TEACHING IN HIGHER EDUCATION
https://doi.org/10.1080/13562517.2025.2468978

The role of academic and extra-academic actors in transdisciplinary challenge-based learning

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ABSTRACT

To solve societal, sustainability-related issues, higher education requires new and innovative didactical concepts in learning. We introduce the concept of transdisciplinary-CBL (T-CBL) to explicate the role of diverse disciplinary and extra-academic actors in learning processes where students work in teams to co-create innovative solutions to societal challenges. To increase our understanding of how students learn from different actors in T-CBL, we used a survey, semi-structured interviews and sociograms to elaborate the nature of interactions with and the value students ascribed to these actors. The results show that students learn from a wide variety of actors in T-CBL. Extra-academic actors help by contributing expertise and informing solution pathways, whereas friends and family provide emotional support. T-CBL results in specific learning gains including perspective-taking. The results offer a picture of T-CBL as social learning in which students interact with networks of actors from which they learn 'on-demand'.

ARTICLE HISTORY
Received 29 May 2024
Accepted 5 February 2025

KEYWORDS
Transdisciplinarity; higher education; transdisciplinary challenge-based learning; sustainability

Introduction

Transdisciplinarity seeks to extend interactions outside academic institutions to integrate expertise, experience, tools, and methods from both academic and extra-academic perspectives to tackle problems of societal importance (Gibbs 2015; Klein 2014; LERU 2016; O'Sullivan 2023; Vienni Baptista and Rojas-Castro 2020). Within academia, there is a growing consensus that transdisciplinary education is necessary to enable current and future generations to address complex societal and environmental challenges

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Supplemental data for this article can be accessed online at https://doi.org/10.1080/13562517.2025.2468978

(Kueffer et al. 2012; Sterling 2004; van Rijnsoever, Sitzler, and Baggen 2023). Students need to learn how to develop, maintain and enact relationships with extra-academic actors to co-create knowledge that results in action pathways. We define extra-academic actors as those actors who are connected to transdisciplinary work on challenges but who are external to the academy (O'Sullivan 2023). These are actors with either lived or professional knowledge of the challenge.

Challenge-based learning (CBL) has been described as an intervention or pedagogical approach (Leijon et al. 2021). We perceive CBL as an educational concept that represents views not just on what should be learned but how a complex set of educational practices can support students to develop skills to engage with complex societal and environmental challenges (Malmqvist, Rådberg, and Lundqvist 2015; Membrillo-Hernández et al. 2018). These practices include vision, support, principles, and activities to enable student learning (van den Beemt, van de Watering, and Bots 2023). In CBL, students take part in a learning process where they are stimulated to take their own lead in learning through applying, acquiring, and learning knowledge to work on real-life, open-ended challenges (Helker et al. 2024). While CBL is described as multi-disciplinary in nature (Malmqvist, Rådberg, and Lundqvist 2015; Nichols and Cator 2008), the literature to-date describes CBL as often occurring within single disciplines of Science, Technology, Engineering and Mathematics (STEM) and focused on socio-technical problems (Gallagher and Savage 2020). Additionally, according to Leijon et al. (2021), most research to date focuses on challenges where student groups are predominantly mono-disciplinary, and students undertake challenges within their own discipline (particularly within engineering education).

Within the context of this paper, we introduce the term transdisciplinary CBL (T-CBL) to describe CBL that brings students from multiple disciplines together to work with a broad network of actors – including academic actors from multiple disciplines and extra-academic actors – on challenges of societal and/or environmental importance (European Commission 2021) such as captured in the United Nations' Sustainable Development Goals or the European Green Deal (Bammer et al. 2023; European Commission 2021; Fam, Neuhauser, and Gibbs 2018; Kueffer et al. 2012; OECD 2019; Sterling 2004).

T-CBL is increasingly evident in higher education. However, little is known about how these actors are integrated into T-CBL, what role they play and how they contribute to student learning. This is problematic because higher education institutions need to have a greater understanding of the role of different actors in student learning to appropriately resource, support and manage this broad network of actors. Research on these networks of actors is also needed to build an evidence base for how effective T-CBL is for developing student competencies and what role different actors play in this.

The aim of this paper is to map the student learning process in T-CBL by utilising the theoretical perspective of social learning (Wenger-Trayner et al. 2019) to give an insight into what actors are present in the T-CBL learning process. We adopted the learning gains perspective (Vermunt, Ilie, and Vignoles 2018) to increase our understanding of the role actors play in student learning. We present the results from a mixed-method case study of students engaged in T-CBL courses within a Dutch alliance of universities. We used a combination of a survey, semi-structured interviews, and sociograms to understand the connections students had with various actors during their learning journey. We gained an insight into what actors students connected with in the learning

process, how students perceived the role of these actors and what value they ascribed to these actors.

Transdisciplinary education

Within the European tradition, transdisciplinarity is a normative and societally-oriented educational approach that prioritises solving societal problems through the integration of knowledge and the equal participation of societal actors in the knowledge creation process (Hadorn et al. 2008). Within transdisciplinarity, learning takes place through collective and collaborative interactions across disciplines (e.g. arts, natural sciences, and social sciences) and with actors external to the higher education institution (Fam, Neuhauser, and Gibbs 2018). These extra-academic actors can be those with lived experience of a complex societal issue, e.g. drought in a local community; those with professional experience of the complex societal issue, e.g. hydrologists or governmental policymakers; those with extra-academic research expertise of the complex societal issue, e.g. private consultancy firms; or those with a political interest, e.g. local, regional or global political groups, activist or otherwise.

Therefore, in transdisciplinary learning, students collaborate and interact to understand where their knowledge sits in relation to the knowledge of others (e.g. different disciplinary and extra-academic perspectives) thereby creating both 'distributed intelligence' and 'collective intelligence' (Gibbs 2017). The assumption is that transdisciplinarity closes the knowledge-action gap.

T-CBL and social learning

T-CBL can be conceptualised as social learning wherein individuals participate in interactions with various actors to gain new insights and resources that will lead them to changed practice and transformational potential (Wenger-Trayner et al. 2019). Those who partake in social learning engage in dialogue and interactions, share problems and insights and collaboratively construct new knowledge through dialogue and social interaction (Vrieling, van den Beemt, and de Laat 2016). Social learning requires team members to have an outward perspective, to a wider network containing expertise (Wenger-Trayner et al. 2019).

T-CBL in practice

In T-CBL, learning is self-directed, active, and triggered by the focus on real-life challenges. Students work with their team in dialogue with academic and extra-academic actors to narrow an authentic, open-ended challenge area to a specific problem. The learning process involves gaining as much expertise and knowledge as possible on the problem in order to propose a possible solution pathway. Students are then given responsibility for finding, appraising, and integrating the expertise they need to develop a solution to a problem within the challenge.

Through accessing extra-academics' experience-informed knowledge, the idea is that students understand the challenge more deeply and learn to integrate the perspectives of others. Students then feed new insights back into the solution-making community (their

student team, coach, and course coordinator, for example) and back to the extra-academic actor who proposed the challenge (within this case study, these were referred to interchangeably as challenge agents or challenge owners). In the case of T-CBL, we conceive of this as a learning network, which enables us to consider the diversity of social relationships within students' networks and focus on the strength of these relationships and their impact on learning (Vrieling, van den Beemt, and de Laat 2016). Social learning through learning networks generates value, defined as 'importance, worth, or usefulness' (Wenger-Trayner et al. 2019, 7). This learning can be informal or formal and the networks can also be formal or informal (Vaessen, van den Beemt, and De Laat 2014).

Learning gains as a conceptual framework

We drew on the conceptual framework of Vermunt, Ilie, and Vignoles (2018) to understand what types of changes in learning students perceived as occurring in T-CBL due to their interactions with different actors. Vermunt, Ilie, and Vignoles (2018) define learning gain as 'students' change in knowledge, skills, attitudes, and values that may occur during higher education across disciplines' (272). They propose four components: cognitive, meta-cognitive, affective, and socio-communicative, which they conceive of as learning outcomes in which students can bring about gains during university education.

- Cognitive: deep thinking, critical thinking, analytical thinking, synthesising, analysing, evaluating and problem solving.
- Meta-cognitive: self-direction and self-regulation of learning; grit; information seeking; need for cognition; skills like monitoring, adjusting, and evaluating goals.
- Affective: motivation; engagement; professional/academic interest.
- Socio-communicative: level of belonging in social (professional/learning) networks; social embeddedness; communication skills; and societal engagement.

As T-CBL is a novel educational concept, the learning gains framework allows us to identify which components of higher educational learning T-CBL develops and what competencies students may develop that are unique to T-CBL. Helker et al. (2024), for example, describe how the socio-communicative component is strongly referenced as a learning gain in literature on CBL.

Aims of the study

Existing literature shows a lack of information about who the network of actors is in T-CBL, what the roles of these actors are and how students interact with different actors to further their learning (Gallagher and Savage 2020). Answering these questions will help universities understand how different actors contribute to student learning. The following questions guided the study:

(1) Which actors are connected to T-CBL?
(2) What role do these actors play in student learning in the challenges?
(3) How valuable are these actors to the students in terms of perceived learning gains within the challenge?

Methods

Research design

This research followed a mixed-methods case study design (Stake 2012; Yin 2018). In this research, as we used this case to understand larger research questions, an instrumental case approach was taken (Stake 1995; Stake 2012). The case comprised a programme of T-CBL courses created by a strategic alliance comprising four higher education institutions in the Netherlands. This study drew participants from two T-CBL courses within the Alliance, referred to as Challenge A and Challenge B.

Context of the study

The present study was conducted within two of the challenges that ran during the academic year 2021–2022. Within Challenge A, students were challenged to explore solutions that could enable dairy farms to continue existing in a healthy, sustainable, and economically feasible way, taking into account the perspectives of the animals, the environment, and the farmers. Within Challenge B, students were challenged to find ways to replace the use of laboratory animals for testing in healthcare and food safety research. The two challenges followed a similar course design, had a duration of twenty weeks, included four live events, and were credited with 7.5 ECTS upon completion. The combined roles of actors described in the course manuals were CBL facilitator*, course coordinator(s), challenge agent(s), coach, students/participants, course examiners*, challenge agent, coach, experts* (see Appendix 1 for a description of roles from course handbook for Challenge A).[1]

At the outset, students were divided into teams, tasked to define a problem within the specific course challenge area and to work together on a proposed solution to the chosen problem. The challenge agent (an extra-academic and expert working within the challenge area) introduced the challenge to the student teams. At intervals throughout the course, the challenge agent attended group meetings or 'live events' with students and other actors. Additionally, the challenge agent played an advisory role in the assessment. The course coordinator was an academic staff member responsible for the design, organisation, and assessment of the challenge. The coach had the role of supporting the learning processes of the team and the individual students. In Challenge A, there was also a 'CBL facilitator' who was present to keep an overview of the process and connect with the Alliance's central team of educational developers.

Students were assessed based on a team track (70% contribution to final grade) and an individual track (30% contribution to final grade). For the team track in both challenges, each team delivered a project proposal, an advisory report, a proof of concept and a final presentation. For the individual track, students formulated at least three individual learning objectives with the support of their coach and reflected on their personal learning throughout the process of the challenge.

Participants

Purposive sampling was used to recruit respondents from the two courses. The target group was students. Students were selected on the sole criteria that they were enrolled

in and actively attending these courses. A total of 36 students participated in the two challenges; of which $n = 20$ students completed the survey and $n = 15$ took part in the semi-structured interviews. All 15 students that participated in the semi-structured interviews indicated that it was their first time participating in T-CBL. Table 1 presents the characteristics of the participants that took part in the interviews. The first two letters of the name of each participant refers to the challenge that they participated in.

Instruments

Surveys and semi-structured interviews were used as instruments for data collection. The survey asked students which actors they contacted during the challenge, how often they contacted them and using a numerical value (1–4; 1 = not valuable, 4 = very valuable), what value they placed on the role. This survey data informed sociograms, a graphic representation of an individuals' social links, drawn on Miro boards for each student (see Figure 1). Semi-structured interviews allowed the researchers to gain greater insight into student survey responses, as will be explicated in the following section.

Procedure

The survey was distributed in May 2022. At this point in the challenges, students were working towards their solutions to the challenge they defined. The survey contained introductory text explaining to students the purpose of the research and sought their informed consent. The survey asked about the actors (people, resources, objects) students contacted during the challenge; the role of these actors (if any) in their learning during the challenge and the purpose of the contact.

Two researchers conducted the interviews separately using an interview guide created in advance and informed by the research questions. As students were spread across The Netherlands, the interviews were conducted online via Microsoft Teams. During interviews, interviewees were given access to the sociograms and were encouraged to further refine the sociograms on Miro boards to visually map the connections between the students and others in their network for the challenge they were involved in. Sociograms enabled a mapping of social learning (Wenger-Trayner et al. 2019). The contacts

Table 1. Interview participants' characteristics.

Name	Gender	Level of Study	Discipline
CAA	M	MSc	Animal Sciences
CAB	F	MSc	Urban & Economic Geography
CAC	F	MSc	Innovation Science
CAD	F	MSc	Veterinary Medicine
CAE	M	BSc	Agrotechnology
CAG	M	MSc	Veterinary Medicine
CBA	F	BSc	Life Sciences
CBB	M	MSc	Medical Engineering
CBC	F	MSc	Biology
CBD	F	BSc	Biology
CBF	F	MSc	Sociology
CBG	F	BSc	Life Sciences
CBH	F	BSc	Life Sciences
CBI	F	BSc	Natural Sciences and Innovation Management
CBJ	F	MSc	Drug Innovation

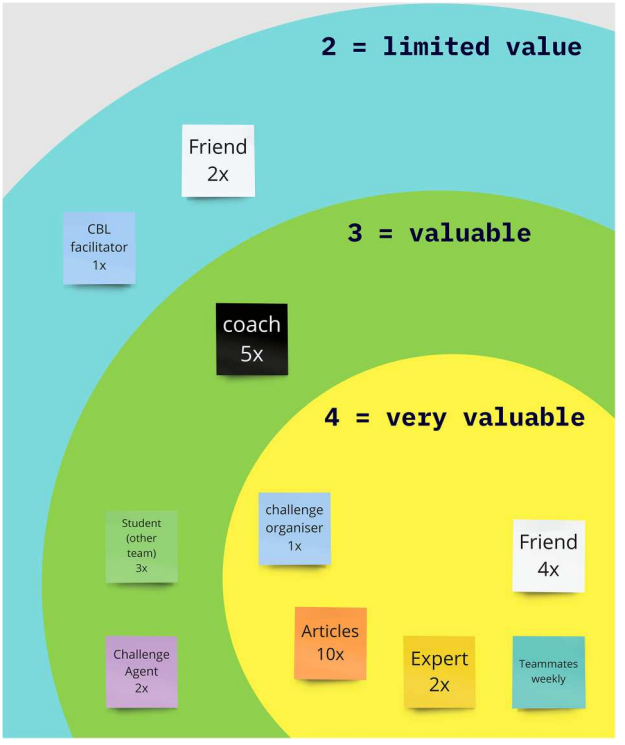

Figure 1. A screenshot of the sociograms created from student surveys and used as a tool to support semi-structured interviews.

were placed in concentric circles, according to the value that the interviewee assigned for each contact (the inner-most circle contained the actors perceived as very valuable, and the outer-most circles contained the actors who were considered least valuable). The sociograms also served as a narrative stimulus for further exploratory questions in the interview (Buckley and Nimmon 2020) as well as an aide memoir (all students added further contacts during the interviews). During interviews, students revised certain value ratings when they were asked to explain value ratings applied.

During the interviews, students were asked to describe the actors they contacted; the purpose of their interactions; what they learned from the different actors; and how they valued their contact with the various actors.

Data analysis

We employed step-by-step thematic analysis to inductively identify themes emerging from the student data (Attride-Stirling 2001; Clarke and Braun 2013). We balanced this with deductive coding using the learning gains components proposed by Vermunt, Ilie, and Vignoles (2018). Both researchers read raw transcripts downloaded from Microsoft Teams and proposed codes based on the research questions (a priori codes) and emergent codes. The researchers discussed these codes and reviewed them with the entire research team. From this discussion and review, two researchers drew

a list of final codes combing a priori, emergent and in vivo codes. Both researchers coded two transcripts with final codes (see Appendix 2) and compared results. Based on this comparison, researchers refined final codes to create greater alignment and clarity on the choice of codes. This list was shared with the research team and points of debate were discussed to reach consensus. The research team held monthly meetings with the larger group and bi-weekly meetings with a smaller group to discuss the coding scheme and thematic analysis.

Following the steps of thematic network analysis, the two researchers extracted salient themes from the codes. Using the four categories of learning gains (Vermunt, Ilie, and Vignoles 2018) as an analytical frame, Organising Themes were grouped into four Global Themes: cognitive, meta-cognitive, affective and socio-communicative.

Results

First, we explore which actors are connected to challenges in T-CBL. Then, we investigate the roles these actors play in student learning within these challenges. Finally, we assess the value of these actors to students in terms of their learning experiences within the challenges. While these were different challenges, they were both organised according to the guidelines of the interuniversity alliance. The involvement of extra-academic actors is central to T-CBL and this case was chosen to place a boundary within which a case of innovative educational practice can be studied to inform larger research questions. Our findings are framed within Vermunt, Ilie, and Vignoles (2018) learning gains components, with an additional fifth component emerging from our data analysis: perspective-taking.

Which actors are connected to challenges in T-CBL?

Data collected indicates that during T-CBL, students contact a wide variety of actors. The size of students' networks in this case ranged from six to 18 actors. Students with lower numbers in their network attributed this to the fact that they were hindered in their progress due to problems within their team or delays in working on their solution. The average number of contacts listed per student was nine. Table 2 shows the types of actors described by the students. The number of times a certain type of actor was mentioned by students varied from seven (CBL facilitator) to 38 (sectoral expert). The course coordinator, as an actor, was predominantly associated with administrative matters and was mentioned infrequently across all students interviewed.

Students described two types of experts. Based on our thematic analysis of students' descriptions of these experts we assigned these actors the following titles: sectoral expert and academic expert. Sectoral expert refers to actors, as explained by students, who are employed in the sector and who have expert knowledge either in the challenge area or the solution area. For example, in Challenge A, sectoral experts included employees of a large dairy cooperative. In Challenge B, sectoral experts included researchers working outside the university on alternatives to animal testing. They also included those actors, cited by students, whose personal life or livelihood is directly affected by the challenge. For example, in Challenge A, as the challenge was the sustainability of dairy farms, this referred to dairy farmers. Academic experts refer to academic experts

Table 2. Range of actor types and number of times they were mentioned by students in completed surveys.

Actors	Description	No. of mentions	Total %
Expert (Sectoral)	Individuals working outside the university within/connected to the challenge area.	38	23%
Family & Friends	Family and friends listed by students in the survey and interview.	34	20%
Teammates	Students who are in the same team as the interviewee.	18	11%
Coach	The individual assigned to the team by the course coordinator to fulfil functions of a coach.	17	10%
Expert (Academic)	Individuals working within the university connected to the challenge area.	14	8%
Resources	Non-human sources of information for students, e.g. Google and academic databases.	13	8%
Course Coordinator	An academic member of staff within the university responsible for course coordination.	10	6%
Student (non-team)	Students enrolled in the course but in a different team to the interviewee.	9	5%
Challenge Agent	Individual(s) representing the organisation, external to the university, who proposed the challenge area as a course topic.	9	5%
CBL Facilitator	A staff member employed by the Alliance's central educational team with expertise in challenge-based learning. This is not an academic role.	7	4%
		169	

that students sourced either in their own course or other disciplines at their university or other universities (Table 2).

Students referred more commonly to family rather than friends but as both groups provided affective and self-regulatory support, we subsumed the two groups into one category: Family & Friends. Students also referred to both teammate and the team as actors but more commonly they referred to individual teammates by name. Therefore, we combined these two actor types into one type: teammates.

We assigned the title student to describe actors within the students' networks that were fellow students but not friends or teammates. For example, these were other students in the student's education programme, in other challenge teams, or who students met through other university activities. Resource/object refers to actors such as Google and journal databases, both of which students mentioned frequently as sources of knowledge to inform their understanding of the problem within their challenge.

What role do these actors play in student learning in the challenges?

Based on students' descriptions of why they contacted different actors and how these actors helped them progress with their perceived learning goals within the challenges, the data suggests that students associated certain actors with certain learning gains.

Cognitive

Students' interactions with sector experts helped learning outcomes that can be conceptualised as cognitive: synthesising, analysing, evaluating and problem solving. Sector experts helped students evaluate the viability of their solution or analyse the problem. Student CBJ described the contribution of a sector expert as giving them a solution to the problems that they had as a team: 'Not only an opinion, but a solution … For example, he [the sector expert] in just one hour gave us a lot of information that would take me maybe weeks to find'.

Students saw the challenge agents (who worked in the sector) as important in helping them analyse the problem definition. The challenge agent also gave students feedback on their project proposals and solutions. While students mentioned academic experts in their sociograms, they mentioned them infrequently in student interviews. When mentioned, academic experts were seen as providing disciplinary information to better understand the problem area.

Meta-cognitive

Students identified both Google and sector experts as valuable actors for what Vermunt, Ilie, and Vignoles (2018) call need for cognition (information seeking). Students said they used both actors to find information they needed to understand the problem area and potential solutions. Student CBJ described how useful Google was at all stages: 'Just looking for information and you get a thread that you pull and you find something'. Regular use of the internet as a source of information was common to all students. Student CBJ explained:

> I didn't have a clue about what a chip was before this challenge, so I had to read a lot and I always try to go first to the books because it gives you an overview of everything and then I go to articles to know more specific details.

Students also turned to their teammates to satisfy this need for cognition (information seeking), for example, Student CBI said their team helped them with a lot of terms that they didn't know about or didn't get: 'I do not have any biomedical background. So they provided me with a lot of knowledge about the biomedical stuff because they do have a background in biomedical things.'

Students associated coaches with the skills of monitoring, adjusting, and evaluating learning goals. The perception of the coach as someone who is there to help students set learning goals and encourage them to complete the necessary reports was common across all students. For example, Student CBH said that while the coach did not help with expertise or the problem definition, they helped the student manage the T-CBL process: 'How to take an overview of what you were doing and so step back and then watch what you have. And then you can go and think about what direction you want to go in'.

Affective

Students frequently mentioned the emotional and social support they received from different actors. Student CBJ, for example, spoke of the support from her friends in venting problems or brainstorming how to handle conflict or conflicting needs and workloads within the team. Students gained similar support from their families, with whom they were in contact very frequently. Student CBH said:

> They helped me … they had no idea what I'm doing, what I'm studying. They find it difficult and hard to understand, but they help me with emotion … so when we had a difficult team meeting, they were like 'Talk it out and say how you feel and say how you want to work together', so that I could feel better and I can move on.

In addition, some students turned to their teammates for emotional support, for example, Student CBG said: 'In our group we have some difficulties – people flaking on meetings and we were always both there, so we were always supporting each other, which is really valuable for me.'

Socio-communicative

Students frequently mentioned the challenges and benefits of social interaction that occurred due to their membership of a team. Students said that they had weekly meetings with their team and separately would contact each other about different matters ranging from help with information seeking to workload management, group progress and solidarity. CBH described how working as a team on a shared problem helped them to develop both communication skills and the skills needed to belong. It gave them insights into 'how not to work together'. The team provided students with ongoing opportunities to see different perspectives and use their communication skills. Student CBJ described it as:

> … how to explain things; how to share your point of view without being too rough, but also trying to be confident in what you're saying. And taking the lead or sometimes knowing that you cannot take the lead because it's not your expertise. So, bit of everything you always learn.

Students said communicating with a broader network of students from other challenges helped them reflect on their proof of concept or problem definition. Challenge agents, in the case of Challenge B, provided students with networking opportunities. For example, CBH said their challenge agent gave them insights into what people are working on in the challenge sector and where to find them. CBI said:

> I don't have anyone in my network who is in the field and the position that we needed to talk to … because we needed to talk to people in government and we needed to talk to people who are like very good researchers and I don't know anyone of them and my LinkedIn also does not have anyone of them … so I think I wouldn't have been able to reach them on my own.

How valuable are these actors to the students in terms of the challenge?

The findings demonstrate that, overall, students found teammates to be holistically most valuable, i.e. students described each other as valuable in all areas of learning gain: cognitive, meta-cognitive, affective and socio-communicative (see Table 3). However, extra-academic actors were mentioned more frequently.

Students described the insights and information gained from sectoral experts as supporting them to reframe their understanding of a challenge and to meet what they perceived as their learning goals, i.e. propose a solution to the problem they defined. Sectoral experts were seen as important sources of information that were unique in terms of working towards a solution. Student CBJ described this as follows:

> I would say that the people that are invaluable or very valuable are actually giving me solutions to the problems that I had. Not only an opinion, but yeah, a solution, so I ask a question and they will give me an answer that I could use for the challenge.

Students placed a high value on receiving both lived experience and sectoral expertise from sectoral experts to give them a full understanding of a challenge. Students emphasised the usefulness and value of this knowledge in supporting them to propose solutions that were actionable and relevant.

Students saw disciplinary knowledge as secondary in value to this. Most students said they found disciplinary knowledge through their own network outside the challenge or more commonly through Google. Students gave frequent mention to the emotional

Table 3. Actor type by value rating assigned by student in surveys and confirmed in interviews.

	Actors	Very Valuable (score = 4)	Valuable (score = 3)	Limited Value (score = 2)	Not Valuable (Score = 1)	Total # of mentions	Avg value score
1	Teammates	15	3	0	0	18	3.8
2	Expert (Sectoral)	20	13	5	0	38	3.4
3	Resources	6	6.5	0.5	0	13	3.4
4	Expert (Academic)	3.5	10.5	0	0	14	3.3
5	Coach	6	7.5	3.5	0	17	3.2
6	Challenge Agent	3	2	4	0	9	2.9
7	Course Coordinator	2	5.5	1.5	1	10	2.9
8	Student (non-team)	0	6	3	0	9	2.7
9	CBL Facilitator	2	2	1	2	7	2.6
10	Family & Friends	6	6.5	19.5	2	34	2.5

support they gained from family and friends but, as Table 3 demonstrates, they were more inclined to rate the value of this less highly that other actors. However, they said the support contributed to their success in participating in T-CBL.

Additional findings

Approximately 10% of all coded segments did not fit into the categories proposed by Vermunt, Ilie, and Vignoles (2018). These segments captured a common theme in students' social learning that we describe as perspective taking. The actors most commonly cited were sector experts. Students referred to the value of being able to see the issue or problem from different perspectives. The perspectives they mentioned were sectoral perspectives (including those whose livelihoods were directly affected by the challenge, for example, farmers) and disciplinary perspectives, especially those of their fellow students. But perspective-management also presented learning opportunities. CBC said: 'This really is a challenge because everyone has such a different perspective on things. And then you have to work twice as hard to get everyone on the same page about what we're actually talking about.'

Discussion

In this article, we introduced the term T-CBL, which we define as an educational concept that brings students from multiple disciplines together to work with a broad network of actors – including academic actors from multiple disciplines and extra-academic actors – to collectively examine, understand and attempt to solve complex societal challenges by integrating diverse perspectives and knowledge. This form of learning brings new networks of actors into student learning. This potentially has a significant impact on the roles of academic actors and how valuable students perceive these roles to be. Within the literature, there are, to date, few (if any) studies that examine the role of non-student actors in T-CBL, what the role of non-student actors are and how they impact on student learning. Adopting a social learning perspective, we sought to map what

actors – either students, academic or extra-academic actors – are connected to student learning in T-CBL. Using learning gains as a conceptual framework, we sought to understand what students learned in interaction with these actors and how they valued these interactions. We mapped actors within a particular case – a course organised and run by an interuniversity alliance in the Netherlands. By their nature, cases can have limited generalisability and may not be representative and in this instance a case was a necessary approach to study an educational concept in its infancy (Denscombe 2010).

Learning in T-CBL

This article focused on the learning environment of T-CBL. We view the learning environment as a network of actors which students interact with to meet their learnings goals. Our findings indicate that much of the knowledge that students seek out during T-CBL comes in different forms and is held by different actors across disciplines and sectors and generated in interactions between different actors. This seeking out of knowledge – both academic and sectoral knowledge – means a new range of actors are involved in pedagogy and also new conceptualisations of learning, for example, perspective taking, can be seen. When comparing the student-built networks of contacts, it becomes apparent that these contained more actors than those listed in the course outline. For example, students refer to different types of experts, family members, friends, and resources as actors. Learning in T-CBL can therefore be described as social learning: a continuous loop 'between learning interactions, insights, practice, results, and back' (Wenger-Trayner et al. 2019, 7).

In contrast to previous research, which proposed that within CBL, the role of the teacher shifts from an expert role to a coach who scaffolds learning (Doulougeri, van den Beemt, et al. 2022; Helker et al. 2024), the case presented here identifies the importance of the external network in learning. Students did not perceive the role of academic as connected to their learning process and instead highly valued attaining the external expertise they needed to meet their goal as a team: to propose a solution. Students described contact with the course coordinator as predominantly administrative. Coaches, who were all non-academic members of staff, were assigned to the teams but students did not value their contribution highly and in interviews did not seem clear about what the role of the coach was. Students looked to academic and extra-academic actors as providers of expertise in an on-demand manner. In this case, students perceived the role of the coach as a learning process expert and they placed a low value on this role. They turned to teammates and other students to talk about the learning process.

This case study also demonstrated that T-CBL is a team effort. Students counted their teammates as the most valuable in terms of value ranking. However, students frequently mentioned the need for emotional support to bolster their engagement with the challenge and advice on how to deal with challenging interactions with teammates. Students proactively sought support for this from family and friends. This suggests that students may then benefit from interventions at the outset of T-CBL outlining the challenges they may encounter, what the learning process entails and who is present within their learning environment to support them.

T-CBL course coordinators and academic leaders may also consider the implications of the centrality and importance of extra-academic actors in student learning in T-CBL.

The involvement of extra-academic actors and the development of relationships with extra-academic actors requires time, management and resourcing that is not currently supported by the system (OECD 2020; O'Sullivan 2023). Universities need structures, mechanisms and resources to build and manage trusted long-term relationships with extra-academic actors and they need to commit core resources to the development of transdisciplinary skills, methodologies and practice development (OECD 2020; O'Sullivan 2023).

Further research

These findings both supported and reaffirmed the need to further explore the experiences of extra-academic actors in T-CBL (Augsburg 2014; O'Sullivan 2023). For example, how do extra-academic actors experience participation in transdisciplinary education? How does their participation influence curricula? Extra-academic actors, through their contact with students, are also placed in positions of power vis-à-vis assessment, mentoring and problem-framing. Thus far it is not apparent how extra-academic actors are supported in developing or having an awareness of the competencies necessary to work with students in this environment, who are actively learning, are in unequal positions of power and may be vulnerable to feedback.

Students reference the emotional support they sought out and received from friends and family during T-CBL. Uncertainty can be a felt experience by students and staff in T-CBL (Caratozzolo and Membrillo-Hernández 2021; O'Sullivan 2023). A further avenue of research is to concentrate on the emotional aspect of student engagement in T-CBL. This case suggests that students seek support from friends and family to manage the challenges of working in a team and the process of learning. This raises a concern about the skillset, training opportunities and time allotted to the development and participation of coaches in T-CBL. While students placed a low value on the role of coaches, they did reference their value in helping them solve conflicts within the team. Research could beneficially examine the role of coaches, how individuals become coaches, what training is involved/required and how this role can create more value in T-CBL.

Limitations

As this case study predominantly adopts a qualitative research approach, it does not aim for generalisability in its results. Instead, it emphasises understanding participants' unique contexts over seeking broad generalisations (Creswell and Poth 2016). In alignment with qualitative research principles, our objective was not to universalise our findings. Instead, our aim was to offer a detailed and contextually grounded understanding of students' experiences in T-CBL supported by rigorous data analysis techniques.

These findings were limited by the difference in course design between the two challenges: Challenge A and Challenge B. Additionally, to support an exploratory approach to student learning, students were not asked which learning gains they experienced with which actors. The research team decided that focusing interview questions on learning gains from the outset would restrict the identification of potential new learning gains that are specific to T-CBL, for example, perspective taking or the actionable knowledge ability. Likewise, we did not provide a definition of value at the outset of the research design.

This study is potentially further limited by its focus on specific competencies and learning outcomes within T-CBL. This may have led to lack of insight into other potentially significant factors influencing student learning and engagement. Further investigation into a broader range of variables and their interplay within the T-CBL framework might be relevant for a large-scale study.

Additionally, this study depended on student recollection of network formation, which can lead to inaccurate recall. Engaging the students in diary writing for the duration of a course could improve the quality of data and opportunities to analyse interactions in more detail.

Conclusion

This article demonstrated that it is important within the landscape of CBL, to differentiate between CBL and T-CBL. The latter specifically requires the active and consistent engagement of extra-academic actors in the learning process. Through the engagement with extra-academic actors, T-CBL provides the opportunity for social learning, comprising metacognitive, socio-communicative and cognitive learning. This is because a multiplicity of actors are engaged in student learning, albeit in different ways and of different perceived value to students. This offers a picture of T-CBL as a form of learning in which students form networks of actors with whom they initiate contact in an 'on-demand' fashion. This learning process leads students to seek emotional support from teammates, friends, and family.

These findings give educators involved in planning a T-CBL course insight into factors they must consider before designing a T-CBL course including which actors to involve, and how to prepare actors for their respective roles in T-CBL. The findings also contribute to a better understanding of transdisciplinary education theory and practice broadly and more specifically in teamwork settings in education (Fam, Neuhauser, and Gibbs 2018; Klein 2018). Through its focus on students and actors from multiple disciplines, this research also broadens research on T-CBL which to date has been predominantly focused on STEM (Gallagher and Savage 2020).

Note

1. Roles marked with an asterisk were named in the course handbook in only one challenge.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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