

Learning Trajectories in Hyper-Hybrid Spaces

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Abstract: This paper investigates undergraduate students' learning trajectories when working on an architectural design and building a property. The article is theoretically positioned within learning ecology and investigates the field of students' learning trajectories during the Digital Days to gain new knowledge on learning on hyper-hybrid collaboration in these learning spaces. Previous research on students' learning trajectories in hybrid spaces seems to be limited to the didactical planning of teaching activities in hybrid learning environments or to the digital solution during physical activities. The paper adds new knowledge to how students from technical education from a university, a university college in Denmark, and a university in Vietnam collaborated and navigated multiple hybrid spaces to meet the need to design a solution to the addressed challenges during the digital days. The methods included participant observations of student trajectories and collaboration in a hyper-hybrid learning environment. Based on the purpose of the study, a thematic analysis was carried out. The findings reveal that students' learning trajectories are supported by tools, resources and the students' interdisciplinary collaboration in hyper-hybrid spaces. Project management, interactions and trust among peers during the digital days seem to play a crucial role in student learning trajectories and in the progression of the assignment.

Keywords: Hyper-hybrid Spaces, Learning Trajectories, Digital Days, Learning Ecology, Interdisciplinary Collaboration

1. Introduction

This paper investigates student learning trajectories in hyper-hybrid spaces, with a special interest in students' learning trajectories in solving real-life problems. Applying hybrid learning spaces in higher education curricula provides a basis for employability (Bennett, Knight & Rowley 2020). Working with hybrid learning spaces is found to support design thinking, where different spaces hold potential for different parts of the design phases (Kohls 2019).

Hybrid learning spaces combine the physical and the digital environments and are a relatively contemporary concept aligned with the concept of blended learning. To capture the enormous complexity of the different spaces in actions during practice-based learning, the concept of hyper-hybrid learning spaces has been introduced by Nørgaard & Hilli (2022). Hyper-hybrid learning spaces appear in situations where, e.g., cross-national collaboration in online and onsite entanglements is practised (Nørgaard & Hilli 2022). Thus, a hybrid learning space is a merging of more than one form of space where the boundaries of different learning spaces are continuously crossed to expand the affordance of learning. Hybrid learning spaces give room for connectedness and dynamic integration of space and time dimensions (Trentin 2015). Eyal & Gil (2022) distinguish between three types of hybrid learning: Blended, spaces of merging interactions, and fluid, where boundaries are blurred. Hyper-hybrid learning spaces are complex as they include shifting assemblages where humans and artefacts are intertwined in different ways (Ellis & Goodyear 2016, p.149) and where borders between modalities can be more or less blurred. Cook et al. (2015) describe two types of hybridity, respectively, formal and informal social structures in an activity system and the combination of physical and digital tools mediating an individual interaction with the world and society" (Cook et al., 2015). They stress that people interact and collaborate using a hybrid network of physical and digital meetings, activating the necessary knowledge needed, and metaphorically, they conceptualise the affordances of the trajectories of spaces as "Zones of possibilities" in the interfaces between higher education and real-life workplace tasks.

Recent studies on hybrid learning spaces in higher education seem mainly to be limited to the perspective of how teachers can scaffold, design and plan for hybrid learning (e.g. Bennett, Knight & Rowley 2020; Pischetola, 2022; Kohls 2019, Wiig, Silseth & Erstad 2018) or to the different digital technologies in blended and hybrid learning environments (e.g. Raas et al. 2020) for instance related to peoples meeting, collaboration with the physical and digital tools (Cook et al., 2015). However, we have not found any observational studies investigating the hyper-hybrid interactions of students from different backgrounds. Thus, our research study will explore how the students' learning trajectories are afforded by the hyper-hybrid student learning trajectories in these kinds of hybrid spaces where students' collaboration is interdisciplinary.

2. The Hyper-hybrid Setting

Digital Days (DD) at the University College of Northern Denmark (UCN) is an interdisciplinary construction engineering, communication testing, and technological/digital experimentation event with space to explore ideas, develop solutions, make mistakes, create new discoveries, and reflect. The event helps prepare students from construction's vocational and professional courses, as well as engineering studies, for reality and gives them new perspectives to include in their careers. DD involve companies on an equal footing with students and teachers when concrete building challenges are solved in groups using dig DD is a yearly event in collaboration with the region's small and medium companies (SME), the municipality, a university, a University College and a vocational training institution. The DD is a yearly interdisciplinary event in collaboration with the region's small and medium companies. The connections between students from different educational backgrounds and areas were organised to combine the different competencies to create a sustainable property building for people living in the neighborhoods. This is in accordance with Cook et al.'s. (2020) describes bridging social capital with people from various backgrounds to afford the learning and solve the assignment appropriately, giving the student the opportunities to work in an interdisciplinary manner, just like in the workplace. During the three days, students from Architectural Construction and Management in Denmark and Vietnam, and students working in Building Construction, Electricity, Contracting and Engineering joined the DD, trying to solve a real-life problem in creating sustainable property. During the DD, students had access to relevant tools, hardware and software for digital analysis, planning and visualisation. In connection with the group processes, all participating parties experience the complexity of the human and digital collaboration that characterises the construction of the future, and develop solutions adapted to this complexity.

2.1 The Roles of Students at the DD

The students were assigned different roles at the DD to manage the process and tasks needed. This was visualised by the shirts that the students had to wear, illustrated by Table 1 below:

Table 1: Illustration of students' role by coloured t-shirts during the DD

Project Manager (Blue)	Bim Manager (Gray)
Contractor (Green)	Project Manager Assistant (Light blue)
Engineer Construction (Red)	Engineer MEP (Orange)
Architect (Yellow)	Bim Manager (Gray)

The project manager (PM) was responsible for the assignment as a whole, and he had support from the project manager assistant (PMA). The MEP Engineer (ME) was responsible for wastewater and ventilation. The contractor (C) was responsible for the general contractor work. The BIM manager (BM) was responsible for leading the digital collaboration. The architect (A) was responsible for the planning, design and oversight of the construction, and the construction engineer (CE) was responsible for the infrastructure.

2.2 The Pedagogical Foundation

The pedagogical approaches of the participating educational institutions are based on, respectively, problem-based learning and reflective practice-based learning, which together are conceptualised as Experiential Collaborative Learning (ECL) (Jensen et al., 2022a).

2.3 Research Question

How are students' learning trajectories afforded by interdisciplinary collaboration in hyper-hybrid learning spaces during Digital Days?

3. Theoretical Positioning

The theoretical positioning is mainly related to the learning ecology. However, the concepts of learning trajectories and boundary crossing are related concepts and, in the following, are described as part of the paper's theoretical positioning.

3.1 Learning Ecology

A theoretical perspective on learning ecology provides a conceptual framework to address the challenges of navigating a technologically rich and continuously developing society. It offers a frame for understanding people's interactions and activities across different environments. Applying a learning ecology perspective gives a nuanced perspective on blurred, multiple, and permeable boundaries and an understanding of how the environment affects people's identities and development. Therefore, it is a relevant approach to looking into student learning trajectories across spaces where technology and digital competencies are continually developed and changed. A learning ecology thus offers an adaptive and dynamic perspective on learning, where learning is regarded as ubiquitous, flexible, and contextualised. Moreover, it provides access to knowledge dimensions of habits, identity, behaviours, and narratives as relevant conditions. Accordingly, it raises possibilities to research the complexity of people's interactions with emergent technologies across different settings, spaces, and places. Hence, Barron's (2004, p. 6) definition of learning ecology as "the accessed set of contexts, comprised of configurations of activities, material resources and relationships, found in collocated physical or virtual spaces that provide opportunities for learning," frames our understanding of the concept. The ecological perspective gives access to investigate learning spaces through the interactions of learners in interplay with technology, tools and resources in physical and digital environments (Damsa et al. 2019).

In relation to the learning ecology perspective, affordance is understood as a mix of the physical, mental and conceptual relations that the environment offers or furnishes for better or worse. Affordance is also determined by humans' preconditions, prior experiences, and capacity, as well as their previous engagement with the environment, tools, people, and artefacts (Dau, 2021).

3.2 Learning Trajectories as Wayfinding and Mapmaking

Learning trajectories are multidimensional and include peoples' pathways in and across different contexts (Membrive et al., 2022), affording the learning process. Thus, the learning trajectory is related to people's participation in different learning activities and their engagement with the environment and the artefact. From a learning ecology perspective, the learning trajectories are a process of mapmaking and wayfinding. Ingold (2000) describes these kinds of learning trajectories as trajectories of motions and becoming: "...in wayfinding, people do not traverse the surface of the world whose layout is fixed in advance - as represented on the cartographic map. Rather, they 'feel their way' through a world in motion, continually coming into being through the combined action of human and non-human agencies" (Ingold 2000, p. 55). Ingold (2000) differentiates wayfinding, mapmaking, and navigation and juxtaposes wayfinding and mapping as an ongoing cartography process which can also involve mental representations. However, navigation is compared to map use and thus following paths already made or represented. Map-making is related to humans' capacity to make a map. Nevertheless, it is not about drawing a cartographic map on paper but about remembering, sensing, structuring, consolidating, and comparing processes. Moreover, questions of "Where am I?" and "Which way should I go?" are found in narratives of prior movements. How people find their way is thus characterized as complex structures holding complex processes (Dau 2020). For instance, research on campus students' orientation reveals that it is formed by their prior study trails, practices, habits, and movements. The students seem to find their academic and professional way based on instructions, the peers' movements and approaches, artefacts, and the teacher's acting and guiding. Social connections and co-constructed knowledge are parts of a common mapmaking process that affords students wayfinding and professional identity development (Dau 2015). Therefore, in this paper, trajectories are framed as processes of mapmaking and wayfinding.

3.3 Boundary Crossing and Ecotones

Boundaries are part of any learning process (Akkerman & Bakker 2011). Boundaries are stressed to hold different learning potentials in relation to identification, coordination, reflection, and transformation (Ibid.). Boundary crossing is typically described as a person's transitions or interactions across and between different settings. Similarly, boundary objects are often described as transition, bridging artefacts (Ibid.). Contrary to the transition concept, the concepts of boundary crossing and boundary objects include interactions between contexts and people and between artefacts and people across time (ibid.). This is aligned with the combined action between human and non-human agencies, as described in wayfinding (Ingold 2000). Applying a learning ecological approach seems to give room for understanding students' learning trajectories during boundary crossing and working in ecotones. The concept of ecotones originates from biology and is described as a transition zone between two relatively different kinds of entities or areas (van der Maarel 1990). The term ecotones have

recently been applied to studies of the humanities to understand post-digital thinking (Ryberg et al. 2021) and students' navigation in blended learning environments (Dau & Ryberg 2014). The conceptualization of ecotones contributes to a nuanced investigation of students' learning trajectories during transitions and border crossing.

4. Method

Qualitative studies are typically applied to fully understand students' learning trajectories in hyper-hybrid learning spaces and, thus, the complexity (Bennett, Knight & Rowley 2020). Thus, the method applied was participant observations (Glaser 1996) of the digital days in 2022. Two groups of students were observed. The students were selected by snowballing, where the teacher in charge of the days was to find two voluntary groups of students who agreed to be observed during the digital days. The data collection method was based on observations of two groups of students working on solving a real-life assignment for two days. Data collection consisted of pictures and field notes, including citations. Participants had signed a consent form before the observations took place. In total, 42 students were observed, divided into two groups of 21. From each group, 17 students were physically present, and four were online. The findings from the observations of one of the groups are included in this article. The observations took place in the autumn of 2022.

An observation scheme was conducted beforehand based on the ECL-related concepts. Thus, the observation scheme included subcategories related to the pedagogical approaches used at the educational institutions involved to see if they were practised (Jensen et al. 2022b). The subcategories are presented in Table 2.

Table 2: Subcategories in Observations Scheme

Student oriented
Collaborative
Nonlinear/linear
Iterative processes /or not
Disruption of activities/or not
Reflective dialogues
Self-efficacy
Experimental/inquiry-based

Furthermore, attention was paid to the focus of the content of the learning process in relation to students' problem orientation, theoretical immersion, value-based choices, professional judgment, and academic competencies.

5. Analysis

A thematic analysis was applied to identify patterns of relevance in relation to the research question and structures of the main subcategories presented in Table 1. Inspired by Braun and Clarke's (2006) analytical process, we followed the six steps in the thematic analysis. Get familiar with our data, 2. Initial coding, 3. Searching for themes, 4. Reviewing the themes. 5. Naming the themes and reporting. In Table 3 below, the coding and themes are presented.

Table 3: Analytical codes and themes

Observations Categories Based on ECL	Codes	Themes
Student oriented	Division of labour – seeking balance	Professionalism in action -Supported by role taking and peer-learning
	Overview of roles and actions	
	Peer-learning	
Collaborative	From mono-disciplinary to cross-disciplinary	Hyper-hybrid collaboration -Design processes scaffolded by input and structure
	Structure support collaboration	
	SME representative shares knowledge	

6. Findings

The findings are structured in relation to the themes retrieved from the analysis. The interpretation is made on the basis of the research questions investigating how students' learning trajectories are afforded by collaboration in hyper-hybrid learning spaces.

6.1 Professionalism in Action

In general, the student division of labour afforded the real-life project collaboration, supported by participants from SMEs and their knowledge sharing and questions.

The predefined different roles exemplified by the t-shirt colours supported the student's immersion in the role of a professional. Moreover, the PM's scaffolding of the interplay and structure seemed to afford the flow of the work during the DD. The PM and the APM took notes and looked at the different roles and responsibilities to gain an overview before they structured the processes by giving the students in the group access to a Teams group where they could follow the progression of the assignment based on continuous updates from the different professions involved. The PM also managed to balance the interplay with the students (A) from Vietnam:

"We must also think of them in Vietnam" (PM).

The PM followed up later with the PM in Vietnam, asking the constructors (C) about their contact with the Vietnamese PMs, which made them pay attention to the computer to test it.

"They are on chat and Teams" (C).

The cross-national interaction across different time zones made the students aware of how to navigate international collaboration, but at the same time, this blended hybrid collaboration also made them aware of differences in competencies and culture and their own professionalism. This was addressed during their work, where a couple of the Danish Cs mentioned that the Vietnamese did not have the specific knowledge needed, thus challenging the hyper-hybrid learning. Nevertheless, the Vietnamese were included as part of the group during the DD, and the students from Denmark managed to navigate differences, distance and online-onsite collaboration.

6.2 Hyper-hybrid Collaboration

Students' blended hyper-hybrid collaboration is characterised as an interplay between people from different professions and countries and the available or searched artefacts and technologies. The hybridity in the group is, however, also afforded by the project manager's (PM) overview and continued questions and input to merging actions exemplified by this quote from the PM:

"We must have control over the construction, and it has to be sustainable – we have to talk together quickly if design and the sustainable construction are not in place."

Also, the PM orientation toward the needs of the peer student in performing the tasks seemed to support collaboration and progression.

PM: *"Do you need one to change to MEP engineer?"*

ME: *"Cool, if we can be two MEs"*

Based on the experienced need of ME, the PM mapped the situation and thus the need for more resources to solve the ME tasks. Therefore, a CE changed its role to an ME by changing t-shirts and engaging in interactions with the original ME.

The use of different technologies seemed to give students access to the needed information for further progression. Thus, the students work on different software programs used in SMEs, whereas some are new to the students, and some are familiar. They also apply a TV screen for collaboration on the task and different 3D programs suitable for testing the solutions on screen and in VR. The affordance of VR is illustrated by the following dialogue between the architect(A), the MEP engineer (MEP) and the construction engineer (CE):

"So, we can enter in VR and look it through".

The student discussed the indoor task for the architect, including corridors and room distribution. There was a loud discussion between the different professions on possibilities and limitations, triggering students' individual reflections. The interaction, students' wayfinding, and attention to visible failures in VR were afforded by the communication.

The fluid hyper-hybrid interaction navigation was afforded by access to different online and physical spaces with different resources available, illustrated by the student's trajectories between spaces and tools. In this situation, learning was scaffolded during their wayfinding online and onsite, both in regard to the use of the VR facilities and the available online programs for managing collaboration and solving professional tasks by applying relevant engineering and digital solutions. Furthermore, students' interaction between different professions, transversing a variety of spaces and crossing boundaries in interplay with technology, tools and resources illustrated the learning ecology in action.

6.3 In Time, Revision, and Progression

Time seemed to be essential for the progression and decision-making, and the student's mapping furnished problem-solving during DD and limited revision, as illustrated by the quote:

"It does not make sense – I am starting now... the construction will look different in half an hour" (Dialogue between A and CE).

Students' awareness of the interactions and continuous follow-up with different professions to meet the need for thought-out solutions seemed to support the progression of the tasks. Moreover, the progressions were also supported by the 3D stretching, the immersive VR technologies available and the interplay between students:

"It is the great this; here we edit at the same time without it fucks up" (CE).

"The plan is to finish the building today – so we can walk around in it" (PM).

As quoted above, setting goals also supported students' learning trajectories during the DD. The PM's ability to keep an overview, supported by the online progressions scheme, became essential for timely collaborations, revisions, and progression.

Hence, the student's learning trajectories were structured by the PM setting up deadlines for the peers in relation to their specific partial assignments. This scaffolded students' commitment and engagement in the project. The interplay between different professions during the days became more and more interdisciplinary, crossing borders between the roles. For instance, the BM asked which software to use and what it should be used for later, and the CE confirmed it while raising a loud question about why he could not buy less than ten meters of steel plate. Also, loud reflections took place between ME, A, PM and two Cs. The merging of competencies supported students' wayfinding and, thus, their individual learning trajectories.

6.4 Knowledge Sharing and Tools Fostering Iterations

The interdisciplinary knowledge sharing and bridging of different perspectives and artefacts was afforded by the setup and questions raised during the DD. For instance, A asked PM about building regulations and solar panels, and they discussed how to make a flat roof green. CE asked questions in relation to Building Information Modelling (BIM) and how to work and analyse using BIM. A dialogue between C and ME took place about the plan at the same time. The border crossing of different perspectives was also afforded by the openness of students' own limitations:

"...we have actually never learned it" (CE)

Also, questions raised by the SME representatives seemed to foster knowledge acquisition:

"Do you have an overview of where it does not work?" (SME representative).

This was followed up by sharing knowledge on calculations and demands. BM tried to get an overview of the applications while he interacted with the SME representative, who asked about demands in relation to light and heat. At the same time, A and PM discussed the size of the elevator shaft based on the calculation among the CEs. All the work was shared at a joint meeting, where the dependence of the different roles and their progression became visible:

"I cannot start to draw it before they are finished" (ME).

At the joint meeting organised by the PM, with a representative from each of the roles, different problems were addressed, and possible solutions were suggested. The student shared their reflections and how to gain help from others. They agreed to share knowledge before they decided on the final solutions.

"We must talk together before we decide the final solutions" (PM).

Together, they discussed the opportunity to make an offset roof and talked about living rooms and following the local plan. They agreed to ask a teacher about the requirements for the foundation of the building, and ME presented the calculations in relation to ventilation and heating, supplemented by two SME representatives' input on thermostat control. The joint meetings thus seemed to foster renewed engagement and trust in the group. The engagement became visible in the observations where students became loudly eager to contribute and laughed at their challenges, triggering ideation and commitment.

The entanglement and mapping of different perspectives during the knowledge-sharing process joint meeting supported the student's upcoming navigation in the available shared online and physical rooms, giving them an idea of how to progress with the assignment.

6.5 Disruptive Practice Relevant Input Triggers Reflections

Appropriate disruptions are one of the teaching principles at UCN based on the signature pedagogy of Reflective Practice-based Learning. During the DD, two kinds of disruptions took place: disruptions that triggered reflection and progressions and disruptions without any affordances. An example of disruption triggering reflection was when the SME representative asked the students about quality requirements, resulting in a discussion of AutoCAD (a program for 2d and 3d modelling) and Revit (a building information modelling software) supported by the SME representative's knowledge of the use and their experience in using the programs. The disruptions paved the way for a closer collaboration between students and the SME representatives. The SME representative's engagement became more visible when they were able to share their expert knowledge, and the questions fostered students to investigate and reflect on their work.

"I don't know if it (Revit) can handle it...What about the sealings and the steel construction? We must have a pillar here in the middle, and what about the kitchen? How do you visualise it in 3D" (SME representative).

The questions were followed by ideas and suggestions and discussed with the SME representative in relation to the specific dimensions. The interplay with the SME representatives also disrupts some of the other students' work, and they join the mapping of the problems raised with different viewpoints, adding further knowledge to the discussions. For example, C turns his screen to the SME representatives, ME, A and CE, and they engage in a common dialogue.

Students also trigger their peers' reflection by addressing challenges and asking questions:

"The problem is just that it is heavier" (A).

"How about the light boxes?" (CE).

"I do not know if there are other rules when there is a deflection?" (A).

"Can it be double?" (CE).

During the discussion fostered by the SME representatives, several new questions were raised, triggering students to look at their designs and redesign part of the building. Following the paths of SME representatives' experiences in working with different systems and the construction of buildings in an interdisciplinary environment seems to help students' own mapmaking and wayfinding.

Questions and immersive VR actions trigger reflection

The use of immersive VR gives the students the opportunity to navigate and traverse the surfaces in their created 3D building. For instance, the students C, PM, BM and ME went to the VR room. PM and ME took place at the PC, and C and BM each put on the VR glasses and navigated the immersive building. BM and C investigated the windows. There was a hyper-hybrid conversation between the four in the room, two at the PC station and two in the immersive VR space. The quotes below illustrate the conversations between MB and PM where PM followed MB's navigation in VR:

"Yes, the steps are too low" (BM)

"Is there a hole in the floor?" (PM)

"I don't know if there is a mistake" (BM)

"Wait a minute- yes, yes, it is huge windows, there are red lines all over" (PM)

"It is a creative process" (BM)

"Let's continue" (PM)

"I am not sure the model is updated" (BM)

"There is something with the balconies again, can you see?" (PM)

"I really think it works well" (PM)

"I look at the two bars, they are overlapping" (BM))

"They are extremely close to each other" (PM)

"Ahh there" (BM)

Working in the hybrid spaces supported the students' design thinking during the interplay with the VR tool. The interplay was supported by the PMs observation on screen and BMs navigation in VR and their shared communications. The crossing of onsite, online, and immersive technologies seemed to add an extra dimension to their design process and provide a realistic experience of their drawn building and its limitations. Thus, the blurred hyper-hybrid VR actions triggered student reflections and thus gained insight into their redesign of the constructions and the building as a whole. Testing the solutions in VR became central to the success of the assignment.

"I cannot fly out of the building" (C).

The affordance of the VR setting created seamless navigation and student language, illustrating how the immersive environment has its own language, illustrated by the term "flying out". The crossing of borders and the extended possibilities in VR support students' mapping of the building, and the mistakes become more visible. The online onsite entanglement offers new forms of interdisciplinary collaboration and reflections.

Interdisciplinary collaboration affords decision-making

The students' interdisciplinary collaboration supported their decision-making and continued the progression of the assignment. For instance, when students across disciplines continuously look into the description of the assignment and the affiliated requirements. Also, the PM's attention to the roles and support of changing roles during DD helped to get a better balance between the tasks to be done and the design challenges to be solved. The interdisciplinarity afforded a synergy between the students and between the SME representative and the student. The dialogue, discussions and common reflections between students were the "glue" that supported interdisciplinary wayfinding and problem-solving. For example, when an SME representative talked with the PM, A and CE about the roof's construction while studying the construction drawing on TV and sharing previous experiences.

The examples and quotes from the VR setting in the section above also highlight how students with different roles are intertwined with tools and resources to find common ground and necessary solutions. The blurred and messy navigation between online and onsite students across different levels, educational practices, and countries seems to mirror real-life scenarios on a construction site. The cross-disciplinary navigation and negotiation support students' wayfinding and learning trajectories across spaces and places in the design process.

6.6 Navigating Digital Tools in Interdisciplinary Investigation

Navigating digital tools supported student learning trajectories by collaboration across disciplines. For instance, during the DD, C found a bin on the internet, and CE and ME discussed the technical solutions for ventilation by looking at the shared 3D model on the television screen. The visibility created a common ground for students' interdisciplinary investigation and mapmaking while exceeding existing borders.

The VR setting also supported students' interdisciplinary investigation. At a time when the two Cs wore VR glasses and a PM and a BM sat in front of the computer screen following the Cs on screen, the investigation became fluid hyper-hybrid during the entanglement of different kinds of presents.

"I can see where you point with your right hand" (PM to C)

"I am on the second floor now" (C)

At the same time, a dialogue took place between PM, C and BM

"Can you not hop over the door?" (PM to C)

"There is a mistake in the system" (PM to C)

"Maybe we should print and read the report" (C to PM).

"Okay, I am outside now" (C no. 2 – now wearing the VR glasses)

"Can you see there is a window there? Can you mark it?" (C to PM)

The other C no 1 sits by the computer with PM and asks him how to take a picture. PM help C no. 1 to take a picture and walks toward the other C to guide him and inform him of the mistakes already documented by the VR system.

"I have a lot of mistakes – this door is one out of three" (C no. 2)

"There is a slide-door" (C no.1 by the screen)

"There is grass, where there is supposed to be a lift" (C no. 2)

During the collaboration in the VR room, students experienced how their common investigations helped them understand the system and the mistakes they made as a group. This triggered their reflections and further progression. The students supported each other in navigating to mark the failures and guide the movement in the VR-created building. Thus, their learning trajectories were supported by the interdisciplinary investigations taking place.

7. Discussion and Conclusion

The study's use of a learning ecology approach has demonstrated its relevance in capturing the complexity of students' learning trajectories and border crossing in interaction with different settings, tools, resources and people. The study has contributed with additional knowledge on students' learning trajectories in interplay in a hyper-hybrid interdisciplinary environment where cross-country collaboration, structure, tools, technologies and practitioners play a central role in students' wayfinding. It has been illustrated that different hyper-hybridity mirrors real-life complexity and engages students in a collaborative learning journey.

It reveals how students' learning trajectories are afforded by interdisciplinary work, the tools and resources available or found on the internet, and the disruptions created by SME representatives or peers. However, structuring the communication, the goal, and group meetings played a central role in student design making and the ability to learn new competencies as they faced huge complexity in relation to the design process. The complexity of navigating was characterised by an entanglement of different onsite digital and physical tools and students from different educational institutions, both nationally and internationally. These hyper-hybrid learning environments forced the students to make in-time knowledge sharing across disciplines to meet the need for creating a new and sustainable building for citizens in the area. Students' learning trajectories were facilitated by the SME representatives who had experience with similar situations from their work life, and the student's gained insight into the complexity and how interdisciplinary collaboration is similar to what happens in real life. Students' learning trajectories were thus afforded by the interdisciplinary collaboration in a hybrid setting, where software systems and hardware tools played a significant role in supporting student reflections and troubleshooting. Students not only followed paths already made by, for instance, SME representatives, but during the DD, students created their own physical and probably also mental maps, which were furnished by the setup and the access to different tools, artefacts and people.

The study, however, is limited to investigating just one out of several groups of students and cannot be generalised, as it seemed that some of the other groups did not receive the same experience during the DD. Nevertheless, the study constitutes the limited empirical research available on hyper-hybrid spaces and their impact on student learning trajectories when students are in charge of their own design process. Future studies would benefit from including a larger population of students to strengthen the evidence on how collaboration in hyper-hybrid learning spaces can support students' learning trajectories. Also, future studies investigating the support of a generative AI assistant during the hyper-hybrid collaboration could be relevant, as generative AI has disrupted most educational practices today.

Ethics Statement

Ethical clearance was not required for the research.

AI Declaration

AI has not been used in the creation of this paper

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