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Bohm, Nina Lotte; Klaassen, Renate G.; van Bueren, Ellen; den Brok, Perry

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Education in collaboration with cities: the intentions of transdisciplinary courses

Bohm, Nina Lotte[1]
Management in the Built Environment; Delft University of Technology; Delft; The Netherlands.

Klaassen, Renate
Delft University of Technology; Delft; The Netherlands.

van Bueren, Ellen
Management in the Built Environment; Delft University of Technology; Delft; The Netherlands.

den Brok, Perry
Education and Learning Sciences; Wageningen University and Research; Wageningen; the Netherlands.

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[1] Corresponding author: Nina Bohm (n.l.bohm@tudelft.nl)

Structured abstract

Purpose – In collaboration with their home cities, universities increasingly develop courses in which students investigate urban sustainability challenges. This paper aims to understand how far-reaching the collaboration with urban stakeholders in these courses is and what students are meant to learn from the transdisciplinary pedagogies.
Design/methodology/approach – This research is designed as a qualitative multiple-case study into the intentions of transdisciplinary courses in which universities collaborate with their home cities: TU Delft in Delft and AMS Institute in Amsterdam. The study compares the written intentions of eight courses in course descriptions with the ideal intentions that teachers describe in interviews.
Findings – First, seven of the eight investigated courses were designed for urban stakeholders to participate at a distance or as a client, but rarely was a course intended to lead to a collaborative partnership between the city and students. Second, the metacognitive learning objectives, such as learning to deal with biases and values of others or getting to know one's strengths and weaknesses in collaboration, were often absent in the course descriptions. Learning objectives relating to metacognition are at the heart of transdisciplinary work, yet when they remain implicit in the learning objectives, they are difficult to teach.
Originality/value – This paper presents insight into the levels of participation intended in transdisciplinary courses. Furthermore, it shows the (mis)alignment between intended learning objectives in course descriptions and teachers' ideals. Understanding both the current state of transdisciplinarity in sustainability courses and what teachers envision is vital for the next steps in the development of transdisciplinary education.

Keywords – Transdisciplinary learning and teaching / university-city collaboration / urban sustainability / higher education
Paper type – Research paper

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1 Introduction

Higher education increasingly consists of transdisciplinary courses (Gibbs, 2017). In their most basic definition, transdisciplinary courses involve a specific context, where students learn by working on real-world challenges with real-life stakeholders (Jaeger, 1998). Increasingly, challenge-based learning is used as a teaching and learning approach in transdisciplinary courses but also pedagogies, such as project-based, experiential, or inquiry learning, can be part of transdisciplinary education (Gallagher and Savage, 2020). When teaching methods become transdisciplinary, the intended learning in those courses changes as well (Van den Akker, 2003).

In the 1970s, transdisciplinary education arose from the need to engage students with the complexity of societal challenges (Piaget, 1972). More recently, there are two additional reasons for universities to make education more transdisciplinary. First, transdisciplinary education speaks to students who want to become agents of change for societal transitions (Newman, 2006). Currently, many young people in Europe consider creating a sustainable society the most prominent societal transition of this time (Horton et al., 2013). The sense of urgency in sustainability challenges motivates students, and transdisciplinary education allows them to be part of the action (Bohm et al., 2020).

The second driver for universities to develop transdisciplinary education is that it enables them to respond to the critical concerns of society (Thomas, 2020). In the past decade, policymakers have been encouraging universities to support their local economies by making the expertise of researchers and the human capital of students accessible to local stakeholders (Kempton, 2019). Generally, universities feel a responsibility to have a societal impact by contributing to sustainable transitions (Leal Filho et al., 2022). Continuing urbanization, for instance, challenges cities to accommodate a growing population and use of resources, while improving the quality of life (Van Bueren et al., 2012). Through transdisciplinary education, universities are involved in those urban sustainability challenges in their home cities and connect them to societal needs.

Consequently, universities have been seeking 'university-city collaborations' to develop transdisciplinary research and education (Goddard and Vallance, 2013). University-city collaborations are collaborations between universities, municipalities, and other urban stakeholders that focus on local challenges (Kempton et al., 2021). These collaborations offer both the proximity of the location as well as the network of actors that is crucial for developing transdisciplinary answers to local problems (Harris and Holley, 2016).

Even though universities are committed to university-city collaborations on an institutional level, little is known about how teachers deal with transdisciplinarity on the level of the course. In the past, not all educational changes on the school level have made it to the classroom (Van den Akker, 2003). Especially in universities, where academic freedom is fundamental, teachers have a deciding role on changes in the curriculum and course design. When it comes to transdisciplinary education, there are two important issues teachers are confronted with.

First, the learning objectives in transdisciplinary education are opaque. Transdisciplinary education is concerned with more than cognitive learning (Thomas, 2010). Therefore, principles of transdisciplinary learning consist of a variety of skills, ranging from teamwork, and co-creative problem-solving, to bridging the gap between academic theory and practice, and abilities to deal with conflicting world views (Biberhofer and Rammel, 2017). Furthermore, several authors find that adding new learning objectives to the existing mix in a course is not enough if students need to become agents of change in sustainable transitions (Biberhofer and Rammel, 2017, Thomas, 2010, Gibbs, 2017). To them, transdisciplinary education should contribute to transformative learning, allowing students to reframe problematic assumptions and expectations (Mezirow, 2000). How teachers currently deal with the unclarity of transdisciplinary learning objectives in practice is unknown.

Second, stakeholders can participate in transdisciplinary courses in various ways. For example, the level of participation of urban stakeholders is different in a course that informs

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students about the challenges in energy transitions in a presentation by the municipality and a course where students collaboratively make a design for an urban park with a citizens' group (Gaete Cruz et al., 2022). Hence, teachers need to decide on the level of participation in the course design.

To the knowledge of the authors, research into transdisciplinary education is still limited and fails to offer concrete implementation guidance to teachers (Daneshpour and Kwegyir-Afful, 2021). Little is known about the learning objectives used in transdisciplinary courses or the role urban stakeholders are envisioned to play in these courses. This study compares the transdisciplinary education goals in course descriptions to the transdisciplinary aims of the teachers. The research will answer the main research question:

> *How are learning objectives described in transdisciplinary higher education courses concerning urban sustainability challenges and how does this relate to the aims of the teachers?*

Eight transdisciplinary courses in two university-city collaborations in the Netherlands are investigated: Delft University of Technology in Delft and Amsterdam Institute for Advanced Metropolitan Solutions in Amsterdam. In Section 2 the paper starts with constructing a framework to analyze transdisciplinary learning objectives in courses. In Section 3 the authors explain how they used document analysis and semi-structured interviews with the teachers to get to the results presented in Section 4. The paper ends with a discussion and conclusion, where the authors discuss the main results, limitations, and implications.

2 Background and analytical framework

This section describes the theoretical background of this study and constructs an analytical framework to study learning objectives in transdisciplinary courses. A course can be studied through the lens of its learning objectives by investigating the 'intended curriculum' (Van den Akker, 2003). A curriculum, whether on the level of a course or an entire educational program, is not always what it looks like (Martin, 1982). Educational research often distinguishes three curriculum representations: the 'intended' curriculum (i.e. the vision as described by its designers), the 'implemented' curriculum (i.e. the curriculum-in-action as operationalized by teachers), and the 'attained' curriculum (i.e. what is learned and experienced by students). According to Van den Akker et al. (2013), the intended curriculum can be approached from two perspectives: a 'written/formal' representation in curriculum materials, and an 'ideal' representation that is the vision, rationale, or basic philosophy of a curriculum (see Table I). Ultimately, all representations of the curriculum revolve around a specific rationale. The push towards transdisciplinary teaching and learning suggests that the rationale behind the curriculum is changing.

Table I. The two representations of the intended curriculum (authors' work adapted from Van den Akker et al., 2013, p. 56)

Intended curriculum	Ideal	Vision, rationale, or basic philosophy underlying a course
	Formal / Written	Intentions as specified in course documents and/or materials

The shift towards education that prepares students for real-life sustainability challenges has become increasingly visible since Kates et al. (2001) positioned sustainability science as an academic field. Since then, several scholars have investigated which key competencies should be part of that curriculum (Wiek et al., 2011). Rieckmann (2012) found in a Delphi study that systemic thinking, anticipatory thinking, and critical thinking are the most relevant key competencies in educating for the Sustainable Development Goals (SDGs). These thinking skills are not limited to the field of sustainability science alone, Wiek et al. (2011) pointed out that further research should investigate

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the relationship between learning outcomes in sustainability education and regular academic competencies, such as critical thinking.

At the course level, the taxonomy of Bloom has proven to be a helpful tool in formulating intended learning objectives for regular academic competencies (Biggs and Tang, 2011). Now widely used in course design all over Europe, the 'taxonomy of educational objectives' was once developed to enable the exchange of test items and a common language for educational objectives between universities (Krathwohl, 2002, Bloom et al., 1956). Instead of using a transdisciplinary or sustainability-specific vocabulary, this study made use of Bloom's revised taxonomy to take advantage of this common language to structure the research using the language of university teachers. This will enable us to evaluate if the taxonomy is useful for transdisciplinary purposes as it is for other academic courses.

Bloom's revised taxonomy distinguishes two dimensions within a learning objective (Table II). A learning objective has a 'cognitive process dimension'. This dimension can be recognized by the verb used within the objective. As the level of complexity of the task increases, there are six categories within this dimension: remember, understand, apply, analyze, evaluate, and create. The key sustainability competencies as they are defined by UNESCO (2017, p. 10) include complex cognitive processes, such as "analyze complex systems", "evaluate multiple futures", or "create viable, inclusive, and equitable solution options that promote sustainable development".

In addition to the process dimension (the verb), a learning objective contains a 'knowledge dimension', which is the object of what is being learned. This has been aggregated in the framework on four levels: factual, conceptual, procedural, and metacognitive knowledge. Reflecting on positions, perceptions, and views is especially important to the aims of transdisciplinarity (Leal Filho et al., 2018) and sustainability (Rieckmann, 2012). The metacognitive knowledge dimension is thus expected to be represented in the learning objectives of transdisciplinary courses in particular. In addition to Bloom's taxonomy, previous research also shows the variability of affective learning objectives in higher education (Mintz and Tal, 2014). Furthermore, Taylor et al. (2021) emphasize the importance of collaborative competencies in the context of urban sustainability. However, civic engagement remains difficult to integrate in sustainability courses (Mintz and Tal, 2014).

Table II. Description of the different categories in Bloom's Revised Taxonomy (authors' work adapted from Krathwohl, 2002).

Dimensions	**Categories**	**Description**
Cognitive process dimension	Remember	Retrieving relevant knowledge from long-term memory.
	Understand	Determining the meaning of instructional messages, including oral, written, and graphic communication.
	Apply	Carrying out or using a procedure in a given situation.
	Analyse	Breaking material into its constituent parts and detecting how the parts relate to one another and to an overall structure or purpose.
	Evaluate	Making judgments based on criteria and standards.
	Create	Putting elements together to form a novel, coherent whole or make an original product.
Knowledge dimension	Factual	The basic elements that students must know to be acquainted with a discipline or solve problems in it.
	Conceptual	The interrelationships among the basic elements within a larger structure that enable them to function together.
	Procedural	How to do something; methods of inquiry, and criteria for using skills, algorithms, techniques, and methods.
	Metacognitive	Knowledge of cognition in general as well as awareness and knowledge of one's own cognition.

Investigating the learning objectives in transdisciplinary education offers insights into *what* learning teachers intend to achieve, but it does not explain *how* teachers expect students to attain these objectives in the course. Although the development of sustainability education calls for

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changing teaching methods, teachers find it difficult to adopt new pedagogies, such as challenge-based learning and prefer traditional lectures, tutorials, and discussions (Christie et al., 2013). This study looks at the levels of participation of urban stakeholders to understand to what extent teachers succeed in adopting transdisciplinary pedagogies in the course.

Participation can be perceived on a continuum of increasing levels. The well-known ladder of participation by Arnstein (1969) has eight rungs, ranging from manipulation of citizens to full control by citizens. Originally, the ladder was meant to criticize the often not genuine involvement of citizens in decision-making processes (Arnstein, 2019). Arnstein differentiated between 'empty rituals' of going through the movements of participation without any real decision power for the people participating, and a process in which power is redistributed to parts of society that would otherwise not be heard. Over the years, the ladder of participation has been translated for many different processes, not just aimed at citizen involvement, but also in the context of education (Hart, 1992). This study makes use of a simplified version of the ladder to distinguish the level at which urban stakeholders are expected to participate.

Arnstein grouped the eight levels of participation into three categories (Table III). 'Non-participation' for the bottom rungs of the ladder, where there is no genuine participation objective. In this study, this is translated into a *distant* level of participation in higher education. Stakeholders are only involved in the preparation of the course, but students do not meet or speak with them as part of the course. The second group of rungs on Arnstein's ladder is called 'tokenism'. Applied to the higher education context, participation can be defined as tokenism when there is an exchange of knowledge between students and stakeholders during the course but no collaboration. The stakeholders are involved in the course to inform or consult the students in their work, often in the role of *client*. In some cases, student work is presented as advice to the stakeholders, however, the stakeholders themselves retain the right to decide to use it. Finally, the upper rungs of the ladder form a third group, which Arnstein categorizes as 'citizen power'. On this level, participants have power in the decision-making process. Translated to higher education courses, stakeholders are involved as *partners* of the students and they collaboratively work on solving a problem.

Table III. Levels of participation adapted for transdisciplinary learning environments (authors' work adapted from Arnstein, 1969).

Arnstein's levels	**Level of participation in higher education**	**Description**
Non-participation (Passive)	Distant	The collaboration stops with the collaborative formulation of a problem that originates from the city.
Tokenism (Responsive)	Client	There is a client that presents the challenge at the start of the course and that collects the results at the end.
Citizen power (Active)	Partner	The students are depending on the involvement of others or are expected to involve others in order to solve the problem.

This study investigates the intended curriculum of transdisciplinary courses in university-city collaborations. In the analysis, the taxonomy of Bloom is used and the levels of participation as the authors have derived them from Arnstein's ladder. The study is structured into three sub-questions:

1. What do course descriptions say about (a) cognitive processes, (b) knowledge dimensions, and (c) levels of participation? (written curriculum)
2. What do teachers say about desired (a) cognitive processes, (b) knowledge dimensions, and (c) levels of participation? (ideal curriculum)
3. What are the similarities and differences between the written (1) and ideal curriculum (2)?

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3 Materials and methods

3.1 Two university-city collaborations as case study context

This study was designed as an explorative and qualitative multiple-case study (Yin, 2009) into the intended curriculum of transdisciplinary courses in two university-city collaborations. The first investigated university-city collaboration is the collaboration between the city of Delft and Delft University of Technology (TU Delft). The TU Delft can be categorized as an 'old' (founded in 1842) and 'big' (over 27.000 students) higher education institute and is therefore expected to focus more on its national or international role than on its local role in the city (Kempton et al., 2021). In the past years, however, national policies have been encouraging the development of a closer relationship with Delft (Netwerk Kennissteden Nederland et al., 2017).

The second university-city collaboration included in this study is Amsterdam Institute for Advanced Metropolitan Solutions (AMS Institute). Founded in 2013 by the TU Delft and Wageningen University, in response to a subsidized call for such an institute by the city of Amsterdam, this smaller research institute facilitates a master program called 'MADE' (Metropolitan Analysis, Design, and Engineering) (<200 students). Research and education at MADE focus on metropolitan challenges of the Amsterdam Metropolitan Region. The relationship with the city is thus already institutionalized in the institute's mission. From these two collaborations, eight transdisciplinary courses were selected as cases that could be investigated in more detail.

3.2 Case selection and data collection

First, the authors selected courses that used an urban challenge in Delft or Amsterdam in the past five academic years (between 2015-2021) in their teaching curriculum. The courses were collected through program coordinators at the two institutions and coordinators of the municipalities in Delft and Amsterdam. Although eleven courses fitted the selection criterion, the coordinating teachers of eight courses (six at TU Delft and two at AMS Institute) were available for interviews. These courses form the case selection in this research.

Some of the transdisciplinary courses in the selection were part of a core curriculum and others were offered as electives. Only one of the cases was a bachelor's course. All other courses in the study were at the master's level. From the eight courses, two types of data were collected: course descriptions and interviews with the coordinating teachers.

First, the course descriptions were collected from course guides in which the general background, objectives, planning and structure of the course were described. In one instance the course guide was not available and the teacher provided us with other documentation: slides from the introduction lecture and the course webpage. All courses were conducted multiple times between 2015 and 2021. Therefore, the authors chose to analyze the course guides from the most recent edition of the course.

Second, the first author conducted semi-structured interviews with seven teachers who coordinated the eight courses. An interview guide was developed with questions on four themes (Bryman, 2016): the origin of the course, the aims of the course, how the course collaborated with partners in the city, and reflections on the success of the course. The interviews were conducted jointly by two researchers, the first author asked guiding questions based on the interview guide. The second researcher made notes during the interviews and asked verifying questions based on the notes. While the course descriptions provided insights into the written intentions of the course, the interviews allowed us to ask more in-depth questions about the reasoning, visions, and ideals of the teachers in those courses. Written consent for the involvement in the research was obtained from the teachers before the interviews.

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3.3 Data analysis

The course descriptions and interviews were analyzed through concept coding (Saldana, 2016) using a codebook based on the theoretical framework presented in Section 2. The codebook consisted of three code groups with the main concepts of Table II and Table III providing a priori codes. Table IV shows a coding example from each of the code groups for the course descriptions and interviews. The codebook was collectively tested by all authors to resolve unclarities before the first cycle of coding.

The coding (Saldana, 2016) was done by two researchers in two cycles using *Atlas.TI* as coding software. During the first cycle of coding two researchers coded all documents separately. After calibrating the results, a second coding cycle was done to ensure completeness. The results were based on 109 quotations from the course descriptions and 264 quotations from the interviews. When counting which courses mentioned which learning objectives or which levels of participation, the researchers did not consider how often those codes were mentioned. Furthermore, a thematic analysis (Saldana, 2016) of the interviews was done to include the motives of teachers for transdisciplinary education. The results from the thematic analysis are presented in section 4.2.

Conflicts that arose were discussed and resolved after the coding was done to come to a consensus on the findings. Conflicts could be codes assigned to a document by one researcher but not by the other researcher or different levels of participation being assigned to the same document. To assign a single level of participation for the entire course, the researchers chose the highest level of participation found in the course descriptions and interviews as the lower levels are contained within the higher levels of Arnstein's ladder.

Table IV. Coding examples for each code group in the analytical framework (authors' work).

Code group	Code	Example quote from course guide	Example quote from interviews
Cognitive process (a)	Apply	*"[The student is able to] compose an analytical survey or interview."*	*"Within the group they need to make agreements on how to distribute the work. So that is immediately connected to applying group dynamics."*
Knowledge object (b)	Conceptual	*"[The student is able to] explain critical issues of AI with respect to fairness, accountability, and trust."*	"*So, you're looking for a theme that is complex enough to pull apart, but at the same time, integrated enough to write a synthesis on.*"
Level of participation (c)	Client	*"Apply their academic knowledge, general academic skills and attitude to a project dealing with a complex problem commissioned by a client outside the university."*	*"That [the introduction by the municipality] is the first handover of information to the students. At the same time, it is combined with an actor perspective: this is how the municipality looks at it."*

4 Results

4.1 Course descriptions (written curriculum)

4.1.1 Cognitive processes: a wide variety of objectives

The transdisciplinary courses in the analysis aimed to develop a wide variety of cognitive processes. Table V shows how many courses include a cognitive process. The eight courses contained verbs ranging from the level of 'understanding' to 'creating'. Only the category of 'remembering' was not mentioned, which indicates that teachers do not use these transdisciplinary courses to train that cognitive process. 'Apply', 'evaluate', and 'create' were most often mentioned in courses. As many

courses were connected to the Faculty of Architecture and the Built Environment, their focus was often on design skills. For example, a learning objective related to design in the category 'evaluate' was:

> *'[The student is able to] identify and explain the qualities of the proposed design.' (Urban Health 2)*

4.1.2 Knowledge objects: conceptual understanding and problem-solving at the core

The analysis of the knowledge dimensions showed a more distinct picture, with fewer mentions of factual and metacognitive knowledge. By contrast, the conceptual knowledge dimension was coded 33 times and occurred in 7 of 8 courses. The procedural knowledge dimension was coded 27 times and occurred in all courses. This suggests that these courses emphasize conceptual topics in a specific discipline and the skills or procedures students need to practice within these topics, such as:

> *'The student is able to divide the tasks in the project within the student group.' (Procedural knowledge in Urban Development)*

4.1.3 Level of participation: contextualizing complex challenges

Five of the courses described the participation in the course in the client category. The remaining two are categorized as distant. The highest level of participation, the partner category, was only reached by one course. An example quote from this course guide reads:

> *'Students are asked to collaboratively shape their projects while also working with the case owners, coaches, and other stakeholders in the case.' (Urban Sustainability 2)*

Table V. This overview of the analyzed course descriptions shows which cognitive process dimensions (verbs) and knowledge dimensions (objects) were found in the learning objectives, and the course's participation level (authors' work). The courses were connected to Delft unless otherwise indicated.

	Cognitive process dimensions						**Knowledge dimensions**				**Levels of participation**		
Course subject (city)	*Remember*	*Understand*	*Apply*	*Analyse*	*Evaluate*	*Create*	*Factual*	*Conceptual*	*Procedural*	*Metacognitive*	*Distant*	*Client*	*Partner*
Urban design		✓	✓	✓	✓	✓		✓	✓		✓		
Social inequality					✓	✓		✓	✓			✓	
Urban development			✓		✓	✓		✓	✓	✓		✓	
Sustainable renovation		✓	✓	✓	✓			✓	✓	✓	✓		
Urban health 1			✓	✓		✓		✓	✓			✓	
Urban health 2		✓	✓	✓	✓	✓	✓		✓			✓	
Urban sustainability 1 (Amsterdam)			✓	✓	✓	✓		✓	✓	✓		✓	
Urban sustainability 2 (Amsterdam)			✓		✓	✓		✓	✓				✓

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4.2 Interviews (ideal curriculum)

4.2.1 Cognitive processes: varied objectives but more analyzing and less applying

Create: problem-solving, knowledge application, or stakeholder integration

'Creating' was often mentioned in the learning objectives and was similarly stressed as important by teachers. Whether the result of the course was a product, a participatory process, or a personal learning process, creating was described as the main component.

Teachers talked about three kinds of creating. First, their transdisciplinary courses are meant to train problem-solving abilities and should result in a 'product'. Several teachers mentioned that the product is not the aim, but the tool with which they can guide the learning process of design or problem-solving abilities. In the interviews a teacher described the tensions between different stakeholders:

> *'The case owners are concerned by the solution, the product. To the students, the product is actually […] not the most important thing. The most important thing is their learning process.' (Teacher Urban Sustainability 2)*

Second, teachers mentioned that their course is meant to offer students situations to apply academic knowledge in practice. In the course, students need to recognize where their academic knowledge from previous courses can be of added value when solving problems in the real world, as summarized by this teacher:

> *'Students should learn how to apply academic knowledge and skills in the process of solving an issue in practice.' (Teacher Urban Sustainability 1)*

Third, some courses specifically required students to create a process that integrates the perspective of stakeholders. Stakeholders could be citizens living in the area, or other actors that were involved there, such as the municipality or a housing corporation. Teachers mentioned that students were asked to integrate the insights from stakeholders in their design or interact with them in the process of analyzing the problem. These were some questions that could arise during the course:

> *'How do you create a process? What sorts of products, or new concepts, are necessary to accommodate the needs of citizens?' (Teacher Sustainable Renovation)*

Evaluate: the student's position, collaboration, and reflection

In the interviews, teachers described how students should use an evaluation to position themselves within the world and develop the ability to critically reflect on that position. Several teachers mentioned that evaluating the collaboration within the student group is an element of the course. Teachers also mentioned reflection. In one case, a teacher refers to metacognitive, procedural, and conceptual knowledge objects:

> *'We asked them to reflect on three things: their learning objectives, the collaboration within the student team, and the content of the course.' (Teacher Sustainable Renovation)*

Analyze: existing or new analytical skills

The learning objectives about creating build upon analytical cognitive processes. Teachers approached this roughly from two directions. Some teachers made use of existing analytical skills from the diverse disciplinary backgrounds of students in their courses. In other courses teachers spent time letting students develop new analytical skills, such as observation and interview techniques. These skills were specifically aimed at gaining insights from local people. Although all courses made use of analysis in the learning process, many teachers stressed that it is not the main learning objective:

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'They do some analysis and fieldwork, but that is all quite limited.' (Teacher Social Inequality)

Apply: skills and collaboration

Teachers expected students to apply a variety of skills in their courses. Some skills that were mentioned were writing a synthesis report, negotiating, phasing a long-term project, and project management. One teacher talked about these cognitive processes as 'basic skills' that are content-independent.

Most teachers specifically mentioned collaboration and group dynamics. One teacher even said this was the most important objective of the course (see the quote below); however, most teachers mentioned that they spend little time on collaboration as a topic. In most courses the dominant philosophy is that collaboration is a process that students learn by doing.

'[The most important objective is] that they learn to collaborate. Although I only have one workshop specifically about collaboration in the course.' (Teacher Urban Development)

Understand: the complexity of participation

On the level of understanding, teachers were not addressing specific conceptual areas, but aimed for an understanding of the complexities of collaboration or the dynamics of participatory processes. Teachers said that students need to understand the wishes and reasoning of citizens or other stakeholders in the area. This is a different kind of understanding to what is usually meant by this category in Bloom's taxonomy. Understanding or relating to other people refers to the ability to empathize and can be better defined from the perspective of metacognition in learning objectives in the next section. An example of the kind of empathetic understanding teachers aimed for is:

'[Before the course] they have little knowledge about citizens or citizen participation. And they know little about the complexities of these kind of sustainability projects.' (Teacher Sustainable Renovation)

4.2.2 Knowledge dimensions: more factual and metacognitive knowledge

Factual knowledge: sharing knowledge

Teachers barely talked about factual knowledge in the interviews. Three interviewees mentioned 'knowledge sharing' as part of their course. They then referred to experts from practice or teachers sharing knowledge on specific (factual) topics that were relevant to the course. One teacher mentioned that students shared knowledge with the commissioners as part of the course:

'It might be the people from the municipality that focuses on knowledge transfer. They think: 'We have twenty students here, what if they gather all knowledge that is available and hand it over to us'.' (Teacher Urban Sustainability 1)

Conceptual knowledge: complexity and multi-actor perspective of urban challenges

Most courses had specific conceptual themes related to urban challenges, such as socio-spatial segregation, loneliness, climate adaptation, or urban governance. Teachers aimed for students to understand the depth or complexities of these themes, and they aimed for students to understand these themes from a multi-actor point of view. One teacher described this as follows:

'I find it to be important for the teaching staff to point out to the students that the question is often formulated by just one person, or based on the vision of one expert. As an urban designer, you should consider this. You should be sure to integrate public interests and not just the interests of the municipality or the interests of just one expert.' (Teacher Urban Design)

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Procedural knowledge: design process, interview techniques, collaboration, and uncertainty

Teachers mentioned four kinds of procedural knowledge. First, procedural knowledge of how to design was mentioned in the objectives. Knowing how to integrate conceptual knowledge into a specific product was core in most courses. Furthermore, the design of a process in which citizens are involved was part of most course objectives. Second, students were meant to gain procedural knowledge on collaboration within a multi- or interdisciplinary student team. Third, the courses that dealt with interview and observation techniques also paid attention to the specific procedural knowledge that comes with applying those analytical skills, as this teacher described:

> *'They need to learn 'Okay, how do I get this conversation going before those questions I really want to ask'. But in a respectful manner, giving the other person the feeling that it is a pleasant interaction.' (Teacher Social Inequality)*

Finally, only one of the interviewees mentioned dealing with uncertainty. This teacher specifically explained how students are expected to deal with uncertainties in the assignment in the course:

> *'That is a standalone thing: the uncertainties and ambiguities of the assignment that students need to deal with, to be able to, or to dare to, make assumptions, and not knowing what the result will be.' (Teacher Urban Development)*

Metacognitive knowledge: personal development, collaboration, and empathy

Teachers talked about the personal development of students in the course. Some courses intended to make room for students' learning objectives, for example. Students develop metacognitive knowledge also in collaboration with others. Within a team students do not only learn procedurally or conceptually about collaboration but also about which qualities or knowledge they can bring to the team.

Almost all teachers described how students were confronted with reality in their courses. Some teachers also added that this was to gain an empathetic understanding of the experiences of citizens or a specific target group that they needed to design for:

> *'I hope that we deliver students that are somewhat more streetwise. That they understand that outside of these university walls, there is an entire world, where all kinds of things happen that have nothing to do with technology.' (Teacher Sustainable Renovation)*

4.2.3 Levels of participation: from the real world to city and co-creation

Distant: participating with the real-world complexity instead of the city itself

Teachers in courses in this category aimed for real-world complexity to enter the course material. This resulted in courses that present a challenge from the city to students to work on and, in some cases, also the people involved with that challenge to explain more about it. The realness then adds a level of urgency that motivates students. It was also a way to understand the complexity of the conceptual contents of the course. Some teachers explicitly described that making an impact is not the aim of their course:

> *'Of course, it is not our primary aim to make an impact. The aim is for students to learn what they need to learn.' (Teacher Urban Design)*

Other teachers did want the city to participate more in the course but were not able to organize this. They mentioned two reasons: the limited resources on the side of the partner and the rigidity of the institution's learning objectives. The latter stands in the way of adjusting the course to the needs of the outside world, as this teacher mentioned:

> *'I'm fine with integrating the interests of a citizen organization into the course, but sometimes, as a coordinating teacher, that is complicated due to the*

predetermined learning objectives of an existing course.' (Teacher Sustainable Renovation)

Client: starting with an authentic challenge

The starting point for these courses was a challenge defined by a practitioner. Just like courses in the distant category, the teachers that were involved in client courses said that the realness of the problem is crucial to them. However, in this category, teachers actively search for clients that could take the role of the client in the course. One teacher described that ideally, a client seeks help from the university first:

> *'One of the potential pieces of evidence [for the authenticity of the problem] could be an email saying: 'Hey hello, could you help me with this problem?'.' (Teacher Urban Sustainability 1)*

Next to the challenge of finding authentic clients, teachers mentioned three other elements that are important to them in deciding on a challenge. First, the challenge needs to connect to the core themes within the course. Second, the client presenting the challenge needs to be able to invest resources (time and people) in the course. Third, the client's challenge needs to connect to students' interests.

Partner: creating co-creation

In the analysis, one course could be defined as a partner course and one course had aspects of both the client and partner categories. The course that was solely categorized as a partner course gathered as many thematically different cases as there would be student groups each year, and then let students choose which case they wanted to work on. Although all the cases related to urban sustainability, the challenges were diverse within that overarching theme. All cases were brought in by partners from the university-city collaboration. They were vetted by the teachers in the course against the criteria of being an open challenge, having space for a co-creative process, and being able to provide a location for the students to work. The course is unique in that it allows students to co-create a further definition of the challenge together with their partners, as the teacher mentioned in the interview:

> *'Also, the challenge should be co-created. This way the challenge is more specific and easier to tackle than the original case described [by the partner].' (Teacher Urban Sustainability 2)*

In the other course, the teacher described that they were working with the city so that students could learn how to do participatory or human-centered design. In that case, the transdisciplinarity of the courses was not only aimed at bringing the assignment closer to reality, but also at seeking participants that students can learn to interview, observe, or design for. With that knowledge of the experiences of citizens, students worked on new ideas or designs for the neighborhood. Although the course also had a client, students depended on the input of other stakeholders to do the necessary work in the course.

4.3 Comparing course descriptions and interviews

4.3.1 Cognitive processes: less analyzing and more applying in the course descriptions

In the interviews, teachers emphasize 'analyzing' more often as a learning objective than in the course descriptions (Figure 1). Almost all teachers describe analyzing as a critical part of the learning process. They referred to specific research methods, such as interviewing or observations, that students are expected to use, but might not have been familiar with. The importance of analyzing is not clear in the course descriptions.

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Conversely, ‘applying’ certain skills was described more often in the course descriptions than in the interviews. The interviews showed that applying referred to basic academic skills, such as writing and presenting. These were deemed less important in the interviews. They might have appeared more often in the course descriptions to bring learning activities in line with the learning objectives.

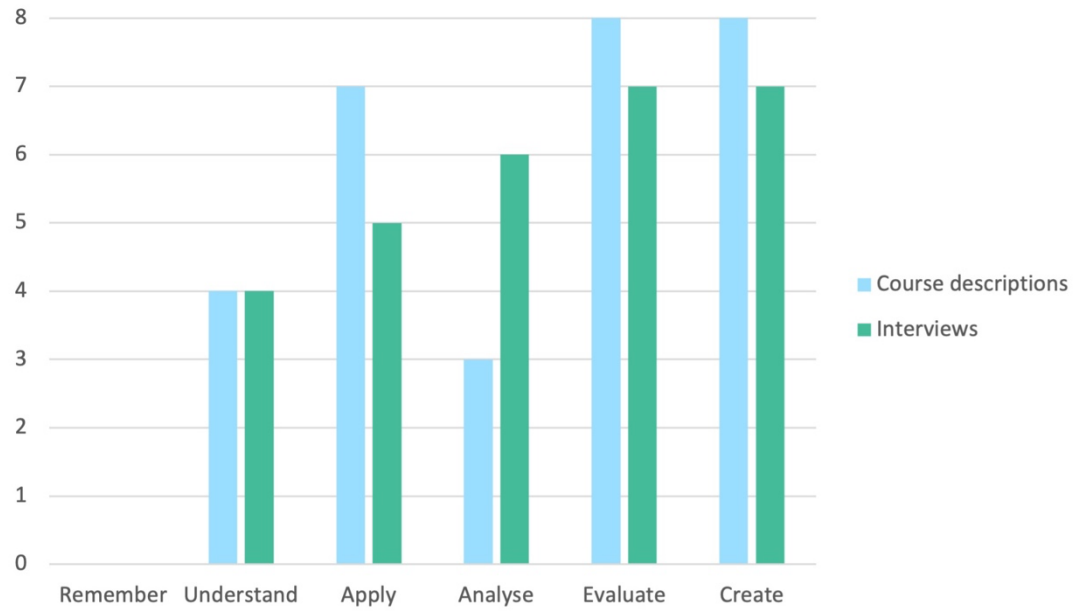

Figure 1. Comparison of the cognitive process dimensions (verbs) in the written and ideal curriculum (authors’ work).

4.3.2 Knowledge dimension: less factual and metacognitive knowledge in course descriptions

All teachers mention conceptual, procedural, and metacognitive knowledge dimensions as part of the course aims. However, the course descriptions do not represent the metacognitive knowledge dimension (Figure 2). As self-knowledge and meta-understanding are important parts of transdisciplinary education (Mokiy, 2019), it could be expected that the metacognitive knowledge dimension would be part of the aims of transdisciplinary courses.

In the interviews, teachers mentioned two metacognitive aspects that were not mentioned as learning objectives in the course descriptions. First, teachers emphasize how students will learn to position themselves within the complexities of sustainability challenges. They refer to the conceptual understanding of these challenges, as well as the personal motivations of students. Second, students learn to collaborate in an interdisciplinary team, while gaining a better understanding of their qualities or the added value of their discipline.

Factual knowledge was mentioned in the interviews but did not appear in the written learning objectives. As teachers expected students to be able to use analytical skills without mentioning them in the learning objectives, also factual knowledge might have played a role in the course implicitly.

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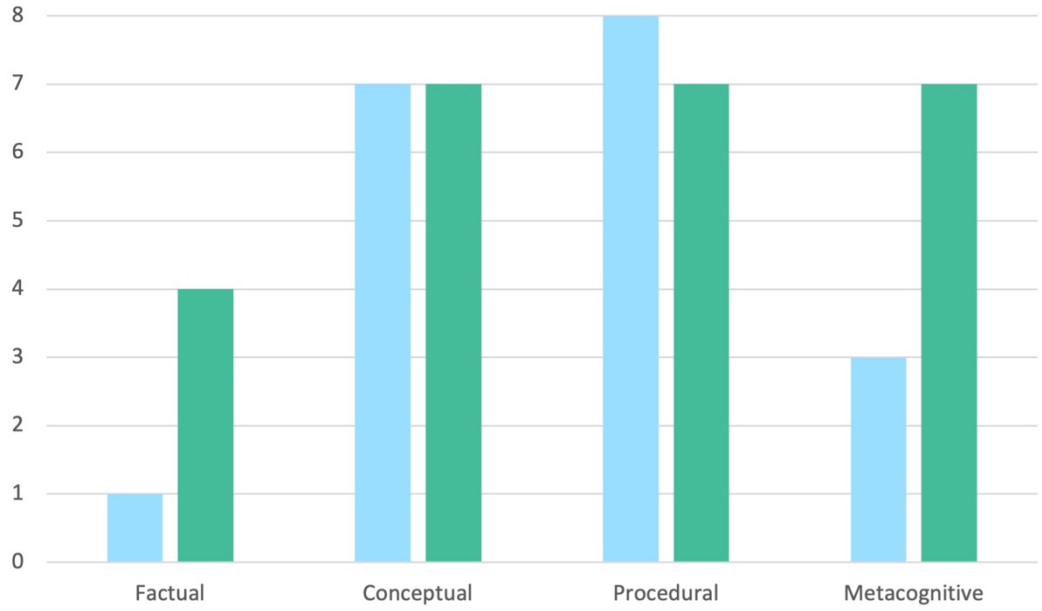

Figure 2. Comparison of the knowledge dimensions (objects) in the written and ideal curriculum (authors' work).

4.3.3 Levels of participation: no differences between course descriptions and interviews

The level of participation was aligned between course descriptions (written curriculum) and interviews (ideal curriculum) (Figure 3). Although the written and ideal courses are in line with the transdisciplinary pedagogy they use, only one course aims for the partner level of participation. In the interviews teachers mentioned the barriers to changing the intended curriculum within their courses to make them go beyond a distant or client level of participation. Most teachers feel confined by the rigidity of learning objectives when they want to adapt the course to include the interests of urban stakeholders. Christie et al. (2013) already found that it is hard for teachers to step away from traditional teaching methods. This study suggests teachers experience difficulties in adapting traditional learning objectives to the transdisciplinary pedagogies they envision.

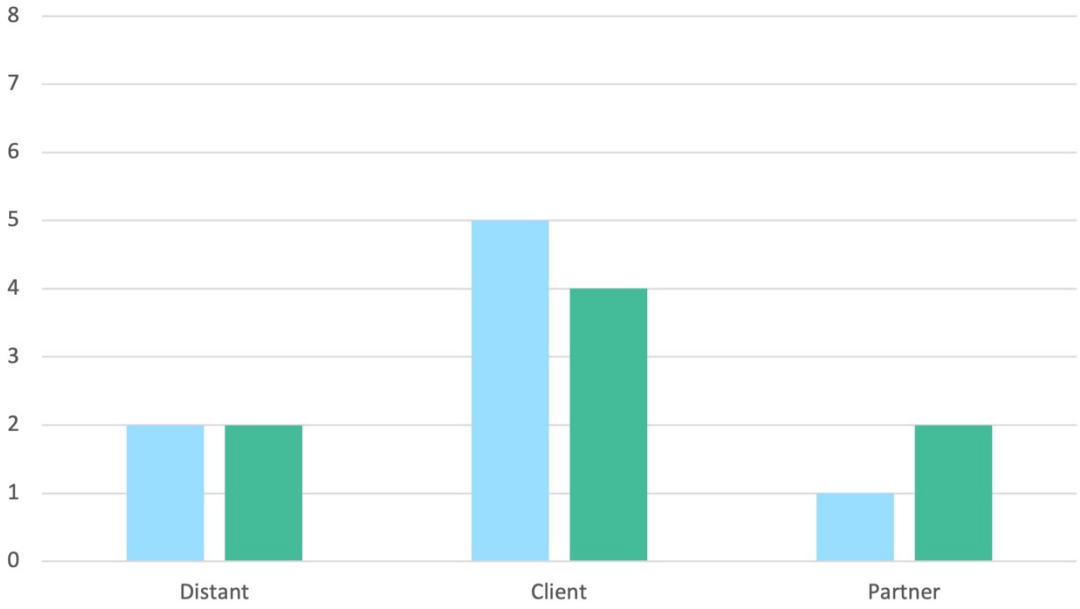

Figure 3. Comparison of the levels of participation in the written and ideal curriculum (authors' work).

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5 Discussion and conclusion

This research investigated the question ‘What is the intended curriculum of transdisciplinary higher education?’. This study aimed to get an understanding of how far-reaching the participation of the city in these courses is and what students are meant to learn from the transdisciplinary pedagogies used. In this final section, the authors discuss the main results, limitations, suggestions for further research, and the implications for transdisciplinary education in practice.

The results of this study show that teachers ideally use transdisciplinary courses to teach problem-solving of conceptual themes and issues in an integrative manner. Additionally, they want the teaching to be centered on authentic issues that are topical and relevant to students' lives. These overarching aims are written down in the course descriptions and are described by teachers in interviews. This study found a misalignment between the written course descriptions and the ideal visions of teachers in three instances.

First, the cognitive processes in the learning objectives focus less on analyzing than teachers explain in the interviews.

Second, students are meant to get to know their strengths and weaknesses in collaborative teamwork in these courses and learn how to undertake participatory research. Through participating in local communities, teachers aim for students to learn to move outside their world of experiences and gain a deep understanding of the biases and values of others that they might be designing for in the future. Empathy and dealing with uncertainty were mentioned as specific skills in working on sustainability challenges. Those skills also occur in the UNESCO (2017) framework of sustainability learning goals yet do not occur in the written curriculum in the analyzed courses. In the interviews the metacognitive dimension was mentioned, and the courses aimed for students to understand who they are and what they (can) know. The written learning objectives seldomly included metacognitive knowledge as an object. This suggests they are more difficult to teach or assess in the implemented or attained curriculum.

Finally, although there are transdisciplinary intentions in all courses, not all courses position stakeholder participation in the same way. The results show that most investigated courses remained on a level of client participation. In those courses, students are expected to develop a professional attitude and in some courses act as consultants to advise the client. However, some scholars argue this is not enough and to contribute to sustainable change. Instead, transdisciplinary education should aim for more responsive or active forms of participation from the students with the stakeholders (Gibbs, 2017).

This study is limited to the intended curriculum. Other curriculum representations, namely the implemented and attained curriculum, require different research objects, such as interviews with students and course materials. By focusing on the intended curriculum, this study aimed to provide a better understanding of what teachers aim to achieve on the ground. In future research, the authors will investigate the experiences of students and the assessment of learning in these transdisciplinary courses.

Furthermore, this study was built on the perspective of teachers, who focus on urban sustainability challenges. The authors recognize that in education in general the perspective of students, and in transdisciplinary education specifically the perspective of stakeholders from outside the university, co-shape the curriculum. The focus on teachers emphasizes the academic perspective on transdisciplinary learning in this paper, but it is not an exclusive perspective.

A final limitation of this study is that it zoomed in on two university-city collaborations. In future research a larger selection of university-city collaborations would be preferable, especially beyond the Dutch border. In this study, the courses in Amsterdam profited from the small-scale institutional context. The teachers mentioned that this allowed them to experiment more easily with

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transdisciplinary pedagogies. However, this study is too small to draw strong conclusions on the impact that the university-city collaboration has on the intended curriculum in the courses.

This study adds a research approach to transdisciplinary education focused on the intended curriculum. By introducing three levels of participation, it can now be analyzed to what extent different transdisciplinary courses intend to involve others. Different levels of participation have different learning effects. Teachers play a crucial role by deciding on the participation level when writing down the intended curriculum. Historically, teachers have had this form of academic freedom to decide how they want to teach their subjects to students. Today, they remain the custodians of transdisciplinary courses, which gives them the power to decide which stakeholders enter the learning arena.

Although academic freedom is essential to higher education, teachers do not necessarily have the means to establish the courses they envision by themselves. Apart from overcoming practical barriers, such as time and resource constraints, teachers need a vocabulary of learning objectives that fits their transdisciplinary intentions. This paper contributes to the development of a common vocabulary and language. That vocabulary of learning objectives should specifically include metacognitive knowledge as vital to transdisciplinary education and consider a more specific way to describe analyzing as a cognitive process. By making implicit intentions in the curriculum explicit, teachers can better prepare students to become agents of change for sustainable transitions in the city.

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Biographical Details of the Authors:
Nina Bohm is a PhD Candidate at Delft University of Technology and affiliated to the 4TU Centre for Engineering Education. She investigates how engineering students learn to deal with uncertainty in transdisciplinary education, such as living labs. As an embedded researcher, she has been course coordinator of the Living Lab course in MSc MADE (Metropolitan Analysis, Design, and Engineering).

Renate Klaassen is a Senior Policy Advisor and Executive Secretary at the Graduate School and Board of Directorates and Senior Researcher at the Delft Institute of Applied Mathematics, all at TU Delft. Her research interests are inter- and transdisciplinary learning in challenge-based contexts, math competencies, transfer and gender in Mathematics Education. Consultancy activities include assessment (policy, quality and professionalisation). Other areas of interest are the internationalisation of university education and design education. She has extensive experience in curriculum renewal, assessment and interdisciplinary learning and has been involved in various innovations reforms at TU Delft focused on "a vision of the future university." And the future engineer. Last but not least, she is a core staff member of the Joint Interdisciplinary Interfaculty Master Course for 2nd year Masters students in Engineering.

Ellen van Bueren is full professor at the Faculty of Architecture and the Built Environment of Delft University of Technology and Principal Investigator at the AMS Institute for Advanced Metropolitan Solutions in Amsterdam. The governance and management of urban development processes in support of a sustainable built environment is at the core of the work. She teaches in multiple programmes at BSc., MSc., and post-graduate level, many of an inter- and sometimes transdisciplinary nature.

Perry den Brok is full professor and chair of the Education and Learning Sciences chair group at Wageningen University and Research. He is also chair/director of the 4TU Centre for Engineering Education. His research expertise lies in the area of innovation in higher (engineering) education, innovative learning environments and teaching and teacher learning. He teaches in the teacher education programme of Wageningen University.