a growing impact on professions in the building sector since years already (Tuncer et al., 2000; Maciver & Malins, 2015; Sariyildiz et al., 2000). Architectural and engineering offices use on-line communications with remote partners based on whiteboard software and teleconferencing, being increasingly empowered on a global role (Tuncer et al., 2000). New technologies and their appropriate use are essential for the collaborative and inclusive paradigm of contemporary design practices, where designers are demanded to have experience with the use of ICTs (Maciver & Malins, 2015). Collaboration tasks face the risks of time and data losses during information exchange and negotiation on conflicting subtask as well as of misunderstandings consequence of incomplete information, occurring in a constant dynamic renegotiation of project characteristics (Lottaz et al., 2000). The ICT infrastructure can facilitate handling this collaborative process but requires necessary ICT skills and awareness. These regards ways of sharing items such as data, images, 3D models, communication messages, and other shared documents to interact and to exchange information up-to-date, secured and consistent with the latest project characteristics (Lottaz et al., 2000). The conditions of the COVID-19 Pandemic brought this paradigm to an increased application in education.

3 Case study: comparison of two design courses at Delft University of Technology

Following the discussion of group work-on-campus vs on-line, we introduce two design courses that incorporated intensive group works. URG is offered by the Department of Management in the Built Environment (MBE) and attracts faculty wide students as well as from other Dutch Universities, and MEGA is offered by the Architectural Engineering and Technology Department and attracts students from the MSc tracks of Architecture, Building Technology, occasionally MBE and Building Engineering at the TU Delft faculty of Civil Engineering and Geosciences (CiTG). Both courses run in the fourth quarter of the first year master program, April to July. The following section first explains how group work is incorporated in the design of the two courses, then discusses differences observed in group works on-line compared to on-campus, including group dynamics and data sharing.

3.1 Group work in URG and MEGA

Background information
URG is an interdisciplinary course in which students apply various analytical, technical, and social-political skills to address an ongoing urban development project. Students develop in-depth knowledge of the site and the project using role simulation and are asked to create an urban development plan. They work in teams of 10-14 students each. Each group includes different realistic roles: several municipality parties (Land department, economic affairs, urban planning), market parties (2-3 real estate developers, housing association), independent parties (process manager, environmental law consultant, urban designer).

MEGA is an interdisciplinary design course aiming to align the integrated design and engineering of a complex multifunctional high-rise building. Students work in teams of 6-7 students each. Within the team, each student follows one discipline (architectural design; structural design; climate design and installations; façade design; design and construction management; and computational design). Each team delivers an integrated design based on multidisciplinary principles.

3.2 Group work in URG and MEGA in the on-campus setting

Group work is used in the two interdisciplinary courses. Both courses include a forming stage (first two-three weeks) to guide students in deepening their specialized disciplines. Lectures and workshops are organized. Besides, (pin-up) presentation(s) allow students to introduce their roles, discuss perspectives of different disciplines and exchange knowledge. The students are guided by tutors specialized in specific disciplines. In URG, students in groups are also guided by group supervisors helping them integrating disciplines on urban development.

Students in URG experience the storming stage in weeks 4 to 7 as they need to achieve their own interests and goals through concession after rounds of confrontation. An intensive collaborative workshop helps students to translate abstract concepts into visual products. Sessions with groups or between different roles are organized by students themselves and sometimes assisted by the process manager. This negotiation aims to agree on the overall plan design, functional program, financial feasibility, land price, phasing and contract forming. In MEGA, students negotiate design alternatives with conflicting requirements, especially in weeks 3 to 6. Numeric assessments and qualitative considerations are used to evaluate various scenarios toward a consensus for a design solution meeting an intended design strategy.

At the norming and performing stage (the last 2-3 weeks of the course), students following the URG course translate the final negotiated results into development vision, development phasing, contract for land transfer and sustainability actions . During the final group presentation the result is presented by the team to a jury and the public. A similar presentation is held at the end of MEGA, during which projects are assessed and graded based on integrated multidisciplinary teamwork. In both courses, students are expected to deliver an individual report, with in-depth work into their discipline, and to reflect on their own learning process, interaction experience and learning outcomes.

3.3 Group work in URG and MEGA in the on-line setting

During the COVID-19 pandemic, the on-campus courses were translated into on-line courses. The weekly meetings between tutor and students moved on-line, using skype for business and Zoom. All presentations by students occurred on-line, with the same structure as if they were on-campus. The fieldwork was replaced by on-line lectures and Q&A session with involved practitioners in Microsoft Teams or Zoom and supported by various digital maps and other digital information. The meetings between roles at the storming stage occurred in zoom meetings, often coordinated by the process manager. Students made use of various digital interaction tools to communicate, interaction (e.g. Zoom) and collaborate in design (e.g. Miro). Workshops were carried out in a shorter version.

Next to group interaction and collaboration, how to exchange data digitally is crucial. In on-campus setting, the students in URG use Google Drive or Dropbox to store meeting memos, discussion results and drawings accessible and revisable by each team member. On-line, the storage of data becomes more critical. Besides, students started to use on-line design tools such as Miro to exchange design concepts. In MEGA, on-line data storage is critical also in the on-campus setting, and this helped the move to on-line setting. The computational designer of each team was responsible for organizing a digital collaborative workflow, including a system to exchange digital information and guarantee everyone worked on updated files. All teams engaged in full-on-line collaboration via data platforms and BIM-based systems, such as Speckle for Rhino McNeel (an open-source data platform for AEC) and Autodesk BIM 360 (a unified platform for collaborative design, management and engineering).

4 Observations and feedback from the students and teachers

When the course URG was transitioned on-line for the first time, many doubts came about on whether students could really carry out group work on-line instead of on-campus studio setting. During the URG course, one of the authors joined in a number of group sessions to check whether students really encountered any problem in group sessions. After the course was completed, these doubts were discussed in a panel session organized by the students, with students attending on voluntary base. In the course MEGA, individual feedback was collected during and right after the course. Based on the standard teaching activities, afterwards reflections have been made. Activities in MEGA did not include any moment for intentional observations on group work.

In both courses students generally displayed a notable commitment to the new mode of working. Group work interaction was often discussed or reported as manageable, although lacking the more complete and intuitive communication of face-to-face interaction and the nuances of spontaneous interpersonal exchanges. On average, students reported missing the group interaction afforded by on-campus education, even though they eventually reported satisfaction with the content development during the course. They missed informal interaction, such as the use of subtle hints and body language. Some students found it slow and time-consuming to understand each other. Group discussions on a single topic were often longer than expected in the attempt to communicate ideas. Additionally, some students noted that verbal remarks disconnected from body language and mutual context could be interpreted more personally among team

members. To some extent, the efficiency of the work structure and punctuality appeared to be higher than in on-campus education. Group work proved to be effective in terms of results, with all expected deliverables generally being met. Students from URG reported that the on-line setting reduced free-rider behaviors as each member's task was clearly defined and irreplaceable. Nonetheless, the final deliverables on average demonstrated considerably more effort dedicated to the process compared to on-campus education. The process seemed to demand more attention and extra time to achieve results, sometimes at the expense of energy invested on the final outcomes.

5 Conclusion

The paper has presented the experiences of two MSc design courses based on group work, conducted remotely throughout the COVID-19 pandemic. It has reflected on the influence of the sudden move to on-line education in the case of group work, reporting observations on processes and results. The two design courses examined in the paper were transitioned from on-campus to on-line version with the assistance of digital tools such as Zoom, Miro and Google Docs, as well as platforms for interdisciplinary 3D modelling in cloud-based environments like Speckle with Rhinoceros McNeel and BIM 360 with Revit Autodesk.

Regarding the effect of on-line group work, there are two aspects: On one hand, the efficiency of the work structure and punctuality were observed to be generally higher than for on-campus education, and the content development met expected standard. On the other hand, both students and teachers highlighted the time required to adapt to online meetings and virtual collaboration. They also noted that the lack of spontaneous interaction could lead to tension or harsher reaction among group members, thereby undermining the effectiveness of close interpersonal understanding.

The translation of the two design courses to an on-line setting revealed increased explicit verbalization to structure the process. We observe a greater utilization of digital tools for remote interdisciplinary collaboration, including on-line meeting tools, data sharing platforms and web-based BIM software, nowadays increasingly required in practice. While improvements in interpersonal interaction within group work dynamics are necessary, the formulation of explicit group process dynamics and the use of digital tools are to be considered valuable beyond the contingency of the pandemic. This paper provides firsthand insights into the performance of group work in on-line design education. Its conclusions reflect both the resilience and vulnerability of group work in virtual context. Addressing how to enhance on-line communication in group work should be a focus in future on-line education practices.

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The research proposal of this study has been approved by Human Research Ethics Committee at TU Delft. The figure used at the beginning of the article is an example of urban development plan from the course Urban Redevelopment Game (URG) - The fusion of Fellenoord at eye level - drawn and provided by Olga Surogina. Please not that this figure is created in 2023, not during the corona period 2020-2021.

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Towards transdisciplinary urbanism education

Lessons learned from two elective courses

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Abstract

Although some degree of multi- or interdisciplinarity has been inherent in urbanism education, today, the skills and knowledge for transdisciplinary work are increasingly required from graduates facing the challenges of sustainable urban development in the field. In this article, we show how the master's programme in urbanism at TU Delft has been tackling this challenge, and we discuss what further steps may be required to achieve the full potential of transdisciplinary education. We present two cases – both elective design courses from the Department of Urbanism – to identify (1) challenges of multidisciplinarity, (2) elements of the current educational setup that contribute to interdisciplinarity, and (3) the potential improvements to transdisciplinary learning. The two cases, both part of research projects carried out in collaboration with practice, show essential features of education that can strengthen the education-research-practice nexus underpinning transdisciplinary practices for sustainable urban development.

Keywords

Interdisciplinarity, transdisciplinarity, research-drive education, design-driven research

COVER FIGURE Participants working on their projects during the I-SURF workshop, by C. Forgaci, 2020

1 Introduction

Master's-level courses in urbanism at TU Delft are context-driven and multi-scalar, aiming to capture the social, environmental, and spatial complexity of the urban environment (Nijhuis et al., 2016). As such, the programme includes multidisciplinary work and some level of interdisciplinarity and transdisciplinarity (Klaassen, 2018). A multidisciplinary approach means that different disciplines work within their own frames and methods on the same task (Davoudi, 2010), while interdisciplinary work involves the integration of knowledge, working mainly with frames and methods between disciplines on the definition of a (design or planning) task (Sands, 1993, as cited in Davoudi, 2010). The Department of Urbanism comprises six sections: urban design, spatial planning and strategy, landscape architecture, urban studies, environmental technology and design, and urban data science. It also includes staff members from different disciplines. Each of the six sections contributes to different parts of the master's programme, and together, they form a multidisciplinary learning environment in which students become aware of the multiplicity of views and interactions among the different disciplines involved.

Moreover, with a growing emphasis on sustainable development and societal challenges, such as health and well-being, food and energy security, resource efficiency, sustainable mobility, and climate adaptation, the courses of the master's programme in urbanism have been progressively reaching out to practitioners for real-world assignments and expert input from a variety of fields. Likewise, research conducted in the department on various topics has become increasingly integrated with educational activities. This setup is a precondition for the teaching-research-practice nexus (Schneider et al., 2017) required for transdisciplinary practices underlying sustainability, but it has yet to be developed from an educational perspective.

Students are exposed to this environment at different stages throughout the master's programme. The quarterly studios and accompanying theory, methodology, and technology courses teach students how to deal with assignments of increasing complexity and the communication and collaboration skills needed for interdisciplinary work. During the graduation year (second year of the master's programme), basic multidisciplinarity is ensured as students must choose two mentors, each from a different section of the department. Depending on the thematic focus of each graduation studio, a series of lectures and workshops are offered to the students early in the graduation year.

All in all, the actual level of multi- or interdisciplinary work varies across the different stages of the master's programme, and evidence of the effectiveness of current practices is scarce. Multidisciplinarity and the first attempts at interdisciplinary work are mainly integrated into the learning objectives of elective courses. In these courses, students from multiple educational tracks, namely urbanism, architecture, landscape architecture, and industrial ecology, work together in teams on one project. In our view, the setup of such elective courses has proven effective in developing skills leading to interdisciplinary solutions and, thus, can give insight into how transdisciplinarity could be attained.

In this article, we look at two such elective courses and aim to scaffold the knowledge and practices required for transdisciplinary education in urbanism by answering three questions:

1. What challenges must be considered in a multidisciplinary learning environment?
2. What course setup and learning components nurture interdisciplinary work on projects?
3. How could urbanism education support and contribute to transdisciplinarity?

In what follows, we briefly position this article in the transdisciplinary education literature. Then, we describe the two elective courses and briefly summarise the main findings. We conclude with a discussion about challenges and opportunities in developing effective transdisciplinary education.

2 Transdisciplinarity and urbanism education

Multidisciplinarity involves combining more than one discipline in a study without any necessary interaction between those disciplines. Interdisciplinarity establishes a certain level of interaction between the disciplines involved, but it remains limited by its disciplinary focus and its goal – to reach consensus. Transdisciplinarity overcomes that limitation by placing the emphasis outside disciplinary boundaries (Sands, 1993, as cited in Davoudi, 2010) on real-world problems (Brandt et al., 2013). As such, it focuses on *articulating* rather than reconciling disciplinary perspectives (Ramadier, 2004).

This *pragmatic* and *relational* approach to disciplinary knowledge allows for the emergence of ideas, concepts, and solutions that are not the purview of a single discipline. It is pragmatic because it recognises that there are a multitude of possible realities subject to interpretation, of which only some interpretations might prove relevant for the assignment at hand. It is relational due to the construction of a network of interrelations, interdependencies, and articulations of different fields of knowledge to allow for the emergence of transdisciplinary knowledge. Moreover, transdisciplinarity extends the focus of interdisciplinarity on professional knowledge to non-specialists' knowledge, and, as such, it is more appropriate for processes that require complex stakeholder involvement (Klaassen, 2018) and co-creation (Rooij & Frank, 2016).

In a transdisciplinary approach, education, research, and practice must be interlinked (Schneider et al., 2017). Education provides a testing ground for practice and research while benefiting from practical and multidisciplinary input from those other two domains. Urbanism education, with its integrative and multidisciplinary character and its extensive use of high cognitive levels in teaching and learning, is particularly apt to fulfil that role. To show *how* that is or could be achieved, we examine two cases of urbanism teaching that involved interdisciplinary work.

3 Learning from two cases

The two cases presented in this article are design-driven research projects that are notable in their attempts to involve students in research and to create an interdisciplinary learning environment. Both projects employ a testing methodology in which students design while using a predetermined method or instrument (subject to testing): *a set of design instruments* for sustainable riverfronts in the I-SURF project (Forgaci & Timmeren, 2021) and *a pattern language* developed as part of the Cities of Making (CoM) project (Hill, 2020).

In addition to supporting designers in achieving a design outcome of a certain quality, the methods and tools of the two projects are designed to articulate knowledge across disciplines. Thus, the students test

the effectiveness and usability of the method or instrument presented, *as well as* its capacity to facilitate inter- or even transdisciplinary work. In this article, we summarise the latter for both cases. We look at findings from the two cases to identify (1) challenges encountered in bringing different disciplines together, (2) components of the learning setup that nurture interdisciplinary work, and (3) the potential for transdisciplinarity. To facilitate comparison, we structured the description of each case into task and methods (input) and process and outcome (output).

3.1 Case 1: Instruments for Sustainable Urban Riverfronts (I-SURF)

The I-SURF research project (2019–2020), initiated at TU Delft in partnership with the Amsterdam Institute for Advanced Metropolitan Solutions (AMS) and the city of Amsterdam, tackled issues of urban environmental and ecological degradation through a set of four design instruments for river space design previously developed at TU Delft (Forgaci, 2018). The instruments, tested, elaborated, and refined through design workshops and participatory sessions in Amsterdam (Figure 1), were meant to aid designers, planners, decision-makers, and stakeholders in developing spatial interventions for social-ecological integration.

FIGURE 1 Participants working on their projects during the I-SURF workshop, by C. Forgaci, 2020.

Task and methods

As part of the I-SURF project, a one-week design workshop was organised to test the instruments in different riverfront locations in Amsterdam. Prior to the workshop, data collection instruments

(questionnaires, handouts) and a workshop plan (website, scheduling, site visits) were prepared. During the workshop, data were collected on the use of the instruments and the quality of the outcome. Besides being set up as a data collection environment for research, the workshop had an additional educational component. It was meant to teach participants how to design social-ecologically integrated urban riverfront areas.

The workshop was open internationally to master's and post-master's students, PhD candidates, and young professionals. For master's students from TU Delft, the workshop was offered as an elective course with an additional post-workshop assignment. In order to complete the course, students enrolled in the elective had to prepare a critical reflection of 1,000 words about their experiences in and of the workshop. In their reflections, the students were asked to include answers to a set of questions about the instruments, the design approach of the workshop, working in a multidisciplinary team, and the impact of the workshop on their learning trajectories.

Process and outcome

The workshop participants tested the I-SURF instruments and provided data about their usability, ease of use, and effectiveness. By actively participating in the I-SURF data collection process, they also improved their knowledge of the role of research in the design process. The design assignment helped them better understand how to integrate spatial and environmental qualities in the design of riverfront urban areas. They had the chance to work in teams with other participants from different disciplines, cultures, and levels of knowledge. The workshop simulated a complex real-world environment and aimed at providing a comprehensive disciplinary approach. Moreover, participants engaged in a reflective task as part of the workshop setup and the elective course assignment.

FIGURE 2 Participants discussing one set of patterns during the elective run as part of the CoM research project, by B. Hausleitner, 2020.

3.2 Case 2: Patterns for Cities of Making (JPI Urban Europe)

The Cities of Making (CoM) project was about understanding the conditions for a (re-)integration of manufacturing in European cities (Hill, 2020). The (re-)integration was approached via three pathways – space, people and networks, and material and technology (Hausleitner et al., 2022). These pathways are related to three disciplines – spatial design, sociology, and industrial ecology.

The project elaborated a co-creation instrument – a pattern language – to create affordances for urban manufacturing. A pattern language is an instrument that presents systems of solutions (Alexander et al., 1977; Salingaros, 2000) and can integrate solutions (patterns) of multiple disciplines and actors. The strength of the pattern language is that it shows how patterns (individual solutions) are interconnected.

Task and methods

As part of the CoM project, a two-week elective design course with master's students from urbanism, architecture, landscape architecture, and industrial ecology was organised at three sites in the region around Rotterdam. It tested the applicability of the pattern language in multidisciplinary settings and examined whether it supports the development of interdisciplinary solutions. The course focused on each dimension of the project for one day in the form of design workshops accompanied by introductory lectures and site visits. The course ended with an integrated design, presented to and reflected upon by key stakeholders of the design sites.

Data to evaluate the use of the instrument was collected in questionnaires filled out by each student at the end of each session. The evaluation included questions regarding the clarity of the pattern cards, the usefulness of the pattern application to achieve an interdisciplinary developed plan, and the effectiveness of the instrument to achieve a consensus for the design.

Process and outcome

The students participating in the course tested the application of the pattern language and provided feedback on the daily design process. They learned to work in a multidisciplinary setting by developing the project and negotiating solutions from different disciplines, gradually gaining transdisciplinary skills. The development of a transdisciplinary plan was framed by an iterative process of designing and developing solutions and reflections, a process supported by the provision of patterns embedded in the different disciplines. Each sub-theme was placed centrally for one day, and all students from the different disciplines had to work jointly with the patterns from this discipline to derive a plan. At the end of the day, each group had to reflect on opportunities, shortcomings, and challenges that appeared through the application of the set of patterns provided for the day. This process was repeated with the patterns of the different disciplines as a starting point. Finally, the plans developed each day were compared in another round of discussion, testing, and assessment, concluding in an integral plan shaped by the limitations and opportunities each specific frame provided.

During the course, the students became aware that they design differently depending on their professional training, even when they have easy access to the needs of other disciplines. Besides becoming acquainted with the specific method, the students also gained knowledge of the disciplinary solutions required for facilitating urban manufacturing within their chosen field and how these are linked to the solutions found in other disciplines. They thus became aware of how research is embedded with design.

4 Main findings

The two cases took place in comparable multidisciplinary settings, testing research-based design instruments in workshops of similar length, followed by an evaluation of these instruments. Although the student group sizes were rather limited due to the courses being short electives, the first indications of transdisciplinary learning are noteworthy.

The experience of conducting the workshops and the outcome of the evaluation forms show two main challenges when bringing different disciplines together. In the CoM elective, students with different disciplinary backgrounds attended at a similar rate. However, in the I-SURF elective, the number of designers enrolled was considerably higher than that of non-designers. This finding implies that students not studying design might not perceive the elective as suitable for their education or that the administrative hurdles of reaching students from different disciplines are too strong.

Second, the end product of the I-SURF elective was clearly related to the spatial design disciplines. Students who were not from design-related fields viewed this spatial design focus as 'incomplete', and designers were more comfortable creating a drawing as the final output. Within the design disciplines, those participants with a less specialised focus could integrate solutions from other disciplines more easily than others. The non-design participants mainly contributed in terms of expert input or illustrating their input more abstractly in a diagrammatic way, which the designers then translated into the plans.

In both cases, four main course components of the learning setup proved relevant to nurturing interdisciplinary work. First, the participants worked in multidisciplinary groups, maximising their backgrounds and levels of expertise. Second, the students were guided by experts from different fields through lectures and feedback during the design process. Third, the design instruments provided in both electives already integrated knowledge from different disciplines and were created in a transdisciplinary way. This course design allowed the participants to relate the individual solutions from within their own field to knowledge from other disciplines. The fourth point is related to the teaching process and the cognitive capacity of the participants, hence their level of education and experience in multidisciplinary settings. While the more experienced participants could directly test and apply multiple solutions simultaneously, the less experienced participants benefited from the stepwise increase in complexity. In the two-step process, the participants could first draw the solutions from the perspective and interpretation of their own discipline. This second step helped the participants use drawing as a joint language understand the spatial implications of the different disciplines to adjust the final plan in a way that integrated different needs.

5 Discussion and conclusions

Our findings reveal several challenges and opportunities that can inform future efforts in achieving transdisciplinary teaching and learning. The learning outcomes in educational settings involving multiple disciplines should include products relating to all disciplines involved. This integration would allow students of all backgrounds to contribute equally, using products relevant to their own discipline, and with designers making a meaningful impact. That way, a more holistic final product could be achieved. In urban development, we can imagine that these projects could include the formulation of development policies, adaptations in planning law, and budget plans.

From the course components that contribute to interdisciplinarity, we notice the need for acknowledging the different means of communication or representation of the disciplines involved. Understanding their means of communication is critical to effective interactions among the disciplines. While spatial designers communicate mainly via spatial design drawings, industrial ecologists communicate via abstract diagrams, and many other disciplines communicate via different types of texts. Developing a common language that considers all these different means of communication is vital in transdisciplinary work and education.

Overall, the coupled research and design setup of the two cases and the involvement of experts and decision-makers who provided input to the students during the workshops indicate potentially fertile ground for a transdisciplinary approach to design education. In our academic and practical experience, the most challenging component of the teaching-research-practice nexus is the mismatch between the timeframes and paces of research and practice. In contrast, education-research and education-practice collaborations are more likely to be fruitful. We conjecture that, in addition to its effectiveness in serving as a testing ground for research and practice, education can play *a key mediating role* between research and practice. This finding presents both an opportunity and a challenge. It is an opportunity as education might receive increasing attention and resources from the other two domains. The challenge concerns transdisciplinary learning, which requires a wider set of skills and knowledge from beyond the field of urbanism.

Those skills and knowledge, some of which were mentioned in the previous section, can be summarised in the three categories of *systems thinking*, *empathy*, and *metacognition* (Tejedor et al., 2018, as cited in Orozoco-Messana et al., 2020) at the intersection of *methodological groundedness* and *epistemological agility* (Haider et al., 2018), which are required for sustainability scholarship and practice. Although these indicators of transdisciplinary learning were not recorded at the time of the workshops, and hence, firm conclusions cannot be drawn, a few observations can be made in retrospect.

In both cases, systems thinking was embedded in the definition of the instruments to be tested (e.g. helping users identify cross-scalar interdependencies or synergies and conflicts between different urban systems). In their feedback and reflections, students mentioned that understanding those systemic features was among their most important takeaways. Empathy was stimulated through group work in which participants were prompted to have a constructive and critical attitude towards each other. To that end, the development of communication and collaboration skills was facilitated in the teaching process. Metacognition was stimulated through reflection sessions and discussions about the meaning of different aspects of the content and learning process. The feedback and reflection sessions sought a balance between solid argumentation (methodological groundedness) and the ability to easily navigate an ill-defined problem space (epistemological agility).

The two cases presented in this article hint towards the next steps in developing better ways to teach transdisciplinarity in urbanism education. Confronted with the broader transdisciplinarity literature, we raised questions that require further research into more extensive, full-quarter-length courses in which transdisciplinary learning is explicitly involved as a learning objective and in which the indicators of transdisciplinarity presented in this section are recorded systematically. Other emergent forms of teaching and learning, such as the MSc MADE programme of the AMS Institute in Amsterdam, heavily involved in Urban Living Labs of the city of Amsterdam, could provide further insight into the potential and challenges of educating the next generation of urbanists.

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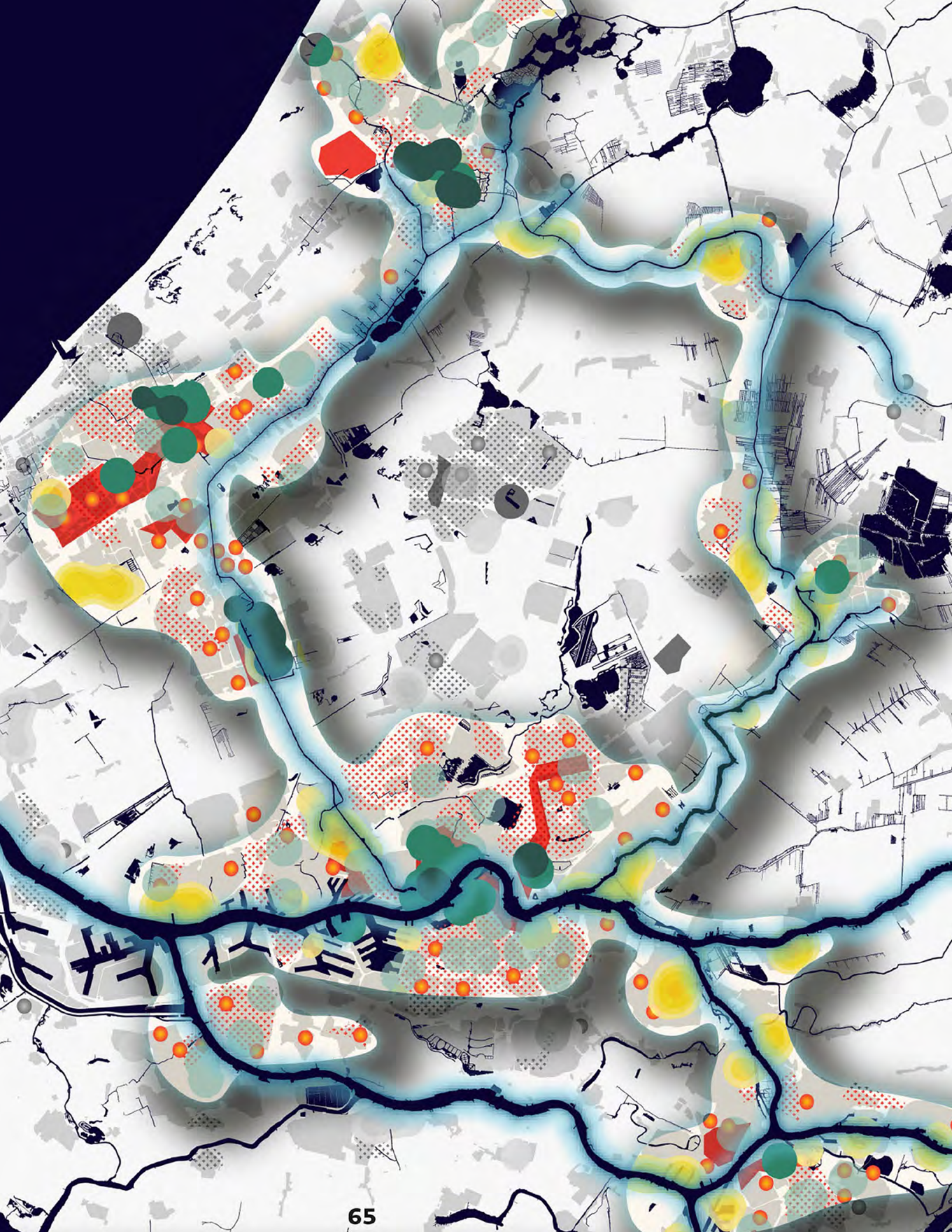

Between practice and research

The MSc Urbanism studio 'Spatial Strategies for the Global Metropolis' as an experiment on situated learning environments

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Abstract

This article discusses an experiment on 'situated learning' carried out in the context of the design studio 'Spatial Strategies for the Global Metropolis', part of the MSc Urbanism curriculum at Delft University of Technology. In the academic years between 2016 and 2020, this studio has focused on the design of spatial strategies that stimulate the transition towards a circular economy in the southern and northern parts of the Dutch Randstad region. Supported by researchers in the ongoing EU-funded Horizon 2020 project *Resource Management in Peri-Urban Areas: Going Beyond Urban Metabolism* (REPAiR) and regional planning practitioners, groups of students developed regional visions and strategies to support this transition.
The overarching aim of the studio is to teach students 'regional design': to train them to understand complex and uncertain regional spatial development and to act in complicated and, at times, contentious multi-actor settings.
The studio facilitated situated learning by involving expert knowledge from REPAiR and by relating students' work to actual regional spatial planning practices. In this chapter, we describe how these two aspects of a situated learning environment were combined in the set-up and conduction of the studio. In our conclusions, we argue that the success of the course – evidenced by high student ratings and appreciation by stakeholders – lies in its systematic linking of academic and professional practice.

Keywords

Situated learning, regional design, circular economy

COVER FIGURE Urbanism Q3 R&D studio group work, by Monserratt Cortés Macías, Thomas van Daalhuizen, Paula Nooteboom, Siene Swinkels, and Rosa de Wolf.

1 Introduction

The R&D studio 'Spatial Strategies for the Global Metropolis', a compulsory course for MSc Urbanism students, has 'regional design' as its core theme. Regional design is concerned with agglomerations of dependent places, often stretching across multiple administrative boundaries. It considers structural and spatial interventions, the effects of which extend across intricate socio-spatial networks in ways that are difficult to foresee. Imagined regional design solutions are likely to cause conflict in societal and political domains, meaning they often entail a collaborative planning effort: imagination aims not just at spatial change but also at negotiation and consent among diverse public, private, and civil actors (Balz, 2019; Lingua & Balz, 2019).

The motivation behind 'Spatial Strategies for the Global Metropolis' is to teach students how to design and plan in an uncertain and contentious arena. It aims to prepare students for future professions that involve collaboration among actors from different disciplinary and societal domains. A 'situated learning environment' mimics such a reality as it complements disciplinary specialisation with a transdisciplinary context (Müller et al., 2005). Within such an environment, students are encouraged to innovate and actively advocate best practices instead of learning passively (de Hei, 2016; Schweitzer et al., 2008). In 2016, the coordinators of the studio (and authors of this article) seized an opportunity to compose a situated learning environment that reflects not only the professional practice of regional design but also mimics a real-life research setting. By becoming involved in an externally funded research project, they engaged in an experiment to link students' work with both professional and academic practice.

Over the following four academic years, initial formats of the learning environment were reviewed and adapted in order to create a situation that benefits all involved parties. The original set-up of the R&D studio was built upon the tradition of the Delft 'research-by-design' approach (Verbeke, 2016): students were asked to address design assignments through evidence-based systemic thinking and to use design as a tool to investigate an unknown but plausible future reality. The following sections will explain how the experiments in a situated learning environment have influenced the course.

2 Experiments of creating a situated learning environment

2.1 Collaboration with an ongoing externally funded research project

In recent years, the Department of Urbanism has engaged in a number of externally funded research projects. Among these was the EU-funded Horizon 2020 project *Resource Management in Peri-Urban Areas: Going Beyond Urban Metabolism* (REPAiR), which has focused on resource management in peri-urban areas within the broader theme of the circular economy. It applies a geo-design approach to reveal the space-specific challenges of waste and resource management. Analysis was to be conducted by means of case

study research in close collaboration with stakeholders in case study areas. The project also included a work package on disseminating generated knowledge via education. Due to a good fit with its assignments, the studio 'Spatial Strategies for the Global Metropolis' collaborated with the REPAiR project for such dissemination. In retrospect, this good fit was fortunate, as it might not always happen naturally if the collaboration between a research project and an established course had not been formulated within the initial research proposal.

Several initial alignments of course content resulted from its connection to the research project. First, the Amsterdam metropolitan area (AMA), one of the six study cases of the REPAiR project, was chosen as the region for students' investigation. Second, the thematic focus of the REPAiR project – the circular economy – became the overarching conceptual complex framing assignments in the studio. Third, some Urbanism staff members serving on the REPAiR research team joined the studio mentor teams. Their particular expertise in, for instance, analysing the spatial scope or governance of the circular economy was carefully distributed across student teams. Fourth, the series of lectures and workshops on regional design was complemented by events on the circular economy, material flow analysis, and systemic design (see Figure 1). Finally, the REPAiR project partners included stakeholders in the AMA, such as waste treatment firms, local municipalities, and project developers. They participated during the excursion and gave feedback on students' mid- and end-term presentations.

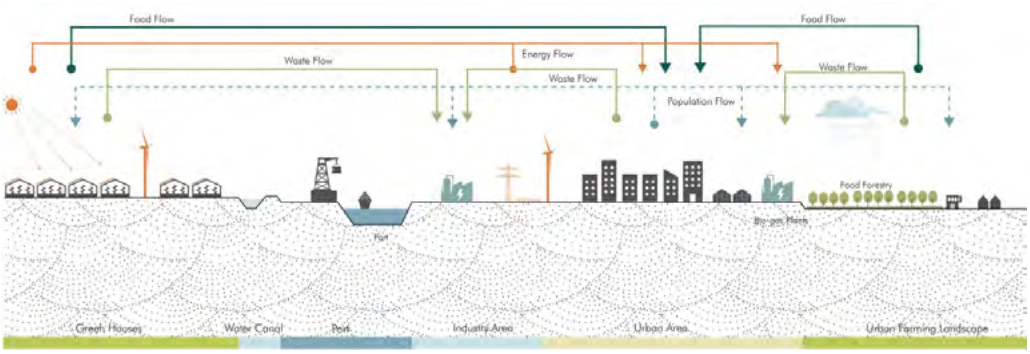

FIGURE 1 Regional design studio work integrating material flows and spatial configuration, by Anke van Eijk, Baokun Wei, Kinga Murawska, Lisa Lieftink, and Maud Ebbers, 2020.

The REPAiR project ran over four years, and expert knowledge about the transition towards a circular economy in the AMA deepened over the period. This process led, above all, to refined, detailed assignments for students in consecutive years. Additional changes concerned a wider set of accessible data and information, as well as the more extensive involvement of researchers in education.

2.2 Collaboration with leading partners in practice

The collaboration between the studio and the REPAiR project lasted for four years, as noted above. However, it could be accommodated as a formal part of the project during the first two years only (staff members from the REPAiR team were then fully funded, for instance). During the following academic years, REPAiR team members remained involved in the studio as experts, but new relations with regional planning practitioners had to be found. Supported by growing attention to the circular economy in Dutch planning, two new collaborations could be established. During the 2018–2019 academic year, the studio collaborated with the Deltametropolis Association (*Vereniging Deltametropool*). This non-profit organisation

supports regional spatial planning in The Netherlands and became a partner because of an ongoing project concerned with the AMA landscape. During the 2019–2020 academic year, the study area changed to the region of Southern Holland. The province of South Holland (PZH) became involved because of its goal to transition to a 100% circular economy by 2050 and its search for a deeper understanding of the spatial consequences of this ambition.

Several alignments of course content resulted from these new settings. First, while the circular economy remained the most important framing device, the assignment of the studio was refined to match the policy agendas of new partners. Second, following the involvement of the Deltametropolis Association, more attention was given to the roles of natural and cultural landscapes in the transition towards a circular economy. Third, South Holland province, which was very actively involved in the creation of the students' assignment, emphasised new material flows (in particular plastic), reiterated the importance of land as a finite resource, strengthened social justice as a normative goal, and emphasised transition management as a planning approach. Fourth, the series of lectures and workshops on regional design was revised to involve these new interests (a particular aspect here is the strong involvement of 'transition managers', responsible for managing particular material flows at PZH, in the series).

The formats for engaging new partners generally resembled those used to involve stakeholders in the AMA under the umbrella of the REPAiR project. What changed, however, was their role. While the stakeholders in the AMA were mainly supporting students with knowledge input and feedback via the REPAiR project setting, the new partners were more actively involved in defining the assignments for students in line with practical needs.

3 Outcomes of the experiments

The four years of experimentation in the R&D studio 'Spatial Strategies for the Global Metropolis' reflect efforts to create a situated learning environment in which to provide students with an opportunity to participate in a 'community of practice' (Lave & Wenger, 1991). Participation was facilitated by engaging students with particular regions, not just as spatial but also as institutional settings. Actual stakeholders in the development and planning of these regions were involved in shaping assignments, excursions, lectures and workshops, assessment, and dissemination. While these components of a situated learning environment are often adopted by design studios at the Department of Urbanism (and the Faculty of Architecture and the Built Environment more broadly), the Urbanism Q3 studio added a less common element: it placed the studio in the context of an ongoing academic research project.

It is too early to quantify the success of the experiment since experiences have not yet been fully assessed. However, observation and initial feedback by researchers, practitioners, and students indicate that the created environment has benefitted the involved parties.

From the perspective of the REPAiR project, students' work has not only corresponded to initially defined project deliverables but has also contributed to the development of research content. The exploratory regional design proposals developed by student teams brought various sub-themes of a circular economy to the foreground. While some of these themes resembled the ones earlier defined by the REPAiR project (material flows, such as food and organic waste cycles, for instance), others added to a deeper understanding of the spatial dimension of the circular economy concept (the re-use of land became a more

central concern, for instance; Wandl et al., 2019). Another benefit of the research project occurred when the study area was moved from the northern to the southern part of the Randstad region. Researchers encountered new information while testing earlier propositions and became acquainted with new material flows and planning approaches. Moving also encouraged the effective dissemination of research results among potential future partners.

From the perspective of the leading partners from practice, students' often comprehensive and evidence-based design proposals have enriched ongoing debates. Societal partners have always appreciated the inspiration that students' explorations of future scenarios deliver for planning and policymaking. Their ability to visualise is frequently mentioned as an important asset. Due to its association with a prestigious and extensive research project, work became less easily considered as 'just a visualisation', 'naïve' or overly 'quick'; innovative components became more likely to be considered by practitioners, and in-depth discussions won out over superficial conversations. In more general terms, the studio has contributed to a diminished distance between academia and practice.

Such a situated environment seemed challenging for students, as it involves different perspectives from research and practice. However, students' feedback on the studio has been positive since the experiment started in 2016, according to the assessment done by the faculty's quality assurance section and the Urbanism student association POLIS. Some consistent remarksare related to notions about situated learning environments: students feel that the project is genuine and that they are supported by specialists from both research and practice. Many students are also enthusiastic about an assignment that is related to an identified knowledge gap in both the academic and professional realms. This feature seems to foster their willingness to not only participate in a learning process but also seek opportunities to innovate.

Last but not least, creating such a situated learning environment was also challenging for the teachers involved. The preparation of the course was time-consuming for the coordinators, as it required the integration of diverse course elements and contributions from inside and outside of the faculty. The studio teachers also needed the capacity to guide interdisciplinary projects that touched upon a broad range of topics, which were very often out of their comfort zones. Nevertheless, the challenges were taken and managed well, a belief reflected in the positive student feedback mentioned above.

4 Conclusions

Linking research, education, and professional practice is not a new pedagogical endeavour at TU Delft – R&D studios at the Department of Urbanism usually employ 'research-by-design' approaches to encourage the use of evidence when envisioning the future. However, the application of such approaches often emphasises situated learning environments that prioritise professional over academic practice. In this context, research is usually reduced to involving knowledge held by teachers, invited lecturers, and juries. The R&D studio 'Spatial Strategies for the Global Metropolis' was presented with an opportunity to expand the setting by building substantial links with the REPAiR research project. Based on the experimentation within this setting, a few concluding notions are worth the attention:

1 The setting has 'pros and cons': the benefits of the created situated learning environment were wide-ranging, as described above, but had downsides, too. The preparation of the course was time-consuming – it required the systematic positioning and integration of diverse demands; the created environment seemed

challenging for students at times, particularly because it required them to distinguish research using a political perspective.

2 Lessons learned are probably not fully transferable, and it is important to note that the studio benefitted from a particular research project – one that was prestigious, long-lasting, very relevant in societal terms, and that broadly involved stakeholders via case study research. These aspects may have conditioned the fruitful results from experimentation. Therefore, the authors recommend a deeper understanding of the extent to which ongoing research projects can become an essential ingredient of situated learning environments and how this can be supported in an established course.

3 Be proactive: the REPAiR project has foreseen a work package on disseminating generated knowledge via education. Based on our experience, we envision that education can play a more active role in research projects and vice versa if such a role is foreseen early on. To maximise the collaboration potential of a situated learning environment, both researchers and teaching staff need to be proactive when preparing research proposals and course guides. They need to actively seek possibilities to work together within the academic world and with societal partners.

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Rethink the City

Education approaches to understanding global and local urban challenges

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Abstract

'Rethink the City' is a massive open online course (MOOC) in the Faculty of Architecture and the Built Environment at Delft University of Technology. The course emerged as a bottom-up initiative for PhD candidates who wanted to share and discuss their research with students and professionals in the field. The purpose of the course is to progressively build a critical perspective on local urban challenges in the Global South around the themes of spatial justice, housing provision and management, and urban resilience. Since its creation in 2017, 'Rethink the City' has had more than 29,000 learners from 184 countries and 37 lecturers from 20 nationalities.

By describing the evolution of the five editions, this chapter presents the course's continuous adaptation in terms of content, partnerships, and outreach to offer an up-to-date online experience and to promote the formation of an online community. Drawing from the 'Rethink the City' MOOC experience, the chapter closes with insights into future developments in online education regarding the challenges for equal access to education and language barriers, the opportunity for more substantial participation of PhD researchers in the online portfolio, and the need for stimulating online education and blended tools in higher education.

Keywords

Online education, hybrid education, Global South, MOOC

COVER FIGURE City of Panama, by Igor T. M. Pessoa, 2024.

1 Rethink the City. New educational tools for new urban challenges

Urban development is being led by the highly accelerated urbanisation process of emerging economies, positioning the Global South at the frontline of the urban agenda. Consequently, traditional planning practices and theories, usually emerging from northern and Anglo-Saxon experience, need to adapt to this new reality (Watson, 2016). As these traditional planning tools and practices might not be suitable, educational strategies may also have to change in order to more closely address and meet the needs of the Global South (Moreno Pessoa et al., 2019). It is, therefore, imperative to discuss how planning education is dealing with this change.

In order to contribute to this debate, the course Rethink the City emerged as a bottom-up initiative of PhD candidates at the Faculty of Architecture and the Built Environment, who are researching and in contact with alternative theories. An international community of young researchers focusing on the Global South wanted to expose and discuss their work with students and professionals in the field. The PhD community provided valuable expertise and a stronger connection between participants and lecturers while enriching the educational perspective on global urban challenges at the faculty level.

''The concept behind the course was to explore educational strategies that would connect the researchers from TU Delft with practitioners and urban enthusiasts in the Global South. From the beginning it was clear that to be able to reach a great number of participants from the Global South, the course had to be online and affordable. The option to go for a Massive Open Online Course (MOOC) seemed the best fit.'' (Moreno Pessoa et al., 2019, p.73)

The result was the creation of the Rethink the City MOOC, which attracted more than 10,000 participants in its first run. The decision to develop a MOOC was two-fold. Firstly, we felt that the best way to learn about the urban challenges of the Global South was to get in touch with practitioners and students from the Global South in order to obtain firsthand insights. In this regard, an online format allowed us to easily connect and interview professionals on the ground and hold debates with students all over the world, stimulating South–North cross-learning. Secondly, European international programmes are traditionally residential (Frank et al., 2014) and tend to address a small elite of planners and planning students of the Global South, given the general increasing financial challenges of accessibility to higher education (Parreira do Amaral et al., 2015). A massive open online course, which can be followed for free from the home environment, offers democratic and inclusive access to education, giving the opportunity to students, professionals, and urban enthusiasts, with no distinction, to access a high-quality education.

2 Course content and structure: Spatial justice, housing provision and management, and urban resilience

The MOOC Rethink the City is structured around three themes: spatial justice, housing provision and management, and urban resilience. The purpose of the course is to progressively build a critical perspective on local urban challenges in the Global South. Through a combination of short theoretical lessons by senior researchers, the presentation of case studies by PhD candidates, testimonies from practitioners, and practical assignments, participants learn how to develop a critical approach to understanding their urban environments and how to translate this knowledge into analytical tools and innovative urban solutions.

The course has four main learning objectives: (i) identify alternative theories in spatial justice, housing provision and management, and urban resilience; (ii) identify urban challenges in local contexts; (iii) develop a critical perspective about their urban environment; (iv) translate knowledge into analytical tools and innovative solutions to contemporary urban challenges. By the end of the course, it is expected that the participants will have learned new perspectives to identify, understand, and analyse one urban challenge of the Global South.

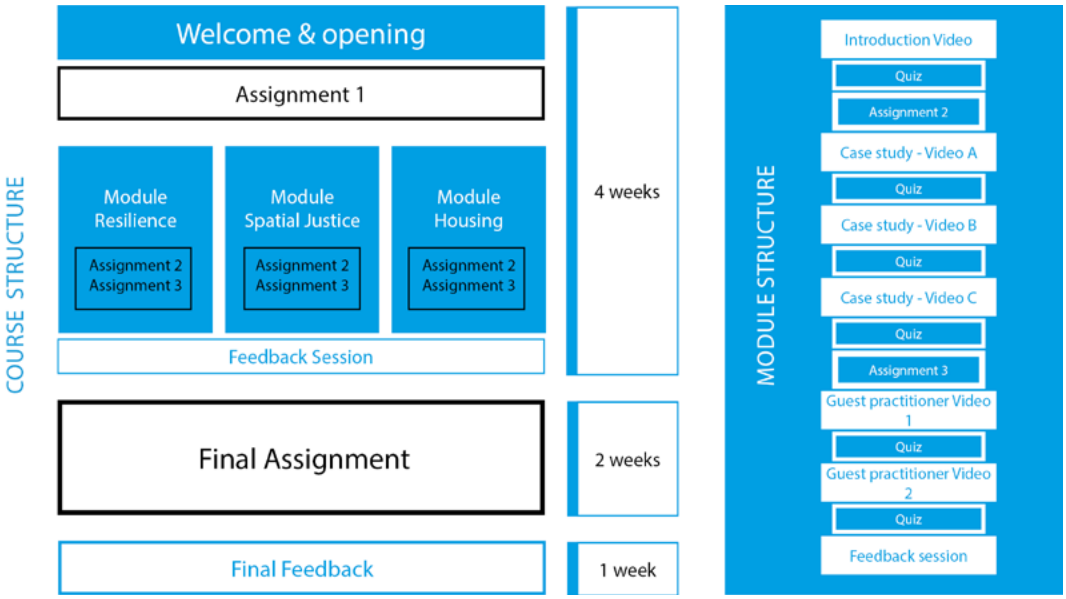

FIGURE 1 Course structure (left) and module structure (right). From *Rethink the City course materials* (2018).

As previously stated, the dialogue between global and local and the critical perspective to analyse urban challenges are the central components of the course. To successfully achieve them, every module uses practical assignments to help students understand the main topic discussed by presenting applied examples, usually from their own context. The critical perspective is then further developed in the final assignment, which consists of a visual essay. Learners have to critically analyse a specific urban challenge of their choice, which is important to them and the local community. Using images and text, the visual essay conveys the message in a poster, presenting the problem, using the theory and the case studies to analyse

it, and discussing perspectives to tackle it. During the first runs of the course, final assignments addressed topics such as gender inequality in Curitiba, Brazil, the right to the city in cities with striking inequalities like Buenos Aires, the urban impact of forced displacement and relocation in Turkey, and the re-significance of public spaces through the lenses of urban resilience in Athens.

FIGURE 2 CaptionExamples of final assignments of RTC learners Gabrie
materials (2017).

Students' engagement and the creation of an online community are important challenges of online learning. Traditional elements used to build a learning community, such as face-to-face classroom engagement or fieldwork, are difficult to replicate in an online environment (Shapiro et al., 2017; Vergara et al., 2024). In order to deal with this disadvantage, the course was a pioneer in using the platform Sketchdrive for online education at TU Delft. This platform allows students to upload their visuals and comment on each other's work with text or drawings, facilitating communication with an intuitive interface. More than 10,000 visuals have been uploaded and discussed during the course life. In this regard, Sketchdrive and the forum in EDX represent the central space of knowledge exchange and interaction with the course team and among students. Additionally, the use of Facebook as the main social media channel has been significant for maintaining this community outside the EDX platform.

3 Five editions, five additions: New material, partnerships, and outreach

Since its first version, the MOOC Rethink the City has been continuously adapted to remain up-to-date. The fact that it focuses on the frontline agenda of urban challenges implies that the content has to be

reviewed and enriched as these challenges evolve. An important lesson in past years reveals that MOOCs require not only a significant initial investment in terms of preparation and content but also adjustments that allow future and previous learners a fresh educational experience in every run.

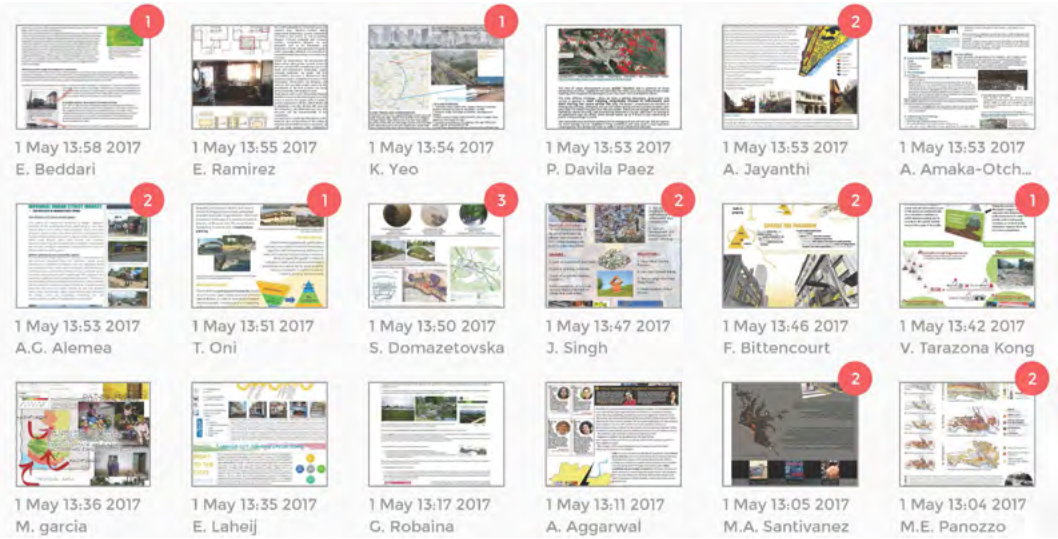

FIGURE 3 Use of Sketchdrive to promote active feedback and student engagement in the course debate. From *Rethink the City course materials* (2017).

In the first run (2017), two critical elements were incorporated into the MOOC to strengthen the connections between the faculty and the e-learning community. First, a partnership with the summer school *Planning and Design with Water,* organised by the Urbanism department, which provided one scholarship for the best student in the MOOC to attend the summer school at TU Delft. This prize encouraged the engagement of the students during the course, and it was an important recognition of learners who provided high-quality work. The 'Rethink the City Prize' remained a distinctive feature of the course during the three instructor-pace versions. Second, and motivated by the quality and amount of the assignments received, the course team prepared an exhibition at the faculty that showed a selection of the students' work. The students received a certificate for their participation in the exhibition, and the launch was streamed through the Facebook page. After the first edition of the Rethink the City MOOC, the course was awarded the Excellence in Teaching Award 2017 by AESOP (Association of European Schools of Planning). It was the first time an online course had received this recognition. The jury concluded:

"This was a very innovative module which emerged in a highly original manner from the initiative of PhD students from the Global South. The Committee was impressed by the way in which such a 'bottom-up' initiative was accompanied by academic staff and subsequently the institution as a whole. The module was clearly-structured around three key themes of 'social justice'; 'housing provision and management'; and, 'urban resilience'. Themes which it is vital for planners to explore critically, objectively and confidently in a post-truth political climate.'' (AESOP, 2017)

FIGURE 4 'Rethink the City' Exhibition. From *Rethink the City course materials* (2017).

In the second run (2018), the MOOC incorporated a new module focused on the urban challenges of the African continent. The three themes (spatial justice, urban resilience, and housing) were reviewed using different cases in the region and explored with professionals working on the ground. This module was part of the African Perspectives Conference, a faculty-wide initiative that focuses on fostering cooperation with African universities and urges the greater involvement of faculty, students, and staff in the pressing urban challenges of African cities. The conference had events in Addis Ababa and Delft, allowing the course team to interview relevant practitioners and academics actively working in African cities.

The addition of the African module was the first step in consolidating the 'geographic module' as a new feature in the course. The interest in developing another geographic module led to a partnership with EDRAAK an Arabic-speaking online educational platform based in Jordan. EDRAAK supported the creation of the *Arab module*, which focused on the urban challenges in the MENA (Middle East and North Africa) region. This module involved PhD candidates, researchers, and practitioners from the MENA region, who provided an overview of predominant urban challenges in the area, such as post-war reconstruction, informal settlements, and refugee camps, using cases from Syria, Egypt, Jordan, and Lebanon.

The third run of the Rethink the City course at the beginning of 2020 offered the Arab module in EDX and the same version of the course in Arabic at the EDRAAK platform (planned for April 2021). Additionally, the Comenius project used this run of the MOOC to explore interactions between on-campus students and e-learners using common exercises and the online resources of the MOOC. The project experimented with four interactive tools between on-campus and online students: an online forum, a social platform for images, live sessions, and a game. Unfortunately, the game had to be modified to be played fully online due to the restrictions created by the Covid-19 crisis. The project was adapted after the hiatus of on-campus education during the first semester, but it showed how the integration of online and on-campus education can be mutually beneficial.

The pandemic brought forward the new run of the MOOC in the format of a self-paced version, where the two previous geographic modules were incorporated into the course content. The idea was to take advantage of this comprehensive turn into online learning and make all of the course content available to everyone at any time. The second self-paced version, launched in October 2020, is part of the Professional Certificate Programme (PCP) in Inclusive and Sustainable Cities. In this programme, Rethink the City is

the introductory course of a series of three MOOCs developed by the Faculty of Architecture and the Built Environment. The programme focuses on how architecture and urban design can be used to tackle inequality and socio-economic segregation and to promote more inclusive and sustainable cities. Since the creation of the professional certificate, the Rethink the City MOOC has continued running in the self-paced format, and it remains up-to-date through revisions and additions of new content.[1]

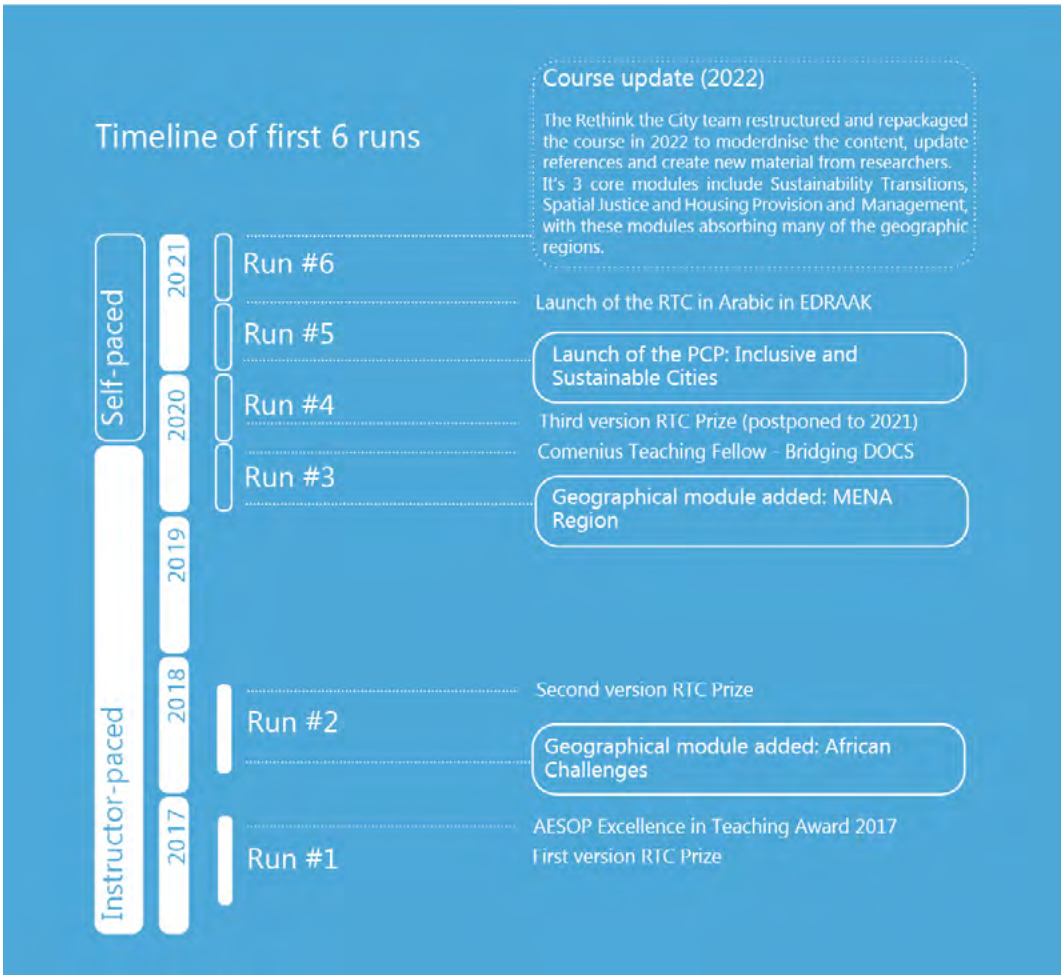

FIGURE 5 Timeline of the Rethink the City MOOC. Adapted from *Rethink the City course materials* (2022)

1 The last course update was carried out in 2022 when the Rethink the City team restructured and repackaged the course. Currently the course is embedded in the Urbanism department and coordinated by Caroline Newton with the technical support of Anja van der Watt.

4 Lessons and future developments in online education

Since its creation in 2017, the MOOC Rethink the City has had more than 29,000 learners from 184 countries. The enthusiasm and engagement of participants have consolidated a library of 10,106 visuals that represent an extremely valuable first source of knowledge. Despite the inspiring numbers, there were lessons learned that we find important to highlight here. First of all, being an open and online course does not mean that we created equal access to it. There are still structural socio-economic challenges in many countries around the world that jeopardise the participation of learners. It is crucial to keep in mind that an open course does not mean equal access from all over the world.

Additionally, there is the intrinsic challenge of aiming for a global audience with a course based on the English language (Vergara et al., 2024). We tried to circumvent this challenge by offering lecture subtitles in Spanish and Chinese, two languages with a significant audience worldwide. Nevertheless, the assignments were still in English and understanding the lectures was only a small part of the course. Further, the Chinese subtitles did not turn out to be sufficient to attract Chinese-speaking learners, most probably because the course platform was not allowed in China. Another strategy to be explored further is hosting the course on local online learning platforms using other languages. As aforementioned, the first partnership was developed with EDRAAK in Jordan for the release of the Rethink the City MOOC entirely in Arabic in April 2021. We believe that such a partnership could have a positive impact if replicated on other online platforms, offering the full course in another language.

The participation of PhD candidates from the Faculty of Architecture and the Built Environment also demonstrated that their research is not only valid for educational purposes but also that the course can be an efficient channel for their research output and to build connections with practitioners abroad. More substantial participation of PhD candidates in the online educational portfolio should be embedded in doctoral training programmes. Financial and training support for PhDs, for example, to translate their research into online lectures, would be useful in fomenting such a process.

The year 2020 was challenging for educators worldwide due to the restrictions created by the Covid-19 crisis. Nevertheless, it created an opportunity for a concerted effort to accelerate a natural process that was already taking place: the popularisation of online education. The great majority of educators were forced to adapt and develop new skills to be able to work with the new normal: online teaching platforms. Online education was already an important part of contemporary education; however, it has become a fundamental part of current higher education. There is now a clear necessity to improve not only the quality of online teaching but also to explore further possibilities of blended learning since the current situation will probably have long-lasting effects. In general, the Covid-19 crisis demonstrated how important it is to have a high-quality, stimulating, and engaging online experience. We believe that Rethink the City can offer some insights in this regard.

5 Conclusions

The MOOC *Rethink the City, New Approaches to Global and Local Urban Challenges* was created in 2017 by PhD candidates as an educational strategy to better address and meet the needs of the Global South: new urban challenges of emerging economies also require new practices and theories beyond the predominant sources of knowledge in the Global North. The creation of a massive online open course offered the possibility of getting in touch with practitioners and students from the Global South, obtaining firsthand insights, promoting South–North cross-learning in a safe environment, and promoting inclusive access to education.

Throughout its five runs, the MOOC Rethink the City has experienced a continuous process of adaptation and innovation to improve the learning experience. Main additions consider the Rethink the City scholarship in partnership with the Summer School at the Urbanism department, the creation of geographic modules focused on the Africa and MENA regions, a partnership with EDRAAK to offer the course in an Arabic-speaking platform, interactions between on-campus and e-learners under the Comenius research project, and the inclusion of the MOOC in the Professional Certificate Programme: Inclusive and Sustainable Cities.

The experience of the MOOC Rethink the City leaves us with three main insights. First, open and online education does not necessarily mean equal access. Structural socio-economic challenges and language barriers in many countries still jeopardise learners' participation. It is fundamental to pay attention to such challenges and to push for innovative ways to minimise them in our educational practices. Second, the more substantial participation of PhD candidates in online education should be promoted and embedded in doctoral training programmes. The participation of younger researchers brings diversity to the course teams and allows them to expose their research to a wide audience. This process also allowed a more informal and less hierarchical learning experience. Third, Covid-19 has increased the ongoing popularisation of online education and the relevance of having high-quality and stimulating online experiences in higher education institutions. In this regard, the development of innovative and up-to-date online education promotes critical thinking and creates an online community that is more relevant – and necessary – than ever.

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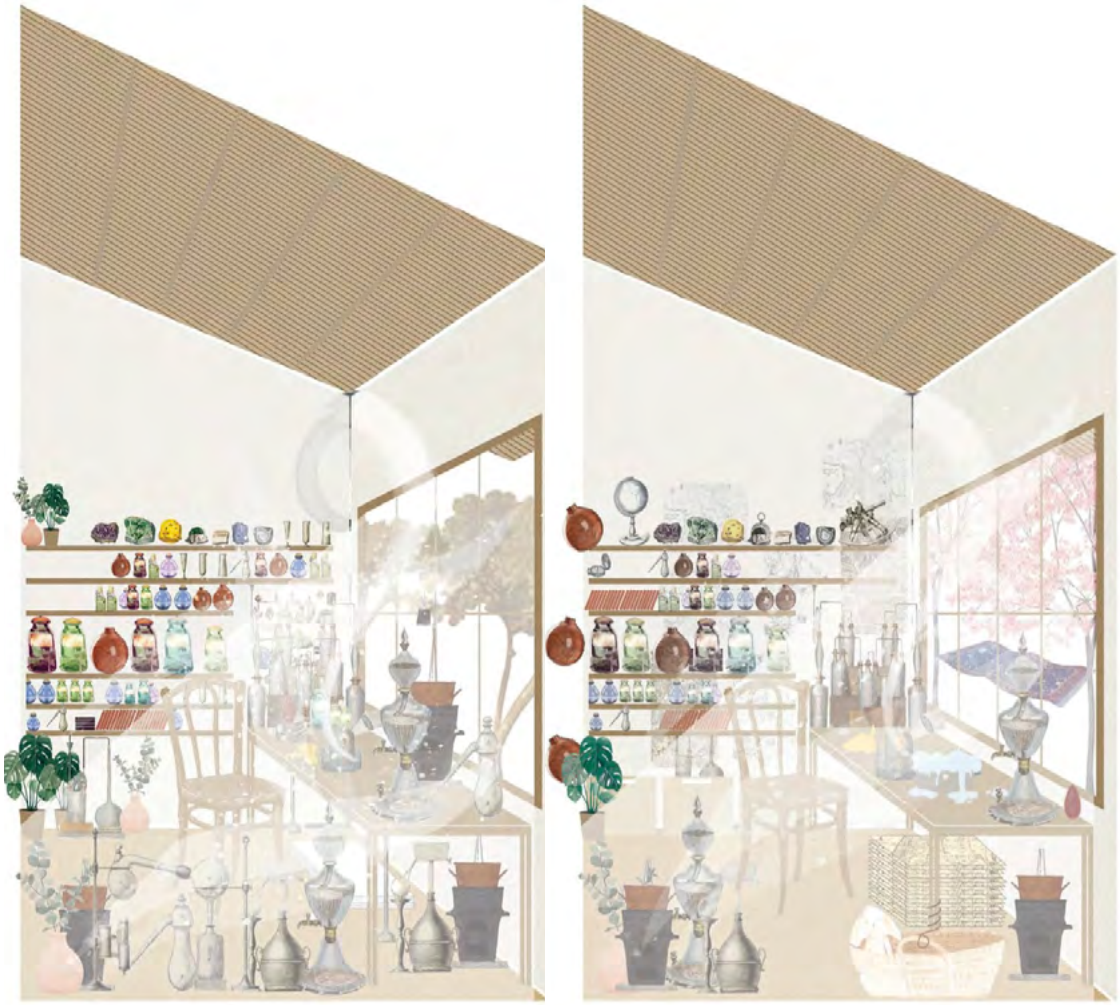

Learning from literature

Scriptive exercises in architectural education

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Abstract

This reflection on the use of literary methods in architectural pedagogy departs from the observation that literary descriptions often provide detailed information regarding experiential, social, and imaginative aspects of architectural and urban places. In this contribution, I discuss how the three 'scriptive' perspectives that I developed in my dissertation on urban literacy – description, transcription, and prescription – can be used productively in architectural education. Following these three perspectives, I explain how a literary take on architectural questions helps to address questions of experience, use, and imagination and which methods of architectural education derive from them (see also Havik, 2014a, 2014b).

Keywords

Pedagogy, architecture, literature, novels, urban literacy

COVER FIGURE The Alchemist Laboratory, drawing based on reading the novel *100 Years of Solitude* (Gabriel García Márquez, 1967). Made for the Msc2 Studio Transdisciplinary Encounters: Architecture & Literature, by Karthika Ranjit, 2021.

1 Introduction: Experience, use, and imagination

Literary language has the capacity to dwell on the complexities of spatial experience. Evocative literary descriptions of spaces, whether in novels or poetry, often provide detailed information on how people *experience* architecture. While in architecture, the visual and the formal tend to dominate, literature often describes other sensory perceptions of spaces with great detail and intensity and includes other aspects, such as atmosphere and memory. Additionally, literary narratives often reveal the social aspects of space – it is through the literary accounts of places that we can learn how they are *used*.

Exploring the relationship between the activities of characters and the spatial setting of the novel allows architects to consider the life of a building after its inauguration: a life marked by changing uses and users. Novels can often be seen as sketches of another world, balancing reality and imagination. If novels present constructions of another world, architectural designs are much alike: they give an account of a not-yet-existing situation. By studying the tools that writers employ in constructing their spatial imaginations, such as scripts and scenarios, architecture students can learn new ways to imagine the city.

In this chapter, I will address these three themes through the conceptual framework of literary methods from Urban Literacy (2014). This triple framework of scriptive concepts, description-transcription-prescription, underpins a threefold perspective to conduct analysis and design in the context of the Master of Architecture programme.

2 Description: Addressing architectural experience through poetic writing

Following a phenomenological approach (Holl et al., 1996; Merleau-Ponty, 1945), the first perspective, *description,* seeks to closely observe and evocatively describe qualities of sensory experience, atmosphere, and detail. Literary descriptions often pay close attention to perceptual details, considering the multi-sensory experience of a place, its temperature and light, the age and haptic characteristics of its materials, and other aspects that constitute the atmosphere of a place. As human geographer Yi Fu Tuan (1974, p. 49) notes, 'the forceful and precise articulation of environmental attitudes requires high verbal skills. Literature rather than social science provides us with the detailed and finely shaded information on how individuals perceive their worlds'.

Descriptive exercises can encourage students to develop an awareness of the perceptual qualities of architecture, for example, by creative writing exercises that address the senses. More complex tasks of site-writing (Rendell, 2006) can enrich students' understanding of sites as *lived* places, while descriptive tasks regarding their own architectural projects can offer critical insights regarding their design decisions. When challenged to describe the tactile and audible aspects of their work, students develop a critical understanding of the role of materiality and detail in the perception of architecture and consequently elaborate their designs accordingly.

3 Transcription: Narrative tools for social spaces

Transcription, the second perspective, addresses the notion of use. It refers to the capacity of literary works to serve as indicators of societal issues. In literary works, the social aspects of architectural and urban space often come to the fore: space is always connected to time and characters, as social events happen in time and space. Theorists such as Edward Hall (1966) and Michel de Certeau (1984) argue that in order to understand the social dimension of space, one should turn to stories, which indeed contain valuable information about everyday life in cities, illustrating the dynamic relationship between people and places. Looking at architecture from this perspective allows us to address the role of the user in urban and architectural space and to include 'other' perspectives in design.

In terms of methods, the transcription perspective in architectural education uses the literary tools of character and narrative. Character can be used to include the user's perspective in architecture. By taking on the perspective of another character, the designer gains empathy for the user. From this perspective, such aspects as materiality, routing, programmatic organisation, colour, or sound are seen differently, and design decisions can be critically evaluated. The literary character is thus a creative tool to address the user's perspective: by imagining how spaces are experienced and used by other characters, students better understand the conditions their design could offer for different types of users.

Narrative – a connected sequence of events – helps locate a design in time by exploring the possible programmes and events it may accommodate. In the analysis of locations, existing narratives provide insights into how places are 'lived', used, and remembered by inhabitants – valuable information for a designer dealing with the regeneration of existing sites and neighbourhoods. By constructing narratives in relation to their own site and design, students become aware of the diversity of use and the multiplicity of possible events that spatial settings can offer.

By imagining the everyday life of the characters who will occupy their future buildings, students are challenged to consider the practices taking place in space. The next step in narrative exercises is to introduce an event to the characters in the site where they work. Through such exercises, making use of characters, narratives, and events, students learn about social practices, the relation between space and its users, and the role of time.

4 Prescription: Architectural imagination

The third perspective, prescription, addresses the condition of architecture to design for a yet unknown future. While literary works may take a critical stance towards reality or speculate on brave new worlds, architects also need to find a balance between existing reality and the imagination of a new situation. To cope with such indeterminacy, architects and urban planners may turn to the imagination – indeed, one of the key skills of writers of literary novels, scripts, and scenarios. As architect Rem Koolhaas, who in the early years of his career worked as a journalist and scriptwriter (Gargiani, 2008, p. 4), states: 'In a script, you have to link various episodes together, you have to generate suspense and you have to assemble things – through editing, for example. It is exactly the same in architecture. Architects also put together spatial episodes to make sequences'.

In terms of architectural education, a 'prescriptive' approach stimulates students to take a critical stance towards the cultural and societal context of design tasks and to imagine innovative alternative realities. Prescriptive exercises can teach architecture students to act as writers of new spatial scenarios. Scenario is a literary tool that helps to imagine multiple possibilities in regard to future developments. In the design phase of a studio exercise, scenario writing can come into play to challenge the idea of the influence of time and the limits of control. One can use scenarios to test the resilience of an architectural or urban design to accommodate different activities or confront the design with changing circumstances.

5 A pedagogical sequence

While the discussed perspectives and educational exercises can be put into play separately, they become even more productive when seen as a sequence. In various earlier educational settings, we have used the three perspectives to structure research and design studios offered in 'Methods of Analysis & Imagination' at TU Delft.

For instance, in the Msc1 studio Ways of Doing,[1] the students move from a descriptive phase in which they analyse a spatial and material condition to a phase in which they connect these observations to social and programmatic themes through narratives. As a third step, they develop scenarios for the future. This setup has allowed students to develop an in-depth reading of their sites in relation to the themes and challenges upon which they based their designs.

In the elective research and design studio Transdisciplinary Encounters,[2] students worked within the three 'blocks' – description, transcription, and prescription – to engage in the transdisciplinary encounters between architecture and literature. Students were invited to discover, explore, and examine the intricate connections between architecture and literature across different scales and on three parallel inquiries: urban places in literature, literary methods and perspectives, and writing urban places.

Each student chose a novel for their analysis: Gabriel García Márquez's *100 Years of Solitude* (1967), Georges Perec's *Life: A User's Manual* (1987), Yevgeny Zamyatin's *We* (1921), or John Lancaster's *The Wall* (2019), or Mark Danielewksi's *House of Leaves* (2000). Within the first theme, *urban places in literature*, students investigated how urban places were described within that novel: at the level of the experience of a character (description phase), then at the scale of the community (transcription phase), and finally at the larger scale of the city or society. The second inquiry concerned the methods employed by the literary writer, asking how urban places are described. What use does the author make of, for example, characters, perspective, timeframes, or evocative descriptions of details? The third theme, *writing urban places*, concerned design experimentation. Within this framework, emphasis was placed on the study of scale: the descriptive phase

1 Msc1 Studio *Ways of Doing*, Methods of Analysis and Imagination programme, fall semester 2020-21, taught by Angeliki Sioli, Willemijn Wilms Floet and Pierre Jennen. Published as: Angeliki Sioli, Willemijn Wilms Floet, Pierre Jennen, 'Binckhorst: A Palimpsest Of Architectural Lives' in *The Architect and the City, conference proceedings* EAAE / ARCC nov 2020, in Editorial Universitat Politècnica de València, 2020, pp 676-686

2 *Transdisciplinary Encounters* was an elective Msc2 course offered in the Method of Analysis & Imagination course of study. Each edition explored the connection to another discipline. The edition in Spring 2021, taught by Klaske Havik and Jana Culek, focused on architecture and literature. For a further exploration of particularly utopian literature and it's potential as a method for architecture, please see Jana Culek's PhD on the topic, (Culek 2023).

focusing on the scale 1:10, taking into account details and aspects of perception; then the transcriptive phase, which moved towards the collective through design exercises at the level of the community, moving to a larger scale; and in the prescription phase, taking into account societal aspects, designing at the urban scale and beyond.

THEMES	URBAN PLACES IN LITERATURE	LITERARY METHODS AND PERSPECTIVES	WRITING URBAN PLACES
Experience ''Description''	Study of novels	Poetic writing, sensory observation	1 : 10 - experience of the individual
Use ''Transcription''	Study of novels	Narrative, character	1 : 100(0) - gradual imagining of surroundings
Imagination ''Prescription''	Study of novels	Speculation, scenario	1 : 1000(0) - speculative world-building

TABLE 1 Pedagogical scheme of the Msc2 elective studio, using the description-transcription-prescription sequence across different scales and themes. Developed by Klaske Havik and Jana Culek

Using the description-transcription-prescription sequence in relation to scale, the design process subverted the standard process of an architectural design, working from the detail to the larger whole instead of the usual 'zooming in'. This approach resulted in heightened attention to sensory perception from the beginning of the design project, embedding the social spaces emerging in the second 'transcription' phase in a strong material and experiential presence. For instance, Alina da Porciuncula Paias, who studied Gabriel García Márquez's novel *100 Years of Solitude* and observed the presence of sound in many spatial descriptions, focused on the perception of sounds and developed a design for a series of small pavilions adjacent to a graveyard, as spaces for contemplation and experience, seeking how memories could be manifested in space, through the evocation of sensory perceptions.

In the case of Karthika Ranjit, who developed a design proposal for a 'Literary Laboratory' for a community with low literacy in India, the changing perception and details of the Alchemist room in *100 Years of Solitude* became a source of inspiration for the series of frames flexibly defining the space, evoking curiosity, and functioning as a catalyst of change.

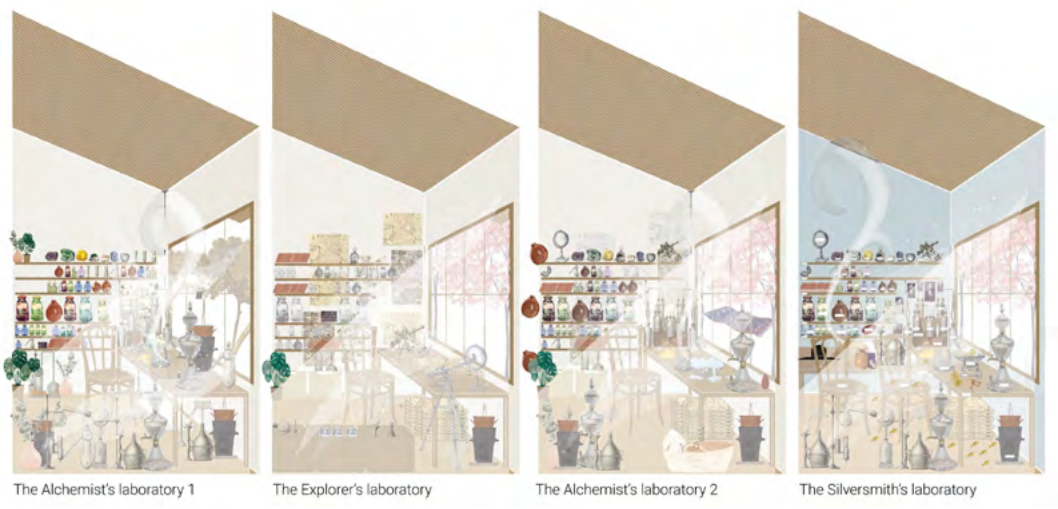

FIGURE 1 The Alchemist Laboratory, drawing based on the reading of the novel *100 years of Solitude* (Gabriel García Márquez, 1967), by Karthika Ranjit, 2021.

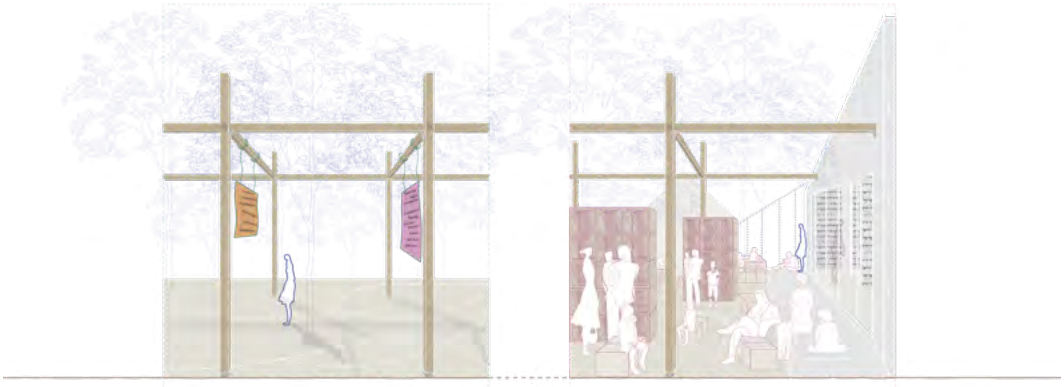

FIGURE 2 Frames from the design project for a Literary Laboratory, by Karthika Ranjit, 2021.

In Georges Perec's novel *Life: A User's Manual*, a Parisian apartment block is the framework for the narrative, which consists of multiple social stories, each connected to a character living in an apartment in the building. The analytical scheme, drawn by Matteo Armenante, highlighted the structure of the novel and the way in which events unfold in time. Lucie Ros Castillo took the presence of multiple characters as a starting point in her 'prescription' phase and developed scenarios for the former swimming pool Tropicana in Rotterdam based on three different characters.

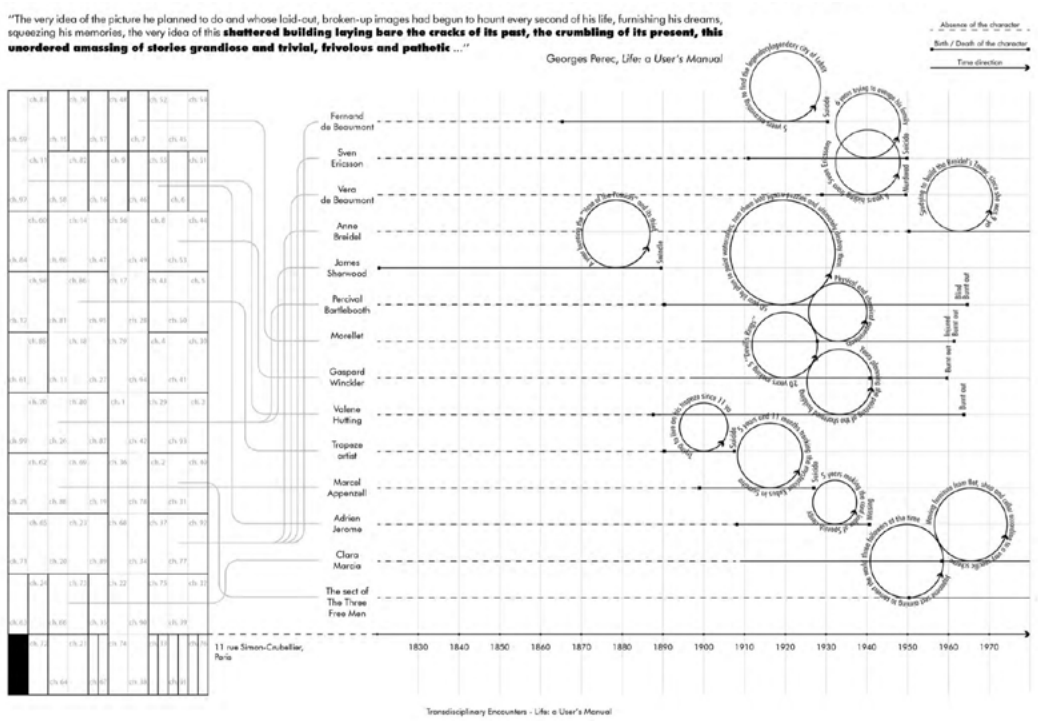

FIGURE 3 Scheme of Georges Perec's novel *Life: A User's Manual*, highlighting the structure of the novel and the way in which events unfold in time related to the characters inhabiting the structure. By Matteo Armenante, 2021.

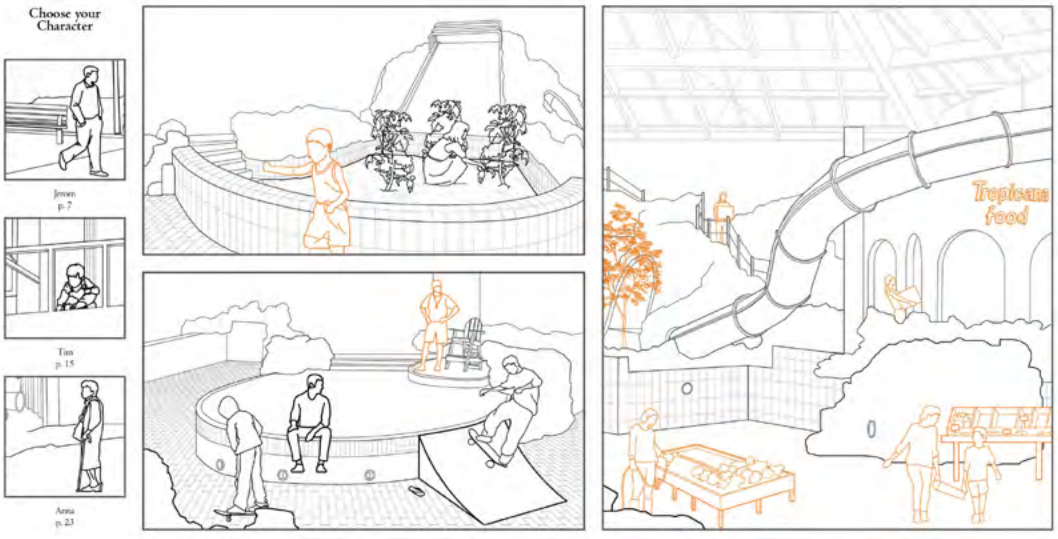

FIGURE 4 Scenarios for the former swimming pool Tropicana in Rotterdam, based on three different characters, by Lucie Ros Castillo, 2021.

6 Conclusion

In conclusion, the description-transcription-prescription sequence offers a structuring tool for research and design studios, generating a continuous shift from experiential to social to imaginative perspectives. The shift towards greater attention to the perceptual aspects in the first (description) stage of the course brings material concerns into the studio in an early phase: details play a crucial role in the experiential qualities of architecture. By foregrounding perception in the early stage of a course, architectural detail becomes a driving force of the design rather than a problem-solving element at the last stage of the project.

Moving from individual to collective perception, the transcription phase offers students ways to engage with the social dynamics of their projects, taking the wishes and needs of 'characters' as a point of departure. Consequently, students learn to empathise with different user groups and design more inclusively. Finally, the prescription phase has made students aware of the indeterminacy at stake in design. Literary exercises help them to think imaginatively about alternative possibilities for the future, resulting, in some cases, in designs that offer flexibility to accommodate multiple scenarios.

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Tevreden met groen
Veel zwerfvuil
Hier graag:
DREMPELS
Veel zwerfvuil bij de brakjes
Hier graag:
Afval containers bij elkaar, papier is nu de weg
Hier graag:
Veel zwerfvuil

Community engagement through research-based design and spatial planning education

Towards a conceptual framework for conditions and tensions

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Abstract

Universities worldwide are becoming increasingly interested and active in fighting social inequality and strengthening social cohesion at a local level, often referred to as 'university–community engagement', 'local engagement', or 'community outreach'. Many activities are clustered under this heading, such as lifelong learning, volunteerism of staff and students, service-based learning, and participatory research. Despite the rise of internet-based communication, community engagement in education requires face-to-face, reciprocal interactions between stakeholders and community members. While the goals of students, instructors, and community members may partly overlap, community engagement embodies fundamental tensions among the different interests, knowledge, and time frames of these actors. The extent to which these conditions can be met largely affects the level of community engagement. The chapter uses the relevant literature and experiential knowledge to develop a conceptual framework of the basic conditions for and inherent tensions in local university–community engagement in the context of research-based design and spatial planning education.

Keywords

Community engagement, community development, transdisciplinary, civic university, spatial planning

COVER FIGURE Residents' input on a map of the Kuyperwijk during a community engagement event organized by students, by Reinout Kleinhans, 2024.

1 Introduction

Universities across the world are becoming increasingly interested and active in fighting social inequality, creating opportunities, and strengthening social cohesion at local levels. This phenomenon, in the academic literature known as 'university–community engagement', 'community outreach', or 'community-university partnerships', increasingly receives attention from stakeholders such as policymakers, academics and local or regional authorities (Farnell, 2020; Goddard et al., 2016; Grau et al., 2017; Millican & Bourner, 2014). There are many ways to conceptualise university–community engagement (UCE), which has hitherto resulted in vague definitions and overlapping terms (Benneworth et al., 2018; Hart & Northmore, 2011; Sandmann, 2008; Sie & Frank, 2022). Many definitions and theoretical models incorporate spatial elements, and terms such as 'local', 'surroundings', and 'regional' are often used, referring to the spatial settings in which universities are embedded.

Despite rapidly growing interest in UCE, the literature is still characterised by a lack of conceptual clarity (Koekkoek et al., 2021). Due to the prevalence of broad definitions, many activities are clustered under this heading, e.g. lifelong learning, volunteering of staff and students, service-based learning, participatory action research, cultural events, and access to university buildings, for example, by art groups renting spaces (Benneworth et al. 2018; Goddard et al., 2016; Humphrey, 2013; Sandmann, 2008). Such activities partly stem from the increasing 'pressure' on universities to show their relevance and contribution to society. Other motives behind the growing popularity of UCE are related to its presumed benefits, including strengthening democracy, empowering marginalised groups or communities, combining scientific methodologies with 'real-world' problems, students becoming 'better citizens', equity, and generational solidarity. Through UCE, students are expected to transcend their disciplinary 'bubbles' and obtain relevant knowledge from people who are not experts, academics, or policymakers (Bourner & Millican, 2011; Brewis et al., 2010).

While the notion of UCE can be found across a wide range of disciplines, this chapter focuses on UCE in the context of *architecture and spatial planning education* at the university level. These are disciplines with an inherent interest in creating new knowledge and design for a 'better world', including housing, public space, and facilities for work, retail, health care, and other domains. In the context of their education, students are presented with settings that include a mix of research, design, and local problem-solving, whether or not there is an explicit requirement to address specific target communities. It is for these reasons that *architecture and spatial planning* are interesting and relevant disciplines for UCE. At TU Delft, these disciplines are embedded in the engineering programme, building on the current vision of TU Delft, which is inspired by the notion of a 'civic university' (Goddard et al., 2016) and reflects the concept of UCE: 'Delft University of Technology contributes to solving global challenges by educating new generations of socially responsible engineers and expanding the frontiers of the engineering sciences' (TU Delft, 2018, p. 12).

Two parts of the TU Delft mission statement which are connected to the vision, are particularly relevant to UCE (TU Delft, 2018, p. 12):

- We develop and enhance the expertise of tomorrow's engineering leaders and educate professional, high-level, and *responsible* engineers throughout their careers.
- We help to develop and deliver technology-driven, innovative solutions to societal problems through collaborations with leading national and international partners while *being firmly rooted in Delft*.

It is precisely the combination of responsibility, innovative solutions to societal problems, and being rooted in certain localities that underpin the relatively unexplored merits of community engagement. In this context, instructors develop educational activities that enable students to make a positive local impact, for

example, a knowledge-based intervention or network in a locality (street, square, neighbourhood, shopping centre, or school area), informing urban policy, or answering specific questions that local practitioners who often lack time and other resources to do the research themselves are trying to address.

Before moving towards solutions, we need to carefully identify the extant knowledge and challenges regarding UCE in the context of architecture and spatial planning education. Based on the relevant literature and experiences piloting UCE in existing courses, the aim of this chapter is to develop a conceptual framework of the basic conditions for and inherent tensions in local university–community engagement in the context of research-based design and spatial planning education. The next section briefly explores the notion of community engagement. Section 3 develops a conceptual framework that includes the basic conditions and potential tensions between actors participating in UCE. The final section presents the conclusions.

2 Definitions of community engagement

Similar to UCE, the notion of community engagement (CE) is characterised by a plethora of definitions and activities. In its essence, CE refers to various ways in which local community members, such as residents, policymakers, entrepreneurs, and others, can be engaged with (research in) design and spatial planning education. Engagement entails participation. The International Association for Public Participation (IAP2) has developed a Spectrum of Public Participation, which can 'assist with the selection of the level of participation that defines the public's role in any public participation process' (IAP2, 2018). The spectrum is used internationally, and it is found in many public participation plans. It is a useful framework for explaining CE and its community impact. If, for example, residents participate as informants in students' research, the level 'Consult' applies, whereas students and local stakeholders who jointly develop strategies or a design would be reflected by the level 'Collaborate'. With each step to the right (see Figure 1), the level of engagement by the public increases, as well as the strength of the reciprocity between academics, policymakers, and 'the public'.

In an effort to tackle the plethora of definitions and meanings, Benneworth et al. (2018) recently completed a critical synthesis of the state-of-the-art on UCE in higher education. Based on their review, they define UCE as 'a process whereby universities engage with community stakeholders to undertake joint activities that can be mutually beneficial even if each side benefits in a different way' (Benneworth et al., 2018, p. 17). These activities may relate to teaching and learning, research, service and knowledge exchange, student initiatives, and university-level engagement, whereby universities open up their facilities or venues to the community and provide open access to educational resources (Farnell, 2020). In this chapter, the focus lies on teaching and learning.

IAP2 Spectrum of Public Participation

IAP2's Spectrum of Public Participation was designed to assist with the selection of the level of participation that defines the public's role in any public participation process. The Spectrum is used internationally, and it is found in public participation plans around the world.

INCREASING IMPACT ON THE DECISION

	INFORM	CONSULT	INVOLVE	COLLABORATE	EMPOWER
PUBLIC PARTICIPATION GOAL	To provide the public with balanced and objective information to assist them in understanding the problem, alternatives, opportunities and/or solutions.	To obtain public feedback on analysis, alternatives and/or decisions.	To work directly with the public throughout the process to ensure that public concerns and aspirations are consistently understood and considered.	To partner with the public in each aspect of the decision including the development of alternatives and the identification of the preferred solution.	To place final decision making in the hands of the public.
PROMISE TO THE PUBLIC	We will keep you informed.	We will keep you informed, listen to and acknowledge concerns and aspirations, and provide feedback on how public input influenced the decision.	We will work with you to ensure that your concerns and aspirations are directly reflected in the alternatives developed and provide feedback on how public input influenced the decision.	We will look to you for advice and innovation in formulating solutions and incorporate your advice and recommendations into the decisions to the maximum extent possible.	We will implement what you decide.

FIGURE 1 IAP2's Spectrum of Public Participation. From *international Association for Public Partcipation,* 2024 (www.iap2.org). Reproduced here with written permission.

3 Applying UCE in courses: Conditions and tensions

In November 2019, I acquired a Delft Education Fellowship to explore the implementation of UCE in the context of education. This fellowship aims to improve our understanding of the feasibility of and effective approaches to strengthening community engagement by enabling architecture students to conduct research and design that truly connects to and engages (members of) local communities in the context of regular coursework, which will be further developed for this purpose. The two courses used for piloting are:

1. The minor 'Cities, Migration and Socio-Spatial Inequality' (BK7470/7471/7472)
2. The MSc elective 'Social Inequality in the City, Diversity and Design' (AR0095)

The piloting yielded several insights that helped build the conceptual framework. While both ten-week courses have learning objectives regarding the skills and competencies that students acquire or extend during the course, local community engagement is an implicit underlying objective. In terms of the IAP2 Spectrum of Public Participation, students are expected to consult and involve residents and professional stakeholders (such as civil servants or the local police force) in selected target neighbourhoods in their research efforts, i.e. as a source of information, but also in the proposals for strategies or designs.

The extent, nature, and quality of the exchanges between students (and instructors) and community members are affected by many conditions. Even if all involved actors agree on the relevance and desirability

of UCE, the various scopes and boundary conditions may not be easily aligned. This situation can be conceptualised as an (im)balance between centripetal and centrifugal forces (see Figure 2), which reflect different interests and scopes.

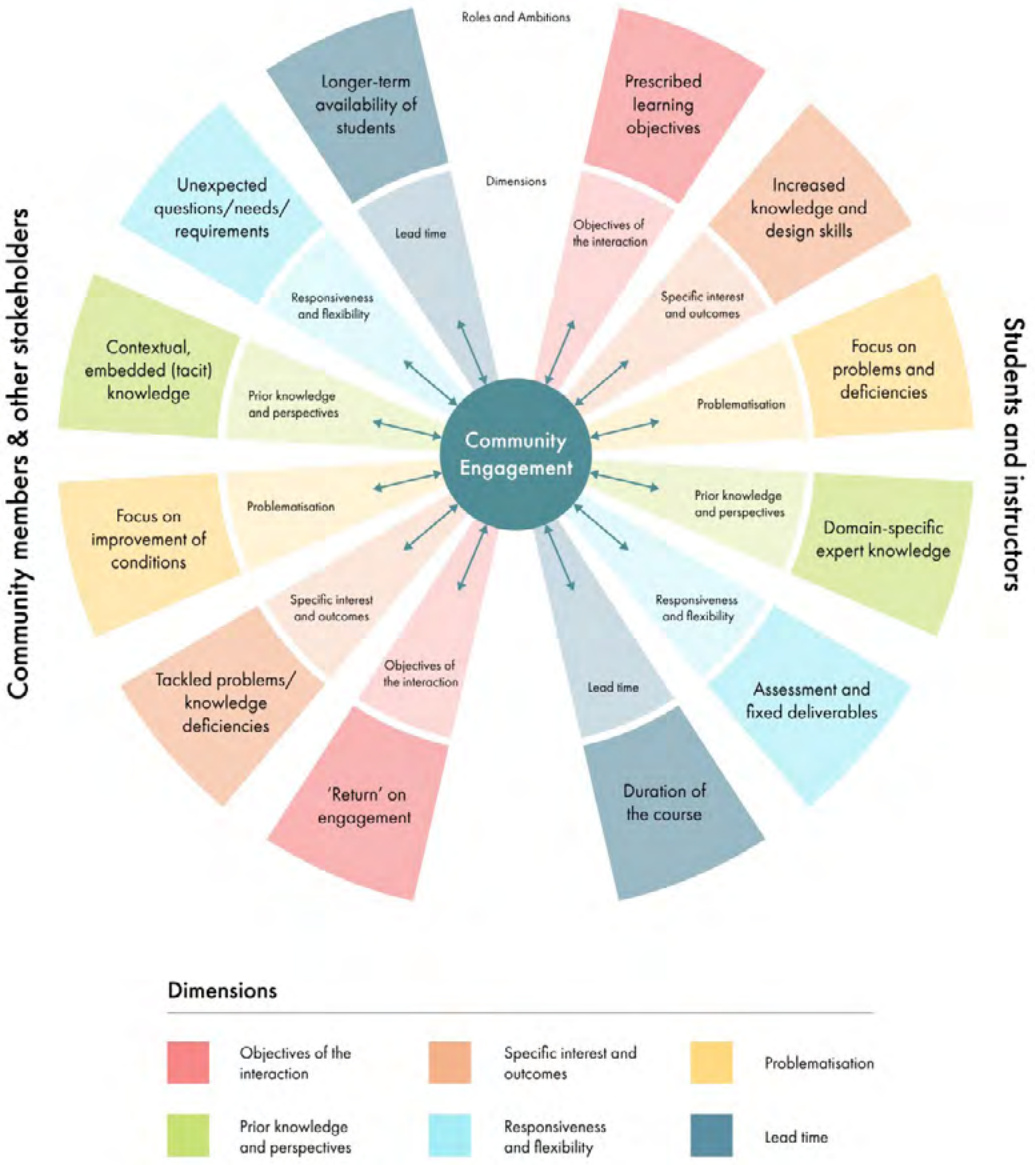

FIGURE 2 A framework of conditions and tensions in UCE in the context of design education and research, by Jonas Althuis, 2024.

While the core of the diagram refers to both the process and the outcome, the intermediate circle reflects six dimensions that include boundary conditions, interests, and scope in the context of UCE. The outer circle operationalises the nature or elements of the dimensions, particularly roles and ambitions, from the perspective of the students and their instructors (right part of the diagram) or by community members and other stakeholders (left part). Each dimension will be briefly discussed below.

3.1 Objectives of the interaction

As explained earlier, UCE aims for broader effects than only offering challenging education. However, in the context of educational activities that will be graded, the *prescribed learning objectives* and related instruction will lead students' learning activities. In the context of UCE, proper learning objectives define the outcomes not only in terms of acquired knowledge and student skills (e.g. developing a research-based design) but also in terms of benefits for other involved actors or institutions (e.g. a local strategy). For the non-academic partners in UCE, the *'return' on engagement* with students and instructors may be similar to the learning objectives but is more likely to be related to changes in policy, the built environment, social services, or economic facilities. In the pilot courses, this often emerged in the form of expectations, whether the elaboration of an incomplete problem analysis or a 'fresh' outsider perspective from students regarding such changes.

3.2 Specific interests and outcomes

In both pilot courses, local stakeholders (i.e. representatives of local governments or programme offices) offered certain 'questions' in advance, hoping that these could be tackled in the course. In many cases, such questions were not 'ready' to be processed directly as a research question within (student research in) the course. Notably, there is at least a partial difference in interest between academics and non-university stakeholders. While UCE may be part of students' personal goals, they are ultimately interested in finishing a course with good results through *increased knowledge and design skills*. In contrast, other stakeholders are looking for certain *problems, opportunities, or knowledge deficiencies* to be effectively addressed. This difference reflects a more fundamental tension between the interests of students and local communities.

Whereas local communities hope to obtain a result that is as beneficial as possible, students benefit from making mistakes and failing during their educational career – a crucial element of learning. During the pilot courses, it turned out that making mistakes is not – by definition – conducive to an optimal outcome for the community, as it may diminish the robustness of the problem analysis, the resulting strategies, or both.

3.3 Problematisation

All instructors involved in architecture and spatial planning education know that many of their students are ambitious (and partly naïve) 'world improvers' who are keen on solving large (societal) challenges. This is often reflected in their approach. In the piloting courses, students tended to focus on *problems or deficiencies*, while community members looked for the *improvement of a situation or conditions* without disturbing positive elements in the status quo. The imminent danger of a 'deficiency approach' is that it ignores local strengths, assets, and opportunities and devaluates community members' efforts to generate local benefits or improvements. In asset-based community development, a key principle is to 'focus on what is strong, not what is wrong' (Russell, 2020).

3.4 Prior knowledge and perspectives

As a consequence of their previous education, experience, and active intellectual schemata, students and their supervisors accumulate significant *domain-specific (expert) knowledge* that they apply to a real-life situation, trying to make sense of their observations in the chosen UCE context. Usually, they are new to this situation, whereas local community members are embedded in it and have a large amount of *contextual (tacit) knowledge* and experiences. In other words, the perspectives of both groups are affected by their prior knowledge, and combining these types of knowledge is very useful but can also pose challenges. During the interactions in the pilot courses, we noticed, for example, that certain interpretations of students (e.g. regarding the use of public space) were constructively 'falsified' by residents who offered different explanations. In other interactions, 'unarticulated' questions arising from the community fell partly or completely outside the expertise and skills of students and their instructors.

3.5 Responsiveness and flexibility

As no one can predict community responses in the context of UCE, the approaches adopted by universities need to be flexible, and academics must maintain an open mind and receptiveness towards *(unexpected) questions, needs, views and requirements* of community members and other local stakeholders (e.g. Benneworth et al. 2018). This aim can be at odds with a priori course requirements regarding clear learning objectives, boundary conditions, planning, fixed deliverables, and assessment. In other words, any attempt to be flexible and respond to particular community inputs and requirements may come at the expense of the aspired constructive alignment (Biggs & Tang, 2007), for example, because it expands the subject matter beyond reasonable limits for a ten-week course. Flexibility is also needed in relation to the tension between benefitting a (local) community and students' opportunities to fail in their educational efforts, which is a crucial element of learning.

3.6 Lead time

The *duration of the course* may be at odds with community expectations regarding the longer-term 'availability' of students and their instructors, as well as the duration of policy cycles. Consequently, many previous UCE attempts have been perceived as 'hit and run' projects in which students quickly gather the data they need and withdraw from further engagement with the community. In the pilot courses, this issue was felt very strongly because both courses only last one academic quarter (ten weeks). This length turned out to be just sufficient time to consult community members but a bit too challenging to involve them in the elaboration of strategies and designs. A possible solution is 'stacking' the work of several student cohorts, who build upon each other's work. A disadvantage is the time gap between 'episodes' of the same course, which may result in the loss of momentum.

4 Preliminary conclusions: Towards establishing clear boundary conditions for UCE

This chapter has reported some preliminary outcomes of an education innovation project, i.e. my TU Delft Education Fellowship (2020–2021). I have developed a conceptual framework of the basic conditions for and tensions in university–community engagement in the context of research-based design and spatial planning education. Based on a literature review (not reported here) and the piloting of several courses at the Faculty of Architecture and the Built Environment, this framework (Figure 2) contains six dimensions that encompass the conditions, interests, and scope of the crucial actors in the context of small-scale UCE within regular courses.

At this stage, several conclusions can be drawn. First of all, even if instructors and community members agree on the relevance of UCE, significant preparation is required to set clear boundaries for the research and design efforts by the students. Such work should include 'preparing' community members, especially residents, for their engagement with students so that they know what to expect from student interaction, deliverables, feedback, and lead time. Students need to be prepared as well. Double-sided expectation management is key.

Second, the pilot experiences showed that a lead time of ten weeks is very short for community engagement to move beyond the consultation level (see Figure 1). This issue may be overcome by either 'stacking' the work of student cohorts in the same course or embedding UCE in longer-term studio settings (including MSc thesis research).

Third, student deliverables need to be reconsidered to allow for more flexibility and to ensure they are more 'understandable' to the community, though this may complicate the constructive alignment in the course. One of the pilot courses showed the utility of a supplementary Dutch note on top of the English reports.

To support implementation in other courses (and beyond) with a desire to venture into community engagement as part of student research and design, a TU Delft-wide learning community (also known as a 'special interest group') was established under the umbrella of the Teaching Lab at the Delft University of Technology. In this learning community, instructors and education coordinators from several faculties exchanged experiences and worked jointly on further professionalisation regarding this topic. This process occurred in close collaboration with colleagues at the TU Delft Community Outreach Team.

The findings were also fed into the development of the Thesis Hub at The Hague Southwest (see https://www.scriptiewerkplaats-dhzw.nl/english). This initiative stems from the educational programme of Leiden-Delft-Erasmus universities, which actively connects with practice and policy. In the Thesis Hub, student research is linked to concrete challenges in The Hague Southwest. Instructors closely collaborate with local stakeholders such as the municipality of The Hague, housing associations, welfare organisations, local neighbourhood professionals, and residents of The Hague Southwest. The author of this chapter is active in the steering committee of the Thesis Hub. In a recent evaluation of Leiden-Delft-Erasmus Centres by an external committee, the Thesis Hub was lauded as an exemplary education innovation. Indeed, the fundamental thinking underlying the work described in this chapter is gaining ground and will continue to do so in the coming years.

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Interdisciplinary design education in the field of urban infrastructure

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Abstract

Building resilient urban infrastructure that can anticipate the challenges that come with climate change needs an interdisciplinary approach. Deviating from the paradigm of engineering protection can only be done when the spatial context is integrated. Yet, interdisciplinary cooperation between civil engineering and spatial design, fields with very different cultures and languages, has been protocolized to a multidisciplinary collaboration over time. In order to change this Delft University of Technology incorporated interdisciplinary design into its MSc-level education of civil engineers and spatial designers. Taking challenges in Japan, which have been subject to storm surge and tsunami hazards, Albania, the United States, and Ghana, all of which suffer from pluvial, fluvial, and coastal flooding proved solid learning grounds. The interdisciplinary design projects, organised for students from various disciplines, were set up to learn from and perform the hypothetical redesign and reconstruction of areas in flood plains, aiming to increase disaster resilience and liveability.
The participating students were asked to evaluate their projects to be able to assess the effectiveness of the Tohoku interdisciplinary design method and discuss lessons learned for interdisciplinary projects with engineering and design students. The results show that the interdisciplinary project provides engineering students with more broad and practical experience of the sort that has been lacking in the decades since engineering education came to be dominated by academic researchers rather than practitioners. On the other hand, students in architecture and urbanism viewed this opportunity as a chance to apply their already acquired integrative skills in an interdisciplinary setting.

Keywords

Interdisciplinary design, urban infrastructure, sustainable development

COVER FIGURE A photo series representing the different disciplines of interest in the reconstruction of Otsuchi after the tsunami disaster 2011. By (from top to bottom and left to right) Jochem Roubos (structural engineering), Fransje Hooimeijer (urbanism), Frans van de Ven (water management), second to top Aditya Rao (landscape architecture), Jesse Salet (structural engineering), third row Gayatri Mujumdar (urbanism), Eline van Unnik (transport planning), fourth row Ilse Nederlof (water management), Nataly Filipouskaya (geo engineering) .

1 Introduction

The call for a more conscientious and integrated design process in urban infrastructure design stems from the realisation that increasing the resilience of the built environment is essential for enduring natural disasters (Amirzadeh et al., 2022). Cutter et al. (2008) contend that achieving this resilience necessitates multidisciplinary collaboration (the assembly of the team), culminating in interdisciplinary design (the result of the work by the team). The partnership between the civil engineering and spatial design disciplines presents significant hurdles, with one of the primary challenges arising from differences in terminology, starting with the very definition of 'design'. In its broadest interpretation, design serves as a methodology to discover common ground in situations where measures, problems, and objectives remain undefined (Van de Ven et al., 2009). However, engineers are accustomed to employing an optimisation methodology when designing solutions, whereas spatial designers adopt a research-by-design approach. These distinct fields operate under different paradigms and problem-solving rationales (see Table 1).

MEASURES	PROBLEMS AND GOALS	
	FAMILIAR / EXISTING AGREEMENT	UNFAMILIAR / NO AGREEMENT
Known	Optimisation	Negotiation
Unknown	Innovation	Design

TABLE 1 Solution strategies for different types of problem (Van de Ven et al., 2009, derived from Thompson and Tuden, 1964)

According to Webber and Rittel (1973), engineers commonly confront 'tame' problems, whereas spatial designers grapple with 'wicked' problems. This dichotomy underscores a disparity between the pursuit of the most efficient solution to a problem (which is tame) and the endeavour to identify the most contextually appropriate solution within complex societal systems lacking clearly defined boundary conditions (which is wicked). Webber and Rittel (1973) identify the transition away from the notion of efficiency in the late 1970s with the reintroduction of the urban context with complex societal systems within the problem solving.

A similar change has also occurred in engineering education, a field dominated by a research-focused from the 1980s onward (Crawley et al., 2007). This shift has pushed students toward more focused, fundamental knowledge with less emphasis on application or group work skills. Moreover, the introduction of the computer brought unprecedented calculation capacity that allowed for theoretical system behaviour and exploratory scenario analyses. Prior to this, engineering education had been dominated by practitioners, not researchers, who put more emphasis on project work, learning-by-doing, and testing in practice. Today, industry leaders value the depth of knowledge in modern engineering graduates but bemoan their lack of group work skills, which are necessary for a multidisciplinary working environment (Lang et al., 1999).

Reviewing a range of project-based, interdisciplinary engineering programmes, Mills and Treagust (2003) conclude that students who graduate from traditional engineering programmes have good fundamental knowledge but require extra on-the-job training and experience before they can function productively in a project setting. In contrast, students from undergraduate programmes with a heavy emphasis on interdisciplinary work struggle with engineering fundamentals and have trouble with core engineering work.

Education in spatial design, encompassing urban design and landscape architecture, emphasises creative design orientation, aiming to harmonise stakeholders' interests in urban projects across all scales. Consequently, it draws from various disciplines and fields of expertise. Unlike engineering, this field is

marked by an epistemic culture and depends on a range of scientific disciplines such as engineering, sociology, economics, history, and natural sciences. Within an epistemic culture, each scientific field operates with its own unique methods, instruments, tools of inquiry, and modes of reasoning, as well as methods for establishing evidence (Knorr Cetina, 1999).

Designers traditionally have operated under the assumption that technological advancement could inform any design concept. Consequently, engineering became somewhat separated from this epistemic culture, and creative design has primarily been influenced by social and economic indicators rather than being inherently connected to engineering (Hooimeijer, 2014). However, the current imperative of addressing climate change necessitates reintroducing engineering into the spatial design process to develop the resilient cities of the future.

The main objective of this chapter is to investigate the effectiveness of interdisciplinary design projects for engineering and architecture students to learn how to integrate engineering into spatial design programmes. It presents lessons learned based on interdisciplinary project-based education. The next section explains how interdisciplinarity is incorporated into the educational programmes at Delft University of Technology in the Netherlands and outlines the Tohoku method of interdisciplinary design, named after the region where it was developed. Subsequently, the effectiveness of the programme is discussed and analysed via a survey among participating students. The answers to the questionnaire elaborate on the following topics: multidisciplinary team and interdisciplinary process, role of the engineer, and products of the projects.

2 Interdisciplinary (project-based) education at Delft University of Technology

The review by Mills and Treagust (2003) implies that intradisciplinary (knowledge and skills inside one subject area) education is necessary at the beginning of undergraduate engineering studies to form the foundation of practical knowledge. Further, interdisciplinary education (integrating knowledge from different subject areas) is profitable if applied in upper-year or graduate curricula. Dutch and European university systems traditionally consisted of a five-year programme culminating in the degree of *Ingenieur* (engineer). After the Bologna process (European Commission, 2019), however, EU universities have divided this into a three-year bachelor's (BSc) programme and a two-year master's (MSc) programme. At Delft University of Technology (TU Delft), the first year of the engineering master's programme consists of in-depth courses within each student's chosen discipline, more focused than the broad engineering curriculum of the bachelor's programme. Interdisciplinary education is implemented in the second year of the master's programme, consisting of project course work and graduation thesis research.

For students at the Faculty of Civil Engineering and Geosciences (CEG), the latter is accomplished through a ten European Credits (EC) component that can be done as 'multidisciplinary project group' (MDP) work or as individual research work. Some students also take an interdisciplinary approach to their 40 EC Master's thesis project. In this way, foundational engineering knowledge has already been obtained, and students can apply it in an interdisciplinary setting similar to what they might face in industry, depending on the type of job function they enter. Faculty of Architecture and the Built Environment (ABE) students participate in

interdisciplinary groups as part of the Delta Futures Lab (the education platform of the interfaculty research group Delta Infrastructure and Mobility Initiative).

A project-based approach in cooperation with an active case or client is essential to simulate practice, which is interdisciplinary by nature. This structured activity that focuses on participation and interaction is called experiential learning, which allows the learner to create meaning from first-hand experience (Johnston, 2015). It implies a very active learning style experience in how material and principles are encountered, integrated, and applied to new situations (Feinstein et al., 2002).

These collaborations between disciplines are stimulated at TU Delft by dedicating the first quarter of the second year of all MSc tracks to making these connections. Next to working with students in an honours track (excellent and ambitious students adding 20 EC to their study), it is possible to dedicate research courses to this type of work and gather students from the participating faculties in the Delta Futures Lab.

3 Tohoku method of interdisciplinary design[1]

To facilitate an interdisciplinary approach, the regions of Tokyo and Tohoku in Japan (Edogawa, Yuriage, and Otsuchi), Tirana in Albania, Muni-Pomadze Lagoon in Ghana, and Houston in the United States were selected as case studies for multi disciplinary student teams. The projects in the Tohoku region in Japan are foundational for developing the interdisciplinary design methodology, which is why it is called the Tohoku method. Tohoku's coastal cities were devastated by the 2011 Great East Japan earthquake and tsunami, and the region has been rebuilt from scratch using a combination of engineering measures such as seawalls and elevated landfills (Suppasri et al., 2016), natural measures such as coastal forests, and social measures such as land use control, enhanced warning systems, and evacuation drills. This collection of measures allows for the assessment of the physical and social effectiveness of reconstruction measures in real-time, demonstrating whether and how civil engineering and spatial design intertwine.

After the studies in Japan, the student projects shifted to Tirana (Albania), Muni-Pomadze (Ghana), and Houston (USA), locations that are struggling with fluvial and pluvial flooding plus coastal erosion. Solutions for these problems also benefit from an interdisciplinary design approach in which understanding each other's constraints and values not only resolves them but also implements liveable and resilient urban development. Here, the Tohoku method was further developed.

The initial crucial step in the Tohoku method is finding the proper set of disciplines and assigning staff members per discipline to provide intensive guidance. Subsequently, the projects follow the three main phases of the (interdisciplinary) design process: analysis and synthesis, design, and conclusions (Van Dooren, 2013).

1 The methodology description is similar to the paper that is published on these projects but with a focus on the theoretical fundaments of the difference between multi- and interdisciplinary design: Hooimeijer F.L., J.D. Bricker, A.J. Pel, A.D. Brand, F.H.M. Van de Ven, and A. Askarinejad (2022) Multi- and interdisciplinary design of urban infrastructure development. Proceedings of the Institution of Civil Engineers - Urban Design and Planning 2022 175:4, 153-168

During the first phase (analysis and synthesis), the project's conditions and context were established through a series of workshops where participants familiarised themselves with each other and their respective disciplines, as well as a site visit accompanied by lectures to develop a shared understanding of the project. Interdisciplinary conditions were fostered by having students formulate questions within their own discipline, determine inquiries for other disciplines, and identify what contributions they could offer to others. Additionally, an inventory of data and information pertinent to the case was compiled for each field, along with essential background knowledge to be presented to the group.

ANALYSIS AND SYNTHESIS PHASE ←	→ DESIGN PHASE →	→ CONCLUSION PHASE
Setting interdisciplinary context Making relations between the disciplines Investigation of the context: field trip	**CONNECTING WORKSHOP** 1 From an interdisciplinary preliminary group vision on the problem(s) and potential solutions strategies, 2 Form a disciplinary body of knowledge, 3 Define a scope of each discipline applying the same criteria for evaluation, 4 Integrate the scopes in several charette rounds and define the final framework, 5 Connect the framework to the preliminary vision.	Iterations of disciplinary refinement and interdisciplinary integration
		Final plan and report

TABLE 2 The sequence of activities in the projects

Two 'in-house' workshops preceded the site visit, during which staff and students visited the site and engaged with stakeholders. The subsequent workshop, conducted during the field trip, entailed a lengthy collaborative session over several days, with the following agenda:

1. Formation of an interdisciplinary preliminary group vision regarding the problem(s) and potential solution strategies, which is crucial for goal integration and determining the best future course for the case.
2. Definition of the shared scope to develop uniform criteria for evaluation along this shared value system.
3. Development of disciplinary knowledge and ideas applicable to the case.
4. Each discipline evaluates its ideas by use of the shared scope.
5. Integration of scopes through several charrette rounds to define the final framework, enabling better insight and understanding of concepts and facilitating connections to proposals from other disciplines.
6. Linking the framework to the preliminary vision to demonstrate the relationship between choices within disciplinary scopes and to provide an interdisciplinary viewpoint on the case.

During this phase, extensive mutual exchange, influence, goal integration, basic integration, and managed integration were established, resulting in a preliminary interdisciplinary design. This design was further developed after the field trip through simulation, evaluation, and decision-making processes. These activities were conducted through alternating disciplinary and interdisciplinary workshops, group meetings, subgroup meetings, and homework sessions. Each discipline refined its proposal component, and the

group collectively re-evaluated the proposal to determine necessary refinements. Subsequently, each team member oriented their disciplinary component of the plan toward the final design proposal. The outcomes were presented in a report or scientific paper accompanied by reflections from each team member on the process and project content. Additionally, the group produced a short video presentation showcasing the results of their work.

4 Evaluation of student survey results

To assess the efficacy of this interdisciplinary approach, a survey was conducted among students who participated in the projects, yielding 38 responses. Of these, 66% were involved through project groups, while 34% participated via MSc theses. Even though the latter group only fully engaged in the workshops and site visit activities during the analysis and synthesis phase and then pursued their thesis research, the interaction on the interdisciplinary design level with the multidisciplinary project groups during the design and conclusion phases was very valuable. During these interactions and the presentations of their graduation projects, the collaborative process grew more genuine and intense.

At the time of the survey, 71% of respondents were still students, while 29% had graduated and were employed. Engineering students (CEG) represented various MSc tracks, including hydraulic engineering (HE, 10 students), geo-engineering (GE, 2), transport infrastructure and logistics (TIL, 7), transport and planning (TP, 1), and urban water management (WM, 3). Architecture students (ABE faculty) were enrolled in MSc tracks such as urbanism (U, eight students), landscape architecture (LA, 4), architecture (A, 1), building technology (BT, 1), and management in the built environment (MBE, 1). Among the 38 students surveyed, 2 participated in the 2016–17 Tokyo case, 8 in the 2017–18 Yuriage case, 5 in the 2018 Tirana case, 12 in the 2018–19 Otsuchi case, 5 in the 2019 Ghana case, and 6 in the 2019 Houston case. It is worth noting that certain sub-disciplines were underrepresented, so the subsequent analysis primarily focuses on the faculties involved (architecture and engineering) rather than specific sub-disciplines.

QUESTIONNAIRE: INTERDISCIPLINARY EDUCATION

The first 14 questions are on your background and perspective on collaboration among multiple disciplines.

I-1. How did you participate: Multidisciplinary project student or MSc thesis student?

I-2. Are you a student?

I-3. What is your core discipline? Choose one:

I-4. If you have multiple core disciplines, what do you consider your secondary and tertiary disciplines?

I-5. Which group did you participate in: Tokyo (2016–17), Yuriage (2017–18), Otsuchi (2018–19), Tirana (2018), Ghana (2019), Houston (2019)

I-6. What do you consider to be the core activities of multidisciplinary work? Multidisciplinary working concerns independent, parallel learning assignments of different disciplines. (more answers available) A) open attitude, B) inspiration, C) innovation, D) information integration, E) design, F) communication, G) cooperation, H) co-design, I) exchange, J) bridging, K) confrontation, L) assemblage, M) juxtapose, N) combine, O) synthesise, P) integrate, Q) transcend, Open answer:

I-7. To what degree is *multi*-disciplinarity (parallel learning) addressed during your studies?

I-8. What do you consider the core activities of *interdisciplinary* working? Interdisciplinary working concerns interdependent learning assignments of different disciplines. Same options as question 6

I-9. To what degree is *interdisciplinarity* (interdependent learning) addressed during your studies?

I-10. How easy or difficult was it to 'integrate'/collaborate with the (representatives of the) participating disciplines?

I-11. Which other discipline was the *most useful* to your project/thesis, for example, because it helped to better inform your project?

I-12. Which other discipline did you learn most from, for example, because it changed your perspective on the significance of your project?

I-13. Which other discipline had the *largest impact* on the project, for example, because it determined the boundary conditions or the final goal of your project?

I-14 What disciplines, which would have added value to your project or thesis, were missing from the team?

The next 22 questions are on your perspective on the methodology and results of the overall project.

II-1 How effective was the overall approach in the project (phasing and steps) for disciplinary integration? Answer on a scale of 0–10 (0 = not at all, 10 = extensively)

II-2 How effective was the scoping method used in the workshops for disciplinary integration? Answer on a scale of 0–10 (0 = not at all, 10 = extensively). For example, did it enable you to build arguments for your design choices?

II-3 How effective was the charrette method for the integration of disciplinary knowledge? Answer on a scale of 0–10 (0 = not at all, 10 = extensively)

II-4 What part of the programme was most effective? List them from most to least effective: A. Pre-trip group work in Delft. B. Site visits. C. Group work on-site. D. Post-trip group work in Delft. E. Post-trip group work on the second case. F. Post-trip individual work. Other? (open answer)

II-5 What was the most challenging part of the project? The content (integrating the knowledge), the process (deciding on the steps), the organisation (getting the group together), Open answer:

II-6 What was the most challenging phase of the project? Analysis (learning from the Japan case), synthesis (initial redesign of the Japan case), design (final design worked on after returning to NL), Production of final report/paper

II-7 What was the primary obstacle to working with other disciplines? Vocabulary/concepts (i.e. the meaning of 'design'), perspective, aim/goal, methods, instruments, Open answer:

II-8 Other than the included disciplines, which factors had a significant effect on the effectiveness of the interdisciplinary work process? List in order of influence, with the most important first: size of the group, gender, individual personalities, culture, local counterparts, Open answer:

II-9 According to you, did the interactive group work lead to an interdisciplinary design? Answer on a scale of 0–10 (0 = not at all, 10 = very much): Why? How would you assess that?

II-10 What could be improved to achieve an interdisciplinary design, e.g. the content (integrating the knowledge), the process (deciding on the steps), and the organisation (getting the group together)?

II-11 To what extent did this project enhance your understanding of fundamental principles within your own discipline? Answer on a scale of 0–10 (0 = not at all, 10 = extensively):

II-12 To what extent did you gain broader knowledge that will enable you to work more effectively within your own discipline? Answer on a scale of 0–10 (0 = not at all, 10 = extensively)

II-13 To what extent were you able to achieve your disciplinary aim in the process of the inter/multidisciplinary assignment? Answer on a scale of 0–10 (0 = not at all, 10 = extensively)

II-14 Do you consider this interdisciplinary experience an advantage in your chosen career? Yes, no, why, or why not? Open answer:

II-15 How would you assess the group's performance? Answer on a scale of 0–10 (0 = bad, 10 = good)

II-16 Was it possible to give open feedback to the group members?

II-17 Did you give feedback?

II-18 How would you assess your role in the group? Answer on a scale of 0–10 (0 = minor/passive, 10 = essential/active):

II-19 Which of these four types of roles comes closest to yours? Specialist: how can we optimise technology for better performance using scientific knowledge? Systems integrator: How can we integrate object-oriented parties and systems for a complete solution? Front-end innovator: How can technology contribute towards innovation for (new) industry and society? Contextual engineer: How can we develop and implement technology internationally in society and industry? More answers are possible.

II-20 How would you assess the role of the supervisors? Answer on a scale of 0–10 (0 = confusing, 10 = helpful):

II-21 What do you consider your disciplinary qualities? Open answer:

II-22 What do you consider your disciplinary constraints? Open answers:

Notes on the full survey: The first batch of 14 questions related to students' backgrounds and perspectives on collaboration among multiple disciplines. The next 22 questions related to their perspective on the methodology and results of the overall project. The answers were subjected to a quantitative (I-7, I-I-9 to I-13, II-1 to II-4, II-11, II-12, II-14, II-18, II-20) and a qualitative (I-6, I-8, I-10 to I-14, and II-5 to II-10, II-13, II-15 to II-17, II-19, II-21, II-22) analysis. The evaluation of the survey results focused on 1) the multidisciplinary team and interdisciplinary process of the projects, 2) what roles the students adopted within the multidisciplinary teamwork, and 3) the reflection on the products of the projects.

4.1 Multidisciplinary team and interdisciplinary process

Consulting the survey results about multidisciplinary and interdisciplinary understanding demonstrates that students consider multidisciplinarity a group process and not an outcome, and they highly value communication skills. The students consider interdisciplinarity to be the outcome and intertwining of knowledge and products. Interdisciplinary design equates to the integration of sectoral responsibilities, goals, and solutions.

The quantitative summary of the responses to the survey questions (I-7, I-9 – I-13, II-1-II-4, II-11, II-12, II-13, II-14, II-18, II-20) is shown in Table 4. It shows that both architecture and engineering students thought their knowledge improved. However, architecture students felt they improved more in regard to fundamental knowledge than engineering students, and regarding broader knowledge, engineering students felt they improved at higher rates than architecture students. Engineers felt slightly more than architects that their education up to this point had been multidisciplinary, though architects felt significantly more than engineers that their education up to this point had an interdisciplinary component (questions I-7 and I-9); note the large standard deviations for these items, indicating that individual experience varied greatly.

Engineers felt a slightly more robust sense of achievement from this exercise than architects. At the same time, architects felt that they had a more critical role in the group process than engineers did. This difference may be rooted in how they approach a challenge: engineers are used to fixing a clear problem, while architecture students are problem-seeking and tend to oversee more issues in a challenge. Engineers were more positive than architects that their supervisors played a useful role in the exercise and that the overall programme was effective. The scoping and charrette methods were appreciated overall, and engineering students, in particular, appreciated the process and tools.

All students and recent graduates experienced that the exercise as a whole was (or would be) beneficial for their chosen career for the following reasons:

- International experience
- Experience with developing shared goals
- Practice is multidisciplinary
- Gave insight into their role/added value as a discipline
- Improved communication skills
- Extended their understanding of other disciplines
- Development of a mindset/holistic view
- More grip on how to influence each other in a positive way

Analysing the components of the workshops before, during, and after the site visit, it is evident that, generally, students valued the site visit and the group work during their time on-site (field trip and local workshops over multiple days/one week), designating them the most effective components of the exercise.

	RANGE POSSIBLE		ENGINEERING STUDENTS		ARCHITECTURE STUDENTS	
	MIN	MAX	MEAN	STD DEV	MEAN	STD DEV
II - 11 Fundamental knowledge improved	1	10	6.8	2.2	7.2	1.1
II - 12 Broader knowledge improved	1	10	8.1	1.6	7.9	0.9
I - 7 Multidisciplinary addressed in education	1	10	6.4	2.3	6.0	1.9
I - 9 Interdisciplinary addressed in education	1	10	5.3	2.4	6.3	2.3
II - 13 Sense of achievement	1	10	7.3	1.6	7.1	1.2
II - 18 Role in the group	1	10	7.4	1.6	7.9	1.1
II - 20 Role of supervisor	1	10	8.3	1.1	7.8	1.9
II - 1 Effectiveness of overall program	1	10	7.3	1.5	6.7	1.1
II - 2 Effectiveness of scoping	1	10	7.1	1.6	7.1	1.7
II - 3 Effectiveness of charette	1	10	7.0	1.9	7.1	2.0
II - 4A Effectiveness of pre-trip groupwork	0	5	2.2	1.3	2.7	1.1
II - 4B Effectiveness of site visit	0	5	4.2	1.0	4.5	0.6
II - 4C Effectiveness of groupwork on site	0	5	4.2	1.3	4.4	0.6
II - 4D Effectiveness of post-trip groupwork	0	5	2.9	1.2	3.5	1.1
II - 4E Effectiveness of post-trip groupwork on second case	0	5	2.5	1.6	2.7	1.4
II - 4F Effectiveness of post-trip individual work	0	5	2.8	1.6	3.9	1.2
II - 14 Usefulness of the exercise for your career	0	1	1.0	0.0	1.0	0.0

TABLE 3 Summary of responses regarding the interdisciplinary process

4.2 Survey results: Role of the student within the multidisciplinary team

In question II-19, the student is asked for their role in the team. To simplify this question, the four roles defined by the Free Spirits Think Tank at TU Delft (Kamp and Klaassen, 2016) were used: specialist, front-end innovator, system integrator, and contextual engineer. This classification addresses the idea that the 'Fourth Industrial Revolution' requires engineers who can work in different profiles in vastly diverse contexts and in collaboration with other specialists to create the best solutions for new world scenarios. The specialist provides in-depth technical knowledge to the systems integrator, who brings knowledge of different fields together. The front-end innovator provides information to the systems integrator on emerging human needs and translates these for the specialist into workable research questions. Finally, the contextual engineer and the front-end engineer develop the regulations needed to execute the plan. This process is necessarily iterative. The roles can either shift in emphasis through time, or various people focus on different roles in parallel and work together to understand and solve a societal problem.

An analysis of the outcomes (Table 2) shows that only TIL students consider themselves front-end innovators. Technical innovations are then about logistics and computer engineering. However, due to the wide scope of the TIL programme, they also see themselves in the other three roles. The GE, HE, and BT students consider themselves specialists, which coincides with the type of knowledge they deliver to the projects in understanding the problem (waves, damage) and developing technical solutions (construction, foundations). HE students see themselves as system integrators, just like TP, TIL, WM, U, LA, A, and MBE students. U and A students also consider themselves contextual engineers as they address the interests of stakeholders for an urban project.

	Q19 WHICH OF THESE FOUR TYPES OF ROLES COMES CLOSEST TO YOURS?	Q20 WHAT DO YOU CONSIDER YOUR DISCIPLINARY QUALITIES	Q21 WHAT DO YOU CONSIDER YOUR DISCIPLINARY CONSTRAINTS?
Geo-engineering	Specialist	The ability to integrate the technical constraints, challenges, and solutions of different engineering disciplines into a feasible and effective solution.	The technical jargon, tunnel vision on the small scale/part of solutions
Hydraulic Engineering	Specialist Systems integrator	Analysing, problem-solving, logical thinking and reasoning, attention to detail, creativity and innovation, critical, 'decontextualise-quantify-assess', pragmatism	Thinking in numbers rather than context, initial narrow focus, pragmatism, focus on small parts of a project, difficulty in seeing the bigger picture of a design project
Transport and Planning	Systems integrator	Not answered	Not answered
Transport, Infrastructure, and Logistics	Mentioned all 4	Analysing the given problem, determining the actual problem, finding solutions, connecting different parts together, innovation, solutions, broad knowledge, and integration-oriented	Being stuck in your own field/bubble, unable to rely on other fields/expertise, unable to see possible drastic solutions
Urban Water Management	Systems integrator	GIS knowledge, flexibility, systems design	Design of spatially detached systems, inflexible
Urbanism	Systems integrator Contextual engineer	Connecting different stakeholders, mediation, synthesising various streams of information to generate spatial designs, strategic planning, system thinker, holistic, grounded overview, fluid, flexible, organising, broad point of view, open, innovative, integrate systems, generalist to multiple topics and assess their part in the larger context, create overviews for everyone's understanding	Technical knowledge, weakness in quantitative methods, technology integration within space, unable to work within only one scale, might be at risk of being a generalist and hence not considered a specialist
Architecture	Systems integrator Contextual engineer	Problem framing and information synthesis	A lack of quantitatively defined goals with which to design and evaluate, broad and unclear 'value-based' aims
Building Technology	Specialist	Attention to detail, which invariably has a significant impact on the overall design	Lack of in-depth structural design knowledge
Landscape Architecture	Systems integrator	Generalist, knowledge of the different environmental and urban flows, integrating various solutions	Limited in spatial design, lack of technical knowledge, new technologies are coming out every day
Management in the Built Environment	Systems integrator	In interdisciplinary work, a manager is needed to bring everyone on the same page to achieve a common goal towards an integrated outcome	Not answered

TABLE 4 Summary of responses to the questions (19, 20, 21) on the role of an engineer

4.3 Survey results: Products of the projects

The six student groups collectively produced three scientific papers (Areso Rossia, 2020; Krishnan et al., 2019), seven group reports, one additional thesis, and 12 MSc graduation theses (Areso Rossi et al., 2018; Broere et al., 2019; Claassen et al., 2018; Dobbelsteen, 2018; Filipouskaya, 2019; Glasbergen, 2018; Höller & van de Wiel, 2019; Li et al., 2019; Möhring, 2018; Mujumdar, 2019; Mustaqim, 2018; Nederlof, 2019; Prida Guillén, 2019; Rao, 2019; Roubos, 2019; Salet, 2019; Vafa, 2018; Van den Berg et al., 2019; van Dijk, 2018; Van Driel, 2018; Van Klaveren et al., 2019; Yasaku, 2018, 2019).

The group reports either focused on the interdisciplinary process or the outcomes of the interdisciplinary design. Graduation projects delved deeper into disciplinary aspects while acknowledging that their work was informed by the mindset cultivated through engagement with other disciplines.

In response to question II-9, students were asked to evaluate whether they considered the final project an interdisciplinary design and how they assessed it. Engineering students, numbering 23, rated their projects with an average score of 7/10 (ranging from 4 to 10, with hydraulic engineers showing the most positive responses). Similarly, the 13 architecture students rated theirs at an average of 6.5/10 (ranging from 4 to 8). When asked to assess interdisciplinarity, the following criteria were mentioned:

- Presence of shared storytelling (interconnected ideas)
- Presence of interconnected solutions (serving multiple disciplinary objectives)
- Demonstration of the connection between problem-solving and problem-seeking, with a set of aspects presented in the final product
- Presentation of an integrated design and roadmap
- Demonstration of responsiveness to disciplinary boundaries, with active boundary-spanning evident in the analysis

These responses offer clear insights into achieving and evaluating interdisciplinary design. Among the most important features, students must develop a shared narrative of ideas that actively cross disciplinary boundaries and objectives in urban development.

5 Conclusions

This paper reflects on experiences with multidisciplinary student teams across six projects and presents insights gleaned from the questionnaire completed by the 38 participants (see Appendix A). It is important to consider that there is an imbalance in the numbers of students across different disciplinary groups. For example, hydraulic engineering and urbanism have larger cohorts and, therefore, may be more representative. However, this imbalance is mitigated to some extent by utilising broader classifications, such as civil engineering and architecture, rather than individual sub-disciplines.

Based on the survey results, the effectiveness of the Tohoku methodology is appreciated for three components: multidisciplinary team and interdisciplinary process, role of the engineer, and products of the projects. Regarding multidisciplinary teamwork and the interdisciplinary process, the survey indicates that the Tohoku methodology is experienced as successful because it facilitates not only conscious group

building but is also explicitly linked to the interdisciplinarity aspects that are needed to bring together different disciplines (communication, scoping, fieldwork, and mentorship). On the role of the engineer, the survey indicates that students gain an understanding of their position during the project but tend to feel a little lost during the initial phase. From the results, a hierarchy can be recognised, where students in most disciplines consider themselves system integrators, engineering students consider themselves specialists, and architecture students identify as contextual engineers.

The evaluation of the final project results in respect to interdisciplinarity of the design was guided by several criteria, including interconnected ideas, solutions serving multiple disciplinary objectives, the connection between problem-solving and problem-seeking, and responsiveness to disciplinary boundaries, with active boundary-spanning evident in the analysis. These criteria provide valuable insights into achieving and assessing interdisciplinary design. The essence lies in fostering a shared narrative of ideas that effectively leverages disciplinary boundaries and objectives in the context of urban infrastructure development. By embracing these principles, interdisciplinary projects can yield innovative solutions that address complex challenges holistically and collaboratively.

The primary objective of this study was to assess the effectiveness of an interdisciplinary project for engineering and architecture students aimed at facilitating the integration of engineering principles into spatial design education and design principles into engineering education. Responses regarding 'satisfaction with the project' and 'usefulness for their career' suggest that experiences like these help bridge the gap resulting from the shift from practitioner-led to research-focused education. In contrast, architecture students expressed lower overall satisfaction with the project, and they may derive less benefit from its practical and interdisciplinary nature compared to their engineering counterparts. However, their challenge lies in how to effectively integrate and collaborate with representatives from various disciplines. Therefore, interdisciplinary projects, such as those investigated in this study, play a vital role in facilitating the integration of engineering principles into the spatial design process and design principles into the engineering process.

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A scaffolding perspective on teacher guidance in challenge-based courses

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Abstract

As we know little about the specific techniques teachers currently use to guide students within those different CBL courses, MADE provides a practical case study. Furthermore, we are curious about the way that different kinds of guidance build on each other in the curriculum.
In this article, we describe and analyse four CBL courses within the MADE programme ('Metropolitan Challenges', 'Metropolitan Innovators', 'Metropolitan Solutions', and 'Living Lab') that are connected parts of a learning trajectory towards collaborative problem-solving skills. We analyse the courses from the perspective of 'scaffolding', a pedagogical approach that introduces temporary support for students to gain problem-solving experience without decreasing the complexity of the process.
The four analysed courses all dive deeply into a metropolitan challenge yet offer different kinds of scaffolds. In the first two courses, scaffolding is focused on 'direction maintenance'; at a later stage, 'frustration control' becomes more dominant in teacher guidance. Teachers can use scaffolding approaches to connect to the student learning in their own CBL course and as a language for continued guidance throughout a CBL curriculum.

Keywords

Collaborative problem-solving, sustainability, challenge-based learning, curriculum development, scaffolding

COVER FIGURE Photo of People on Building Under Construction. From *Pexels*, by Igor Starkov, 2018. (https://www.pexels.com/photo/photo-of-people-on-building-under-construction-1117452/)

1 Introduction

Cities all over the world face wicked challenges related to sustainable development. Making cities healthier, cleaner, more circular, and energy-neutral can only happen when their three central dimensions (social, economic, and environmental) transform simultaneously (Larsen, 2012). Planners, engineers, and designers cannot address those dimensions alone. They need to engage a diverse set of actors holding different perspectives to work collaboratively on the transition to a more sustainable city. The two-year master's programme, Metropolitan Analysis, Design, and Engineering (MSc MADE), is aimed at understanding sustainability challenges and the new forms of collaboration that accompany them, teaching engineering students to take action.

MADE is a joint degree programme by both Wageningen University & Research and Delft University of Technology, which has been running since 2017. The programme is hosted at the Amsterdam Institute for Advanced Metropolitan Solutions (AMS Institute), where it offers students close collaboration with the city and the chance to understand its challenges. MADE students not only learn about urban challenges but also experience how to intervene in them, which is a crucial element of the programme.

The quality of guidance is crucial to the success of experiential learning in challenge-based courses (Kirschner et al., 2006). However, we know little about the techniques teachers currently use to guide students within them. Furthermore, the way that different kinds of guidance build on each other throughout a curriculum has rarely been studied.

This article looks at teacher guidance in four consecutive challenge-based courses in the MSc MADE curriculum (Figure 1) from the perspective of scaffolding. In educational sciences, scaffolding is a well-known instruction technique in which students obtain problem-solving skills and gain more independence throughout the learning process (Kirschner & Hendrick, 2020). We then discuss which scaffolding tools are being used in each course to build gradually towards independent, co-creative action by students. In the conclusion, we reflect on the role of teacher guidance in CBL courses and provide some discussion points for developing teacher guidance at the curriculum level.

FIGURE 1 The curriculum structure of MSc MADE. In this article, we focus on the orange-coloured integrative courses (Metropolitan Challenges, Metropolitan Innovators, Metropolitan Solutions, and Living Lab) and explore how scaffolding instruments are used within them, by authors, 2024.

2 Scaffolding

Using scaffolding in education, teachers have to understand students' current perception of problem-solving to support students within the zone of proximal development (Vygotsky, 1978). The declarative and procedural knowledge teachers offer have different functions, such as simplifying the task, keeping the student interested, and modelling possible solutions (Table 1). Over time, support will be phased out so that students can act independently within complex problem-solving processes (Van de Pol, 2012).

Scaffolding is a form of differentiation, meaning that support varies between students depending on their needs (Wood et al., 1976). In the MSc MADE, differentiation is important because the programme is open to students from a wide variety of bachelor's programmes and, at the same time, prepares them for several professional roles connected to metropolitan challenges. Diversity is seen as a resource instead of making students fit a tight mould.

Recruitment	The teacher must somehow elicit the problem solver's interest in the task and the kinds of skills needed to complete it.
Reduction in degrees of freedom	How the teacher simplifies the task to a much smaller number of possibilities so that the tutee is not overwhelmed. For the confused novice, choosing between a correct step and an obviously wrong one is much easier than a wide array of different steps they cannot tell apart.
Direction maintenance	Keeping the tutee interested and focused on the task at hand is a vital part of scaffolding, especially when they experience success for a simpler part of the overall task, such as pairing two blocks, and want to keep doing that repeatedly as opposed to taking the next step.
Marking critical features	The teacher should mark out or emphasise major milestones in the development of the task. The key thing here is to clarify discrepancies between where the student is at the moment and where they need to go next.
frustration control	Having empathy concerning the possible frustration of the student is a vital aspect of scaffolding and requires deft skill. There is a danger that if the teacher makes it too easy, then the student can develop too much dependency.
Demonstrating	It is not enough to simply model solutions to a task – the effective teacher will perform an 'idealisation' of the task to be performed. This can be an execution of the problem to be solved by the student, who may have already partially executed the problem. By elaborately performing the task, the teacher allows the student to imitate the steps required to solve the problem more easily.

TABLE 1 Scaffold functions according to Kirschner and Hendrick (2020).

3 Scaffolding functions in four CBL courses

3.1 Metropolitan Challenges: Getting familiar with the challenges of urban sustainability

In the 'Metropolitan Challenges' course (12 ECTS), students are introduced to various typologies of metropoles. The metropolis is approached as a web of interrelated socio-technical systems. Scaffolding takes shape via *recruitment* and *direction maintenance* (Kirschner & Hendrick, 2020). Recruitment means teachers trigger the interest of students in specific tasks and inform them about the necessary skills to fulfil

the task. In 'Metropolitan Challenges', students are exposed to different challenges, acquainting them with different fields and piquing their interest.

Direction maintenance means that students maintain interest and expand their knowledge and skills to take the next step in the task (Kirschner & Hendrick, 2020). The course offers many different learning activities, and students acquire and practice many skills, such as writing papers and preparing for field trips. They need those skills for independent work in the subsequent courses.

3.2 Metropolitan Innovators: Exchanging theoretical perspectives on city making

The 'Metropolitan Innovators' course (6 ECTS) deals with the challenges of urban innovation in a complex network of actors by promoting a discussion on the theoretical and practical frameworks and tools used to confront urban challenges. The course promotes the idea that the shape of the problem changes depending on which values, norms, and knowledge its observer brings to the scene.

Scaffolding in the 'Metropolitan Innovators' course takes shape via *direction maintenance* and *marking critical features* (Kirschner & Hendrick, 2020). Students are asked to discuss the theory in class and to evaluate the solutions to the challenges they encounter. These group activities prepare and motivate students to work on the final, more complex assignment, which consists of an individual essay in which students critically reflect on a metropolitan challenge of their choosing. Throughout this process, the teacher notes students' development and makes students aware of what goal(s) to reach, which is the scaffold function marking critical features (Kirschner & Hendrick, 2020).

Overall, awareness of the socio-economic context and the implicit and explicit values and cultural norms operating in a specific challenge are essential to achieving sustainable solutions. From this understanding of the system, the courses 'Metropolitan Solutions' and 'Living Lab' can start to raise the question of how to change it.

3.3 Metropolitan Solutions: Experiencing intercultural and interdisciplinary collaboration

The 'Metropolitan Solutions' course (12 ECTS) functions as a hinge between the first and second years. The course is project-based and offers students the freedom to select their learning activities. At the same time, the course focuses explicitly on the challenges of teamwork in a real-life context, centring the collaborative process.

One of the scaffold functions used in 'Metropolitan Solutions' is the *reduction in degrees of freedom* offered through the project-based course (Kirschner & Hendrick, 2020). Commissioners and teachers write a Terms of Reference (TOR) sheet to ensure the challenge has the right starting level for the students. Also, teachers decide on the four partial studies that students will review to learn about the different aspects of the case. Another scaffolding function is that teachers mark *critical features* and help students establish their position and learning questions (Kirschner & Hendrick, 2020). Teachers focus on supporting the process of collaborative problem-solving through lectures and workshops related to, for example, project management and leadership, scenario planning, group dynamics, and multi-actor settings. Finally, teachers engage in *frustration control* (Kirschner & Hendrick, 2020). Students' reflections on their own expertise,

learning goals, and group assignments are an essential part of the course and consist of individual coaching meetings with teachers. This aspect creates an opening for teachers to empathise and keep students motivated and challenged.

In the 'Living Lab' course, these inward-looking experiences that students attained through their interdisciplinary collaboration are extended outward through collaborative, transdisciplinary action with the city.

3.4 Living Lab: Taking co-creative action in the city

The 'Living Lab' course (24 ECTS) is all about dealing with wickedness and the uncertainty that comes with it. Students work in groups on real-life challenges with a governmental, industrial, scientific, or civic partner from the Amsterdam metropolitan region. Learning activities are largely self-defined by the students. The groups receive guidance from an academic coach and the professional partner with whom they collaborate. The academic coach takes on many of the same functions of scaffolding as in 'Metropolitan Solutions', pointing out the *critical features* the student is developing and *managing frustration* that might arise during the learning process.

In an entirely different way, the 'Living Lab' course uses *demonstration* as a scaffolding function (Kirschner & Hendrick, 2020), showing the tasks necessary to solve a problem in an idealised manner. Living labs are used as spaces for real-life experimentation in city-making, and the professional partners in this course have experience with such projects. The course offers an opportunity to practice with elements of these full-scale living labs in a supported learning environment.

4 Conclusions

In challenge-based learning, teachers need to guide students in learning complex skills, such as collaborative problem-solving. With scaffolding, teachers can adapt their guidance depending on the student's level. In this chapter, we looked at different scaffolding functions in four CBL courses.

In the curriculum, teachers used all five scaffolding functions defined by Kirschner and Hendrick (2020; see Table 2). *Marking critical features* was used in three of the four courses and seems to be the most dominant function. The scaffolding function *direction maintenance* was used in the first two courses to keep students engaged and focused. When the curriculum shifts from 'Metropolitan Innovators' to 'Metropolitan Solutions', students start to work more independently on the challenges and *frustration control* becomes more dominant in teacher guidance.

Scaffolding provides a well-researched language to continuously develop teacher guidance in challenge-based learning. However, the perspective of the teacher is very dominant in the theory, and it does not describe other actors, such as commissioners of a challenge, who form a vital part of challenge-based learning. Those CBL-specific teaching and learning approaches could be integrated into further research with this scaffolding perspective, ultimately leading to a deepening of teacher guidance in CBL courses.

SCAFFOLDING FUNCTION	METROPOLITAN CHALLENGES	METROPOLITAN INNOVATORS	METROPOLITAN SOLUTIONS	LIVING LAB
Recruitment	●			
Reduction in degrees of freedom			●	
Direction maintenance	●	●		
Marking critical features		●	●	●
Frustration control			●	●
Demonstrating				●

TABLE 2 Overview of scaffolding function in the four CBL courses in MSc MADE.

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Part 2

Curriculum, evaluation & assessment


OVERAL WAAR IK KOM
LAAT IK EEN STUKJE
VAN MEZELF
APPLAUSJE VOOR
JEZELF

Blending an on-campus undergraduate course by integrating MOOC-based learning activities

The BK6MA3 Management and Redevelopment case

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Abstract

Integrating online study material into campus education poses a significant challenge for coordinators and students. When in-person education activities are limited, structural change in the balance between online and face-to-face learning activities occurs. However, online education development also requires meticulous preparation and tailor-made solutions. This chapter first illustrates the didactical choices made in partly blending the third-year bachelor course 'Urban Management and Redevelopment' (BK6MA3) and then discusses the experiences and evaluations from both instructors and students in the architecture programme.
In designing the blended variant of BK6MA3, a conscious choice was made to re-use and adjust existing videos and assignments from two faculty's massive open online courses in three course themes in a structured manner. Evaluations show that it is pivotal for instructors to explain to students that blended learning is introduced to stimulate active learning and clarify expectations. In terms of education innovation, a healthy balance between online and face-to-face learning activities for a theoretical course is achievable but requires delicacy to create a satisfying learning experience.

Keywords

Blended learning, online and face-to-face learning, bachelor education, massive open online course, management and redevelopment

COVER FIGURE Schiekadeblok, by Erwin Heurkens, 2024.

1 Introduction

Blended learning is a form of education with a 'deliberate "blending" of face-to-face (F2F) and online instructional activities, with the goal of stimulating and supporting learning' (Boelens et al., 2017, p. 1). Blended learning environments with combinations of F2F and online teaching activities have been found to offer several new opportunities for optimising learning (Spanjers et al., 2015). In the last decade, the concept of blended learning has been "widely adopted across higher education, with some scholars referring to it as the 'new traditional model' (Ross & Gage, 2006, p. 167) or the 'new normal' in course delivery (Norberg et al., 2011, p. 207)" (Dziuban et al., 2018, p. 1). In a broader sense, blended and other forms of online learning at many academic institutions are integrated within university policies aimed at establishing education innovation associated with the benefits of blended learning, such as more effective pedagogy, enhanced cost-effectiveness, and increased flexibility for learners (cf. Bonk et al., 2006; Graham, 2006; Graham et al., 2005; Joosten et al., 2014).

These didactical developments offer a contextual background to the design of a blended version of BK6MA3 'Management and Redevelopment' (Dutch: Beheer en Herontwikkeling), a third-year bachelor-level course taught at the Faculty of Architecture and the Built Environment at TU Delft. In principle, this is a traditional 'knowledge'-based course in which students are assessed by assignments and exam-based textbooks and lectures corresponding to five themes. In 2019, this course was remodelled to a blended version supported by the university's Blended Education Programme (BLEAP). The goal was to integrate MOOC-related material within campus education and to provide more (inter)active learning. In terms of objectives and ambitions, this blended course resonates greatly with what literature teaches us.

This chapter intends to provide insight into the didactical choices that have been made to blend this course and to critically evaluate the extent to which this was done successfully. Consequently, the article commences with a short literature review on the didactical challenges of blended learning that are paramount in constructing and running such courses. Then, a more detailed description is given of the didactical choices and changes made in the course structure, particularly learning activities. This overview is followed by a brief discussion of the education evaluations based on experiences from students and staff and a critical reflection of the didactical solutions in comparison to key literature findings. Finally, the article concludes with some lessons learned and recommendations on blending traditional campus education courses in the ABE programme.

2 Challenges in blended learning

When designing a blended course in higher education, several challenges appear (Boelens et al., 2017) and must be dealt with accordingly.

2.1 Incorporating flexibility

Flexibility involves learners having control over the content, learning sequence, pace, time, place, and path (Bonk et al., 2006; Ruiz et al., 2006). In blended learning environments, it is often impossible to let students randomly choose and study a topic within a course and follow their own 'learning path'. This case applies especially to structured blended campus courses offered within a limited time period, including fixed assessment moments, and due to the close relations between online and scheduled F2F activities.

One way to deal with this inflexibility is to enable students to choose between weekly or topical participation in online and F2F modes (Beatty, 2014). De George-Walker and Keeffe (2010) even argue that it is not the role of the instructor to decide on the blend. However, given the complexity of designing a blend, as well as students' limited didactical expertise, it seems that flexibility can best be implemented and achieved (Kineo & The Oxford Group, 2013; Ma'Arop & Embi, 2016) by giving students the flexibility to choose learning activities in random order.

2.2 Stimulating interaction

Both student–student and student–teacher interactions in blended courses are somewhat difficult to organise in the online component of blended learning environments (Okzan & Koseler, 2009; Owston et al., 2013). Specifically, online learning environments can lead to an enlarged psychological and communication space called the 'transactional distance' (Chen et al., 2014; Moore, 1993).

In most blended cases, social interaction is therefore generally stimulated through face-to-face meetings (Boelens et al., 2017) that may occur, to a lesser degree, in the online learning environment. Nonetheless, Nortvig et al. (2018) indicate that educator presence in all online learning activities is paramount, especially in videos for cultivating students' interest in the topic under study (Southard et al., 2015). Additionally, peer-to-peer online activities and individual instructor feedback increase satisfaction and inspire a sense of community, potentially decreasing transactional distance and improving learner engagement (Halverson & Graham, 2019).

2.3 Facilitating students' learning processes

Due to the increased flexibility and autonomy of learners in blended learning environments, self-regulation becomes a critical factor for study success (Barnard et al., 2009). Participation in blended learning courses requires organisation, discipline, time management, technological skills, and self-efficacy to control the learning process (McDonald, 2014). These qualities are more common among 'high achievers' than low-achieving students who have difficulties with independent learning (Owston et al., 2013; Tsai & Shen, 2009).

Vermunt and Verloop (1999) argue that this challenge can be dealt with by instructional activities that follow four regulative strategies: orienting and planning, monitoring, adjusting, and evaluating (see Boelens et al., 2017). For example, instructors may introduce the course and conduct regular tests to assess students' competencies. Students monitoring their study progress can also increase their ability and motivation for independent learning.

2.4 Fostering an affective learning climate

The increased transactional distance in the online part of blended courses is characterised by less spontaneous encounters when compared to face-to-face communication (Osguthorpe & Graham, 2003), an issue that can negatively affect the learning climate. It might cause feelings of learner isolation (McDonald, 2014), reduced motivation to learn (Osguthorpe & Graham, 2003), and higher drop-out rates (Angelino et al., 2007).

In affective learning environments, students seek more blended learning only when it is highly structured, of high quality, and supported by tutorials (Morton et al., 2016). Therefore, the online element should not solely be an addition to classroom-based teaching but rather an integral part of the course methodology (Bowyer & Chambers, 2017). 'Flipped classroom' forms, where students engage with online lectures and textbook material at home before participating in in-person classroom interaction activities, are particularly successful (Stockwell et al., 2015) when compulsory online activities are further applied and assessed within F2F settings. Bralić and Divjak (2018) argue that MOOCs can also enrich traditionally taught courses and provide complementary resources to achieve learning goals.

Instructors can thus overcome the multiple challenges faced in blended forms of education but only by making specific didactical choices within each course. The following section explains the main ideas, structure, and choices for the BK6MA3 course.

3 The case of blending BK6MA3

3.1 BK6MA3 course outline

BK6MA3 is a third-year course taught in the first five weeks of both quarters 1 and 3 within the bachelor curriculum of the ABE programme. It forms the final course of the Bachelor's MA learning track Society, Process, and Practice (Dutch: Maatschappij, Proces en Praktijk) and is taught simultaneously with the BK6ON5 design game course 'Urban Development', for which it provides diverse (management) knowledge. BK6MA3 focuses on management and redevelopment, which is taught and approached from five disciplinary domains or 'themes': urban development, spatial planning, real estate management, building law, and building economics. The learning objectives are:

- Students can define relevant functions, actors, strategies, and performances belonging to physical redevelopment.
- Students can understand physical redevelopment assignments based on accommodation demand and societal needs, drawing upon fields that include real estate management, spatial planning, and urban development.
- Students can apply management methods with regard to the organisational, financial-economic, legal, and sustainability aspects of physical redevelopment.

The learning objectives are assessed based on five theme-based summative group assignments (10% weight) and one final summative individual exam in week 5 (90% weight), making use of theme-specific learning material (textbooks, articles and presentations).

3.2 Blended learning approach

A key element in blending this course was the ambition to integrate MOOC-related material developed by faculty and staff members, thus re-using existing online education material from the MOOCs 'Managing Building Adaptation' and 'Rethink the City'. Notably, the aim was to provide more (inter)active F2F learning activities for students and to deliberately connect blended and F2F activities as assignments. Given the coordinator and staff's familiarity with teaching online courses and the ambition of the faculty to transform some traditional courses in the undergraduate curriculum into blended education versions, BK6MA3 was seen as a logical receptive case.

As part of the university's BLEAP project, the course coordinator, university e-learning developer, faculty education quality coordinator, involved instructors, and student assistant in various workshop settings worked towards designing a logical and recognisable storyboard for two (later three) themes with a blend of online and F2F learning activities (see Figure 2). This storyboard was based on the idea for a recognisable 'blended learning wave' illustrated in Figure 1.

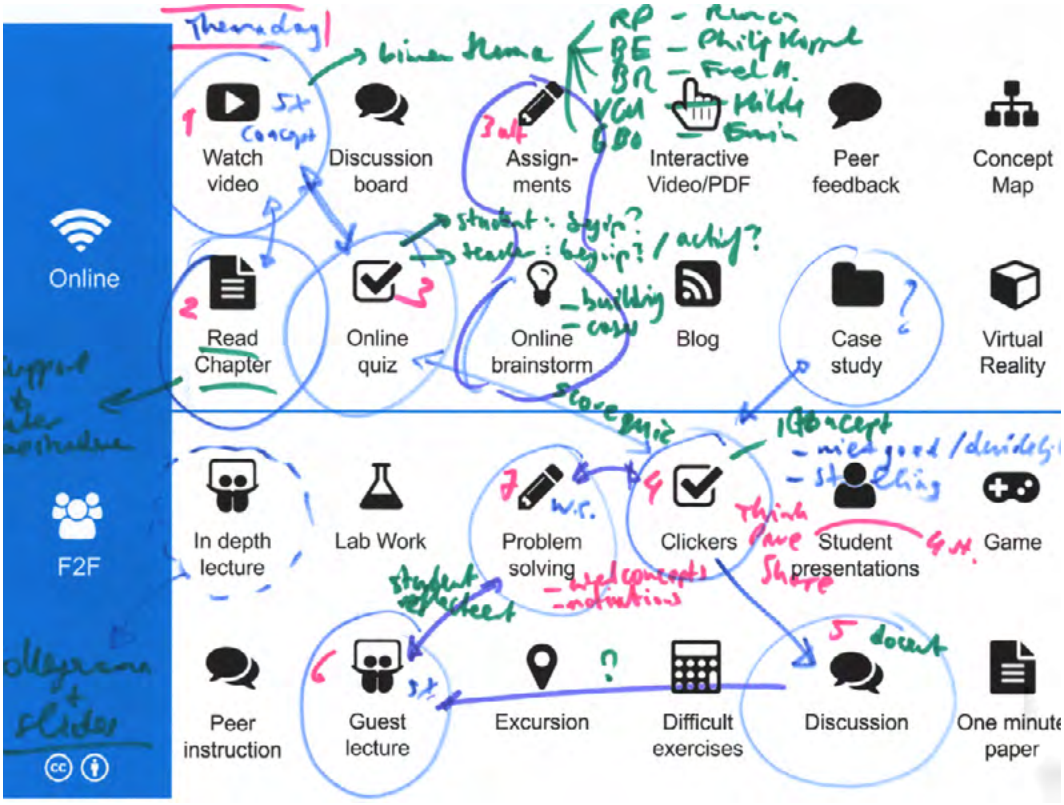

FIGURE 1 Concept blended learning wave with online and F2F activities, by E. Heurkens, 2024.

FIGURE 2 Concept storyboard for two themes, by E. Heurkens, 2024.

As a basis for the 'blend', the decision was made to let students work through part of the learning material of a certain theme (only for urban development, real estate management, or spatial planning) on a designated day (Tuesday or Thursday). Students were supposed to use the morning for online learning activities, and the afternoon was reserved for F2F encounters. For the online part, the teacher team prescribed online learning activities centred around a specific (set of) topics, including:

1. Reading part of the (mandatory) learning material;
2. Watching short videos (taken from MOOCs);
3. Making short quizzes (based on MOOCs);
4. If of added value, reading some practice case stories or news articles.

Importantly, the link between online and F2F activities was stressed, clarifying that the knowledge students gained during morning online activities provided a base for making theme-based F2F assignments in the afternoon. The F2F part of the day included four more interactive learning activities:

1. A short evaluation of the blended learning activities and introduction to the assignment by the teacher;
2. An assignment presented by groups of two to three students (applied learning);
3. Practitioner lecture (illustrative learning);
4. Professor lecture (inspirational and reflective learning).

3.3 Examples of theme day online and F2F learning activities

Figure 3 provides an idea of the learning activities students should carry out during the day, as illustrated here by an example of the Brightspace course page for Gebiedsontwikkeling (Urban Development). In this particular case, students are requested to perform six online learning activities (within four hours): 1. reading a book chapter, 2. watching a short MOOC video, 3. studying policy documents, 4. and 5. watching two other short MOOC videos, and 6. reading a case study document. These online learning activities provide the basis for the F2F group assignment (Dutch: *werkcollege*) in which they apply their insight and knowledge gained through self-study. Besides this assignment, students follow interactive practitioner and professor lectures in class, and the slides are made available afterwards on Brightspace. Students can monitor the completion of learning activity topics with a simple progress bar.

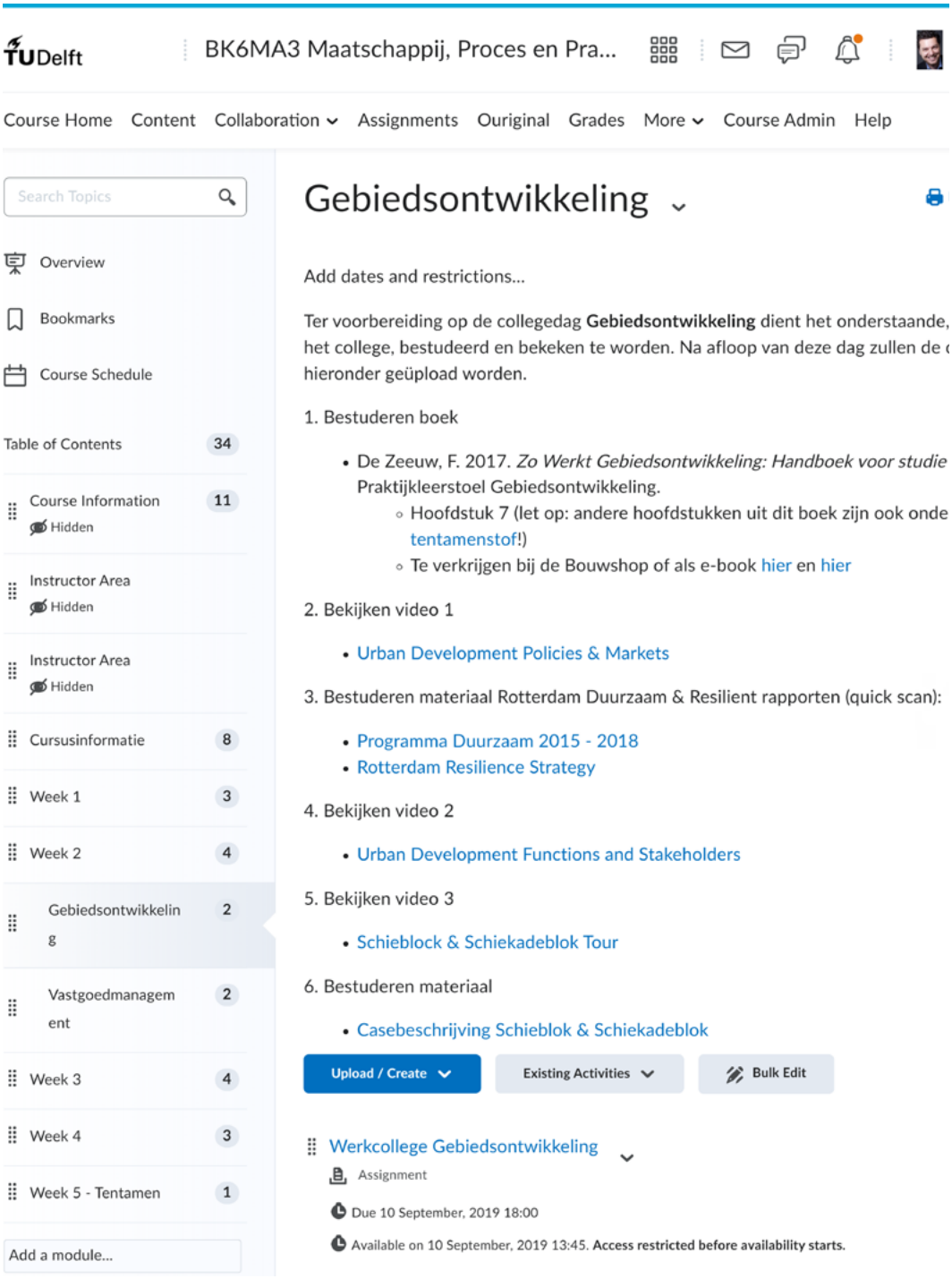

FIGURE 3 Screenshot of the Brightspace online learning environment page for the theme urban developmen, by E. Heurkens, 2024.

Figure 4 below shows a screenshot from the TU Delft OpenCourseWare page, where students can watch a MOOC video corresponding to learning activity 2. Additionally, Figure 5 displays a screenshot of the F2F group assignment the students can make if they have carried out the online learning activities. Students in groups of three discuss and write down their answers in the document in the classroom and upload them to the Assignment page on Brightspace. Subsequently, tutors assess the work, both with quantitative grades and by giving qualitative feedback.

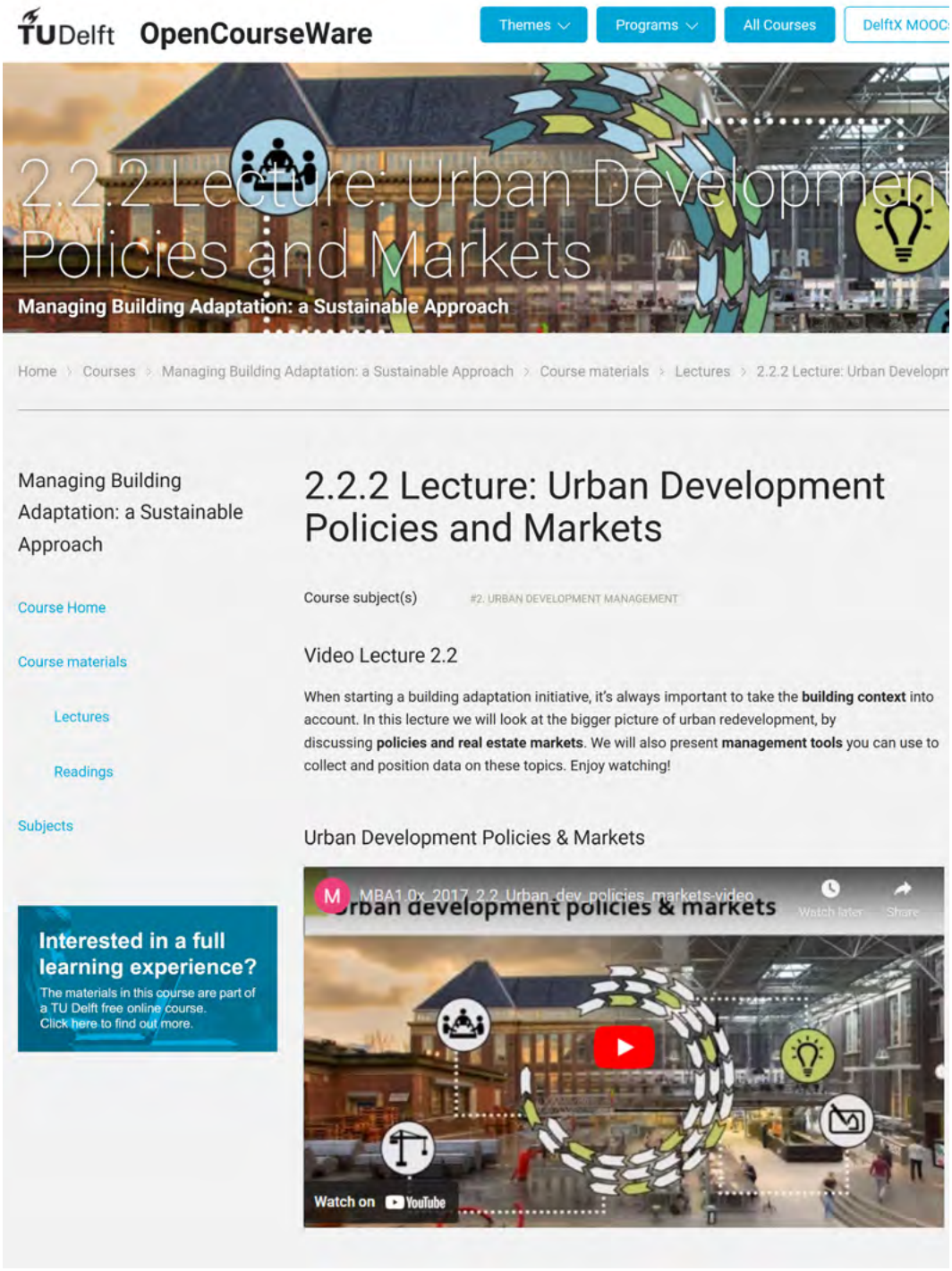

FIGURE 4 Screenshot of the TU Delft OpenCourseWare page with an embedded MOOC video, by E. Heurkens, 2024.

Werkcollege: Gebiedsontwikkeling

BK6MA3 Beheer en Herontwikkeling (2019/2020), Bachelor Bouwkunde

Datum: Dinsdag 9 september 2019

Inleverdeadline: 9 september 2019 18:00

Maak de werkcollege-opdracht in je werkcollege-groep waarin je bent ingeschreven bij Brightspace.

Vul de antwoorden in op de aangegeven plaatsen (antwoord).

Upload per groep één ingevuld bestand in de *assignment submission folder* van "Werkcollege: Gebiedsontwikkeling" op Brightspace. Eén persoon uploadt het ingevulde bestand voor de rest van de groep op Brightspace.

Ontwikkeld door: Erwin Heurkens

Groepsnummer	antwoord	
	Naam ↓	Studentnr. ↓
1	antwoord	antwoord
2	antwoord	antwoord
3	antwoord	antwoord

Opdrachten

De werkcollege opdracht bestaat uit het definiëren en motiveren van een herontwikkelingsstrategie voor gebiedsontwikkeling Schiekadeblok in Rotterdam. Deel 1 bestaat uit het downloaden, tekenen en invullen van de herontwikkkeling naar eigen inzicht, deel 2 bestaat uit een geschreven motivatie voor deze herontwikkelingsstrategie van maximaal 300 woorden.

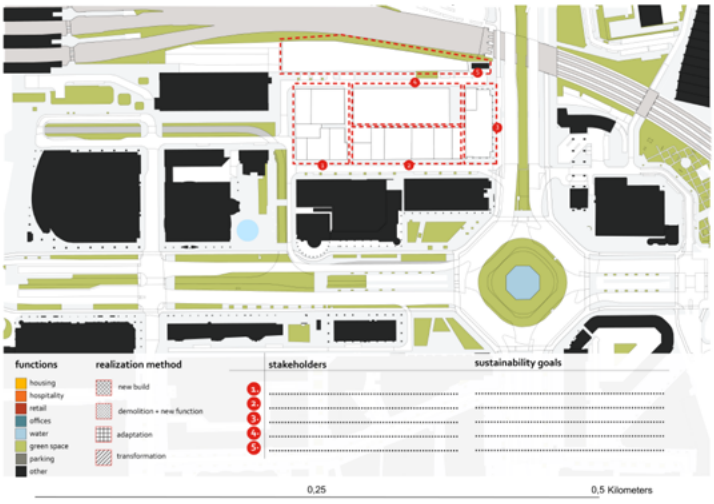

FIGURE 5 Screenshot of a F2F group assignment example, by E. Heurkens, 2024.

4 Evaluation of the blended BK6MA3 course

4.1 Learner perspective

The course has been evaluated amongst participating students, generating interesting quantitative and qualitative results. Additional to general course evaluation questions, some specific questions were addressed, asking about their experiences with the blended learning form. For the former, the survey with a response of 32 students indicates an overall 6.39 grade (out of 10) for the course, which is 0.5 points lower than the average grade given for this course in the previous evaluation. Nonetheless, students indicate with an average grade of 3.77 (out of a maximum of 5) that they have learned a lot in this module. Furthermore, 51.5% of the students indicate they spend more or less the same amount of time scheduled for the course (140 hours for 5 ECTS).

In a qualitative sense, a number of compelling responses emerged. Students are very positive about the organisation, teachers, in-person lectures, and the combination of lectures and group assignments. Important points include the (large) amount and (sometimes less sufficient) quality of the obligatory and facultative learning material. In addition, students responded that they were able to examine the learning activities in the Brightspace online learning environment. However, they also recommend that the coordinator indicate the expected time students should spend on each specific activity and that the 'self-study mornings' be scheduled within their official study timetable to ensure enough preparation time before the F2F afternoon sessions.

4.2 Coordinator perspective

As the course coordinator, I was interviewed in the context of the BLEAP project and then separately by the faculty's education quality staff. In brief, these are my main evaluation points:

- Generally, students proved able to perform the online self-study activities independently, obtaining grades comparable to those of previous years (passing rate 75%).
- The online self-study time slightly reduced the number of F2F learning activities (i.e., traditional lectures). In my view, this contributed to more effective learning.
- The F2F active learning activities were very much valued and attended by students, illustrating student motivation.
- Additional time (about 60 hours) was spent preparing this blended learning version, but it did not lead to higher student satisfaction overall.

In summary, the initial development and implementation of this course went quite well, but some improvements are necessary to increase learner satisfaction and engagement. After completing this course, I remain convinced of the added value of blended learning for students and staff, as the course has become more dynamic and interesting with the various learning activities tailored to specific themes.

4.3 Literature comparison

To what extent does the BK6MA3 course confirm or divert from existing literature? Based on four challenges related to a blended learning environment that have appeared in relevant studies, I briefly illustrate some experiences and solutions in the BK6MA3 course.

1. **Incorporating flexibility**: Students indicated that flexibility was not an issue despite the online learning activities being 'conditional' for the F2F assignments. On the contrary, students noted they would have appreciated the structure and even suggested formalising online self-study time in their timetable.
2. **Stimulating interaction**: Social interaction was generally stimulated in F2F meetings, in both student–student discussions during the group assignments, and tutor–student discussions in practice and professor lectures and debate, and basically not at all in the online learning environment, which corresponds to Boelens et al. (2017).
3. **Facilitating students' learning processes**: Students stated that their learning process was facilitated well enough, as they appreciated the clear structure and relationships between the online and F2F learning activities. Also, the relatively easy-to-use Brightspace learning environment has contributed to that. I believe that both high and low achievers were able to control their learning process autonomously.
4. **Fostering an affective learning climate**: The issues of potential transactional distance, learner isolation, and reduced motivation due to the online parts of the courses, in my view, have been compensated by the biweekly F2F encounters between students and tutors, in which social communication and interaction was paramount.

5 Conclusions and recommendations

Overall, what can be concluded from the development, operation, and evaluation of this blended learning bachelor-level course? Evaluations show that it is pivotal to explain to students that blended learning should stimulate active learning and clarify what is expected from them. Failing to do so might create a sense of demotivation, as, in general, face-to-face contact between students and teachers is preferred over online activities. Nevertheless, good-quality online learning activities can enrich the learning experience and improve learner control.

In terms of education innovation, a healthy balance between online and face-to-face learning activities for a theoretical course is achievable, yet tutors should make well-thought-out choices to find the right combination to motivate students to learn. Finally, integrating MOOC-based learning material and activities into a traditional on-campus course can be a fairly effective way to improve the quality and focus of online learning activities. For example, instead of re-watching previously recorded campus lectures, watching short theme-focused MOOC videos is more appreciated once purposefully integrated into the learning activities.

In terms of recommendations, the focus is on the course itself, tutors, and the institution.

The recommendations for the course are twofold. First, critically assess the amount and quality of the learning material and activities that constitute the blend. Second, the blended learning environment should be extended to the remaining themes of building economics and building law to create a comprehensive, consistent, and logical course structure based on a recognisable blended learning wave. For teachers and coordinators, it is strongly recommended not to underestimate the amount and nature of the educational

tasks involved in blended learning courses and to follow educational courses that provide the background for the do's and don'ts of developing blended courses.

Finally, for the faculty and university, it is of utmost importance to strategically, critically, and carefully assess and choose receptive campus courses to be blended, as the face-to-face social interaction component in some courses by both students and teachers is seen as highly beneficial for the quality level of education and higher order academic learning. This more interactive intangible knowledge and skill development is hard to replicate fully in an online learning environment, but it is achievable in a blended course. Reaping the success of online education efforts thus can best be achieved by a predefined plan of how such material could be used in on-campus education.

Acknowledgments

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ARCHITECTURE

Choosing MSc tracks at the Faculty of Architecture

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Abstract

The Faculty of Architecture features five MSc tracks and several MSc programmes (see Figure 1), but just one BSc programme provides a broad base. In this programme, students take modules from six curricula (*leerlijnen*) that are not directly coupled to the MSc programmes. This research centres on how students choose an MSc programme, which is largely unknown. The findings show that most students enter the faculty with a predetermined plan of what to study after the BSc degree. The largest share plans to choose the MSc track in architecture, and stick to it. Nevertheless, students experience doubt during their education and choice process, and for a considerable group, the doubt remains after they have chosen a path. The doubt might be linked to the awareness of the MSc programmes on offer, the relations between curricula and MSc programmes, sources of information, and the way in which certain modules spark enthusiasm. For some curricula, including the AC (*academische vaardigheden*: academic skills) and MSc tracks (Management in the Built Environment and Landscape Architecture), the relations are very weak.

Keywords

Choice, specialisation, building technology, urbanism, landscape architecture, management in the built environment

COVER FIGURE Faculty of Architecture and the Built Environment, from *TU Delft Mediaportal*, by CheeseWorks, 2022

1 Motivation

There is little knowledge about how students choose their MSc track to continue their studies at the Faculty of Architecture within the MSc programme Architecture, Urbanism, and Building Sciences. Amongst the staff, there is a strong belief that the majority of students enter the faculty with a clear desire to become an architect, which is one of the MSc tracks on offer. The other MSc tracks include urbanism, building technology, landscape architecture, and management in the built environment. It is the belief that students choose these tracks when they have discovered that architecture is in some way not what they thought it would be, when one of the other tracks appears more attractive, or when they discover their skill set is not well matched with architectural design. How students choose their MSc track is interesting since roughly half of the students in the MSc are attracted directly from their own BSc (see Table 1). For each MSc track, the relationship between the BSc and MSc differs as they attract a different percentage of participants directly from the BSc.

To investigate how students are drawn to an MSc track and how they choose their specialisation, a questionnaire was sent to explore how they chose their MSc track quantitatively. The questionnaire consisted of 20 questions and took a maximum of 10 minutes to answer, as most of the questions were closed (i.e. 'yes' or 'no' questions). The questionnaire asked about knowledge of different specialisations, moments of awareness and choice, and the relationship between courses and specialisations.

2 Some background and key figures

The Faculty of Architecture offers four separate MSc programmes and five different specialisations – or tracks – within the MSc Architecture, Urbanism, and Building Sciences (see Table 1). In addition to these core curricula, there are additional MSc programmes connected to other faculties in Delft (an overview is provided in Figure 1).

BSc/MSc/TRACKS	# 1ST YEAR STUDENTS 19–20
BSc Bouwkunde (Dutch only)	379
MSc Geomatics	33
MSc Geographical Information Management and Applications (GIMA)	n/a
MSc Metropolitan Analysis, Design, and Engineering (MADE)	36
MSc Architecture, Urbanism, and Building Sciences (AUBS), five MSc tracks:	692 (264 directly form BSc)
Architecture (A)	518
Building Technology (BT)	42
Landscape Architecture (LA)	21
Management in the Built Environment (MBE)	45
Urbanism (U)	66

TABLE 1 Faculty of Architecture MSc courses and MSc tracks, by O&S BK

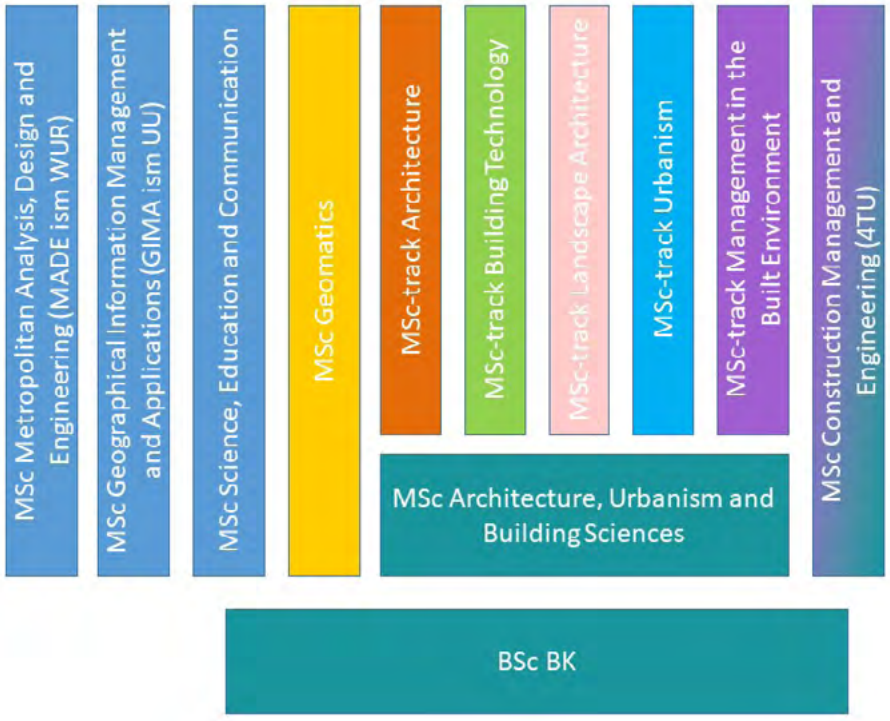

FIGURE 1 The broad BSc Bouwkunde, the several MSc programmes, and the five MSc tracks of the AUBS MSc programme of the faculty of Architecture, by author, 2024.

For the questionnaire, all BSc students who registered for an MSc track after the summer of 2020 and all students who entered an MSc track from the BSc during the 2019–2020 academic year were invited to participate by email (June 2020). Overall, 172 students answered, and 151 questionnaires were completed fully by respondents belonging to the target group (July 2020). The overall response rate was 32% (see Table 2).

	INVITED TO PARTICIPATE*	RESPONSE	% RESPONSE
BSc (to start MSc after summer)	185	75	41%
MSc (finishing 1st year MSc)	289	76	26%
Total	471	151	32%

TABLE 2 Response (*invitations were sent by O&S BK)

TRACKS	# REGISTERED 19-20*	% 19-20	% RESPONSE
Architecture (A)	166	72%	54%
Building Technology (BT)	12	5%	7%
Landscape Architecture (LA)	4	2%	4%
Management in the Built Environment (MBE)	27	12%	17%
Urbanism (U)	23	10%	18%
Total (n)	232		151

TABLE 3 The registration in tracks is limited to students who previously were in the BSc Architecture programme in Delft, compared to participants in the questionnaire (*data from O&S BK)

The average age of respondents was 23.2 when starting the MSc, and 47% of the respondents identified as female. The median time students spend in the BSc programme is 41 months, and the respondents finishing their BSc had spent, on average, 42 months. In total, 50% of the responses came from students starting their MSc after the summer of 2020, and the other half were busy finishing their first year of MSc studies. The response was representative of the student population in the faculty (see Table 3).

3 Findings

A majority (58%) of the students who attended the BSc of Architecture intended to follow an MSc track within the same faculty, of which 66% wanted to enrol in the MSc track of Architecture, making up 39% of the first-year students. However, most students – 53% (42% + 11%) – had no clear plan of what MSc or track to choose when they enrolled in the BSc (see Table 4).

MSc PLAN?	#	%	TRACK PLAN ?	#	%	# CHOSEN INITIALLY
Did have a plan	88	58%	Architecture (A)	59	39%	54
			Building Technology (BT)	3	2%	3
			Landscape Architecture (LA)	0	0%	0
			Management in the Built Environment (MBE)	4	3%	3
			Urbanism (U)	6	4%	5
			Did not know track	17	11%	
Did not have a plan	63	42%			42%	

TABLE 4 What MSc or track to choose when enrolling at the faculty

During their BSc studies, students become increasingly aware of the different tracks. However, it may not be until their final semester that BSc students learn about all of the different MSc options. Most students choose their track to continue their studies only when the deadline for MSc enrolment arrives: halfway through the 6th and last BSc semester (see Table 5).

	BECAME AWARE OF TRACKS	CHOSE A TRACK
Pre-semester 1	1%	1%
Semester 1	16%	5%
Semester 2	11%	0%
Semester 3	22%	3%
Semester 4	20%	4%
Semester 5	14%	23%
Semester 6	15%	54%
After semester 6	0%	5%
Do not remember / no response	3%	5%

TABLE 5 The moment students became aware of MSc tracks and when they made their choice

Students consulted different sources of information to inform their choices. Three main sources stand out: website, informational meetings, and fellow students. When asked to identify the most important source of information in their decision-making process, students also indicated the website and informational meetings and added that their internship experience was also a factor (see Table 6). There were differences between tracks, but website and informational meetings are essential to all of them.

	SOURCES USED	MOST INFLUENTIAL	MOST INFLUENTIAL SOURCE PER TRACK
Website	82%	23%	A (27%), BT (30%), U (19%), MBE (12%), LA (17%)
Informational meetings	59%	17%	A (20%), U (15%), MBE (12%), LA (17%)
Fellow student	68%	10%	BT (20%), MBE (19%)
Flyers	38%	3%	LA (17%)
Family / friends	37%	9%	A (11%)
Former student	32%	5%	
Internship	32%	15%	A (12%), LA (33%), MBE (23%), U (15%)
Minor (BSc-5)	31%	6%	BT (20%), U (15%), LA (17%)

TABLE 6 Information sources for choosing an MSc track, most influential sources, and preference (per track)

Many students considered several MSc tracks before making a final decision, and most were interested in the MSc in architecture. In line with their relative share within the MSc population, fewer students considered building technology and landscape architecture (see Table 7). Half of the students continued to consider another MSc track after making their choice. Some of the alternatives under consideration were from another faculty, and some were from outside TU Delft. Nine registered students switched faculties from BSc to MSc in 2018–2019 (O&S data).

	CONSIDERED TRACK	STILL CONSIDERING ANOTHER TRACK	KNEW TRACK AT START OF THE BSc
Architecture	82%	48%	80%
Building Technology	30%	70%	100%
Landscape Architecture	24%	100%	0%
MBE	41%	27%	25%
Urbanism	49%	63%	45%

TABLE 7 Consideration of tracks during choice, after choice, and the relationship to students' intention at the start of their BSc studies

4 Relations between BSc courses and MSc tracks

The modules offered in the BSc are organised into six different curricula (*leerlijnen*, see Figure 2), and the students pointed out that some modules and some curricula (*leerlijnen*) spark more enthusiasm for a certain MSc track. The relation is strongest for the MSc track in architecture and the design curricula ('ON' for *ontwerpen*, specifically ON1,2,4,6), 'GR' (all GR modules considering *grondslagen*: theoretical basics) and 'OV' (all modules considering communication techniques, *overdrachtstechnieken*). Students who chose the MSc track in architecture mentioned modules from these three curricula frequently as sparking enthusiasm to choose the track. The 'TE' curriculum (Technology) led to enthusiasm for the MSc track in building technology and the MSc in architecture.

The 'MA' curriculum (*maatschappij, proces en praktijk*: society, process, and practice) caused the greatest interest in the MSc track MBE, some interest in urbanism, and little for architecture. The MSc track in urbanism drew some students from the 'ON' and 'GR' curricula (increases with each GR module).

For some modules, the relationship was stronger: ON3 and ON5 focus more on the urban and regional scale, for example. The MSc track in landscape architecture performed similarly to the MSc track in urbanism and drew most students from the ON3 and ON5 modules but also from GR4 (see Table 8 for an overview). Clearly, the MA, OV and AC (*academische vaardigheden*: academic skills) curricula were of the least assistance in sparking enthusiasm for specific MSc tracks. However, for individual tracks, such as building technology, the number of students interested in the modules represented a large share of the students who chose the building technology track. This relationship exists between the MA modules and the MBE track as well.

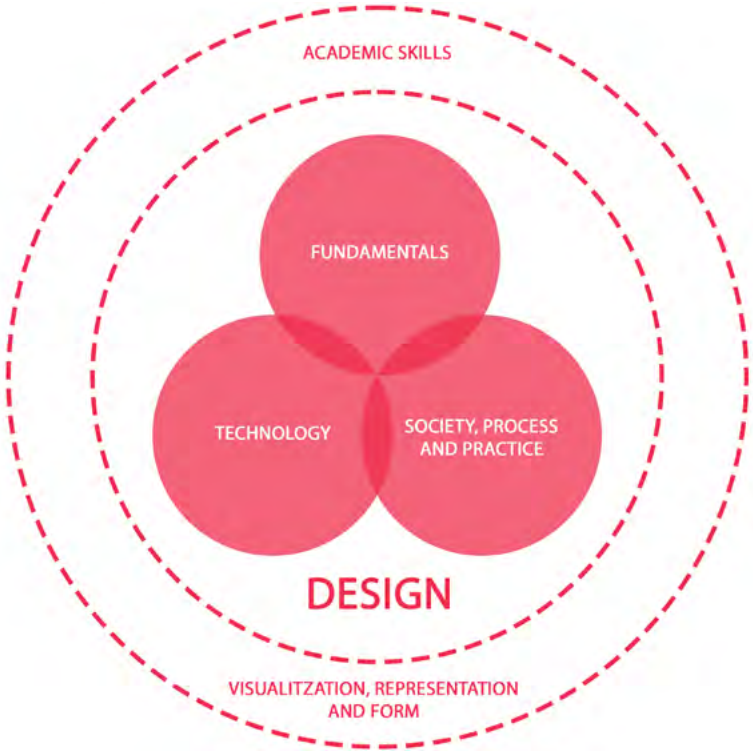

FIGURE 2 The 2013-2024 BSc curriculum concept with 6 throughlines: Academic Skills (AC); Visualisation, Representation and Form (OV); Fundamentals (GR); Technology (TE); Society, Process and Practice (MA); and Design (ON), drawn by author based on information Faculty of Architecture and the Built Environment, 2024.

Q12 / Q11	A	U	MBE	BT	LA	AVERAGE
AC 1	4%	4%	15%	0%	0%	5%
AC 2	6%	0%	15%	0%	0%	4%
AC 3	15%	7%	27%	10%	0%	12%
GR 1	27%	0%	0%	0%	17%	9%
GR 2	33%	7%	0%	0%	0%	8%
GR 3	40%	22%	4%	0%	17%	17%
GR 4	37%	56%	4%	0%	33%	26%
MA 1	1%	15%	35%	0%	0%	10%
MA 2	2%	11%	31%	0%	0%	9%
MA 3	2%	7%	54%	0%	0%	13%
ON 1	57%	0%	8%	0%	0%	13%
ON 2	54%	0%	4%	10%	0%	14%
ON 3	18%	74%	8%	0%	67%	33%
ON 4	72%	30%	8%	10%	17%	27%
ON 5	22%	85%	73%	0%	50%	46%
ON 6	84%	7%	4%	80%	17%	38%
OV 1	34%	0%	0%	0%	0%	7%
OV 2	34%	0%	0%	10%	0%	9%
OV 3	21%	0%	0%	20%	17%	11%
TE 1	5%	0%	0%	20%	0%	5%
TE 2	6%	0%	0%	20%	0%	5%
TE 3	9%	0%	0%	30%	0%	8%
TE 4	18%	0%	0%	40%	0%	12%
TE 5	29%	0%	0%	60%	0%	18%

TABLE 8 Percentage of students who chose a track and mentioned a BSc module as sparking their interest in it

5 Conclusions

Most students (58%) enter the Architecture BSc programme with a predetermined idea to study for an MSc after their BSc degree, specifically the MSc in architecture. At the same time, 42% of the students had no clear plan and little idea of what MSc programmes were offered. A large group of students doubted their initial preference or started to doubt it during their BSc, and almost half of the students still considered other MSc tracks while enrolled in the MSc track of their choice. The predetermined idea and level of doubt might relate to a relatively late awareness of the different MSc track options: in the course the second year mote than half of the students become aware of the different tracks and options. It could also result from the vague content provided about certain tracks or weak links between modules and curricula in the BSc and MSc tracks. Some BSc modules clearly relate to specific tracks and spark enthusiasm for a specific one, like the ON modules do for the architecture track. Other modules, as in the AC curriculum, deliver more generic skills and lack a clear relationship to any enthusiasm for a particular MSc track.

Another key finding is that students receive information about the tracks during the BSc programme, which they gather from different sources. Further clarification and information about choices, relations between modules and tracks, and 'formal' information channels are key. Some of the tracks, mostly MBE and LA,

might consider putting more emphasis on the courses related to their tracks and 'advertising' their track – not only within the BSc but also providing information to prospective BSc students.

The power of the advertisement, as well as insight into the choice process, what students consider, what activities they undertake, and what doubts they have, call for further exploration. Given the BSc renewal in 2024, it would be interesting to repeat the study and supplement it with a focus group to explore the choice process in-depth.

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Game on!

Gamification in urban design and planning education

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Abstract

This chapter reviews the 2013–2023 student and teacher experiences of the third-year bachelor course 'Area (Re)Development', internally known as *the management game*. It looks at the potential this gamification teaching approach has for Bouwkunde bachelor students and reflects on the impact on learning.
The findings are the authors' synthesis of hundreds of personal reflections of students and many student, tutor, and commissioners' evaluations and discussions. Although students may not mention that they have learned many challenges (Leijon, 2022), focusing on current and urgent issues means 'a lot is learned'. Thanks to the focus on professional collaboration and students' enthusiasm, this appears to be possible every time within the desired time commitment.

Keywords

Urban area development, Management game, Roleplay, Challenge-based learning, City Deal Kennis Maken

COVER FIGURE View of the Nieuwe Kuip, case Alexander - Rotterdam, by Maarten Hikspoor and team 2021Q1-10, 2019.

1 Introduction

The second to last 10EC design course of the bachelor's degree programme at the Faculty of Architecture and the Built Environment (ABE) is often referred to as *the management game*. Students roleplay as ten different actors in an urban development process. The course has been given in this format since 2013, changing sites each year. What makes this course uniquely impactful is the realistic simulation of the interaction between the different disciplines and the topical planning themes. The municipalities and other stakeholders from urban planning practice are involved in delivering a brief regarding an area they want to (re)develop in the coming years. Herein, the students are asked to develop a spatial vision and transformation strategy for sustainable long-term development, simultaneously considering spatial quality, programmatic trends, multi-actor decision-making, intergenerational spatial justice, economics, legal issues, politics, and the environment.

This contribution describes the urban development cases since 2013. It reveals the pedagogical model and shows the importance of working with partners from practice, which is beneficial for both the educational part and the cities involved. A leading question in this contribution is how this gamified teaching approach impacts the Bouwkunde bachelor students and their learning. The findings are based on the authors' synthesis of hundreds of personal student reflections they write as a specific, final course assignment and many student, tutor, and commissioners' evaluations and discussions. We will first describe the management game structure. Then, we will present each case, show one student team project outcome per case, and briefly share an important highlight or lesson related to students' learning. We end by discussing where we would like to go from here with the course, emphasising its challenge-based learning character.

2 The management game through the years

During the third and final year of the ABE bachelor's degree programme, students follow the requisite 10EC design course 'Area(Re)Development'. Every year, about 300–350 students, split over two semesters, develop an urban vision and strategy for the coming 50 years in a real-world case with actual urgency. This project takes place as a roleplaying game: in teams of ten, students each take on a specific role crucial to the urban development process.[1]

The first important gaming element is a roleplay – the simulation of a transdisciplinary environment with various actors from the private sector, public sector, and civil society (for the roles, see Figure 1). This varied composition of roles makes drawing up integral advice for an area of development challenging and allows for multiple perspectives.

1 The course setting is unique as a design course in the bachelor's programme but does have common qualities with the courses 'Management in the Built Environment' and 'Urbanism', as described in 'Cultivating the next generation designers' (Qu et al., 2020) on supervising interdisciplinary groups.

2013		2014		2015		2016		2017		2018		2019		2020	
Q1	Q3	Q1	Q3	Q1	Q3	Q1	Q3	Q1	Q3	Q1	Q3	Q1	Q3	Q1	Q3
Economic Affairs (EZ)															
												GIS-expert (GE)			
Landscape Architect (LA)															
Environmental Advisor (MA)															
Project Leader (PL)															
Government (HO)				Regional planner (RP)											
City developer (SO)															
Urban advisor															
RE User (VG)				TU											
RE Owner (VE)				Real Estate Developer (VO)											
Mobility Planner (VP)															

FIGURE 1 Most roles have been in place all years. In 2019, the GIS expert was added, replacing a workshop on that topic. In 2015, the Regional Government and the City Developer were combined as the role of Regional Planner because the earlier roles got in each other's way. The distinction between the owner and user perspective did not match in the TU Delft campus case. After that case, we continued with a Real Estate User role (demand) and a Real Estate Developer role (supply). In 2023–2024, we could not staff the supervisory role of Transport Planner, by authors, 2024.

A second gaming element consists of selecting the playing field, a new design case each year, to keep everyone – students, staff, and practitioners – actively engaged. Throughout the years, these cases have increased in complexity because of all the challenging present-day issues in the realms of climate change, economic developments, housing demand, political dynamics, and the (need for a) shift towards a more circular, healthy, and inclusive society. The casework has been performed on Blaak (Rotterdam 2013-2014), Pompenburg (Rotterdam 2014–2015), Campus TU Delft (Delft 2015–2026), barrier A20 (Schiedam 2016–2017), Merwe-Vierhaven(M4H) (Schiedam and Rotterdam 2017–2018), Railway corridor (Dordrecht and Zwijndrecht 2018–2019), Alexanderpolder (Rotterdam 2019–2020), A-Z (Rotterdam 2020–2021), Delft Zuid (2021–2022), The Hague South-West (2022–2023), and Gouda (2023–2024). Municipalities and several other stakeholders from practice present their views (and questions and struggles) on the case during the course.

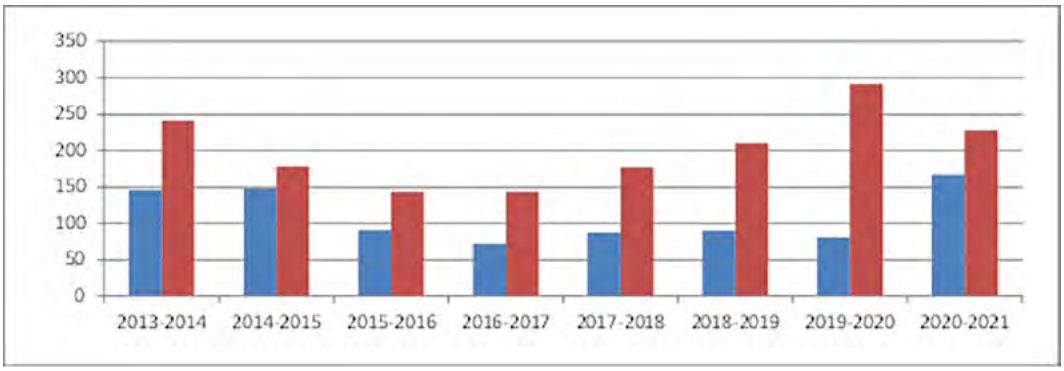

FIGURE 2 Students of BK6ON5 over the years, by authors, 2024.

The third element that impacts the gaming scene, particularly the behaviour and attitudes of the 'players', is the various types of mentoring and feedback. First, via their role supervisors, all students with the same role meet regularly and discuss the area (re)development from their disciplinary perspective. Second, via their group supervisor, who coaches two design teams, students receive feedback on their contributions to the team results (vision and strategy) and team process. Third, students from a design team are asked

to give their team members feedback on their performance at two specific moments during the course. Fourth, the commissioners (that is, the municipalities) respond to several pre-selected proposals. Fifth, we organise workshops and give the students crucial input for their visions and strategies (circularity workshop, policy and governance workshop) and their group process (group dynamics and pitching workshops). Sixth, the students have a lot of time for self-study, which includes unsupervised group work and organised peer feedback.

Via the roleplay, the real-life playing field, and the diverse mentoring and feedback approach, students are guided through the intricacies and significance of real-world collaboration of the different stakeholders in urban (re)development processes. Attention is given to developing the technical qualities, knowledge, skills, and values of each role, as well as the importance of collaborating professionally and effectively in a design team. In collaboration with and sponsored by the national *City Deal Kennis Maken program*, our management game received the opportunity to enhance its visibility and impact outside the university. Among other benefits, it shows our fruitful collaboration with the cities of Delft, Dordrecht, Rotterdam, Schiedam, and Zwijndrecht. The City Deal website can be visited to find more background information, images of the cases, and experiences (quotes) of the stakeholders, tutors, and students.

3 Blaak - Rotterdam, 2013–2014

FIGURE 3 Blaak in motion, by 13/14_Q1-Team06 (code means team 6 in the first quarter of the 2013–2014 academic year), 2013.

In the kickoff year of the 2013 renewed bachelor's curriculum, students were tasked with redeveloping a centrally located but somewhat run-down axis in downtown Rotterdam, from Eendrachtsplein to station Blaak. The axis inherently connected business, retail, and housing but was often on the outskirts of existing development plans. Most student groups implemented greenspaces, transforming the street into a boulevard park for slow traffic, including waterways and seating squares. A few groups subdivided the street profile into categories, giving them a distinct identity and increasing the potential for influx from different target groups. Most teams separated identities in West Blaak and Blaak. The regional potential of the station was often recognised and connected to the slow traffic along the lane. Well before the focus on circularity, adaptive re-use projects here have already contributed significantly to material re-use.

As this semester was an experiment in many ways, a few students commented that they felt like guinea pigs. However, most adapted to the new pedagogical setting fairly rapidly, exploring the potential of the course together with the teachers.

4 Pompenburg - Rotterdam, 2014–2015

The Blaak and Pompenburg cases were initiated by the Urban Development Department of Rotterdam through their participation in our group. Pompenburg has been the smallest area of all cases but is very complex infrastructurally. Students focused a lot on the train tracks, which play a prominent role in the area, and most teams attempted to break through this perceived barrier. Other prevalent design solutions included the proposal of a bicycle highway and improving the pull for schools in the area. One team (14/15_Q1_Team04) introduced an air bridge through the city, while another proposal centred on creating a wall around the tracks that would serve as a green sound barrier and touched upon the theme of the circular economy by re-using demolition waste in its construction.

Sustainability themes were addressed by encouraging circularity and slow traffic, and a BREEAM sustainability certification score was introduced (Dutch Green Building Council, 2020). Functions were mixed, and finally, the scale appeared to allow for thematic creativity, as one team based their entire plan on the painting *Victory Boogie Woogie* by Piet Mondriaan.

FIGURE 4 Victory Boogie Woogie, by Rafaël Woudenberg 14/15_Q1_Team14, 2014.

5 TU Delft Campus - Delft, 2015–2016

Unique to using our campus as a case is how it was inherently intertwined with student life, giving them collective expertise as users and a personal connection to the site. Additionally, the university both owned and worked on the area, resulting in more ambiguous student roles that more closely resembled governmental positions. These factors may have introduced a conflict of interest in the execution of the student projects, as can be seen where the students largely rejected a particular aspect of the brief in which TU Delft proposed demolishing the Faculties of Bouwkunde and EWI – a concept the university embraced in hindsight.

FIGURE 5 View over Mekelweg, by Carlijn Beerepoot 15/16_Q3_Team10, 2016.

Within the student projects, problems were addressed in an urban acupunctural way. Also, when a general theme was selected, individual elements were often isolated, which may be related to the decentralised nature of the campus and the intimate experience the students have with the site. The perspective of students significantly shaped the urban plans; sustainable education was considered more than sustainable material use, and almost every project included a prominent social meeting area. Although the seeds were planted here, it took several years before the university managed to integrate total cost of ownership (TCO) as a real estate development vision.

6 Highway A20 as a barrier - Schiedam, 2016–2017

Due to the large scale of the Schiedam case, it was divided into four sections in the second round of the project (Q3), assigning each student group to a different subarea. Most of the students focused on promoting the area and attracting innovative companies. Students frequently proposed to improve the networks of Schiedam with the South Wing of the Randstad to tackle the (student) housing shortage and improve the academic links between Rotterdam and Leiden.

On a local scale, the teams took measures to decrease automotive traffic and emphasised the importance of sustainable industry by designating a space for craftsmanship to flourish. Different timeframes were adopted – ranging from 17 to 33 years – in which students proposed fairly detailed solutions. Within these timeframes, each sub-site and its respective requirements were considered, as seen in a certain project (16/17_Q1_Team08) that differentiated among real estate, infrastructure, and public space.

FIGURE 6 Student work, By Douwe de Vries 16/17_Q3_Team04, 2017.

The collaboration between the tutors and experts in the city reached an unprecedented height thanks to the enormous efforts of several Schiedam colleagues. They provided interim feedback to improve the plans, and many more Schiedam inhabitants gave their unvarnished criticism during the public closing presentation. 'Hopefully, you are not going to demolish my allotment garden', one citizen said to a student team during the public exhibition in the hall of the Central Station of Schiedam.

7 M4H - Schiedam and Rotterdam, 2017–2018

In Merwevierhavens (M4H), the former harbour industry moved outbound to the seaport. This decades-long process will leave an industrial area to be gradually redeveloped into a (multifunctional) housing area, framed as a makers district.

FIGURE 7 Student work, by M4H 17/18_Q3_Team08, 2018.

Many student projects adhered to the preliminary structural outlines given by the municipality of Rotterdam. After emphasising the disconnect caused by 'dead-end' piers, bridges frequently achieved a prominent position, allowing slow traffic to move between the piers. Although some groups honed in on a specific theme covering the entire area, most teams subdivided the area into designated districts to accommodate the different programmatic elements (housing, industry, education, greenery). This approach could 'be intrinsic to the fragmented physical manifestation of the port' and is also seen in the spatial framework of Rotterdam (Programmabureau Rotterdam Makers District, 2019).

The students could distill similar conclusions to the municipality, consistently allocating the northeast to industrial and educational functions and devising diverse expressions of habitation around it. All groups paid attention to sustainability, considering the sanitation of the area in the project phase, but a few groups extended this to the main focal point of their project. So, the students were not only early adopters of innovations in renewable energy and the know-how to implement them (Schiedam and Rotterdam, 17/18_Q1_Team08 and 17/18_Q3_Team10) – they were also able to apply an integrated approach to the circular economy (17/18_Q1_Team05). With a project deadline of 50 years, the students scrutinised the various phases of the project. We could also see influences from the parallel 5EC course BK6MA3 'Management and (Re)Development', focusing on area development, spatial planning, urban law, spatial economics, and real estate management in which phasing exercises were performed. Some teams also paid special attention to including viable living conditions throughout the planned development (17/18_Q3_Team02).

8 Railway zone Dordrecht-Zwijndrecht, 2018–2019

This case appeared to be another test for collaboration between two cities. Herein, each municipality presented diverging ambitions through a range of scales. Dordrecht found a social imbalance around the station area and was looking to increase public transport mobility through an urbanisation alliance with the south wing of the Randstad. Zwijndrecht saw the station as a focal point, defining its main issue as excessive social housing, which concerns the entire municipality. Both were looking to diminish the air and sound pollution produced along the railroad and the A16, infrastructure that obstructs the urban fabric.

FIGURE 8 Student work, by 18/19_Q3_Team08, 2019.

The most common student design solutions featured a unified and green approach. The area boosts polycentrism, and many students worked towards a comprehensive identity, often by increasing greenery around the railway area and on the banks of the river. A debate ensued on whether the train tracks should be seen as a harsh border or a connective infrastructural element. Redesigning the existing railway bridge into an iconic urban element appeared 'unavoidable', though each group managed to put their twist on it.

During this edition, the collaboration between multiple municipalities proved challenging, with students being approached as mutually exclusive parties. The semester proved to be an inspiration to the municipalities. In 2020, Dordrecht, in collaboration with Mecanoo (2020), presented a development ambition for the coming ten years in which the residential expansion and the connection to the surrounding area are mentioned:

The railway zone is a valuable area. The two municipalities should not see each other as a competitor but as an extension. I suspect the two municipalities could have come closer together during ON5. (Group tutor, Lidija Poth)

9 Alexander - Rotterdam, 2019–2020

In contrast to the earlier cases, Alexander presented a natural centrality, which is reflected in the students' interpretations. Many groups emphasised the locations where the main arterial roads came together, often transforming these junctions into social meeting hubs. The main roads divided the area, and further subdivisions were created with designated programmatic functions. In contrast to the item on sustainability posed by the municipality (emphasising the energy transition), more often than not, traffic hindrances were tackled, and attempts were made to connect green areas.

Though the project area is the lowest point in the Netherlands, water and flooding were not seen as the main hazards. Notable designs were a project emphasising gender equality and a project that opted for a completely wooden structure (Quarter 3, student group 20, Alexander - Rotterdam, 2019 1920Q3-24 and 1920Q3-20). The municipality re-emphasised the energy transition during the second quarter after noting this to be largely absent during the first quarter. However, the students only partially addressed it the second time around.

FIGURE 9 Student work, by 19/20_Q3_Team10, 2020.

10 Van A tot Z - Rotterdam, 2020–2021

The 2020–2021 case, located in Rotterdam, challenged the students to define a subset – a smaller area – and to relate it again to the larger scale. The area includes Rotterdam Alexander, allowing for building upon the previous findings. Within the larger national demand of one million homes, the municipality is looking to build 50,000 homes by 2040, with a large part in this area. The (ongoing) challenge is to combine development strategies related to public transport lines and (connecting) hubs as well as connecting North and South Rotterdam with the new stadium at Feijenoord (See also the front page image 20/21_Q1_Team10) – an 'integral approach' that considers 'mobility, climate, energy, and attractiveness'.

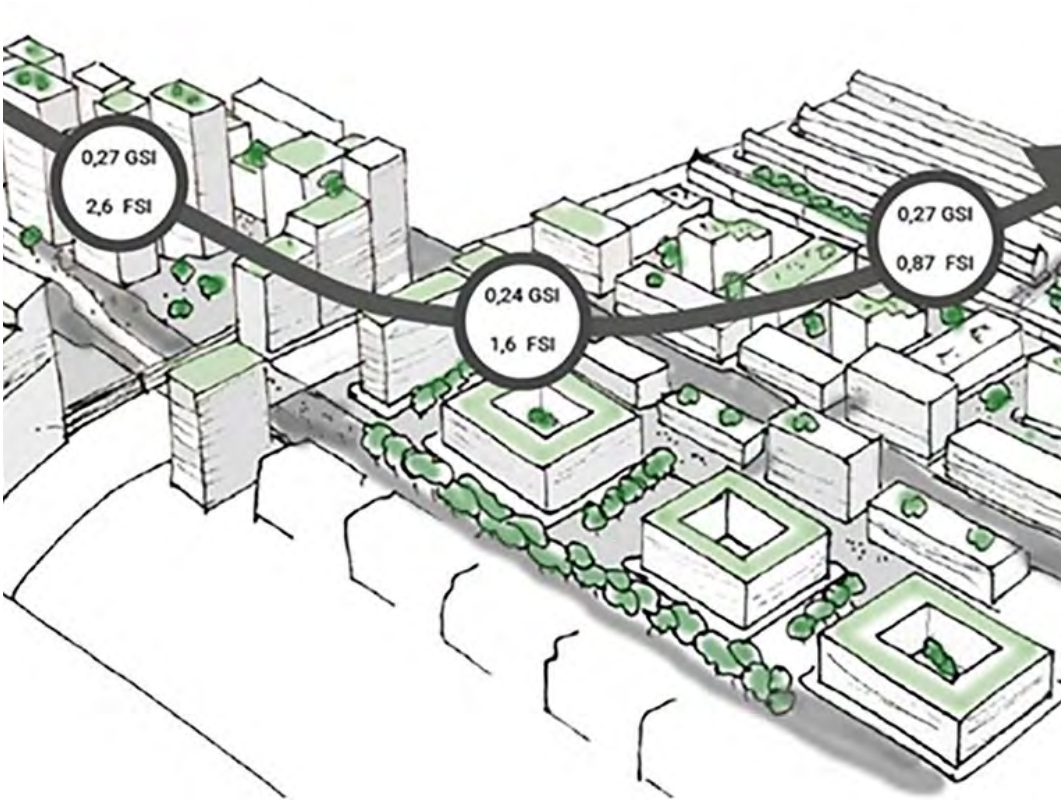

FIGURE 10 Kralingse Zoom, by team 2021Q1-11, 2021.

Even though this case was carried out almost entirely during the Covid-19 lockdown, the essentials of the course, the intrinsic necessity for collaboration, and the benefits of effective collaboration have remained fully intact. Group presentations changed from face-to-face moments to the delivery of short videos, which gave another dynamic to understanding the student proposals.

11 Delft Zuid, 2021–2022

For the second time, our TU Delft campus became the focus, but now explicitly in connection to the wider (re)development of Delft Zuid. The additional research question, therefore, was whether coordination in redevelopment visions between these two major landowners could lead to further optimisation with a joint redevelopment strategy. Today's limited cooperation often leads to a suboptimal result, particularly around the development of the campus station and the surrounding area. Collaboration is key.

Typical of the student projects was the use of student-focused visions and strategies, mixing up the positions of designers and involved users.

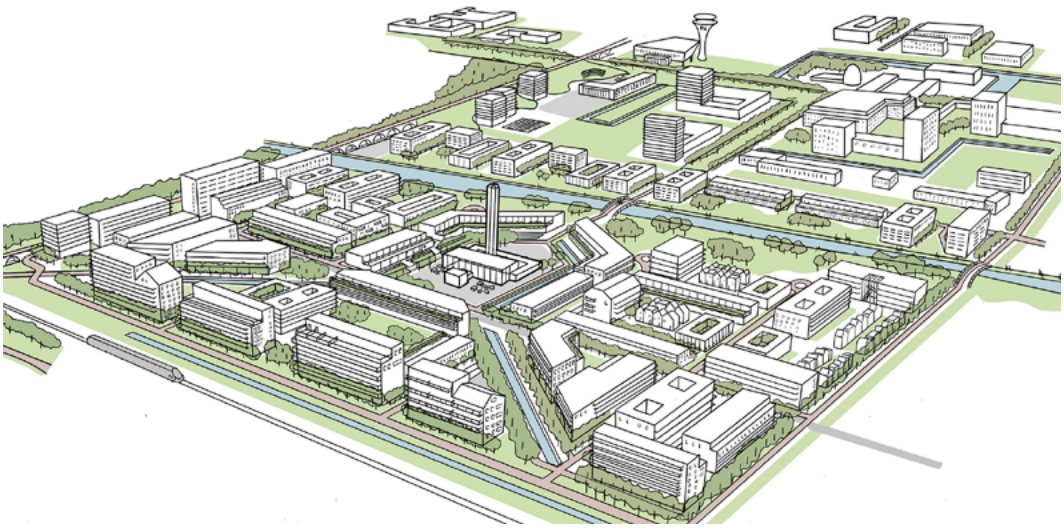

FIGURE 11 De verweving, by 21/22_Q3_Team09, 2022.

12 Den Haag Zuid, 2022–2023

The challenge in The Hague South was to find a more sustainable answer than demolition and new construction for the hundreds of apartment buildings from the 1960s and 1970s, which the city did not have the resources or the capacity to handle. A potentially relevant answer was the TU Delft student Symbiotic Urban Movement (SUM) project[2] on sustainable apartment block renovation. SUM focuses on adding extra layers on top of an apartment building that can also lead to a resource-positive result and contribute to a more inclusive urban environment.

This solution gained a great deal of interest among the corporations and the municipality, which were already partners at the start of the SUM project. It has been investigated how such solutions can relate to all other interventions, such as those aimed at facilities and mobility, which comprise area development. The essential administrative issues, controlling construction flows and circularity, have also been brought up in addition to the technical challenges. Due to the size of the research area, we distinguished sub-areas for the student design teams, resulting in variations in focus and comparative visions.

FIGURE 12 MoerAs, by 22/23_Q3_Team04, 2023.

2 https://www.delftsolardecathlon.com/

13 Gouda, 2023–2024

Gouda's soil is so poor that you lose bricks if you drop them. Subsidence of the soil and water management issues are significant challenges for the construction sector and, therefore, impact area development. For our game, Gouda mapped out the questions and expectations for four city districts. In this run of the management game, we also entered into a partnership with the Mooi Nederland programme (2022) from the Ministry of Interior Affairs. They are responsible for the future 'Nota Ruimte' and have set up a research programme and design approach that fits well with the course and inspires the student teams. The intense focus on the natural conditions (soil and water) combined with the major challenges of the housing construction assignment made this case a great challenge for our students.

FIGURE 13 Westergouwe, by 23/24_Q1_Team11, 2023.

14 Discussion and conclusion

The management game reenacts real-world situations and teaches the student that complex problems, such as urban systems, require collaboration among numerous specialists (de Jong et al., 2017). Many similarities can be seen with policy gaming and its five pillars (the five Cs), as described by Geurts et al. (2007): complexity, communication, creativity, consensus, and commitment. The collaboration pillar is emphasised significantly within the management game via our workshop on group dynamics, personal behaviours, and communication, as well as our official peer feedback moments.

At the end of the course, the students reflect and are asked to make several things of their (design) process explicit (van Dooren, 2020). This reflection allows students to better understand their functioning within a team while adjusting the course's framework. Most of our students have told us that the setup of the management game creates very positive conditions for learning because it differs significantly from their

earlier experiences in design education and teamwork. Most importantly, students expressed surprise at how much they enjoyed working and learning together.

The scope, buildup, and composition of the management game have been tweaked pedagogically and content-wise throughout the years to adapt to contemporary societal developments and lessons learned from previous years. This evolution within the course challenges both tutors and students creatively, as previous visions and strategies for earlier cases are not one-to-one transferable.

Another development that has emerged is the increase in scale and societal complexity, which not only complicates the assignment but also requires a higher level of abstraction from our students. For example, the level of detail (e.g. floor plans, building details) of the first years is no longer visible. In the later cases, the governing complications of several municipalities and governmental bodies as clients have made students more aware of their various needs and demands and, as such, place a heavy burden on empathy and mutual understanding. This connection and collaboration between municipalities and educational institutions is what City Deal Kennismaken is all about. The website www.citydealmanagementgame.nl describes this collaboration in detail and provides the necessary testimonials from all involved.
From day one, the focus for the vision and strategy within the course has been 50 years, which naturally introduces many uncertainties. The rich collaboration between the university and external parties made the course develop further towards a challenge-based learning environment and experience, encouraging students to leverage the knowledge and skills they have and the technology they use in their daily lives to address and interact with real-world problems and stakeholders (Leijon, 2022). Consequently, the cases will continue to focus on the social effects of interventions for sustainability within area development.
The collaboration with Mooi Nederland (2022), which aims for a vision until 2100, contributes positively to 'complexity' and, due to the demand for sustainable interventions, to 'commitment'.
What is special about this eleven-year history of the course is that various people, both within our societal partners and within the teaching staff, completed the course themselves in the past as students and now enthusiastically contribute with their expertise from their positions in practice or academia. What many of the professionals experience is that we learn so much ourselves via this student project. Landscape architecture design tutor Frits van Loon put it very nicely:

''Gradually, it became clear to the students that the Alexanderpolder is a deep polder and that we as a society have to deal with a rise in sea level and – with it – an increase in the groundwater level. There is also another danger, with the enormous drought, which can cause the water to become saline. I have discovered the area because students make discoveries.''

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Active online learning in the geomatics domain

The experiences of five European universities

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Abstract

Geomatics is a domain that has gained relevance and importance within the field of Architecture and the Built Environment. Typically, Geomatics education in Delft, Lund, Bochum, Leuven, and Zagreb was best characterised as lecture-based: traditional and relatively passive. This has changed fundamentally after March 2020. In this article, we analyse the development towards more active learning and teaching in five university degree programmes regarding geomatics. This study found two types of active online education: digitisation of on-campus education and implementation of new online active learning and teaching methods, including clips, quizzes, forums, in-depth Q&A, and debates. Despite the use of active learning methods, universities are struggling to maintain the attention of students during lectures and with the design of online assessments.

Keywords

Geomatics, geographical information, active online education, teaching

COVER FIGURE Photo by authors

1 Introduction

Modern teaching requires innovative methods to meet today's requirements. Educational institutions can no longer rely solely on face-to-face events but must adapt to the digital world. The increasing number of distance learning courses, the desire to combine family and studies, and the trend towards self-study and self-regulated learning have shifted focus towards digital offerings. This adjustment poses great challenges for many educational institutions but pays off in special situations, such as the Covid-19 pandemic, where face-to-face events are impossible. Digital teaching offers new possibilities for educational exchange around the globe. The location factor of the students is no longer decisive, further promoting the exchange of knowledge.

Online teaching and learning come in many shapes and sizes. In this chapter, we have compared the practices and experiences and discussed the lessons learned from the active online teaching methods that are currently applied in educational programmes on geographical information at five European universities: Delft University of Technology (TU Delft), Lund University, Bochum University of Applied Science, KU Leuven, and the University of Zagreb. These five universities cooperated in the open SPatial data Infrastructure eDucation nEtwoRk (SPIDER) programme to develop an education platform to facilitate the sharing of and access to innovative teaching practices on the topic of geomatics. Via this platform, the SPIDER partners shared their innovative active teaching practices and newly developed teaching practices on topics that were not implemented in geomatics education. Via the platform, teachers, trainers, and students can easily discover innovative teaching practices and learning materials on a wide set of topics within the geomatics domain. This chapter uses texts from and builds on our SPIDER project report (Vancauwenberghe et al., 2023).

In Section 2, we will explain what active teaching and learning is about. In Section 3, we briefly review the geo-information domain, and in Section 4, we describe the online teaching practices of the five universities active in this domain. Section 5 presents the main findings from the comparisons between the five universities, and Section 6 concludes this chapter.

2 Active teaching and learning methods

In a constantly changing society, it is necessary to rethink teaching methods on a regular basis. The technical changes that have taken place in recent decades have changed our everyday lives to such an extent that our thinking has evolved, and we approach problems differently today. Therefore, existing teaching methods must be reconsidered and adapted to societal developments. Face-to-face teaching with active lecturers and passive students no longer seems appropriate, and numerous studies have already questioned its effectiveness (see, for example, Bonwell & Eison, 1991; Michel et al., 2009).

2.1 Active teaching and learning

Active teaching and learning strategies can be described as 'anything that involves students in doing things and thinking about the things they are doing' (Bonwell & Eison, 1991, p. 19; cf. Drake, 2012). It is not the traditional one-way direction of teachers or a textbook providing the knowledge to the students. In active teaching, students discuss and reflect on a topic or are challenged to develop solutions themselves (see also McManus, 2001). Fink translates this into three components that are key in active learning strategies (see Fink, 2003, 2005; see also Table 1):

1. Receiving information and ideas (e.g. reading a textbook, classroom lecture)
2. Experiencing the information and ideas (e.g. case study, roleplay, direct observations)
3. Reflecting on the information and ideas (e.g. reflective dialogue with oneself or peers)

	OBTAINING INFORMATION AND IDEAS	EXPERIENCE		REFLECTIVE DIALOGUE WITH	
		'DOING'	'OBSERVING'	SELF	OTHERS
Direct	- primary data and sources	- 'real doing'in authentic settings	- direct observation of phenomena	- reflective thinking - journaling	- dialogue (in or out of class)
Indirect, vicarious	- secondary data and sources - lectures, textbooks	- case studies - gaming/simulations - roleplay	- stories (can be accessed via film, oral history, literature)		

TABLE 1 Learning activities for holistic, active learning (Source: Fink, 2005, p. 5)

Active teaching focuses on the communication between students and teachers. Interactive teaching methods constantly integrate students into the teaching process, whereby they often subconsciously guide the lessons. The different methods for actively involving students are broadly diversified and include the use of modern media, games, group works, presentations, open discussions, or even roleplays. A well-known example of active learning is the so-called flip-the-classroom concept: before the lecture, students prepare the lecture material (papers, presentations, etc.), and in the classroom, the topics are further explored and discussed, allowing for a better and deeper understanding of the topic at hand (see Abeysekera et al., 2015).

2.2 Active teaching and learning online

Online education may come in many forms and, accordingly, has many definitions. Here, we define online education as:

Education being delivered in an online environment through the use of the internet for teaching and learning. This includes online learning on the part of the students that is not dependent on their physical or virtual co-location. The teaching content is delivered online and the instructors develop teaching modules that enhance learning and interactivity in the synchronous or asynchronous environment. (Singh & Thurman, 2019, p. 302)

In addition to a synchronous or asynchronous environment, online education may be organised as an entirely virtual course with all materials and supervision or tutoring online. The course may also use digital tools connected to internet access to complement traditional classroom lectures (Neri-Vega et al., 2019; see also Lopez, 2004). In Table 2, we applied the active learning and teaching framework of Fink (2005) to active online education.

	OBTAINING INFORMATION AND IDEAS	EXPERIENCE		REFLECTIVE DIALOGUE WITH	
		'DOING'	'OBSERVING'	SELF	OTHERS
Direct	- primary data and sources	- 'real doing'in authentic settings	- direct observation of phenomena	- reflective thinking - journaling	- dialogue (in or out of class)
Indirect, vicarious	- secondary data and sources - lectures, textbooks	- case studies - gaming/simulations - roleplay	- stories (can be accessed via film, oral history, literature)	- reflective thinking - journaling	- dialogue (in or out of class)
Online	- watching recorded lectures - watching videos/clips - reading recommended literature in advance - online lectures and shared screens	- pose a question before the video - review learning material and post the take-homes to the forum - virtual labs/assignments - quizzes testing the understanding of the material - interactive textbooks - group work on a case study - gaming/simulations - roleplay	- online exercises	-reflective writing and peer review - discussion with the teacher - debate with roleplay (e.g. court case)	- group discussions in break-out rooms - group discussions with externals - group discussion through the outcome of online (open-ended) polls - online discussion forum

TABLE 2 Learning activities for holistic, active learning (adapted from Fink, 2005)

3 Geomatics education

Geomatics is the science and art of collecting, managing, analysing, and visualising geographical information, defined as information that is linked to the surface of the earth. Geographical data, or the geomatics domain, is well-known for its technological advances and wide applications, such as Google Maps and TomTom.

Geomatics technologies, skills, and competencies are increasingly relevant in the domain of Architecture and the Built Environment. In spatial planning, for example, knowledge about existing structures above and below the surface (e.g. utility networks, tunnels) and their location has always been key. In addition to planning, GIS is also important in analysing and understanding spatio-temporal dynamics in urban areas. The 3D models and visualisations allow for more accurate analyses and, therefore, better-informed decision-making in the built environment. In landscape architecture, GIS plays a prominent role in the historical analysis of landscapes, visibility analyses of landscapes, and landscape design. Introducing the 3D models of the urban environment into architectural practice and design approaches provides new opportunities to visualise and build new structures or to develop digital twins of cities.

Until March 2020, teaching methods in geomatics education at our five institutions were mostly limited to traditional, relatively passive teaching approaches in the classroom, such as lecturing and reading articles from a prescribed literature list. We barely used online tooling or methods. Since the Covid-19 pandemic, however, the SPIDER universities have been implementing active learning methods through labs and project education. In addition, in some lectures, the responses to online quizzes have triggered additional student discussions, some courses have organised debates or roleplays (e.g. court cases), and in a few instances, classrooms have been flipped.

Until SPIDER, there was limited international exchange of educational material and approaches among universities with geomatics programmes. An overview and detailed analysis of existing geomatics education was unavailable, and an international platform facilitating geomatics education was lacking.

4 Active online education in geomatics at five European universities

The 2024 status of active online education in the geomatics programmes of five organisations involved in the SPIDER project is listed in Table 3.

ONLINE ACTIVE LEARNING AT	OBTAINING INFORMATION AND IDEAS	EXPERIENCE		REFLECTIVE DIALOGUE WITH	
		'DOING'	'OBSERVING'	SELF	OTHERS
Bochum University	- online lecture (live and recorded) with chat - reading selected literature (mainly original standards and papers)	- quizzes and online tests - assignments on data interoperability, data literacy, and data mapping - bigger homework: definition of a complete data provision workflow	- demonstration of the model-driven approach using special software products	- individual review and reflection with the teacher	- group discussions - break-out rooms
Delft University of Technology	- online lecture (live and recorded) with active chat - watching videos/clips - forum - reading recommended literature	- virtual online labs/ assignments - quizzes/polls - case study of NSDI (writing a paper)		- debate with roleplay - individual review and reflection with the teacher - reflection section in a paper	- group discussions during classes in break-out rooms - online open-ended poll to start discussions - peer review - discussions outside classes using Discord
KU Leuven	- online lecture (live and recorded) with chat - reading selected literature	- understanding data licences - searching for and accessing data sets (e.g. via data portals) - understanding (open) data assessments and evaluations		- individual review and reflection with the teacher	- group discussions
Lund University	- online lecture (live and recorded) - watching videos/clips - reading selected literature - group discussions	- assignments - quizzes/polls - case study of NSDI and geoportals		- reflection on issues/ proposing innovative ideas for spatially enabled e-government - individual review and reflections	- designing (being approved by the teacher) and implementing a project
Zagreb University	- online lecture (live and recorded) - reading selected literature	- assignments: using OGC web services to analyse spatial datasets		- individual review and reflection with the teacher	- group discussions

TABLE 3 Summary of active online teaching in SPIDER partners

When it comes to teaching practices, approaches differ between and within universities. Two approaches can be distinguished: (1) online active teaching and (2) digitisation of the traditional classroom (i.e. lectures; see Vancauwenberghe et al., 2023). For example, TU Delft introduced a combined teaching approach whereby some lecturers use the flip-the-classroom method, whereas other lecturers choose to digitise traditional classroom lectures. In the latter case, lectures were given online and recorded for students to watch at any time. A similar practice was used at KU Leuven, with the difference that students from KU Leuven used classic learning materials instead of videos.

The strength of this teaching method is that it allows students to focus more on discussions and understanding the topic. In contrast, the other partner universities used traditional teaching methods but in an online environment. For instance, Bochum University of Applied Sciences transferred most lectures to online mode with PowerPoint slides presented in an online session. As for online tutorials (for projects), students followed the steps the tutor demonstrated on screen in real-time. The University of Zagreb used the same technique, as did some teachers from Lund University.

5 Discussion

Although the very first step in the development of online material is to lecture online, record the lecture, and allow for questions through the chat, this format remains rather passive. Adding intermediate quizzes to test the understanding of the students or to stimulate discussion is an appreciated next step towards truly active online education: students are provided 5 to 10-minute clips or instruction videos, which they have to watch before the lecture. During the lecture, the teacher discusses the clip with the students, or the students can ask questions about the video and work on the assignment. There is a forum where students can discuss any course-related topic with readily response times from either students or teachers. If applicable, students cooperate in break-out rooms and present their work in non-traditional ways to their peers and supervisors. Course evaluations by the students and the teachers showed that the flip-the-classroom method is highly appreciated by students. In addition, the assessments showed that the teachers also enjoy creating a flipped classroom (see Mansourian et al., 2022).

In our experience, the remaining issues include:

1. Silent students in the break-out rooms. Unlike in classroom group discussions, where a teacher can walk around to quietly observe levels of participation, in break-out rooms, it is not possible to enter without being noticed.
2. Single active students in a discussion, especially if video or audio are switched off.
3. It is difficult to know how much time groups need in break-out rooms or if they need help.
4. Not all students can easily participate in synchronous activities (unreliable internet access, no quiet space, not in the same time zone).
5. Difficult to assess the exact needs and questions of students as there is no eye contact.
6. Maintaining the attention of students.
7. Ensuring that all students are involved.
8. If the lectures are solely based on clips, the efficient updating of relevant materials.
9. Students do not always grasp the essence of the clips when watching at double speed.
10. Sharing stories and experiences from ‘insiders’ – lecturers participating in real-life situations in an online setting.
11. Efficiently developing course material.

6 Conclusion

Recently, active online education has gained significant traction in five geomatics Master's programmes in Europe. When it comes to teaching practices, approaches differ between and within universities. Two approaches were distinguished: (1) online active teaching and (2) digitisation of the traditional classroom (lectures). The students appreciated that the traditional classroom was transformed into an online learning environment within two weeks during the Covid-19 pandemic, allowing them to continue their studies. However, they preferred the quick change to the new format of true online teaching with clips, in-depth discussions, forums, chats, and discussions in break-out rooms even more.

We are only at the very beginning of the implementation of active online education, and many issues remain to be addressed, such as how to maintain the attention of students, how to involve all students, and how to efficiently develop course material. However, as one teacher put it in 2021, Covid-19 made it possible to successfully implement in five weeks what we have been discussing over the past five years.

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Management in the
Built Environment
MBE
Circular
Kitchen

Advancements in the mutual reinforcement of two similar MSc programmes

How two MSc programmes help each other - and themselves

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Abstract

This paper describes cooperation between two MSc programmes at Delft University of Technology, which are hosted by different faculties: Management in the Built Environment and Construction Management and Engineering. In today's competition for (the best) students, both programmes could easily have decided to rival each other. Instead, their respective faculties decided to cooperate and use each other's strengths to reinforce their programmes. The paper describes various ways in which this was done on two levels. The first level is curricular, for example, the sharing of courses. The second level is institutional and involves the composition of bodies of educational management. This paper shows that it is possible to benefit from increased efficiency resulting from working together while maintaining a distinct identity. The cooperation between programmes outlined in this paper may serve as an inspiration for other universities or departments that face similar situations.

Keywords

Mutual benefits, resembling programmes, efficiency, cooperation between programmes

COVER FIGURE The entrance of Management in the Built Environment in the faculty of Architecture and the Built Environment, by Fred Hobma, 2024.

1 Introduction: Two MSc programmes

At Delft University of Technology, two MSc programmes – Management in the Built Environment (MBE) and Construction Management and Engineering (CME) – focus on management issues in the built environment but are hosted by different faculties. If a university offers two similar programmes, there is a potential danger that they could see themselves as competitors (Rust & Kim, 2012) – trying to attract students from the same pool of bachelor students and not considering the other programme. This approach could lead to different kinds of inefficiencies that these programmes chose to avoid. Instead, the faculties decided to re-design them to achieve efficiency and mutual reinforcement. The intended effect of the concerted efforts to cooperate is a win-win situation for students and staff. This paper shows the advancements made in that direction. For example, their motives for working together are similar to what Lang calls 'the political economy of cooperation' (Lang, 2002), which has allowed these programmes to accomplish goals they could not achieve individually.

The MSc track Management in the Built Environment is a track within the Master of Architecture, Urbanism, and Building Sciences programme offered by the Faculty of Architecture and the Built Environment (ABE). The predecessors of MBE were introduced in 1992 (Prins & Hobma, 2016). CME is much younger – it started in 2007 – and it is offered by the Faculty of Civil Engineering and Geosciences (CGE) with the support of the faculties of ABE and Technology, Policy, and Management (TPM). MBE attracts around 65 students per year and CME around 90 students. Thus, the programmes are fairly comparable in terms of number of students.

MBE focuses on management issues in the built environment on three scales: individual buildings, portfolios of buildings, and urban projects. CME is also oriented to management issues in the built environment but centres on civil engineering. Although each programme has its distinctive focus and identity, some topics are similar. For example, both programmes include the following themes: 'project management', 'economics', 'construction and planning law', 'information management', 'procurement', and 'interdisciplinary cooperation'.

Having two MSc programmes that overlap could lead them to see each other as competitors, challenging one another for students who are interested in management issues in the built environment. There is also a danger that the programmes would develop courses and specialisations without taking the other into consideration, leading to inefficiencies such as 'doubles': courses which are much alike. Yet another inefficiency could be that programmes fail to rely on one another for other qualities, such as unique knowledge, granting it only to students from one programme. This is not to say that programmes should strive for cooperation and efficiency to save costs at the expense of a clear programme structure. A clear programme design should be of the utmost importance (O'Neill, 2015, p. 47).

Luckily, MBE and CME chose the route of cooperation and mutual attunement. The following sections describe the evolution of that process.

2 Prerequisite: Mutual trust and personal relations

The advancements in the collaboration between MBE and CME described in this paper are impossible without mutual trust and warm personal relations between staff members from both programmes. To emphasise, trust and personal relations are prerequisites for mutual reinforcement. In a relevant study, Acedo-Carmona and Gomila (2014) stress the importance of personal trust (as compared to general trust) for cooperation. Without a willingness to cooperate, the programmes cannot benefit from each other's strong points.

CME has shown openness when developing the three specialisations (to be described below) from the bottom up. The starting point for the development was a conference attended by many lecturers from CME, MBE, and TPM, including the CME Director of Studies, CME professors, the head of the MBE department, the MBE MSc coordinator, and other key persons. The conference gave representatives from MBE and TPM considerable influence on decisions to be taken. Such an open attitude is only possible if one (CME) trusts the delegates from other (MBE, TPM) faculties. Openness shown by one party, in turn, creates openness among others.

3 Benefiting from each other's strong points

3.1 Developing a new course by MBE staff for CME students

From the start of CME (2007), it was clear that students would need knowledge and skills in the construction and planning law field. The Faculty of CEG, however, did not have any staff in this field, nor did it want to invest in staff. Therefore, it was agreed that a member of the ABE faculty would take care of a legal course, which is mandatory for all CME students. A new course, 'Legal and Governance', was developed for this purpose. The revenues (in terms of European credits) would accrue to the faculty of ABE. Note that a *new* course was specially developed for CME as opposed to students from CME *joining* the existing MBE legal course. The latter proved impossible because of differences in scheduling and course content.

3.2 Using each other's mandatory courses as electives

MBE students generally take courses in the field of economics and finance. MBE's staff in this field, however, is quite small and does not have the human resources to develop *elective* courses relating to economics. However, MBE students can choose CME's mandatory course in economics as an MBE elective course. In this way, MBE students' wish for economics courses can be satisfied – not by MBE staff, but by CME staff.

The reverse is also possible: CME students can choose some of MBE's mandatory courses as electives, making efficient use of the strong points of each programme.

4 Adaptation of a mandatory course to accommodate students from another programme

A step beyond giving students from one programme access to 'standard' courses from another is adapting a mandatory course to accommodate the students from the other programme, as happened with the course 'Procurement of Large Projects'. Though the course is *mandatory* for MBE students, the topic is equally relevant for CME students, for whom this is a popular *elective* course. To attract both MBE and CME students, the contents (and name) were changed. More specifically, the MBE staff deliberately adapted the course contents in 2019 to attract students from both programmes. Doing so meant going a step further than simply offering a long-standing running course to students from another programme, taking the specific interests of students from another programme into account. In this case, the specific interests of CME students were taken into account by addressing procurement issues related to large infrastructure projects like motorways.

5 Interweaving: Shared mandatory courses

Another step entailed sharing courses that are mandatory in *both* programmes. We can call this a partial interweaving of programmes. This step, taken in 2020, can be seen as a consequence of the trust created and the positive experiences of the earlier steps (as described above). How did this step materialise?

Six months into their first year, CME students need to choose one of three 'specialisations'. The first is called 'Design and Integration' – it was developed by CME in close cooperation with MBE. Students who choose this specialisation are obliged to take the course 'Urban Redevelopment Game', which is a mandatory course for MBE students. To accommodate the CME students' focus on infrastructure, the MBE programme decided to modify the course slightly. They also renamed the course 'Urban Redevelopment and Infrastructure Game'. Today, when students from MBE and CME attend this course, there is no distinction between them.

6 Graduation thesis exam committees

MBE and CME, as distinct MSc programmes with their own faculties, have distinct graduation thesis exam regulations. Nevertheless, CME decided that each graduation thesis exam committee must consist of supervisors from at least two out of three of the faculties involved (CGE, ABE, and TPM). Consequently, staff members from MBE regularly supervise CME students. This institutional provision allows CME students to benefit from the knowledge of MBE staff. CME students now have a much broader pool of supervisors (each with their own specialisation) to choose from, as compared to the situation in which they can only choose CME supervisors. It must be noted that MBE does not have a similar provision.

7 Educational management bodies

As described above, when CME started in 2007, it was agreed that the faculties of ABE and TPM would support the CGE-hosted programme, a feature that resonates in their educational management bodies. By regulation, the CME Board of Studies has staff members from CGE, ABE, and TPM. The same applies to the CME Board of Examiners. In this way, CME shows openness towards input from ABE (and TPM) staff in its committees (and their subsequent decisions).

8 Conclusions

MBE and CME are distinct programmes with commonalities, including topics like project management, economics, construction and planning law, information management, procurement, and interdisciplinary cooperation. However, the programmes also differ from each other. For example, MBE focuses on the built environment in terms of buildings; CME focuses on the built environment in terms of infrastructure. It has never been, nor will it be, the objective to lose the specific identity of each programme since a distinct identity is important for higher education programmes (Nicolescu, 2009). For example, at student information sessions, MBE always pays attention to the *differences* between the programmes (see Table 1).

	MBE	CME
Object	Residential, office, urban development, retail, urban infrastructure	Large-scale infrastructure
Finance	Investment, assets (housing, portfolios)	Assets (infra)
Management	Personal skills, collaborative arrangements	Tools
Foundation	Designing/vision	Engineering/calculating

TABLE 1 Differences between MBE and CME

This situation of similar MSc programmes calls for substantive cooperation, benefiting from each other's strong points and looking for efficiency gains – in short, mutual reinforcement. The unattractive alternative is two stand-alone programmes when both can be better through collaboration, the path MBE and CME chose. Without a willingness to cooperate, the advantages would not have materialised, and both parties must be open to partnership. In the end, the readiness of persons to give precedence to the interests of students and efficiency are key. This process may take time and depends on personal attitudes.

This chapter has described the most important actions that were taken, but the steps toward cooperation reported here may very well not be the endpoint. 'Helping each other and helping yourself', while each programme retains its own identity, is a tempting perspective. The cooperation between MBE and CME outlined here may inspire other programmes in a similar situation.

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PATISSERIE
CONFISERIE
GLACES
SERVICE

Synchronising theory acquisition and practical knowledge in project-based learning through short weekly exams

Didactical choices in the 'Real Estate Management' course at TU Delft

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Abstract

In 2019, we introduced weekly exams in the 'Real Estate Management' course to improve the synchronisation of students' acquisition of practical and theoretical knowledge. The second implementation in 2020 confirmed the positive results of 2019, and weekly exams seem to be a valuable scaffold for project-based learning. In the following pages, we explain the motives behind this choice and describe the techniques that accompany its implementation and the students' evaluations. We shed light on its merits and issues using instruction theory.

Keywords

Project-based learning, weekly exams, scaffolding

COVER FIGURE Photo by Baslaan (Pixabay)

1 Situating the course

The 'Real Estate Management' (REM) course is a 7 EC course at the MSc level that runs at the Faculty of Architecture and the Built Environment of the Delft University of Technology in the second quarter of each academic year, lasting from mid-November until the end of January. It is a compulsory course for the circa 65 students of the first year of the MSc Management in the Built Environment track, for whom it runs parallel with a 7 EC course on housing policy. It is also an elective course for about ten students from the MSc Construction Management and Engineering track in the Faculty of Civil Engineering.
The course is about organisational real estate management and techniques for the strategic alignment of its demand and supply.

2 Structure

Since its introduction in 1991, the REM course has been using project-based learning (PjBL), meaning that students study and apply theory at the same time, a standard didactical method at the four technical universities in The Netherlands. At TU Delft, the academic year is divided into four quarters, each with a duration of ten weeks. Usually, lectures and project work take place from weeks 1 to 8; week 9 is a lecture-free week; and theory exams are held in week 10. Project-based courses can decide how this time is divided between theory and project and what their weights are in the final grade.

Since 2018, the REM course has opted for a 60% weight for the theory exam and 40% for the project report. The project assignment is executed in groups of three or four students, and all students receive the same grade for the group work. Their individual reflection, however, written in week 10, allows for a bonus or deduction based on the group grade.

3 Project-based learning

As noted above, project-based learning is an instructional active-learning approach where students learn by exploring real-world problems and finding answers through the completion of a project (Savery, 2006). 'Project-based learning offers student teams an authentic, engaging, and complex problem for which they have to design a solution or artefact based on data collection, assumptions, and further inquiries. Students apply and integrate concepts and procedures while improving professional skills' (Repko et al., 2017, cited in MacLeod & van der Veen, 2020, p. 1). Based on Adderley's (1975) definition, Helle et al. (2006, p. 288) describe two crucial aspects of this approach. First, projects must involve the solution of a problem, and second, projects commonly result in an end product (e.g. thesis, report, design plans, computer program, or model). Other typical characteristics of PjBL are that projects tend to take a considerable length of time during the course and require a variety of educational activities that guide students towards the desired outcome (Helle et al., 2006, p. 288). Larmer (2015) and the Buck Institute for Education see project-based learning as a broad category that could take several forms as long as there is an extended 'project' at its core.

TU Delft Calendar, Academic Year 2020/2021

1ST SEMESTER

Week no.	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	1	2	3	4
Week type	C	C	C	C	CT	C	C	CW	CWT	T	C	C	C	C	CT	C	V	V	C	CW	CWT	T
Teaching week	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	1.10	2.1	2.2	2.3	2.4	2.5	2.6	X-mas Holidays		2.7	2.8	2.9	2.10
Monday	Open. Acad. year	7	14	21	28	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25
Tuesday	1	8	15	22	29	6	13	20	27	3	10	17	24	1	8	15	22	29	5	12	19	26
Wednesday	2	9	16	23	30	7	14	21	28	4	11	18	25	2	9	16	23	30	6	13	20	27
Thursday	3	10	17	24	1	8	15	22	29	5	12	19	26	3	10	17	24	31	7	14	21	28
Friday	4	11	18	25	2	9	16	23	30	6	13	20	27	4	11	18	25	1	8	15	22	29
Saturday	5	12	19	26	3	10	17	24	31	7	14	21	28	5	12	19	26	2	9	16	23	30
Sunday	6	13	20	27	4	11	18	25	1	8	15	22	29	6	13	20	27	3	10	17	24	31
	September				October					November				December				January				

2ND SEMESTER

Week no.	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Week type	V	C	C	C	C	CT	C	C	CW	CWT	T	C	C	C	C	CT	C	C	C	CW	CWT	T
Teaching week	Spring	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	3.10	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	4.10	4.11
Monday	1	8	15	22	1	8	15	22	29	Easter Monday	12	19	26	3	10	17	Whit Monday	31	7	14	21	28
Tuesday	2	9	16	23	2	9	16	23	30	6	13	20	Kings day	4	11	18	25	1	8	15	22	29
Wednesday	3	10	17	24	3	10	17	24	31	7	14	21	28	Liber-ation Day	12	19	26	2	9	16	23	30
Thursday	4	11	18	25	4	11	18	25	1	8	15	22	29	6	Ascen-sion Day	20	27	3	10	17	24	1
Friday	5	12	19	26	5	12	19	26	Good Friday	9	16	23	30	7	Statutory Holiday	21	28	4	11	18	25	2
Saturday	6	13	20	27	6	13	20	27	3	10	17	24	1	8	15	22	29	5	12	19	26	3
Sunday	7	14	21	28	7	14	21	28	4	11	18	25	2	9	16	23	30	6	13	20	27	4
	February				March				April					May				June				July

SUMMER PERIOD 2021

Week no.	27	28	29	30	31	32	33	34
Week type	V	V	V	V	V	T	V	V
Summer period week	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8
Monday	5	12	19	26	2	9	16	23
Tuesday	6	13	20	27	3	10	17	24
Wednesday	7	14	21	28	4	11	18	25
Thursday	8	15	22	29	5	12	19	26
Friday	9	16	23	30	6	13	20	27
Saturday	10	17	24	31	7	14	21	28
Sunday	11	18	25	1	8	15	22	29
	July			August				

C =	Lectures and other teaching activities
CT =	Lectures and examinations BSc-programmes
CW =	Lectures / free week; varies per study programme
CWT =	Lectures/free week/examinations; varies per study programme
T =	Tentaminations / Resits
V =	No Teaching, Vacation or public holiday

30 August 2021: start Academic Year 2021-2022, week 35

FIGURE 1 The TU Delft academic year calendar 2020–2021, by TU Delft Education Services, 2021.

4 Main challenge

Since the beginning of the REM course in 1991, we have found it necessary to provide students with a series of scaffolds to achieve a 'doing with deep understanding' – a term used by Barron et al. (1998, p. 1). Scaffolding was initially defined as a 'process that helps a child or a novice to solve a problem, carry out a task, or achieve a goal which would be beyond his unassisted efforts' (Wood et al., 1976, p. 90). In the REM course, we have been using scaffolding in the form of externalised support: theory-based lectures, selected literature, contact with practitioners, case lectures, weekly studio work and tutoring, group monitoring, progress monitoring, interim reports with feedback, and revisions. These scaffolds prevent students from getting lost in open-ended investigations, leaving important questions unanswered (Land & Zembal-Saul, 2003, p. 66), growing overwhelmed by the amount of data (Hill & Hannafin, 1997), failing to monitor their findings and progress (Loh et al., 1998), and eventually becoming discouraged.

Scaffolds can either be delivered 'just in time' as a solution to a problem that occurs in the project (Helle et al., 2006, p. 305) or they can anticipate what will happen in the project. Anticipation has been the dominant approach in the REM course: first, we teach our students to differentiate, and after that, we teach them to integrate. For students, the main challenge is to engage with these scaffolds in a timely manner, particularly concerning theory and the relevant literature, as for many students, project work is closer to their natural interests. They prefer to solve problems rather than studying theory!

To avoid project quality suffering from students' procrastination and ensure that learning goals are obtained, the PjBL courses at our faculty often include exams to motivate students to engage with more theoretical discussions. Exams also allow the teaching staff to measure to what extent the learning goals were obtained.

5 Examination alternatives

Before implementing weekly exams, we had already tried two different approaches.

5.1 Single exam at the end of the quarter

The REM course first scheduled the submission of the project report in week 9 and held a single theory exam in week 10 (Figure 2). We trusted that students would study theory on a regular basis to avoid studying all course material at the end of the quarter. We provided a reading schedule and dovetailed the lecture content with the assignment stages. We hoped that through the project work, students would 'develop a need to know' (Barron et al., 1998, p. 290), but saw year after year that the students' engagement with the theory and literature was low. There was insufficient time pressure at the start of the quarter, and at the end, the project demanded all of the students' attention.

As a consequence, many students failed the theoretical exam and the project report. In the course evaluations, students often mentioned that they did not realise on time that the theory closely followed the

assignment, and they regretted not having studied the theory parallel to their project development. On the side of the teachers, we observed that a single exam at the end allowed for a rather sloppy lecture and literature content.

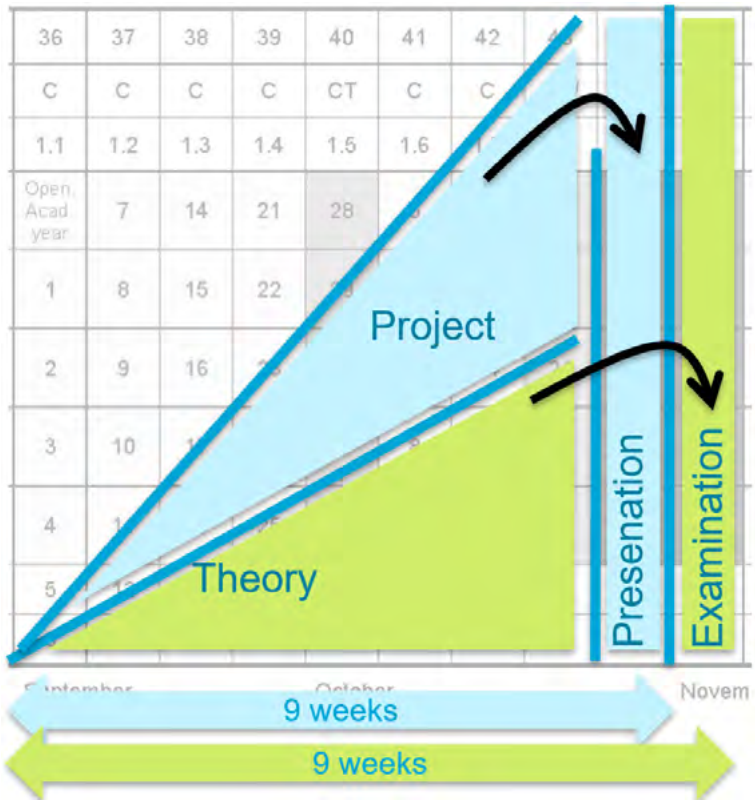

FIGURE 2 Single exam at the end of the quarter, by Herman Vande Putte and Ines Labarca Hoyl, 2024.

One-off assessments have raised many pedagogical concerns, particularly concerning the reliability of these assessments (Popkova, 2018). Single exams also have limited fairness, e.g. students do not have enough time to study because they have exams for other courses at (almost) the same time. Students also have different rhythms: some learn quickly, but others need more time. Also, students tend to delay studying until just before the examination (Kerdijk et al., 2015), leading them to use superficial approaches to learning instead of adopting deep learning methods. In short, students attempt 'to retain the information until the exam is over simply to pass the course' (Tuunila & Pulkkinen, 2015, p. 671).

5.2 Single exam in the middle of the quarter

Based on our observations and the course evaluations of the students, we decided in 2013 to move the theory exam from the end to the middle of the quarter (Figure 3). This shift divided the quarter into two more or less equal parts. The theory was acquired in the first 3 or 4 weeks and was followed by an exam in week 4 or 5. The project took place from week 5 or 6 until the end of the quarter.

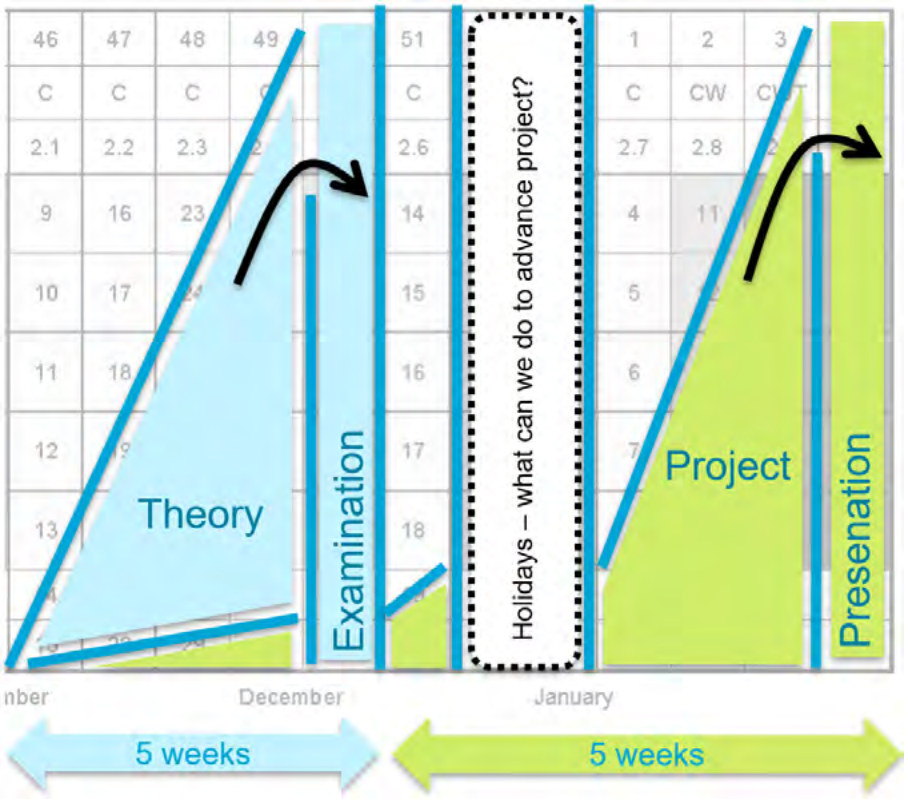

FIGURE 3 Traditional learning combined with an exam in the middle of the quarter, which includes two weeks of Christmas holidays, by Herman Vande Putte and Ines Labarca Hoyl, 2024.

This division worked like traditional learning, where theory and project are considered separate processes. Some traditional learning approaches claim that theory should be explained and assessed before any practical application (Figure 4). At the faculty, this traditional learning approach is used in several bachelor courses in which a significant amount of theory is to be acquired. The content of these classes is then coordinated with the design courses in the next quarter, where the acquired theory is applied. Traditional learning can also be mixed with project-based learning during the same quarter, introducing the project from the beginning but focusing mainly on theory during the first weeks of the quarter, ending with an exam, and then shifting fully to the project phase, which concludes with a presentation (Figure 3).

Until 2018, the REM course was structured according to this 5+5 week scheme (Figure 3). However, we discovered that a significant disadvantage of this scheme is the short incubation time. Deep learning is not easy – it requires students to draw meaning from the theoretical concepts they study, a cognitively complex exercise that requires time. Addressing too much content in a short period can result in cognitive overload, making it hard for students to digest the meaning of the concepts in depth. Incubation time, as opposed to work time, is hard to compress. It is the time someone needs to understand a topic. Leaving time for the incubation of questions and problems has been positively related to better and more creative solutions (Brodt et al., 2018; Gilhooly, 2016; Tsenn et al., 2014).

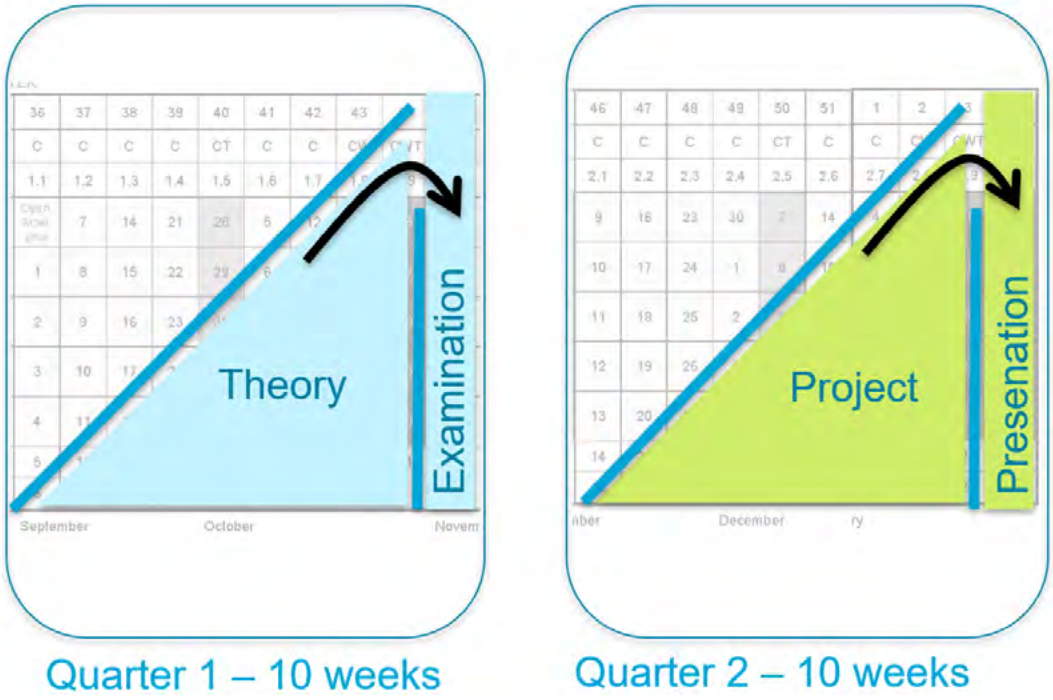

FIGURE 4 Traditional learning spread over two consecutive quarters, by Herman Vande Putte and Ines Labarca Hoyl, 2024.

5.3 *Short weekly exams*

In 2019, we came up with the idea to schedule theory acquisition and the assignment in parallel from week 1 (Figure 5). Short weekly exams that replace the exam at the end or the middle of the quarter would prevent procrastination and better synchronise theory acquisition and application than traditional learning while respecting incubation time. This approach is known in the literature as 'cumulative assessment'. This approach deals with many issues of the one-off assessments described above.

At the start of the course, tutors present the assignment and the relevant theoretical foundations. During the weeks that follow, they combine case information and theory to maximise students' learning experience and project progress. Thus, the entire quarter serves as a positive incubation time for their project.

All weekly exams – eight in total – are open-book tests. The weekly exams focus on that week's theory but builds on the theory of all weeks before. Each exam is graded before the next exam takes place. Students receive a weekly overview of their performance. The correct answers and grading templates are provided, and teachers give feedback in class every week.

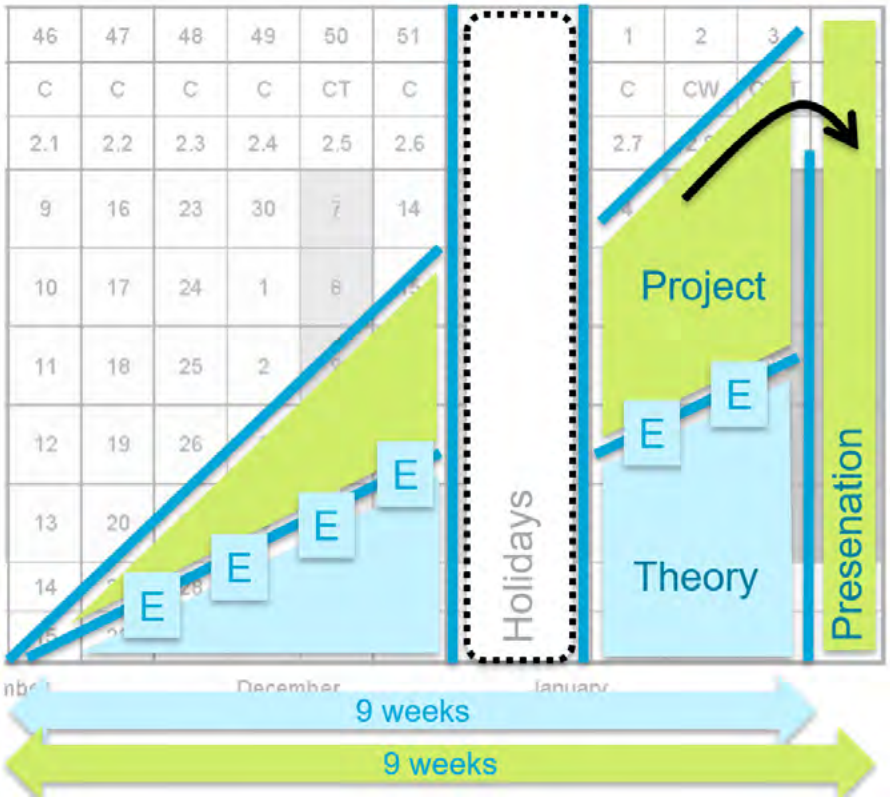

FIGURE 5 Theory and project run in parallel from the start of the quarter, and weekly exams keep them synchronised, by Herman Vande Putte and Ines Labarca Hoyl, 2024.

5.4 Exams build on each other

Since the exams build on each other, they have both a formative and a summative component, which means that each exam is an assessment *for* learning while it is an assessment *of* learning. The formative component allows students to act on the feedback they receive and improve during the later assignments. This approach permits both teachers and students to identify misconceptions early on in the course, allowing them to take on-time remedial actions before the course ends.

Allowing students to have incremental experiences of success could promote students' sense of competence. According to Ryan and Deci (2000), feeling that you are competent enough to achieve the required task is essential for sustaining intrinsic motivation.

5.5 Choosing the best six out of eight exams

One of the risks of including too many exams in a course is that students might become overwhelmed by the high academic workload, which could also hinder their sense of autonomy, leading to lower intrinsic motivation (Ryan & Deci, 2000). To buffer this effect, we decided that only six of the eight exams would count towards the final grade: the best of weeks 8 and 9 to ensure students do not stop studying after the

sixth exam and the five best of the remaining seven. The six selected exams have an equal weight in the final grade, adding an element of autonomy for students and allowing them to decide how to streamline their efforts during the course. This method has the additional practical benefit of counterbalancing illness or absences.

5.6 Offering a variety of assessment methods

During the course, exams and exam questions vary in format. Most are individual, but some are group exams. They can include multiple-choice, short open-ended questions, or a mix of both. Towards the end of the course, the expected answers grow into short essays. Having a wide variety of methods and content assessed increases the reliability of the course's evaluative strategy. Whereas in a one-off summative examination, students may obtain a higher grade because of merely being lucky to have received a question they know best, continuous cumulative assessment takes account of every topic learned in all the variety of tasks and, therefore, is a more accurate reflection of a student's overall attainment (Popkova, 2018). Also, the variety of formats used for testing could be considered more inclusive, as they provide students with diverse opportunities to demonstrate their abilities and maximise their potential (Brown, 2005).

5.7 Distributing the course workload

Usually, the ends of academic periods tend to be busier for students who have more than one course running in parallel. Frequently, courses tend to have higher workloads towards the end. By distributing assessments along the course, these very intense workload 'peaks' for students are avoided. Further, there is scarce evidence that cumulative assessment, compared to one-off assessments, leads to higher performance in the short-term grades of students. However, some researchers hypothesise that there might be differences in long-term knowledge retention (Kerdijk et al., 2015).

Related to the above, studies have described the spacing effect in learning. When learning is compressed into a too short period, *''it is likely to produce misleadingly high levels of immediate mastery that will not survive the passage of substantial periods of time''* (Cepeda et al., 2008). A persistent finding is that distributing learning events over time promotes retention to a greater degree than massing learning events together in immediate succession (Vlach & Sandhofer, 2012).

5.8 Increased relevance of the theory

During the course, students apply the theories they have learned to their group projects on a weekly basis. This practice increases the relevance of the content learned each week and can promote students' motivation, as described in the ARCS model by Keller (1984). Also, by immediately being able to apply this content, students can feel an increased sense of reward or satisfaction (Keller, 1984).

6 Evaluation

One of the main benefits of introducing weekly exams in the REM course was the higher success rates of students. Due to this method, all students immediately passed the course in 2019 and 2020 – the theory part and the assignment part – which exempted us from needing to schedule re-examinations. Additionally, the level of the course significantly increased. Without a doubt, the workload for staff increased due to the weekly exams. However, there is no longer a final exam to be designed or graded.

After running the new format in 2019 and 2020, we began to see a much better learning experience. The positive outcome is already shown in the first runs, which is notable. Further, there seem to be limited setbacks due to this innovation. Students positively evaluated the method, though some felt that six or seven exams instead of eight could lead to the same positive learning experience.

7 Conclusion

Project-based learning, as applied within the REM course, suffered for many years from students engaging too late with the theoretical dimensions of the course offered to scaffold their project work. Moving the theory exam from week 10 to week 5 had significant disadvantages and did not solve the issue. Subsequently, we introduced short weekly exams. After two runs, these seem to serve the synchronisation of the students' theory acquisition and theory application well in the project and have limited drawbacks. Students twice judged the innovation positively. This type of cumulative assessment – when analysed from the learning sciences – indeed contains a formative and summative component, supports students' motivation, allows for a greater variety of assessment methods, better distributes the students' workload, and increases theory retention and learning satisfaction, which together explains their appreciation.

8 Postscript

This paper was written in 2021. In autumn 2021, the Real Estate Management course and the Housing Policy course have been merged to form a 10 EC course. The content of the course has been adapted. However, the didactics, including project-based learning and weekly exams to synchronise the acquisition of theory and its application, were continued. At the end of 2024, when this paper was prepared for publication, the merged course had run three times, and student performance remains high.

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CERTIFICATE

New educational experiment with a human-centered focus on sustainable built environment curriculum

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Abstract

Understanding human decisions and management of stakeholders in the built environment is key for sustainability transitions, and teaching these principles has garnered attention from educators and students alike, both nationally and internationally. In the summer school program 'Sustainable Housing from a European Perspective', we adopted the 'Human as a Core' principle as an experiment, aiming to motivate students to reflect upon built environment management challenges. Human-centric knowledge, viewed through a European perspective, can help students worldwide apply knowledge to their local context, reflecting on overarching principles across cultures and institutions. Consequently, we introduced a cross-topical programme employing active teaching methods such as games, lectures, workshops, and field trips. Top-down, students translated theory into practice using a generic case, and bottom-up, a blended classroom facilitated the deconstruction of knowledge within a local project context. By combining both approaches, students' knowledge could horizontally expand across disciplines and continents.

These approaches were tested and improved in a range of educational initiatives, ranging from a series of TU Delft summer schools for international students to tailor-made approaches for Chinese students (Chongqing University Summer School) and collaborative efforts aimed at fostering local knowledge development with Chinese students in a specific local context (Xi'an, China). Future endeavours will involve leveraging these experiences to further develop an education curriculum centred on Human-centred sustainability in the built environment and to support educational programmes on sustainable human habitats tailor-made for the international and local contexts.

Keywords

Sustainable built environment, management, human-centered, Sustainable Housing from a European Perspective (SHEP), summer school, education

COVER FIGURE Photo by Christel Swarttouw-Hofmeijer

1 Introduction

Universities have a moral and ethical responsibility to develop and facilitate the use of new technologies to empower society, particularly with regard to social change and social justice (Kamp, 2020). The possibility of changing higher education in the context of sustainability needs depends on widespread and deep learning within the higher education community (Sterling, 2004). More specifically, the development of sustainability in the built environment is inherently linked with changing technology management practices as used by demand, supply, and policy actors. Therefore, education on sustainable housing requires a close relationship with and knowledge of these stakeholders and their practices to suggest and implement needed transitions. Moreover, it demands the knowledge of the most up-to-date innovation and experimentation on sustainable housing, balancing international contexts and local applications. Teachers are challenged to stay curious and open-minded to absorb fast-changing practices and develop a periodical review of their education with continuous observations from ongoing scientific research. Educators with multidisciplinary research expertise, as well as experiences from innovators, can help the design of a holistic curriculum or course.

Ideally, education, research, and practice should strengthen each other in a continuous loop to keep students up to date with recent knowledge and hands-on experience to validate theory through practice, especially for the themes of sustainability and sustainable housing. Given the fast advancements in sustainable technologies, design solutions, policy intervention, behavioural nudges, and management practices, there is a constant need for renewed and flexible curriculum design. Adopting innovative solutions and sustainable measures by both construction stakeholders and end users demands a systematic and holistic review of institutional and behavioural changes. If education on housing and the built environment is to support the much-needed sustainability transitions and make an impact, it must be integrated into the curriculum.

This contribution outlines what we learned from bottom-up and top-down initiatives in implementing a sustainable built environment through a human-centered approach. Bottom-up educational initiatives show that knowledge about the behavioural change and decisions of end users and stakeholders in the sustainable built environment, citizen engagement, ownership, property rights and justice in the energy transition, participatory planning and design approaches, transition policies, stakeholder experiences, business models, and management practices from a European perspective can help students across the globe. More specifically, they can learn to apply knowledge to their local context, reflecting on the overarching management principles across stakeholders, institutions, academic disciplines, and cultures. On the other hand, top-down initiatives show that while the university has a vision of incorporating sustainability into its curriculum, integrating human-centred sustainability in education regarding the built environment remains challenging.

The methodology of this experimental educational approach, as demonstrated in the international summer school 'Sustainable Housing from a European Perspective (SHEP)', serves as a model for interactive learning through games and ongoing projects that simulate real-life scenarios. Given that sustainability is a global goal that needs to be implemented locally, educating international students on an ongoing Dutch project necessitates blending with cases in which the principles can be shown from real-case demonstrations. Moreover, we encourage students to test sustainability principles within a specific local context and to showcase demo exemplars that they can deconstruct to analyze decision-making processes, lessons, and choices that fit local cases. The students are turned into educators at the end of the course, sharing their learning insights in applying principles within their local context. The educational goal is to prepare future professionals with immediate knowledge and a flexible mindset to adapt know-how to real applications. With such methodological capacity, students can be prepared to make meaningful contributions toward achieving sustainable goals in their future professions.

2 Approach to management in the built environment

Building management education is strongly linked to social, economic, policy, and environmental developments. The sustainability of the housing stock and the development of adapted housing management and renovation strategies are important issues in the study of management in the built environment. The various housing scales (dwelling, housing estate, neighborhood, urban, regional, national, European) and stakeholders' interests (user demand, affordability, and ownership relations; suppliers' capabilities and strategies; policy goals and welfare state principles) result in complex building, portfolio, and neighbourhood management challenges.

Therefore, there is a growing need for students to be able to define sustainable housing challenges across various scales and in relation to social, economic, policy, and environmental developments. As a learning goal, they should be able to analyze and develop management strategies, particularly from the perspective of various stakeholders and professions.

To support such learning objectives, teaching activities need to explain and illustrate:

- Policy developments, particularly showcasing the effect of recent housing and energy policy measures on housing management practices;
- Existing housing management strategies from an environmental sustainability perspective, particularly analyzing factors influencing the adoption of measures and strategies;
- Housing developments from a management perspective, particularly analyzing the role of various stakeholders in implementing sustainability goals.

Given the growing importance of renovation of the existing building stock for achieving environmental sustainability goals, the teaching activities related to building management should specifically exemplify opportunities and the elimination of barriers for sustainable housing renovations, particularly looking at:

- The impact of changing policies on decision-making, with a focus on the implementation of innovative measures and processes to increase the environmental sustainability of the housing stock;
- The business models of stakeholders with a focus on solving split-incentive (tenant-landlord) problems and identifying financially viable business cases that are applicable for market upscaling;
- The influence of stakeholder interests on management practices and the opportunities for stakeholder dialogue;
- The process and product innovations needed to scale up by shortening renovation lead times and lowering total cost of ownership (TCO) and transaction costs.
- The strategies to match the demand and supply, public-private-civic collaborations organized, and policy dealt with volume uptake of energy renovation for existing building stock.
- How can we better anticipate participation, co-creation, environmental behavior, and cognitive biases of stakeholders such as homeowners, tenants, real estate managers, housing associations, and investors?
- How can we use energy data of buildings, renovation costs, and household characteristics to increase environmental behavior, customer confidence, quality, and energy performance guarantees?

Real-life examples of social practices to improve the development, affordability, and sustainability of housing renovation at various scales.To deal with the above-mentioned learning objectives, the development of related teaching activities was explored from 2016 onwards by experimenting with educational

approaches in various editions of 'Sustainable Housing from a European Perspective' summer schools. Our aim was to introduce simulations, as they can support an understanding of transition processes in a safe and playful environment for students and experts to jointly experiment with process challenges (Bekebrede et al., 2018). The previously developed CO2Zero Game was included, and a new Tender Game was introduced. Each edition was improved based on evaluating previous iterations. The summer school attracted a mix of 20–25 participants from all over the world at Bachelor, MSc, and PhD levels, and it was facilitated by multiple teachers from TU Delft. In the next section, we discuss some of the specific experiences and milestones encountered during the development of these summer schools.

3 Experiences with 'Sustainable Housing from a European Perspective' summer school curriculum design

Sustainable Housing, from a European Perspective, a two-week summer school curriculum design introduced a new educational concept. The Sustainable Transformation Tender Game (STTG), the core group project organized in two weeks, was a major leap in active teaching. In a competitive setting, student groups were asked to develop and defend a plan for a sustainable housing renovation. Groups of four to five students were mixed based on nationality, educational background, and gender. By engaging students in discussions and guiding their reflections on scientific material, instructors assumed roles as facilitators and collaborators rather than sources of authority (El-adaway et al., 2015). Groups of students were tutored and moderated by senior teachers. The tutors continuously supported the students in looking simultaneously at the social, technical, economic, and environmental performance of a proposed multi-stakeholder strategy for renovating an apartment building. Proposals regularly reflected the need for collaboration, partnerships, and innovation.

Interaction with practice was also provided by visiting a project site involving residents, professionals, and staff, as well as a building innovation centre.

The STTG was evaluated highly as being interesting and maintaining students' attention, providing valuable, accessible knowledge, and leaving enough time for questions and interaction. Students expressed that they had learned a lot about sustainability from technical, social, financial, and management perspectives, taking into account the dynamics of stakeholders, innovations, and interactions among team members. As one student wrote: 'It…combined all the economic, technical, and environmental solutions the best'. Related to the (intensity of the) teamwork, some students mentioned that they had forged friendships for life, and they highly appreciated the availability of staff.

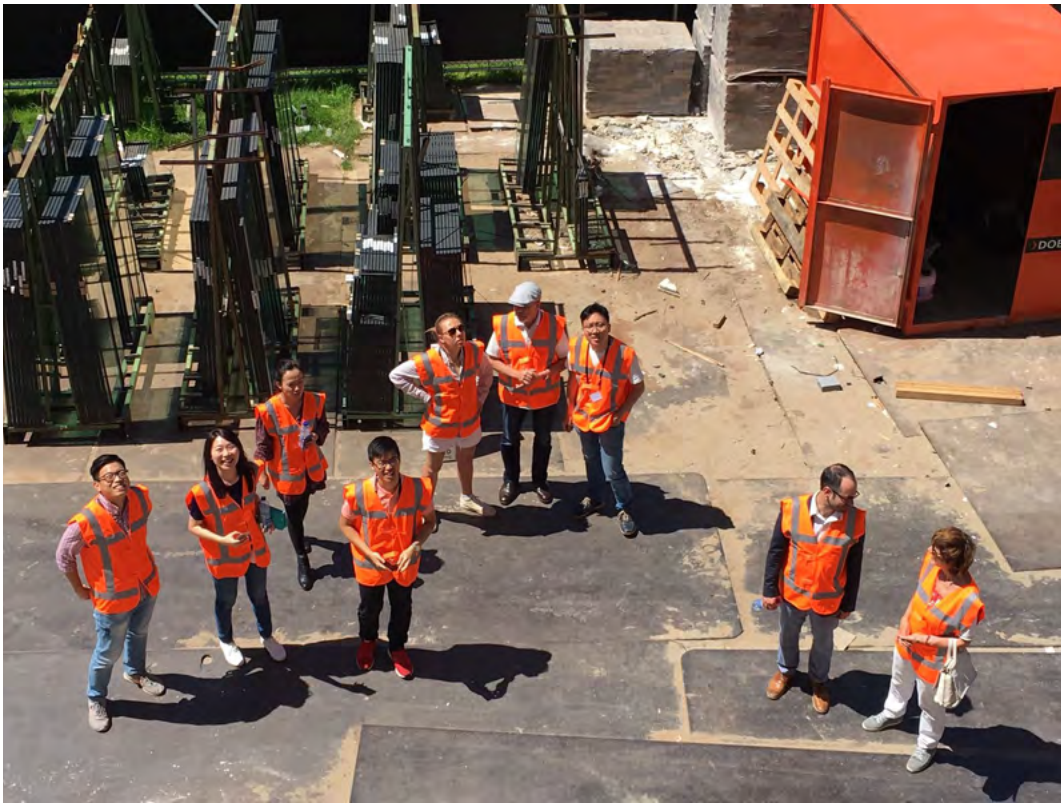

FIGURE 1 Learning from practice: site visit, by authors, 2024

A new educational challenge was that students from various backgrounds (e.g. design, economics, policy) worked together intensively. There was also a mix of Bachelor, MSc, and PhD students. The students were given the freedom to choose their own groups of four to five students. However, this option led to an imbalance in the working group's composition, and therefore, more effort was asked from students and tutors to connect to the strategy development activities of each individual. The tutors were challenged to address students' concerns and explain the process of the game on the go during each session. A lesson learned was that the course organizer should carefully prepare the team composition before the start. Some students also suggested using a social group per team for sharing information and sending targeted input.

Further, the assessment procedure was still evolving during this edition, resulting in the idea of having the students present their final results to a fictitious jury consisting of multiple types of stakeholders. In addition, most students spent their evenings working on the game, which gave them little time to relax and resulted in a stressful last day to wrap up the assignment, considering all the new input they received from lectures. Both students and teachers observed that some summer school lectures were scheduled too late to create significant input for the STTG.

Overall, all teachers agreed that the STTG was the most successful part of the summer school, generating a lot of enthusiasm from both students and teachers. They also agreed that the scattered programme needed to be changed according to the comments. An important tip from a student to increase the time for the summer school to two weeks was also taken very seriously. The various lessons were implemented in later editions.

FIGURE 2 STTG groups in action, by authors, 2024

During the following years, the summer school was rearranged into a two-week period, which was more effective and matched students' level of education. Mixed student teams were now composed based on their CVs and previous experiences, appointing the person with the most experience as a team leader. Social media were introduced for students to exchange course and social information. The lectures were remastered and reordered to provide input for the SSTG: Winning the Tender was developed to be a core objective of the whole summer school. The scheduled involvement of staff for the STTG was optimized, including relative flexibility of expert staff and time for organizing additional group tutoring activities. The STTG began clearly and ended with a summative evaluation, from introducing the assignment and forming the groups to how the jury takes up stakeholder roles for evaluating predefined award criteria. The game was now organized into four (day) parts, plus an evaluation with a final tender presentation and a final evaluation to discuss the lessons learned during the whole course.

A new component that students had to prepare was a summary of the takeaway messages for local development. The course's games and dynamics enabled students to apply lessons to their own national contexts, an approach that led us to recognize that there might be cultural sensitivities related to the educational methodology and the proposed sustainability strategies.

FIGURE 3 Students presenting their final strategy to win a tender, by authors, 2024

4 Moving the school to a local context: China

The 'Sustainable Housing from a European Perspective' summer school, held annually in Delft, has gained an international reputation throughout the years. We have received requests from other universities in China to design a similar curriculum with an integrated local context for a one-week summer school by Chongqing University China, to be hosted at TU Delft. It was tailor-designed based on the success of the existing summer schools, with a combination of lectures, site visits, and a group project. In this case, different group dynamics were observed, which helped us to tailor our program to the target students from Chongqing University, and the course was well received and was successfully held consecutively for three years till COVID-19.

In 2019, the demand and interest from students in China and collaboration with Chinese partners challenged us to organize the course in China. A summer school team and curriculum were designed and moved to be locally taught at Xi'an University of Architecture and Technology in August 2019, attracting 32 enthusiastic Chinese students from several universities across the country for an intensive eight-day programme. This edition also provided an opportunity for us to explore new ideas: students were challenged to connect with local residents to understand their renovation needs and to interact with speakers during a high-end policy development workshop.

FIGURE 4 Site visit in China with students interviewing in a Xi'An residential neighbourhood, by authors, 2019

Raising awareness among recent Chinese graduates and involving Chinese professionals, particularly through a local project case, had a significant impact not only on how students perceived sustainability challenges but also on a societal level in terms of potential changes to the local construction culture. For example, in the past 25 years, China has focused on the massive production of new housing estates with often limited quality. Today, together with more attention to sustainability for newly built constructions, China is challenged to improve the quality of the existing building stock. Our summer school raised awareness among the students and professors, and they became enthusiastic about our Dutch approach. Testing the programme in another country also gave us hope that our educational efforts can boost a more sustainable built environment in other countries, like China, by bringing together local education programmes, research agendas, and practical applications.

5 Discussion: Educational challenges and opportunities

5.1 Academic skills for managing transitions

This programme highlights both opportunities and challenges in addressing much-needed skills development for management in the built environment, particularly concerning housing renovation needs. At the same time, students acquired important management skills such as analysing the sustainability literature and related expert input, working in multidisciplinary teams, developing formal and informal relations, presenting skills to convince an external jury, and using knowledge in personal contexts.
The opportunity for students to regularly 'shine' during presentations while also being open to making mistakes and recognising their own limitations compared to their peers fostered an environment where students learned to consider each other's perspectives, integrate feedback from peers, professionals, and experts, and cultivate a sense of pride and self-confidence.

5.2 Interdisciplinary and transdisciplinary education

The experiments showed the feasibility of working with people from different backgrounds and education levels within teams, across and beyond departments. The course theme allows and stimulates work with guest lecturers from relevant industries and international universities, including field trips guided by practitioners. Working with multidisciplinary student groups of various knowledge backgrounds is very helpful for interpreting various 'languages' and stakeholder perspectives (Rooij & Frank, 2016). Enthusiasm for such an unbounded way of working was evident among students, professionals, and teachers alike. Furthermore, working with colleagues from other universities proved successful, particularly in attracting international students.
An overarching sustainability theme inherently supports co-creation (Rooij & Frank, 2016). The summer schools illustrated that new platforms and educational resources can be developed through co-creating an integrated and multidisciplinary curriculum. Colleagues across departments were brought together, integrating their expertise on sustainable housing topics, encompassing technological, financial, economic, management, policy, social, design, institutional, behavioural, and other perspectives.

5.3 Online/blended education

The summer school 2020 had to be cancelled due to the Covid-19 pandemic, and we are now challenged by developing opportunities for online participation. Combinations with in-person education might be a barrier. On the other hand, it might be easier to connect and work together with multiple students, professionals, and teachers from various countries. Also, ideas emerge to integrate learning experiences from previous students and address how they used the knowledge in their own countries and professions.

Students, stakeholders, and multiple teachers looking at the same subject – sustainable housing renovation – also find it a holistic exercise to put all the pieces of the puzzle together, resulting in lively debates on international boundaries and constraints for process innovation. Additionally, it helps create an understanding of the position of various stakeholders and their collaboration in sustainable housing processes.

6 Lessons for education at BK TU Delft

The summer schools provided an ideal 'experimental' setting where we could test and refine teaching approaches and work with people from different backgrounds and expertise to co-create education. This process resulted in tangible local outcomes, international educational initiatives, and valuable learning and teaching experiences. As part of this experiment, a one-week summer school was also tailor-made for Chongqing University, China, initially held at TU Delft and later on-site at Xi'An University. In this course, students were also challenged to connect with local residents to understand their renovation needs and to interact with speakers during a high-end policy development workshop.

The above illustrates the gradual enhancement of educational activities. Sustainable housing attracted students from all over the world at all levels of education. Government officials from Africa worked in groups with architects from Russia, Chili, India, and Saudi Arabia. Chinese PhD students teamed up with urban planners from Brazil, the United States, Australia, etc. It is not only a cultural exchange – it also challenges participants and teachers to broaden their knowledge beyond local practices, facilitating international networking.

We gradually learned through experimenting with active teaching methods in a multidisciplinary and international setting. As educators, we were challenged to evolve into enthusiastic moderators in a playful environment, continuously encouraging and engaging students through inspiring expertise, learning by doing, and appropriate feedback. The summer schools brought together the expertise and knowledge of our faculty into a holistic programme on sustainable housing, including technology, management, affordability, economics, behaviour, policy and governance, and so on. Seventeen faculty members across the four departments worked together in fascinating discussions and interactions with the students. Students showcased their best performance in an overarching tender game project to persuade a jury and their peers that their design and business plan were the most promising. We were amazed by the dynamic engagement of both students and teachers in supporting mutual knowledge transfer in such a process, as well as in translating know-how into a local context.

We observed that behaviour change, spatial justice, value creation, citizen engagement, adaptive management and business thinking, and institutional revisions are needed to safeguard the transition towards a sustainable housing and built environment. Research findings in this field should be shared globally, particularly with the younger generations, who will have a tangible impact. As scientists, we must better connect with students and practitioners to effectively transfer the knowledge to those who will turn international lessons into daily practice and local implementation. Sustainability is not solely a research issue – it should be integrated into training and educational programmes accessible to practitioners (to-be) and a broader audience, such as students from less-developed countries.

Inter- and transdisciplinary education and research for sustainable management in the built environment hold significant growth potential. It can foster professional empathy and better understand and manage stakeholders' concerns. Experimenting with the summer school was very helpful in designing creative new teaching modules that can also be used in regular educational programmes. This tested educational approach values knowledge and is a very effective way to take on sustainability issues within a global context. Individual care and concern make a difference, and international students play a crucial role in spreading awareness and messages within their home countries.

An integrated course on sustainable human habitat can help reflect our vision of sustainability and serve practical management education needs in a rapidly changing policy, business, and housing environment. Such a programme must be subject to regular review based on up-to-date practices, methods, and international developments. It is important to continuously keep an open mind and stay flexible when planning such a programme. Educational initiatives that are more playful and interactive, where technology and design are less intimidating, are much appreciated in practice. Such a programme also needs to integrate sustainability education, which is currently scattered within our faculty and beyond.

Our vision is, a dedicated course focusing on Sustainable Human Habitat from the basis of the summer school SHEP deserves its own space within education. The new course will showcase further efforts to experiment in education and explore new approaches to international teaching in a highly dynamic context. A course will enforce bottom-up and top-down communication, exploration, and co-creation, fostering connections between the updated research, education, and the circular local–international cycle. It will maintain 'human as the core' in educating future generations, empowering young professionals and students to apply learned principles to various local contexts. Moreover, it will facilitate essential institutional, management, and behavioural changes in the local context where social and process innovation should take place to facilitate technological innovation in the sustainable energy transition in the built environment.

FIGURE 5 Snapshot of the happy moment of SHEP 18 Cohort, by authors, 2024

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INZICHT

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INSIGHT

Academic skills for architects

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Abstract

The book *INSIGHT* focuses on academic skills for architects, in particular for bachelor students. It has proven to be valuable for the BSc programme in Architecture, Urbanism, and Building Sciences (*Bouwkunde*): for the students as learning material, for the authors and editors due to the collegial process of development, and for teaching staff as a book to use as a reference. The basic four-part structure allows for new contributions based on changes in the curriculum: [part one] Architecture as a scientific discipline, [part two] General academic skills for architects, [part three] Specific architectural skills and research methods, and [part four] Academic skills in practice. The book has supported exchange among the throughlines (*leerlijnen*) within the curriculum and collaboration among colleagues. Challenges remain: keeping the book updated as an open learning resource, tracking curricular developments, and creating additional learning materials.

Keywords

Academic skills, methods, research, design, bachelor

COVER FIGURE Cover of the book INSIGHT, Academis skills for Architects, by Remon Rooij, Sake Zijlstra, and Willemijn Wilms Floet, 2022.

1 Introduction

Architecture (in Dutch: *Bouwkunde*) is a practical engineering science that focuses on studying socio-spatial-technical issues in the built environment. At TU Delft, the field of architecture builds on many subdisciplines, such as architectural design, urban design and planning, landscape architecture, building technology, geomatics, and management in the built environment. Thus, when developing learning materials about academic skills for architects (in Dutch: *bouwkundigen*), we are faced with some challenges. Within our field(s) and departments, there is a large variety of ideas and opinions on what an education in architecture entails and requires, and on the relationship between research and design.

This contribution presents the experiences in the development of the book *INSIGHT: Academic Skills for Architects* (in Dutch: *INZICHT – Academische Vaardigheden voor Bouwkundigen*; Hoekstra et al., 2022; 2024), which has been written by many colleagues from our community in Delft for the education of our bachelor students. This chapter aims to present the motivation for the book, its contents, and the development process, then to reflect on its usage, value, limitations, and potential next steps.

2 Faculty background

The Faculty of Architecture and the Built Environment renewed its BSc Bouwkunde curriculum in 2012–2013. The aim was to improve studyabililty (*studeerbaarheid*), efficiency (*doelmatigheid*), and the academic profile of the BSc and to accommodate changes in the profession (Van Ees, 2012). The effect of the curriculum renewal was evaluated in terms of study success (Mudde et al., 2017). The success rate 'propedeuse-in-1year' went slightly down in the first year, but the 'BSc-in-3year' went slightly up. Student and teacher satisfaction went up significantly. Another measure of that time was the introduction of a registration cap (numerus fixus), with a maximum of 400 first-year bachelor students.

The renewal introduced 24 bachelor modules consisting of 10 or 5 ECTS each. Students take no more than two modules at a time. Six throughlines (*leerlijnen*) were introduced to address the different main programme themes (Figure 1): Fundaments of Bouwkunde (*Grondslagen*; 20ECTS), Technology (*Techniek*; 25ECTS), Society, process, and practice (*Maatschappij, proces en praktijk*; 15ECTS), Design (*Ontwerpen*; 60ECTS), Representation, visualisation, and form (*Overdracht en vorm*; 15ECTS), and Academic skills (*Academische vaardigheden*; 15ECTS).

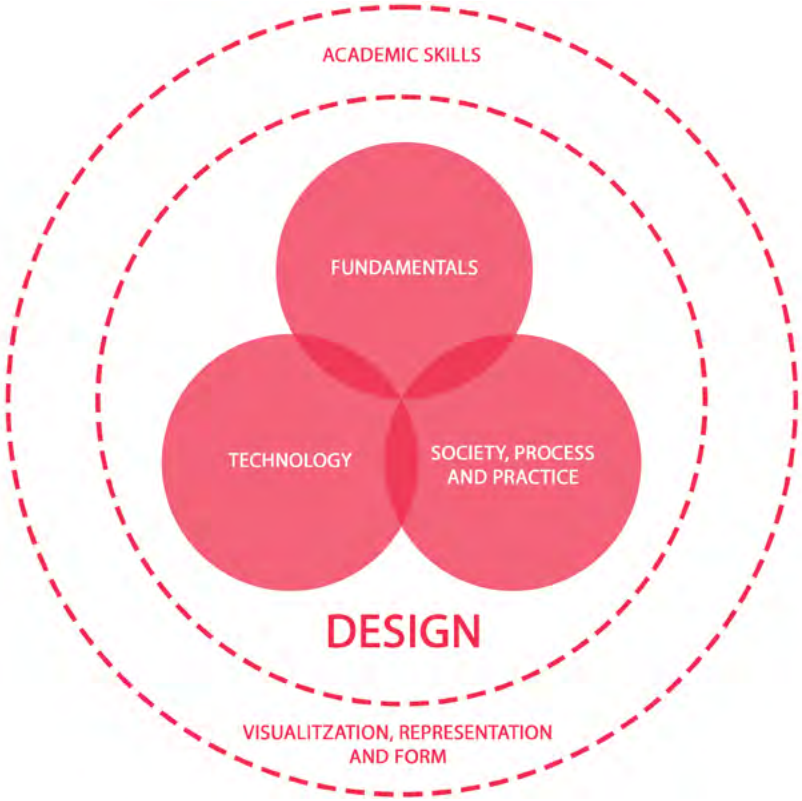

FIGURE 1 The 2013-2024 curriculum concept with 6 throughlines: Academic Skills (AC); Visualisation, Representation and Form (OV); Fundamentals (GR); Technology (TE); Society, Process and Practice (MA); and Design (ON), by author adapted from information of the Faculty of Architecture and the Built Environment, 2024.

FIGURE 2 The curriculum organisation of the 6 throughlines in 24 modules (150EC in total), and the 30 EC minor elective programme composing the bachelor Bouwkunde degree programme of the Faculty of Architecture and the Built Environment at TU Delft, by author adapted from information of the Faculty of Architecture and the Built Environment, 2024.

The 2012–2013 Bouwkunde bachelor renewal brought many curriculum changes to our students and teachers (Mudde et al., 2017; Rooij, 2016). With the new 15ECTS throughline on academic skills, three 5ECTS modules specifically address architecture as a scientific discipline. However, the teaching and learning of all those academic skills occur logically in all six throughlines and throughout the curriculum.

Students graduating from the BSc Bouwkunde can directly continue in one of our MSc degree programmes, and most students continue on to one of the tracks of the Architecture, Urbanism, and Building Sciences degree programme (see Zijlstra (this issue-#) for more details about the relation between the BSc and MSc curricula). The Bouwkunde bachelor curriculum is taught in Dutch. The MSc curricula are taught in English and attract a large number of international students each year. Consequently, an English version of the book would contribute to clarifying the desired academic skills to study in the MSc tracks.

3 The what and why of *INSIGHT*

The 2018 programme visitation and (re)accreditation directed attention to the academic and research skills of our bachelor students, in particular in connection to design (Qanu, 2018). The committee advised giving research and research methodology a more prominent and clear position in the curriculum and the intended learning outcomes (Qanu, 2018). Within the faculty, the introduction of a book on academic skills for architects was seen as one way of embedding and drawing more attention to research skills in the curriculum. The initiative for the book came from the faculty's bachelor's degree programme leader at that time.

The book *INSIGHT* clarifies the pivotal academic skills for architects, in particular novices, beginners, and advanced beginners (Lawson & Dorst, 2009). It serves as a starting point to find references for further reading and sets the bar: this is what is expected from Bouwkunde BSc students in terms of academic skills. However, this book is not only meant as a handbook for Bouwkunde BSc students – it is also intended to help Bouwkunde BSc tutors further academicise the design-oriented curriculum. More specifically, it helps tutors understand what academic skills students have acquired in other throughlines or modules. In this sense, the book might bring tutors closer together as colleagues. Additionally, it sets the bar for our national and international students who enter one of our master programmes or one of our bridging programmes.

The book consists of four parts. First, it sets the scene by presenting architecture as a scientific field within the engineering sciences, and second, it presents general academic skills for architects and conventions of scientific approaches to work. Second, it elaborately focuses on architecture-specific academic skills and research methods, and it presents and discusses the relationship between scientific research and academic design. Third, the book shares insights into academic reflection approaches relevant to architects, with specific emphasis on design thinking and design processes, design implementation and stakeholders (practice, feasibility, entrepreneurship), and moral sensitivity and values for the built environment.

3.1 Part one: Architecture as a scientific discipline

Architecture at Delft is a design-oriented discipline within the engineering sciences. In the Bouwkunde BSc community, academic skills focus to a large extent on assessing design situations, informing design decisions, underpinning design proposals, positioning oneself as a designer, and critically reflecting on design, both process and product. The core knowledge question of the engineering sciences is 'Does it work?' (my design, my prototype, my plan, my model), whereas empirical sciences deal with the core knowledge question 'Is it true?' (Klaasen, 2004). Therefore, engineering sciences also make use of a variety of less traditional academic skills and research methods. All of this is introduced and discussed in the first part of the book, which consists of five chapters focusing on Bouwkunde at Delft.

3.2 Part two: General academic skills for architects

The second part of the book *INSIGHT* (12 chapters) presents several overarching themes, concepts, and approaches that are important and meaningful for architects, among which are setting up a research project, behaving ethically as an academic, looking for (and using) information, academic reading and writing, oral presentations, and using texts and images in research. These topics are relevant for many disciplines and students, but within the domain of architecture, there is always a relation to spatiality, visualisation, and the (design of the) built environment.

3.3 Part three: Specific architectural skills and research methods

The third part of the book *INSIGHT* (13 chapters) presents several more architecture-specific themes, concepts, and approaches that come from or are tailored to the field of architecture and design, including historical analysis, morphological plan analysis, technical analysis, urban data research, observation techniques, and architectural positions.

3.4 Part four: Academic skills in practice

The fourth part of the book *INSIGHT* (12 chapters) views the field of architecture from societal, entrepreneurial, and reflective perspectives. It presents themes, concepts, and approaches that contextualise design, design thinking, and design processes. It focuses on product development, market and market research, actors and stakeholders, and professional identity and entrepreneurship; these themes add a managerial and governance perspective. The contributions on heritage as commons and ethics in architecture add a value-based perspective. Finally, design processes and approaches are looked at from the points of view of academic design reflection, generic elements in the design process, and evaluating design (alternatives).

4 Approach to the book development

The book *INSIGHT* was developed in steps between 2018–2024, several years after the start of the renewed bachelor in September 2012. About 50 colleagues, mostly, but not solely, from the Bouwkunde faculty, contributed to the 400-page document that was published openly – also in phases – via TU Delft OPEN. The process of development was valuable on its own.

The initial goals for the book were shared with and supported by a small number of enthusiasts in the faculty, who decided to become the editors together. These five editors represent (not accidentally) the four departments of the faculty: Architecture, Urbanism, Architectural Engineering & Technology, and Management in the Built Environment. They editors had (at the time of the initiation) key roles in the faculty: coordinator of the BSc programme and module coordinators of different throughlines. Over time running up to the 2024 edition, one of the editors retired and the other progressed careers: as director of education, scientific director of the 4TU Centre for Engineering Education, master-track coordinator, and education leader of the Delft-Rotterdam Convergence programme. The editors established a table of contents and invited authors from among their faculty colleagues. Some critical friends were invited to provide feedback on the contents at several moments in the development. Similarly, a sounding board of students was invited to review the content and progress in several instances. Per book section, the editors and authors assembled regularly, discussed chapter ideas, peer-reviewed contributions, and monitored progress. It facilitated many fruitful collegial discussions and partnerships in co-authoring and trickled down into something 'concrete': a chapter that fits into the book but could also be read independently.

4.1 Writing, editing, and the publication process

Authors were invited to write about their speciality and given some basic guidelines for a contribution:

- contains approximately 2,000 words;
- is written in Dutch (will be translated later);
- is illustrated or uses examples;
- mentions pitfalls as well;
- references some core publications for further studies (preferably used in MSc tracks);
- has no more than seven subsections;
- the final section is a 'reflection';
- cites using APA style

From the outset, the ambition of the editors was *not* so much to develop a book but a digital and freely available learning tool. The TU Delft Library supports the development of open-source learning materials like books, and it has a digital (open) book platform for editing and online reading, as well as a website and print-on-demand (POD) service. The editors worked on publishing the book on the library platform. Authors, teachers, students, and other critical friends were invited to respond and provide feedback on the template, and usage of the (open) book.

Most of the authors were personally invited by the editors to contribute to the book. Once the word spread among the faculty, volunteers offered chapters (and still do). Some authors struggled with one or more of the guidelines, but ongoing evaluations allowed for revision and additions over time. The editors

had the challenging task of having authors follow these guidelines, guarding the coherence of contents across chapters, and having authors stick to the original idea of the contribution, especially when 'new', unanticipated chapters were proposed. The editors had an active role in providing the links between chapters and persuading authors to edit their chapters for focus and length, as well as to align or explicitly disagree with other chapters. The index plays an essential role in this alignment; compiling it was a considerable effort, and it was only included in later editions.

4.2 Challenges and concerns

It was challenging to comply with the 'open' book principles. Getting the (re-used) texts within the (Creative Commons) licences requires authors to be aware of the copyright agreements. A similar check is required for the images used. The TU library supports the checks, but authors and editors need to decide and provide the original sources. The TU library acquires images from the 'open' fund. Actual publishing is supported with the online tool pressbooks. The editors pasted all contributions in the pressbooks environment. This approach allows insight and control over the edits but demands extra effort. Layout, pdf-exporting, and preparing the POD file all occurred within the pressbooks environment. However, aligning the layout across the different outputs (online, PDF, POD-print) is complex, and suboptimal layout issues can be found in each output.

There were (and are) serious concerns about the distribution and version management, especially for the static outputs such as PDF and POD. Readers will need to pay attention to the version they are using. The most secure choice is to use the online tool, which is the most up-to-date version. For those who prefer to read offline, the PDF must be reviewed for version updates. Also, a POD version will become outdated when some chapters are re-edited, or new chapters are added. There is no warning signal or incentive to replace the printed version. Nevertheless, some readers prefer printed versions, and the student reviewers were very concerned with updated versions, expressing a desire for a clear version indicator on the cover.

The sheer size of the *INSIGHT* book, 42 chapters (2024 edition), makes it impressive and maybe even paralysing to students. The student reviewers requested clear and different entrances to the book, with separate tables of contents, e.g. on 'topics', 'courses', and entrances based on the index. The delivery and design of the website also need specific attention, as 'look-and-feel' and 'first impressions' matter a lot when deciding to access, use and download the book. Difficulty accessing the text could kill all readers' intentions to use it, especially considering the large number of chapters.

5 Usage, value, and limitations of the *INSIGHT* book

At the time of its first official publication (2022), the book contained 41 chapters from 48 authors, and the development took 38 months. The first use of the book in education was in September 2020, when the text contained 21 chapters. A year later, the third version consisted of 29 chapters. For the 2022 publication, only two chapters from the original set-up were missing. A first version of the index was compiled, and internal digital links were included in the 2022 version. However, the definitions of the index terms still (2024) need to be made, and the authors' agreement on the terms needs to be reached.

Many people (1,000+) downloaded the 2021 or 2022 version of the book or separate chapters from individual PURE environments of authors and book editors or the TU Delft Library directly: https://textbooks.open.tudelft.nl/textbooks/catalog/book/48. You can call this a positive surprise as the book is not part of the obligatory literature of *any* Bouwkunde bachelor course. It seems that the book has intrinsic value and quality. The launch of the 2024 edition attracted already about 100 downloads in the first month (September 2024): https://textbooks.open.tudelft.nl/textbooks/catalog/book/99 .

The book is 'thick', but it is not complete, as it will never be complete. The TU OPEN publishing format allows to be flexible: the book can be adapted and expanded continuously. Further, our curriculum is a dynamic landscape, as is the field of higher (engineering) education. We are continuously challenged by new (societal) questions, new technologies, and new student and teacher needs that ask for a reconsideration of professional and academic skills. For example, the use of AI in design education or ChatGTP in academic writing assignments could be useful for new chapters. The 2024–2025 curriculum renewal will most probably also result in new contributions. The Technology throughline will focus more on systems thinking, which is not addressed in the book currently.

Being flexible with the book and being able to add endlessly seem nice. However, the other side of this coin could be that students and teachers will seek more concise readings and more practical teaching and learning materials. A project that has started in academic year of 2024 is the development of so-called 'methods sheets' for the bachelor design module Area (Re)Development. A method sheet (see Figures 3) presents – on a double-sided A4 sheet – concepts, planning methods, research methods, design methods, and academic skills in a communicative way. In the run of 2024-2025, the first series of method sheets will be published and openly accessible via the TU Delft Library (Rocco, Qu, Rooij, forthcoming).

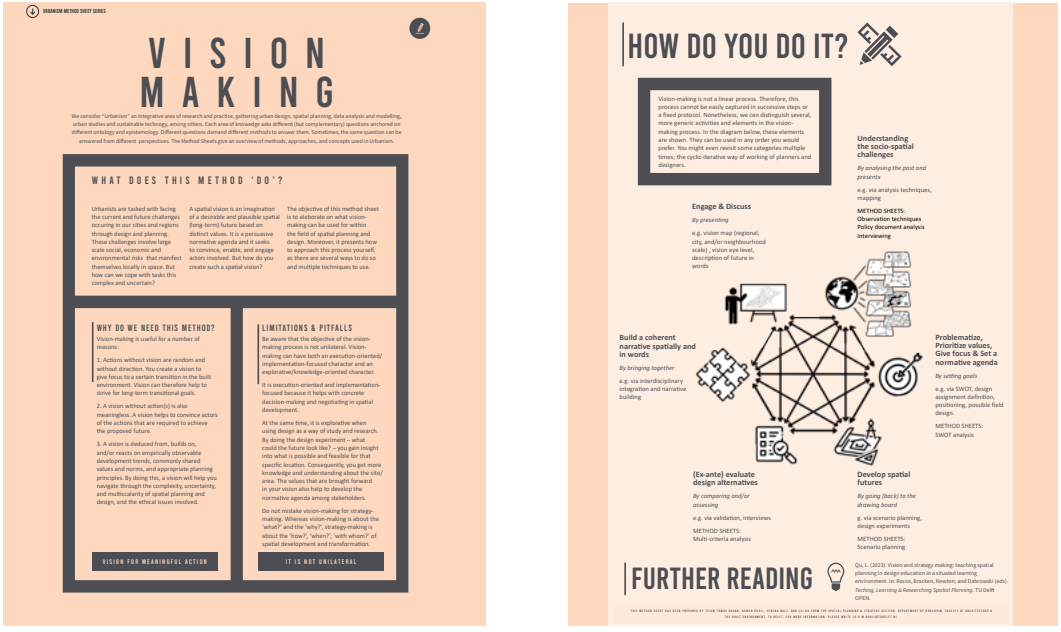

FIGURE 3 An example of the method sheet 'Vision Making'. It focuses on the sections 'What does this method do?', 'Why do we need this method?', 'Limitations and pitfalls', 'How do you do it?', and 'Further reading', by Rocco, Qu, Rooij, forthcoming.

6 Final words

Has the book met its goals? Currently, its publication and use will allow for future evaluations. The editors have experienced raised awareness of academic skills. However, they might be biased by working on the book with enthusiastic authors. The editors consider the book a success when it is regarded as an educational innovation. Evaluation steps should include asking students, tutors, course coordinators, and authors about their experiences. Finally, the main attention needs to remain on the primary goal: serving as a reference text of academic skills for architects, also when new curriculum changes happen, such as the BSc Bouwkunde 2024-2025 renewal.

For the editors, providing continuity is a challenge. Creating an open book that can be improved and updated gradually and that allows new contributions demands continuous energy, editing, and cuts. Additional challenges in terms of technical issues (for example, the platform used changed its membership structure) and time investment are the further development of the book as a digital learning tool with interactive elements, exercises, appendices, further reading, and examples. The web interface needs further work, including the look and feel, as well as the navigation process. These adaptations will become urgent when the BSc renewal in 2024–2025 will be fully implemented. Translating the book is essential to allow international access. Finally, editorship over time is a point of attention as most editors have or will move on in their career paths.

Acknowledgements

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Zijlstra, S. (this issue-#13) Choosing MSc tracks at the faculty of Architecture.


een coursebook voor het vak ARO117
WORKSHOP PRESENTEREN VOOR EEN GROEP
de manier van workshops geven aan ons, was erg leuk
- L
Leermiddel eerder bedenken zodat deze getest kan worden
Vrijdag les van teken beoordeling
Vrijheid bij begeleiding op de donderdagen
ELKAAR WORKSHOPS GEVEN VOOR ARO117
De open en Brave Space die tijdens workshops wordt gecreëerd
Excursie naar Locatie. (Team building met kindjes)
Meer duidelijkheid over hoe veel tijd je mag je docent moet zitten. Dit heeft mij heel veel tijd gekost, terwijl anderen meer één online werkje kwijt waren aan voorbereiding
1) Meer focus op het echt geven van les
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prijs uitdelen aan beste student begeleider
- Misschien maken wij elkaars eindproducten beoordelen
- Relaxte begeleidingen
- Dat alles gerecht kan worden
Meer de lessen die jullie ons willen leren over de structuur van lessen zelf ook consequ toepassen
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Vroegtijdig & Aanmoedigen om lesmiddel uit te testen in de lessen
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- De interactieve lessen hebben echt bijgedragen aan hoe we het lesgeven hebben aangepakt
- Het vak was echt heel leerzaam en leuk op deze manier!
- Uitje naar locatie MA1 met studenten en docenten
houdingen van docenten (zittend, voor de klas, statisch)

Coaching as a professional engineering skill

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Abstract

The elective course 'Didactic Coaching Skills' in the MSc Architecture, Urbanism, and Building Sciences programme aims to provide a safe practice environment for master's students to improve their coaching skills while enhancing the educational quality of the bachelor's course in which the students practice. The experiences of the bachelor students, student tutors, bachelor tutors, coaches, and coordinators were collected and combined to evaluate the success of this elective after it ran for the third time in 2021. The findings show that both aims have been met. All stakeholders enjoy the participation of the master students in the bachelor course and value a more reflective teaching practice for the bachelor tutors and 'their' student tutors. The bachelor tutors and coordinators obtain new and valuable learning materials that the student tutors develop as part of their elective, which also leads to renewed interest in the classroom. Attention needs to be given to the divisions of roles and responsibilities between bachelor tutors and student tutors, especially regarding assessment and the potential for the perceived unequal treatment of student groups.

Keywords

Coaching, active learning, student tutors, teaching assistants

COVER FIGURE Feedback on sticky notes during the evaluation of the course, photo by Monique Arkesteijn edited by Tejon Kraan, 2024.

1 Introduction

In 2018, the Architecture, Urbanism, and Building Sciences (AUBS) MSc students voiced a desire to obtain more formal training in guiding others. In particular, students from the Management in the Built Environment (MBE) track felt this training was missing in the curriculum and mentioned their desire for more hands-on management skills: coaching, managing, leading groups, assessing, and giving feedback. They reminded the faculty that these skills are key in a professional working environment.

To respond to the student interest, an elective course was developed in 2019: the TU Delft 5EC elective 'Didactic Coaching Skills' (AR0117) presents the practical opportunity for MSc students to tutor and coach BSc students in an actual course, BK3MA1: '*Maatschappij, Proces en Praktijk 1: Planning & Programma*' (in English: Society, Process, and Practice 1: Planning and Programme). The elective has run from 2019–2024. The third run in 2021–2022, was the moment and opportunity to evaluate the course systematically with the bachelor students and student tutors, bachelor tutors, bachelor course coordinators, and the course coordinators and coaches of the master elective. This evaluation aimed to understand how stakeholders see the values and attention points of such combined teaching and learning practices. The results of this evaluation are presented in this contribution. For the evaluations, short questionnaires were sent to the bachelor students, student tutors, and bachelor tutors. The authors of this paper are the course coordinators of the master elective and have given their input directly. Two more iterations of the master course have run since then – autumn 2022 and autumn 2023 – and a third will follow in autumn 2024. They are briefly addressed in a separate section as these were not evaluated similarly.

2 Coaching in higher education

Coaching is a complex and relative skill (Diggelen et al., 2019). Consequently, teaching master students to become better coaches is at least equally challenging. Research shows that educators who coach their students, become more reflective, articulate, exploratory, and metacognitive themselves (Lofthouse et al., 2010). So, in the connected courses AR0117–BK3MA1, the aim is exactly this: to have the student tutors become more reflective, but to grow the course coordinators and the coaches more reflective theas well. In coaching, the formulation and the discussion of good review, coaching, or reflection questions contribute to the development of this self-awareness among coaches over time; these kinds of reflective discussions are referred to as 'coaching conversations' (Lofthouse et al., 2010). This kind of conversation is regularly applied in the workshop sessions with the student tutors.

Kamp (2020) suggests that academic staff quite often lack experience with these kinds of personal skills (in a professional setting) and fail to lead by example or to pay attention to these skills, e.g. by (not) providing feedback on them. To combat this issue, the AUBS curriculum includes opportunities for both students and staff to specifically practice these skills, for example, in teamwork, simulation, and roleplay pedagogies. When tutors focus on these personal skills in the design of their learning environment, students will receive feedback – with positive consequences for skill development (see Chen et al., 2019; Qu et al., 2020). However, in general, there is limited focus on the development of personal skills in academic curricula (Kamp, 2020); very often, the skills are not included in the learning objectives and are part of the so-called 'hidden curriculum' (Snyder, 1971).

2.1 Course design and content MSc elective Didactic Coaching Skills

The elective course 'Didactic Coaching Skills for Architecture and the Built Environment' (AR0117, 5EC) is a 10-week MSc elective designed to have the MSc students tutor BSc students in a five-week second-year course on urban planning (BK3MA1). The elective contains four preparatory and supporting workshops, a midterm feedback session, and an evaluation session – six two-hour sessions in total. The four workshops cover the contents of the course to be taught: active teaching, preparing classes, roles of tutors, and feedback and assessment. The workshops are supplemented with a feedback session halfway through the tutoring with peer discussion and peer reflection on their tutoring experiences. Additionally, this midterm session kicks off the development of the final products: an individual reflection paper and teaching/learning materials for the bachelor course. The closing meeting at the end of week 10 provides the student tutors with personal feedback on these products.

The student tutors teach five sessions of the bachelor course BK3MA1 in the first five weeks of the quarter. The first session is an introduction and is prepared by the (principal) bachelor tutor. The next three tutoring sessions are prepared and hosted by the student tutors. The student tutors host the final session, which aims to provide individual feedback to the bachelor students.

2.2 Course design and content of the BSc course Planning and Programme

The course 'Society, Process, and Practice 1: Planning and Programme' (BK3MA1, 5 ECTS) is a five-week course that concludes with two tests: a multiple choice (MC) exam to assess the gained knowledge and a report containing a programme of requirements for an urban area. The MSc (elective) student tutors coach the BSc students in preparing the required materials in cooperation with the 'regular' bachelor tutors. The BSc course has roughly 400 participants and 20 bachelor tutors; each bachelor tutor guides 20 students who work in pairs. Some (around four) of the bachelor tutors have the opportunity to work with the student tutors. One bachelor tutor has two or three student tutors (see Figure 1).

The BK3MA1 course coordinators support their bachelor tutors with a toolbox of learning materials for active teaching for each weekly class. Bachelor tutors and student tutors meet and discuss with the bachelor students the development of their programme of requirements, which is based on desk research. The bachelor students are supported with weekly lectures and related assignments. These assignments have two objectives: gathering knowledge, which is tested in the MC test, and practise-related elements to be addressed in the programme of requirements. The development of the programme of requirements follows the weekly assignments, and each week, a new chapter is added to their reports. Bachelor students receive feedback from their bachelor tutor and student tutors on both the assignments and the chapters. Early in the fifth week, the bachelor students take the MC test and, in parallel, receive feedback on their full draft report.

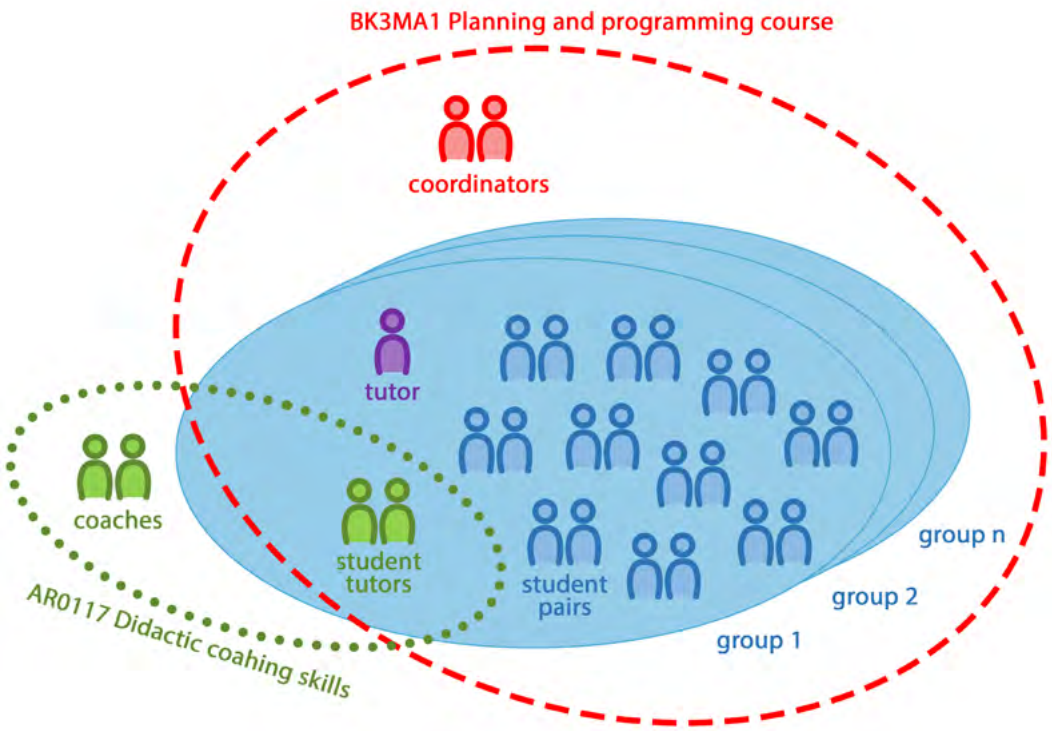

FIGURE 1 The organisation and relationships among bachelor students (pairs), student tutors, bachelor tutors, coaches (elective coordinators) and course coordinators in AR0117 and BK3MA1, by authors, 2024.

3 Experiences and outcomes for the 2019–2021 cohorts

The elective was offered for the first time in September 2019 – with five student tutors, and the second year, which occurred during the Covid-19 pandemic, attracted three participants. In autumn 2021, nine participants finished the course. The participants in that year were divided among three bachelor tutors; at least two student tutors per bachelor tutor to share the work, observe, and learn from each other. To keep a close eye on all student tutors, a maximum of four student tutors per tutor is used. Since 2019, a total of four different bachelor tutors have been involved.

After finishing the 2021 MSc and BSc courses, the bachelor students and the student tutors were invited to share their experiences in a short online anonymous questionnaire, and one-third of bachelor students responded (22 of 69 students from three groups). The response rate of student tutors was eight out of nine. Below are the experiences of bachelor students and student tutors based on the three questions asked: 'How did you experience the course?', 'what should be kept?', 'what should be changed?'

3.1 Bachelor students' experiences

The bachelor students respond in positive terms to the evaluation questions. They mention the experience of having a student tutor to be pleasant and enjoyable, noting that they receive a fair amount of attention from the student tutors in terms of time and detail. They especially mention that they experience less distance between bachelor students and student tutors in comparison to typical student–teacher relations. The use of personal experiences in the course increases enthusiasm and helps personalise the tutoring experience. The bachelor students like adding a student tutor next to the regular bachelor tutor, and they appreciate the feedback being delivered in smaller groups and receiving more attention.

A significant number of the bachelor students do not mention any desired improvements. However, they critically note that the role and position of the bachelor tutors are less clear. Bachelor students question the clarity of the assessment, the quality of the feedback, and the alignment of the feedback and assessment: are student tutors and bachelor tutors weighing aspects equally? At the same time, some bachelor students want even more specific feedback, though they acknowledge that the feedback they receive is more specific than feedback other bachelor students receive in groups without student tutors. Nevertheless, bachelor students who submit critical assessments still note a positive learning experience overall.

Bachelor students were enthusiastic about their student tutors and stated that they felt special. Notably, only three of the 17 bachelor groups had student tutors. The bachelor students appreciated the 'levelled' feedback, the enthusiasm, the depth, and the time. They suggest to pay attention to the differences between groups with student tutors and without, the role of the bachelor tutor, and to the clarity of the assessment procedure.

3.2 Student tutors' experiences

The student tutors responded positively to the evaluation questions as well. They describe the course as fun and enjoyable. Student tutors mention they have learned a lot and experienced the course as a valuable and original elective in the curriculum with unprecedented individual feedback and opportunities for personal development. The most important aspect for the student tutors is the safe and supportive learning environment: the freedom to discuss and take control, the absence of anxiety, the feeling of a safety net, the preparatory meetings and workshops, and a limited group size where the student tutors get to know one another.

Student tutors feel taken seriously and have space to practice tutoring ideas and then critically reflect on them. The tutoring of the bachelor students in BK3MA1 demands considerable time, and some student tutors experience competition in their curriculum in prioritising learning activities. This issue might be caused by individual time investment in preparation for the course and tutoring sessions, as student tutors feel responsible for fully taking on a mentorship role. When the BK3MA1 course is finished, and the bachelor student work is graded, student tutors need to prepare their final products and feel they should have started earlier. They suggest reminders of the course requirements during the BK3MA1 tutoring, as it might help them focus and assist them in making more timely decisions on what to prioritise, as well as better preparing them to ask for intermediate feedback. Further, some student tutors feel that the BK3MA1 tutoring assignment should be emphasised in the elective description and title.

Student tutors value the experience of 'being on the other side': switching places from university student to tutor. They discover the 'complexity' of the roles of tutors – supervising and assessing – as well as their own styles and habits. The reflection papers reflect their interests and learnings. Table 1 provides an overview of all reflection topics the student tutors have studied (2019–2023). The class organisation, roles and styles, communication, and feedback are key topics. The reflections show that the student tutors experience a shift in perspective, which makes them rethink their own study behaviour.

YEAR	TOPIC	YEAR	TOPIC	YEAR	TOPIC
2021	Halo-effect in assessment	2022	Debating	2023	Feedback
2021	Class presence	2022	Connection	2023	Feedback
2021	Class layout	2022	Motivation	2023	Feedback
2021	Tutor's role	2022	Introversion	2023	Feedback adaption
2021	Guidance-independence balance	2022	Feedback	2023	Feedback
2021	Effective communication	2022	Steering and letting go	2023	Expectation management
2021	Effective communication	2022	Keeping attention	2023	Relationships
2021	Challenging	2022	Roles	2023	Coaching
2020	Peer-review	2022	Activation / Attention	2023	Situational leadership
2020	Power of online feedback	2022	Feedback / being corrective	2023	Motivating
2020	Teacher's role / style	2022	Signalling dysfunctional groups	2023	Communication
2019	Instruction versus coaching	2022	Roles	2023	Non-verbal communication
2019	Linking to previous knowledge			2023	Active teaching
2019	Supporting critical reading			2023	Active teaching
2019	Power of written feedback			2023	Adaption
2019	Teaching styles			2023	Interaction / adaption

TABLE 1 Overview of reflection paper topics submitted by student tutors (by year)

The student tutors say that attention needs to go to the group size of the master elective's course; they believe that a maximum of 10–15 students in the elective is desirable and that it is necessary to have a clear role division in the classroom between bachelor tutor and student tutor. Additionally, it is said that the workload distribution does not represent the assessment scheme of the master's course; most time is spent on tutoring, but the reflection paper and the learning materials they develop are most important in the assessment.

3.3 Bachelor tutors' experiences

The bachelor tutors (four individual tutors since 2019) report different approaches to 'making use of' and engaging the student tutors. At one end of the spectrum, student tutors were asked to assist with some specific tasks while the bachelor tutor continued providing feedback and performing all tutoring tasks. At the other end of the spectrum, the student tutors took the lead, even in the final grading. For all groups, the bachelor tutors prepare the classes together with the student tutors and discuss aspects to be addressed in the feedback on chapters and assignments. Bachelor tutors prepare the lesson plans with student tutors and try to evaluate the tutoring sessions directly after each class. All in all, the role of the bachelor tutor varies from tutoring bachelor students with help from the student tutors to allowing the

student tutors to coach bachelor students. Independent of the way the bachelor tutor engaged the student tutors, this approach leads to self-reflection among the bachelor tutors, raising awareness of (un)conscious tutoring habits and pitfalls.

The student tutors are a welcome set of extra hands, lowering the teaching load and demanding energy from the bachelor tutor. In particular, it takes quite some time to organise the collaboration between tutor and student tutors, which entails preparation, evaluation, adjusting teaching plans, alignment of feedback, and assessment. The three bachelor tutors in 2021 gave student tutors control over the lesson plans and acted as a safety net during the classes. Bachelor tutors suggest that the student tutors should perhaps share their tutoring experiences along the way. Scheduling a meeting halfway through the course (when the student tutors have their peer reflection meeting) could serve as a solution. The presence of student tutors positively stimulates bachelor tutors to reflect on and reconsider their class design, planned class activities, and interaction strategies.

3.4 Bachelor course coordinators' experiences

The BK3MA1 course coordinators value the interaction between the two courses: the learning activities and teaching materials designed by the student tutors support the bachelor tutors in the BSc course. By adding new, amended, or improved activities and materials, the course evolves. The learning activities and teaching materials designed by the student tutors vary in quality: some can be used immediately, but others need work and are less challenging for the bachelor students. Most of the materials focus more on the (learning) process than the disciplinary, qualitative content of the course. However, all developed teaching materials add to the available toolbox that bachelor tutors can use in their classes. The coordinators suggest challenging student tutors to (further) develop disciplinary and content-focused teaching materials.

Coordinators find the interaction valuable, but some aspects could be strengthened further – for example, by more actively promoting teaching materials that focus on content, sharing them among all bachelor tutors, and emphasising the creation of teaching materials.

3.5 Master course coordinators' and coaches' experiences

The AR0117 coaches value the course, interaction, and cooperation: the workshops and follow-up sessions allow for reflecting, sharing experiences, and providing references to more in-depth readings. The workshops use (peer-)review to monitor the progress of the final products. The coaches appreciate the in-depth questions student tutors ask and the openness in the workshops. The coaches contribute equally and openly during the workshops, creating a sense of security in the classroom (students explicitly mentioned). Student tutors endeavour to share their vulnerabilities and actively try to act upon feedback. Coaches (intend to) teach as they preach by designing participatory classes in which there is a lot of room for the student tutors to set the agenda and steer the discussion. The coaches also facilitate and moderate the Q&As between student tutors and reflect on those interactions. The coaches observe slight tendencies of mirroring behaviour among student tutors: they emulate habits from the tutor (and coaches) with whom they work, a behaviour that could be explicitly addressed in one of the workshops.

Turning the tables, showing personal vulnerability, and setting a safe and open stage for teaching and learning make a valuable experience for both student tutors and coaches. Discussing mirroring behaviour and crafting a safe space require continuous attention, as these are deemed crucial for the success of the course.

4 Experience and outcome 2022–2023 and outlook 2024

The following runs, 2022 and 2023, saw increased numbers of participants: 13 and 16 master students, respectively. In 2024, 30 students enrolled in the master's elective. Word of the student tutor experiences has spread (primarily) among MBE-track students. The general approach to the course has remained the same, including the learning objectives and assessment. Accordingly, the number of bachelor tutors involved grew to five in 2023, adding one tutor each run. Although evaluations have not been undertaken as systematically as in 2021, the tutors and coordinators have voiced similar remarks as in the past. Notably, the attempt to create learning materials that are more focused on content has not yet delivered the desired outcomes. Moreover, given the increasing number of bachelor tutors involved, the desire for peer feedback and supervision among the bachelor tutors has grown as well. Since 2022, a systematic intervision protocol for the student tutors is used during a midterm (week 5) workshop.

The bachelor students continue to appreciate the attention, feedback, and lessened distance they experience when there is a student tutor around, and critical remarks about the roles and assessment were voiced less loudly (note, however, students were not explicitly asked about this issue).

The 2022 and 2023 student tutors also asked for a fairer assessment strategy (both formative and summative) that adequately acknowledges their extensive coaching efforts and time commitment because, through 2023, the assessment focused on the reflections and learning materials. For 2024, the assessment of the student tutors' coaching skills is changed to include a peer assessment and an assessment by th bachelor tutors accordingly. The weights are changed accordinly.

5 Conclusion

Operating the two related courses, AR0117 and BK3MA1, leads to a productive interaction, facilitating cross-pollination among bachelor students, student tutors, bachelor tutors, coaches, and coordinators. This cooperation introduces a diversified mix of learning activities. All people involved, from students to coordinators, experience the mix and interaction positively. The coaching skills are practised not only by student tutors but also by coaches and bachelor tutors. The attention to the teaching and learning environment and the reflective dialogues among all involved improve teaching quality, positively influencing the learning experience and outcomes for both the bachelor students and the student tutors.

An important point of attention is the time and energy the student tutors spend on tutoring and developing their final projects. The assessment and grading of the bachelor students also require further review: the bachelor tutors are responsible for grading, but their grades are discussed and compared to the grades given by the student tutors. This process could be better communicated to the bachelor students to avoid uncertainty.

Further improvement and development of the elective could be achieved through exchanges with additional courses, as few comparable courses exist in the TU Delft curricula. At the Faculty of Architecture and the Built Environment, '*van Gezel tot Meester*' is a 20 EC course (AR0897) for design students who work together

with a design tutor in a BSc design course. This course focuses on design didactics based on Van Dooren's (2020) design process approach. The Faculty of Industrial Design Engineering has a 5 EC course, 'Design Didactics', which uses a similar basic course design (workshops, tutoring, and reflection). Specialised courses are offered as part of the MSc Science Education and Communication ('*Docentenopleiding*'), consisting of a 6 EC course on education sciences (SL3462) and advanced courses on didactics focused on one of four specialisations: physics, chemistry, mathematics, and technology.

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Colophon

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Front: Graduate students adding tiles with their names in the Alumni Wall of Fame, TU Delft (Photo: Frank van der Hoeven)
Back: Students working into the evening in the modelshop at Bouwkunde, TU Delft (Photo by Frank van der Hoeven)

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