The Shadow Learning Landscape of Paramedic Student Experiences: A Complexity Sensitized Exploration of the Learning-Technology-Spaces Intersection

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(July 2022)

This thesis is submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy

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Abstract

This thesis explores how paramedic students' experiences are influenced by complex interplays of physical spaces, technologies and learning practices. In doing so, it highlights a shadow learning landscape, student-crafted in parallel with, but not endorsed by, institutional offerings. Prior scholarship highlights healthcare student experiences regarding educational spaces, and technology usage within those spaces. That scholarship emphasizes space as the background and technology as the mediator of customized student experiences, to some extent acknowledges spatial (in)adequacies, and (rarely) presents detail regarding how students shape their own experiences in spaces. I argue that the literature largely underemphasizes the importance of materiality in student experiences with technology in spaces.

My thesis presents a case study in paramedic education using a theoretical framework sensitized by complexity thinking – a branch of sociomaterialism. I focus on the concepts of diversity, redundancy, decentralized control, neighbour interactions, enabling constraints and emergence. The first five concepts guide analysis of data generated from interviews-to-the-double, drawings and screen-captures. Emergence guides subsequent analytical work uncovering higher-level themes that draw the initial concepts together.

My findings describe wide ranging rules, interactions, matters of control, functions and compensatory mechanisms through which students' experiences are influenced and regulated by spaces and technology. Examples of this shadow learning landscape include [redacted]

[redacted] and impromptu transformations of ambulance patient care spaces into academic study spaces during idle times.

My contribution to knowledge is threefold. I introduce a shadow learning landscape model, depicting student experiences as complex adaptive learning-technology-space interconnections, student co-created, which could indicate when possible institutional intervention in these experiences is needed. I present new facets of student experiences – e.g., using uniforms to co-create calm in chaotic patient care spaces. I supplement knowledge already described in literature with richer detail regarding how students shape their own experiences.

Table of Contents

List of Figures

List of Tables

Acknowledgements

I would like to thank my supervisor, Doctor Brett Bligh for all the advice, support and patience during my PhD work. This would not have been possible without you.

I would also like to thank my family and friends for all their support. This thesis is as much yours as it is mine. Thank you.

Author's declaration:

This thesis is my own work and has not been submitted in substantially the same form for the award of a higher degree elsewhere. No sections of the thesis have been published. This thesis is not the result of joint research.

This thesis aligns with Lancaster University's requirements regarding the length of a PhD thesis.

Gender neutral pseudonyms were used for study participants. These pseudonyms were chosen by the author after data collection. Any similarity between these pseudonyms and the participants' characteristics or real names, chosen, given or otherwise, is purely coincidental.

This thesis contains a series of sensitive findings. Parts of the thesis have been redacted in the public-facing version of this thesis to protect participants.

Signature:

Publications associated with work on Doctoral Programme

Chiriac, V., & Chiriac, M. (2016). Medical Discourse in an Ambulance. *Discourse and Communicative Interaction Book of Abstracts of the 1 International Conference on Discourse and Communicative Interaction*. http://www.disci.tuiasi.ro/images/6. PUBLICATION/Book_of_abstrascts.pdf

Rusu, O.-C., & Chiriac, V. (2015). Overcoming communication stereotypes through innovative educational technology tools, Managing Communication Issues in a CAT Workshop. *Relaţia Identitate-Alteritate Şi Stereotipurile Socio-Culturale*. http://www.inventica.org.ro/performantica/

Chapter 1: Introduction and Background

1.1 Introduction

This thesis uncovers paramedic student experiences regarding the learning-technology-spaces intersection as a shadow learning landscape. *Student experiences* are "process[es] of observing, encountering, or undergoing a set of circumstances or events from which knowledge, understanding, skills, or attitudes are derived – also, the cumulative result of th[ese] process[es]" (ACER Cunningham Library, 2022). *Learning landscape* embodies the "conceptually holistic, loosely coupled inter-connections of all formal and informal, on- and off-campus, virtual and physical facilities, sites and services" (Thody, 2011, p. 131) which are visible in student experiences taking place at the learning-technology-spaces intersection. *Shadow* denotes that the shape of this learning landscape is student made, exists parallel to, builds upon, mimics, responds to, but does not represent institutional impositions (*Shadow*, 2022; W. Zhang & Bray, 2020).

The shadow learning landscape I present in my thesis stems from my empirical investigation of student experiences regarding the learning-technology-spaces intersection. My research set out to understand the question: "How do paramedic students experience the relationships amongst their learning practices, the technologies they use and the physical spaces they traverse?". I thus extracted meaning from within the middle of the Venn diagram shown in Figure 1.1 and uncovered that students craft, what I metaphorically called, a shadow learning landscape. This landscape has complex adaptive system traits, is co-created by students in an ad-hoc manner and serves as an institutional intervention threshold. Yet does not appear endorsed by educational institutions. I will consider these issues in more detail in chapter six.

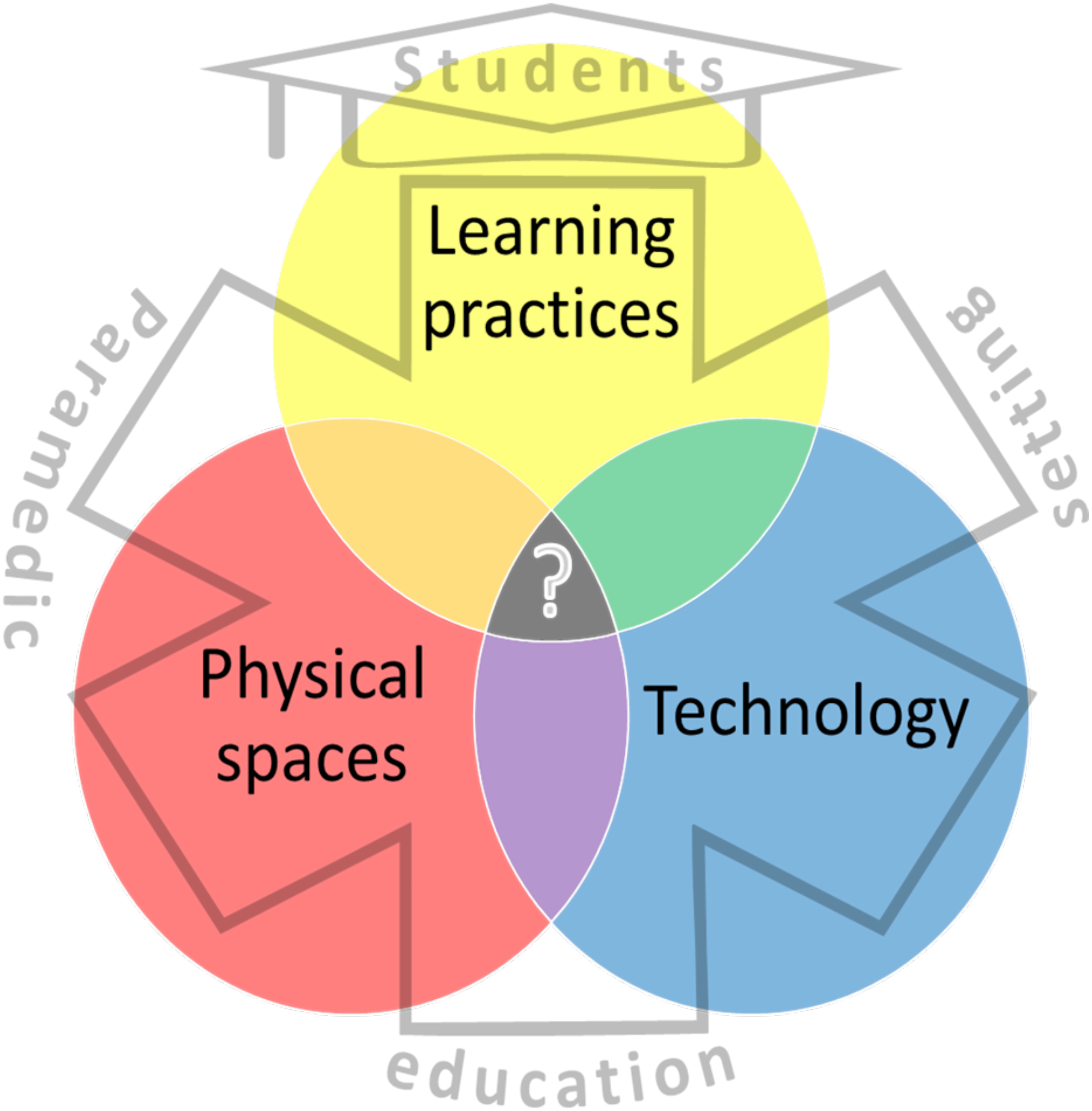

Figure 1.1: My research context – student experiences regarding the learning-technology-spaces intersection. The question mark locates the focus of my thesis. The six-corner start represents the paramedic education setting. The academic cap represents students.

My findings contribute to existing knowledge in three primary ways. In the following paragraphs, I outline and signpost my original contribution to knowledge. I will then detail the ideas introduced here in section 6.3 to fully demonstrate the contribution to knowledge of my research.

First, my research introduces the shadow learning model which replaces the question mark from Figure 1.1. The shadow learning landscape is important because, by introducing a new nomenclature and an associated model, it aims to serve as an unmistakable focusing point for future policy, practice and research discourses. This is also important as it has unique theoretical implications amongst existing research. To explain, my thesis is positioned against the backdrop of a literature that largely notices space (in)adequacies in passing, rarely addresses within discussions challenges identified in findings and presents little information about the way students shape their own experiences – I present these challenges in sections 2.5, 2.6 and 2.7. In contrast, my research leads to a model that provides adequate theorization of student actions outside institutional impositions. The shadow learning landscape is thus a distinctive model which highlights the learning-technology-spaces intersection in student experiences as an entity where different components and interactions mediate for failures in others; which is under the direct influence of students; and where the balance between student (in)actions and comfort could indicate whether institutional intervention in student experiences is needed. This stems from the underpinning approach to research that I adopted, which is different from most of the student experiences literature that I reviewed. The shadow learning landscape's original contribution to knowledge also stems from its unique, focused analysis of a specific combination of elements – the intersection of learning, technology and spaces in paramedic student experiences – which has rarely been considered as the dedicated scope of research in the past – I highlight this in section 2.3. The shadow learning landscape is then important because its usage can introduce a mental shift, potentially solving fundamental challenges identified in reviewed literature. The shadow learning landscape is thus positioned not only as a conclusion to my research but also as a springboard for future policy, practice and research discourses – I will detail this in sections 7.5 and 7.6.

Second, my findings add new facets to existing literature. This is important because it opens up new opportunities for future research. For example, my findings highlight the importance of ambulance design in student experiences which contributes to knowledge regarding how space adequacy affects healthcare student experiences across the campus-clinical continuum – this will be presented in subsection 2.5.1. To clarify, the literature which I review in chapter two, highlights that "adequate facilities are crucially needed to assist students to meet academic demands" (Tharani et al., 2017) and that small, noisy rooms, with inappropriate light and ventilation are inadequate for studying (Anarado et al., 2016; Fajardo et al., 2021; Mthimunye & Daniels, 2019; Oguro et al., 2022; Takase et al., 2019). My thesis, unlike reviewed literature, adds the patient care compartment of ambulances as spaces whose adequacy healthcare students struggle with. This represents an important contribution to existing literature because it offers evidence of situations not previously described which, through their comfort and space-related implications, could affect student learning across many generations.

Third, by providing additional evidence and richer detail, my findings enhance existing knowledge. This is important because it creates stronger evidence to support a number of notions considered in the literature I reviewed which are discussed with relatively small amounts of underpinning evidence or only in research contexts dissimilar to my own. For example, my study participants mimic behaviours visible in the literature that highlights technology's roles in customizing student experiences across different spaces – subsection 2.6.1. To clarify, the students that participated in my study, much like students participating in previous studies are "more or less continuously connected" (Clarke et al., 2019), taking notes and accessing information through the internet (Altmann & Brady, 2005; Clarke et al., 2019; Emory et al., 2021; Lee et al., 2019; Mcnally et al., 2017; Meade et al., 2011; O'Connor & Andrews, 2018; Shanahan, 2012; Willemse & Bozalek, 2015). My students though present descriptions of their own experiences, richer than descriptions of similar student experiences available in existing research. By doing so, while also introducing an enhanced paramedicine perspective, my thesis enhances existing knowledge.

1.2 Personal motivation

Personal observations spawned my broad interest into learning spaces. As a paramedic instructor, I observed that spaces affect students' use of technology in learning. This spotlighted connections between learning, technology and spaces and, more importantly, spawned my curiosity regarding the role of learning spaces in student education.

The following vignette exemplifies the type of observations that influenced my research. Here, the vignette signposts observations and contextualizes my research. In chapter three, the same vignette will help illustrate elements of my theoretical framework. This narrative is slightly modified to avoid unwanted ethical challenges, but it captures the spirit of my observations:

> I was teaching 30 students in a six-hour, face-to-face class focused on patient management. I was bringing printed handouts, flipcharts, markers and chalk to class. The class was held in a rectangular room, five desks wide and seven desks deep. My podium was at the front of class. Behind me there were three blackboards, guarded on each side by two big screen televisions. The entire room had five double electrical outlets: one on the podium and one on each wall of the room. The course referenced a printed book. Students were not required to have access to laptops or any other electronic devices. Yet, each student had a laptop on their desk. Notepads, smartphones and even tablets were also present in front of some students. Only a few printed books were visible in class.

The class used a case-study format. Students were given a handout depicting a patient suffering from an illness and were asked to devise a care plan in line with professional standards. Students worked in groups of five, spent 30 minutes devising the care plan and summarized it all in a short class presentation. One group would present their care plan to the entire class. Since they were all based on the same professional standards, care plans were similar between groups. However, variations in procedural sequence existed between groups – e.g., sitting or kneeling next to a patient, taking a blood pressure or performing an electrocardiogram first. These allowed for fruitful classroom discussions to follow each presentation. This process – case-study, care plan, presentation and discussion – would repeat for the entire class.

For the first few hours, students used laptops to research information and collaboratively create care plans. Groups were staying close together. The classroom was buzzing with excitement. Despite my provision of flipchart paper and markers, students decided to use laptops to present their care plans. While students were presenting, images from their podium connected laptops were projected on televisions for the entire class to see.

Towards the second half of the class, initially some and then all groups moved towards the walls of the classroom to be closer to electrical outlets needed to charge their laptops. As the number of discharged laptops severely outnumbered existing outlets, students switched from digital to analog devices. Paper books came out of backpacks and flipcharts were

> used for presentations. Some laptops were plugged into electrical outlets. Most were used as paperweights holding books open. The buzzing of the classroom was ebbing and flowing as students were moving between reading their paper books and gathering around flipcharts to write their care plans. Flipchart presentations were initially hard to see due to the visual obstacles of desks and chairs. Eventually students decided to stand flipcharts on desks for the entire class to see. However, due to safety reasons, students were not able to stand on desks alongside their flipcharts. This made flipping flipchart papers cumbersome. After a few such experiences, care plans became carefully designed to only occupy one side of a single flipchart paper.
>
> By the end of the day, I was running low on flipchart paper and markers. The class ended before I exhausted all resources. Throughout the day I was surprised to see the transition from electronic devices to flipcharts and markers, books appearing out of backpacks when initially only few were present on desks and the way care plans became concise yet remaining complete and quite detailed.

The above is just a single example. My observations extend beyond students' classroom behaviours. For example, the way I deliver the same content to multiple student sections, each located in a different classroom, is influenced by the combined negative characteristics of all rooms. One classrooms' non-existent internet connectivity and another's immovable desks lead to learning activities, where neither student section can use internet access or re-arrange their desks. Ambulance learning also faces electronic device usage challenges along with insufficient private student spaces. These could affect students’ capacity to access information and study while in preceptorship. The above examples highlight connections between learning, technology and spaces, and pinpoint space related challenges; such experiences spawned my broad research interest into the role of learning spaces in student education.

1.3 Academic and political discourses

Academic and political discourses channelled my initially broad research interests into the specific investigation of student experiences regarding the learning-technology-spaces intersection. Being a technology enhance learning (TEL) researcher, interested in learning spaces, who teaches in healthcare, I turned to TEL and healthcare literature on learning spaces for more information. This literature emphasizes the need to study learning, technology and spaces as interconnected and recommends focusing on student experiences. Concomitantly, political discourses indicate the importance of spaces and technology in future institutional decisions. Academic and political factors morphed my initially broad interests into the current project.

My initially broad interest in learning spaces was channelled towards the learning-technology-spaces intersection by academic literature emphasising the interconnection between learning, technology and spaces (cf. Bligh & Crook, 2017). The literature on educational spaces emphasises that “all learning is spatial” and “technology interacts with and re-shapes learning […] by creating distinctive experiences that are centred upon particular spaces” (Bligh & Crook, 2017). In this sense “digitalized education has […] renewed an interest in physical learning spaces” (Bligh, 2019a). These “must be re-imagined for new modes of […] learning that will blend […] physical settings and technologically enabled experiences” (Nordquist & Laing, 2014). Nonetheless, research literature concerned with this “re-imagining” of learning spaces is merely nascent; this stands true in a wide range of research areas including educational research, human-computer interaction and technology enhanced learning, due to today’s ubiquitous intertwining of technology and spaces in education (Bligh & Crook, 2017; Duval et al., 2017). Existing academic discourses then legitimize observations I made while teaching: learning, technology and spaces are interconnected. Yet the nature of the interconnections remains underexplored. These academic discourses motivated me to focus my investigation from my broad interest in learning spaces to the more specific exploration of the learning-technology-spaces intersection.

My research interests were further channelled into investigating student experiences by an impetus, expressed in learning spaces literature, to actively engage with *denizens*’ experiences (cf. Bligh, 2014; Bligh & Flood, 2014). Denizens are space inhabitants, with no space-related professional knowledge or decision-making power but whose lived experiences provide invaluable information about the spaces they inhabit. Denizens’ “opinion of institutional space is sought because they […] are thought capable of providing insight into how learning happens there that would otherwise remain inaccessible to estates managers” (Bligh, 2014). Students are denizens whose experiences of spaces – and implicitly the learning-technology-spaces intersection – need careful investigation. Prior literature emphasizes that “[d]iscussing with students where and how they study, inside and outside of formal class time, and incorporating such discussions into teaching practices […] can benefit teachers and students alike” (Bligh, 2019a). Without such discussions, educational institutions could risk pursuing inappropriate initiatives or even re-inventing practices already implemented by students. For example, “various forms of off-campus or non-institutional space […] come to be seen as ‘new’ learning spaces, notwithstanding that they may have had longstanding utility for particular segments of the student population” (Elkington & Bligh, 2019). I align with this ethos of listening to denizens and focus my thesis on student experiences.

Politically, in Ontario, Canada (the location in which this research project took place) healthcare educational institutions – including those training paramedics – face increasing budgetary accountability regarding learning spaces and technologies (Colleges Ontario, 2009, 2017; Ontario Ministry of Finance, 2016). Faced with internationally recognized scholarship limitations (cf. Nordquist, 2016; Nordquist et al., 2013), Ontarian healthcare educational institutions risk building spaces and deploying technologies within these spaces in a well-intentioned yet somewhat uninformed manner. Due to the transferability of educational principles, institutions from other parts of the world could also be faced with the same challenges. Therefore, healthcare educational institutions – including paramedic training institutions – need to understand space-technology-learning relationships as prerequisites to demonstrating good practice to stakeholders; my thesis will contribute to this goal.

Academic and political discourses focused my research into an exploration of student experiences regarding the learning-technology-spaces intersection. My research uncovers the intricate workings paramedic students undertake to make their educational experiences successful while engaging with technology and spaces in a manner that accounts for, compensates and completes institutional offerings, yet is not directly or specifically institutionally driven or approved. This is the shadow learning landscape that my thesis presents. My findings are presented in a manner that aims to make them interesting to scholars in three areas: healthcare student experiences, healthcare education and healthcare-focused TEL. Knowledge gained through this work will help design activities, develop knowledge to support the development of more cohesive space-technology combinations, and deploy technologies aligned with student realities.

Learning spaces literature revealed the learning landscapes metaphor which I used when labelling my research findings as the *shadow learning landscape*. “The concept of Learning Landscapes has emerged as a way of thinking holistically about the refurbishment and rebuilding of universities” (Neary et al., 2010). As already presented, learning landscapes now represent those “conceptually holistic, loosely coupled inter-connections of all formal and informal, on- and off-campus, virtual and physical facilities, sites and services” (Thody, 2011, p. 131). Being too broad, this definition cannot provide the specificity needed to focus research questions. Instead, existing scholarship uses learning landscape(s) to metaphorically brand different interactions between elements of learning, technology and spaces. For example:

> "*blended learning landscapes* […] encompass […] interconnected "environments" (including the physical and virtual, the institutional and extra- institutional) and "resources" (such as teachers and other professionals, other students, personal connections and family members, and nonhuman resources – including digital artifacts)" (Bligh, 2019a).

Similarly, the networked learning landscape is a "model […] intended as a guide to planning that emphasizes relationships between the changing curriculum and its alignment with learning environments at multiple scales" (Nordquist & Laing, 2015). Likewise, the *Learning Landscapes in Higher Education* is the metaphorical name of a project which "offers the higher education community a practical and conceptual framework to consider the ways in which learning and teaching spaces are being designed and developed" (Neary et al., 2010). My thesis continues the metaphorical use of learning landscapes when labelling students' experiences regarding the learning-technology-space intersection as the shadow learning landscape.

1.4 Sociomaterialism and complexity thinking sensitized my contextual investigation of paramedic student experiences

My research is contextually situated in paramedic education. Sociomaterialism and complexity thinking sensitized my investigation of student experiences.

This study focuses on paramedic educational settings, which are particularly revealing because they present students with the challenges of learning across interrelated combinations of spaces – lecture theatres, simulation spaces, hospital sites, ambulances – where they interact with varied forms of technology – medical equipment, personal digital devices, and institutional "educational technologies". Relationships between those spaces, technological resources and practices are increasingly recognized as important in paramedicine-specialist literature. For example, Tavares et al.'s (2016) discourse analysis of 99 peer-reviewed and grey literature publications in the field establishes three "framing concepts" for future-oriented paramedicine: "variable contexts of practice", "embedded relationships", and the "health-social continuum". Space-technology-learning relationships are directly implicated in the first two of those framing concepts (and resonate with the third, once its connotations are unpacked). Yet how students understand and manage those relationships is poorly understood.

To frame this investigation, my study recognizes that interactions amongst learning, spaces and technologies involve relationships that constantly form and reform depending on multiple factors. Even though this study is purposefully delimitated to only studying these relationships in paramedic education, these remain nonetheless very complex relationships which involve interactions between human elements – students – and non-human ones – spaces, technology. As I detail in chapter three, to explain these unfolding relationships I use a series of concepts from sociomaterialism and, its branch, complexity theory. This is achieved by using case study methodology and gathering data through artefacts (Creswell & Poth, 2018; Yin, 2014), “photo elicitation […] and interview to the double” (Fenwick & Nimmo, 2015).

From sociomaterialism, my thesis borrows an ethos of looking beyond humans. In my view, research emphasising humans’ hegemony over non-humans is worrisome, as the non-humans, especially spaces and technology, are indissolubly ingrained in human inter and intra-actions. To say that humans act on non-humans without saying that non-humans also act on humans is as pleonastic as saying that action and reaction do not exist in physics. Sociomaterialism provides to my thesis a way of looking beyond humans. Problematically though, non-humans – at least in the context of my thesis – do not have a voice of their own. Their voice comes from interactions with humans. In my thesis I used interviews-to-the-double (Fenwick & Nimmo, 2015), drawings and screen-captures to present the voice of non-human elements. I will detail this in chapter four.

From complexity thinking, my thesis adopts those conceptual “directions along which to look” (Albert J. Mills, 2012) while exploring the way students experience the learning-technology-spaces intersection. To investigate this intersection, I focused my data collection and my initial data analysis on five complexity thinking concepts: diversity, redundancy, decentralized control, neighbour interactions and enabling constraints. Additional analytical work of exploration took place to uncover higher-level themes which appear when considering the initial five concepts together. This was sensitized by another complexity thinking notion: emergence. I will further detail the influence of these concepts on my thesis in chapters three and four.

1.5 The setting for my project

The setting for my project is Durham College's (DC) Primary Care Paramedic (PCP) programme. This is the programme that I refer to when I discuss paramedic students in my thesis. Durham College is an Ontario, Canada, based educational institution which, amongst other programmes, trains Primary Care Paramedics. In the next paragraphs I first clarify matters of paramedic scope of practice and then of paramedic education in Ontario. In the end of this section, I detail specifics of paramedic education at DC as they were experienced by the students involved in this research.

Paramedics are a healthcare profession. Most of the time, they work outside hospitals, in uncontrolled situations, where they come to the help of patients in need. This makes the paramedic profession an exhilarating one, which benefits from "high social prestige" (Majchrowska et al., 2021) yet it is dangerous and exposes its practitioners to "higher fatal injury rates when compared with all workers" (Reichard et al., 2011).

The core of a paramedic's job can be summarized as caring for and transporting patients when suffering health challenges outside a hospital (cf. *Ambulance Act - Ontario Regulation 257/00*, 2022; American Academy of

Orthopaedic Surgeons (AAOS) et al., 2021; Paramedic Association of Canada, 2011). In this prehospital environment, paramedics respond to calls in circumstances that other persons run away from and are responsible for helping people in diverse situations, some more imaginable than others. For example, paramedics treat patients suffering a life-threatening allergic reaction fin the middle of a forest, a fracture on a football field or a gunshot wound in the middle of a parking lot. Transportation involves taking patients to – and from – the hospital, sometimes bypassing local emergency departments and bringing patients directly to more specialized healthcare facilities – e.g., cardiac, stroke or trauma specific hospital units.

In Canada, a National Occupational Competency Profile for paramedics (Paramedic Association of Canada, 2011) exists, but provincial and territorial norms of practice affect the paramedic scope of practice. In Ontario, Canada, there are three levels of paramedics (*Ambulance Act - Ontario Regulation 257/00*, 2022). Primary Care Paramedics represent an entry to practice requirement and are present in most Ontario ambulance systems. Primary Care Paramedics provide lifesaving procedures and transportation to specific destinations for a wide range of patients – some of these are visible in the examples provided above. Advanced Care Paramedics are initially trained as Primary Care Paramedics and then, through additional training, are able to provide more invasive care to their patients. For example, they can provide endotracheal intubation or perform synchronized cardioversion or pacing, which Primary Care Paramedics cannot (*Ambulance Act - Ontario Regulation 257/00*, 2022). Critical Care Paramedics are initially trained as Advanced Care

Paramedics and then, through additional training they increase their scope of practice. For example, Critical Care Paramedics can provide “[m]aintenance and monitoring of arterial and central venous catheters” and “[g]astric intubation and suction” (*Ambulance Act - Ontario Regulation 257/00*, 2022) which Advanced Care Paramedics cannot.

At each level of training, paramedics undergo initial theoretical training, followed by simulation. After engaging in simulation, paramedic students start treating patients in hospital or other patient care facilities. These facilities are less chaotic than the uncontrolled environment of out of hospital care. Paramedics hone their skills in these facilities in order to first achieve competence in a more controlled environment, before treating patients in the ambulance setting. Paramedic training culminates with ambulance training or *preceptorship*, where paramedics can apply all their knowledge in the environment they would be expected to perform in after graduation. Students encounter and use a variety of different spaces and technologies across their training in the paramedic programme.

The Durham College PCP programme follows all provincial and national training requirements and is accredited in conformity to the Canadian National Occupational Competency Profile for paramedics (Accreditation Canada, 2022; Paramedic Association of Canada, 2011). This programme is four semesters long. In the first two semesters, students are introduced to the bulk of their competencies, first in an academic setting and then in simulation. During this time, they also start seeing patients in the controlled environment of long-term care or nursing homes. During the subsequent two semesters, the students finish the academic and simulated part of their training, then engage with patients inside hospitals. In the end, as in other Canadian paramedic programmes, competencies are evaluated in ambulance settings where students are under the direct supervision of the paramedic crews they are assigned to join in the field. This is the preceptorship part of the student training and its successful completion is mandatory for graduation.

At Durham College, only second year students come in contact with all types of spaces and technologies a primary care paramedic student would encounter in their training. This is specifically important for my thesis as second year paramedic students became a particularly interesting study population, from which I recruited my study participants. To explain, at each phase of their training, paramedic students learn using technologies and by interacting with spaces that might be specific to that phase of their training. For example, only during preceptorship, paramedic students learn inside ambulances and use medical equipment to treat real patients. Since only second year paramedic students undergo ambulance preceptorship at Durham College, it is this population that was able to provide the most complete description of paramedic student experiences regarding the learning-technology-spaces intersection. For this reason, my thesis uses second year paramedic students as its participants.

1.6 Defining technology and space

Technology and space are areas of interest for my thesis, whose meaning in my research I will now clarify. This is needed as these terms sometimes have different meanings in different areas of literature.

In my thesis, I see technology as “the application of scientific knowledge to the practical aims of human life or […] to the change and manipulation of the human environment” (The Editors of Encyclopaedia Britannica, 2021). Technology thus represents tools which appear in student experiences. In my thesis these tools are computers, tablets, smartphones but also ambulances, stethoscopes and “books and a blackboard (both of which are, of course, examples of technology but which are so common that we no longer think of them as technological tools!)” (Rushby & Surry, 2016). These tools affect and are affected by spaces and learning and, together, shape student experiences. My thesis though avoids philosophical debates regarding the nature of technology. In my thesis, whether pen and paper are considered technology or not, is just a matter of language. I can say that students use computers in classrooms and pens in ambulances or I can say that students change the type of technology between class and ambulance. What is important for me is that different tools are used in different situations.

In my thesis, physical spaces are seen as “physically/geographically bound” (Hawick et al., 2021) entities which students traverse or find themselves located within when learning. Paramedic students learn in many physical spaces. Some are common to other healthcare professions – e.g., classrooms, libraries, hospitals – while some are paramedic specific – e.g., ambulance, ambulance station. Within existing literature, the terms space, place and environment are used sometimes interchangeably. Even more, space(s), place(s) and even environment(s) are sometimes associated with, usually preceded by, descriptors meant to enhance their suggestiveness. For example, terms like physical or virtual are used to paint a poignant picture of spaces in which different learning takes place (Cleveland & Kvan, 2015). To avoid confusion and mediate a lack of nomenclature cohesiveness, in my thesis, spaces are physical entities in which activities take place and places are spaces that develop meaning based on a given situation; “space is objective (physically/geographically bound), while place is subjective (peoples’ experience of a space)” (Hawick et al., 2021). I use *physical space* to clarify this difference and to account for the lack of universally accepted definitions of terms used to describe human surroundings involved in learning.

1.7 Clarifying research question and next steps

My thesis sets out to answer the following research question:

> How do paramedic students experience the relationships amongst their learning practices, the technologies they use and the physical spaces they traverse?

This question is not limited to classrooms or ambulances. It applies to all learning-technology-space intersections encountered by paramedic students. As will become visible in chapters five and six, some experiences are discussed at greater lengths than others. For example, student accounts do not discuss in-hospital experiences, but ambulance experiences are meticulously detailed.

This is the only question my thesis sets to address. This unusual approach to a PhD thesis is a purposeful choice. It is justified by the intricate, yet systematic approach my theoretical framework affords my research and is made to avoid unnecessarily convoluting my narrative. To clarify, my research uses a complexity sensitized theoretical framework. Five principles of complexity guided my data gathering and the initial stages of data analysis: neighbour interactions, redundancy, enabling constraints, diversity, and decentralized control. I present in chapter five how each of these principles is expressed, in turn, in the accounts of students. I then answer my research question in chapter six. There, I use another complexity concept, emergence, to sensitize (Blumer, 1954) the “additional data exploration and analysis” (Schreier, 2012, p. 220) that led to answering my research question. Complexity thinking principles used in my theoretical framework helped “narrow the central question to specific aspects”; this is the exact same purpose Creswell associates with research sub-questions (Creswell, 2015, p. 218). Essentially then, the complexity thinking principles which influenced my theoretical framework served the same purpose as research sub-questions. By using these principles instead of individual sub-questions, I avoid introducing another layer to my thesis which would convolute my narrative by superimposing the language of sub-questions over the language of complexity thinking already used in my thesis.

Forthcoming chapters will detail the above notions. Already existing knowledge will be analysed in the literature review. This will help formulate my theoretical framework which in its turn will shape my research design. After presenting my findings, my thesis will come full circle through discussions, conclusions and future work suggestions.

Chapter 2: Literature Review

2.1 Introduction

This chapter investigates existing research, identifies literature supporting my thesis and highlights areas of potential scholarship contribution regarding the learning-technology-spaces intersection. Here I build upon first chapter's research objectives and establish support for upcoming chapters.

This chapter has a sequential approach. In section 2.2 I engage with and position my work within the wider learning spaces literature. This further justifies my interest in researching student learning experience and sets the stage for the literature review that forms the rest of the chapter. Sections 2.3 and 2.4 then describe how reviewed literature was chosen and evaluated. Sections 2.5 and 2.6 are standalone reviews, detailing themes uncovered in the two areas of research that I align with: **"educational spaces in the experiences of healthcare students"** and **"using technology in educational spaces in the experiences of healthcare students"**. Section 2.6 builds on an observation made when analysing literature from section 2.5: that matters of technology scarcely appear when notions of spaces are discussed. As such, by reviewing the use of technology within educational spaces I further clarified topics of interest to my thesis. In section 2.7, I analyse theoretical perspectives used in empirical works reviewed in sections 2.5 and 2.6. This analysis helped me conclude that a more theoretically informed research is needed to advance current understanding of the learning-technology-spaces intersection.

2.2 Engaging with the overall literature on spaces and learning

There is a broad, though fairly fragmented, existing literature on spaces and learning. Engaging with such literature early in my project, as I discuss in this section, helped me to channel my initially broad research interests into a more specific investigation of student experiences regarding the learning-technology-spaces intersection that my thesis focuses on – section 1.3. This existing literature also served as the starting point for my scoping review process that defined the literature which my thesis most directly contributes to – section 2.3. Throughout the early training modules of my doctoral studies and the prolonged discussions I had with my supervisor at the start of my thesis project, I became familiar with the main trends visible in the literature on spaces and learning. In this section, I present some of the key arguments evident in this literature, and detail how this existing knowledge helped define the scope of my literature review which I then present in the rest of this chapter.

The existing literature urges us to investigate the role of spaces in student learning. Within the last fifteen years, an impetus for studying spaces in the context of student learning is well documented. This is because the influence of space has become recognised (even if, as I document under the next heading, how that influence works is poorly understood). This impetus has led not only to published articles (Bligh, 2019b; Carvalho & Yeoman, 2018, 2021; Ellis & Goodyear, 2016; Temple, 2008; Yeoman & Wilson, 2019) but also to entire special editions of journals (Lamb et al., 2022; Nordquist, Kitto, et al., 2013a) and books (Carvalho et al., 2016; Ellis & Goodyear, 2018; Temple, 2014). Within all, a clear message resonates: "[t]he proliferation of digitalized education has […] renewed an interest in physical learning spaces" (Bligh, 2019a) and "[i]t has never been more important for those of us with an interest in education to be critically exploring the complex and changing nature of university learning spaces" (Lamb et al., 2022). The issue here seems to be that there is a sense in which spaces have been seen as stable for a long time, and thus taken for granted. Now, it is being realised that we do not know how they really work. The expressed need to study spaces and learning motivates, inspires and focuses my research.

The existing literature acknowledges that learning spaces in higher education are "an under-researched topic" (cf. Temple, 2008). Despite the fact that, as presented in the previous paragraph, active calls exist for the study of learning spaces in higher education, existing literature also acknowledges the scarcity of both adequate theorisation and detailed empirical studies. More than a decade ago, Temple sent a powerful message: "[l]earning spaces in higher education […are] an under-researched topic" (Temple, 2008). The same message was reciprocated a few years later by the same author: "despite its seemingly obvious importance, the available literature on space and place in higher education internationally is scant when compared to that dealing with, say, teaching and learning methods, or with evaluating quality or many other topics" (Temple, 2014). Others have reached similar conclusions (Kitto et al., 2013; Nordquist & Laing, 2015). Most currently, Berman reminds us that space related "research has largely been limited to schools rather than universities, and even less so for informal spaces" (2020). Similarly, Leijon et al. highlight that, in regard to "[f]ormal learning spaces in Higher Education", "[a] broad and fragmented field emerged that is to some extent under-researched and under-theorized" (Leijon et al., 2022). The recognized lack of studies focused on spaces and learning is a gap that my study wants to address, through both adequate theorisation and empirical investigation.

Existing literature acknowledges that, to understand the connection between learning and spaces, researchers need to focus on the wider networks to which these two elements belong. The connection between learning and spaces forms inextricable networks extending beyond these two elements. As many voices already pointed out, learning and spaces should be studied together (Bligh, 2019a; Ellis et al., 2018; Nordquist & Laing, 2015). This being said, researchers cannot ignore the fact that "learning in the context of society today, whether at school, university, work or in informal situations, is occurring through increasingly rapid interaction amongst people, technologies, places and spaces" (Ellis et al., 2018). Learning and spaces are, then, part of intricate networks of humans, physical spaces, technologies, social interactions and many other entities which need to be studied and understood as networks and not as stand-alone elements:

> "[C]onnections between place and learning can be subtle and powerful. To understand them, one needs to understand complex, shifting assemblages involving human beings and things: material, digital and hybrid. Research aligning with this view tends to the qualitative: exploring students' and teachers' experiences and foregrounding subjective meanings and sense-making" (Ellis & Goodyear, 2016).

This recognized need to focus on concomitantly understanding learning and spaces as part of interconnected networks of humans and things inspired me to focus on analysing the research frameworks used to underpin the literature reviewed in the upcoming sections.

The existing literature recognizes that understanding the space-learning interconnections requires analysing their ongoing construction via the lens of student experiences. In the process of learning, “spaces are not simply found, nor are they just “containers” for social practice, but they are constantly generated by students” (Gourlay & Oliver, 2016). “Space is constantly enacted through, and entangled in, these complex day-to-day practices that make up students’ studying“ (Gourlay & Oliver, 2016). In the process of learning, students enact and create their own learning spaces in ways meaningful to them but not necessarily intended by space designers. For example, one study documents how students engaged in individual studying in “an institutional space designed to attract student engagement with study and, in particular, to foster collaboration”, yet such individual studying was valuable and meaningful to the students themselves (Crook & Mitchell, 2012). Other authors argue that there is a tendency for institutional decision-makers to imagine they are reinventing “‘new’ learning spaces, notwithstanding that they may have had longstanding utility for particular segments of the student population” (Bligh, 2019b). Research should, then, look at the way students make their own learning spaces and provide robust explanations of such endeavours. This recognized need to understand student experience was essential in focusing the area of investigation of my thesis.

The existing literature recognises that many important university spaces have a discipline-specific character and, moreover, a distinct literature on healthcare student learning and educational spaces is emerging. As an increasing number of scholars are starting to recognize the need to research learning and educational spaces within higher education, an impetus for specifically focusing on healthcare educational spaces is also becoming evident in literature (Nordquist et al., 2011). In regard to physical spaces, healthcare students, like other higher education students use classrooms, libraries and informal spaces to learn. Yet, the nature of their education and their use of simulation laboratories, clinical learning areas in hospitals or other places of patient care, means that healthcare students have distinct experiences which should not be reduced to those of some imagined “generic” higher education students. This explains the impetus, visible in much literature, to focus on the study of spaces, and the connection between learning and spaces, in healthcare education specifically (Nordenström et al., 2013; Nordquist et al., 2011; Nordquist, Sundberg, et al., 2013a).

Nonetheless, even though understanding “[h]ow space impacts on learning is a central issue in academic medicine and health professions education” (Nordquist, Sundberg, et al., 2013b), “aligning space with curriculum is a burning - and currently under-addressed - issue in health profession's education” (Nordquist & Sundberg, 2013). Furthermore, research focused on the connection between learning and spaces “during active patient care” is still in its infancy (Cooper et al., 2020). “This is yet early days and we have a lot of exciting work ahead of us” but the need to assure congruent learning, space and technology experiences for students is a global necessity, recognized by many healthcare educational institutions (Nordquist, 2016).

2.3 Defining the scope of my literature review

My literature focuses on two areas: **“educational spaces in the experiences of healthcare students”** and **“using technology in educational spaces in the experiences of healthcare students”**. My thesis most connects with and will add to these two areas. This, as I describe below, became evident through a scoping literature review process focused on my research interest described in chapter one: student experiences regarding the learning-technology-spaces intersection which is positioned within the wider context described in the previous section.

Analysing literature on educational spaces connected to healthcare student experiences helped clarify existing knowledge about the role of physical spaces in influencing the learning experiences of healthcare students. Due to their healthcare related nature these experiences extend across the campus-clinical continuum. “Experiences” here are deliberately defined broadly; by scoping this area of the literature in this way I was hoping to capture the manner in which the physicality of educational spaces influences “[t]he process of observing, encountering, or undergoing a set of circumstances or events from which knowledge, understanding, skills, or attitudes are derived” (ACER Cunningham Library, 2022).

Exploring the above literature, however, provided insufficient insight into the roles of technology. Therefore, I decided to examine literature specifically on the usage of technology in educational spaces, with my review focusing on how student experiences were described there. Doing so provided additional insight regarding healthcare student experiences connected to my thesis. I was thus able to understand the way the use of technology within different educational spaces affects student experiences. Experience had the same broad definition as above.

Literature associated with each of the above sections, had a common challenge: explanations regarding spaces and/or their technology connections are mostly noted in passing, or in fragmentary ways, in studies whose research objectives and theoretical perspectives primarily focus on other issues. This finding led to a detailed analysis of theoretical perspectives used in references from within sections 2.5 and 2.6. At the end of this theoretically focused analysis, I realized that theoretical perspectives which fail to foreground materials constrain analyses of spaces and technology in healthcare students' experiences. Nonetheless, richer findings associate with material-focused theoretical underpinnings.

By focusing on the above-mentioned research, I came to appreciate the state of current knowledge in areas connected to my thesis. Literature focused on concomitantly understanding the learning-technology-spaces intersection is scarce. In turn, by looking at areas of literature that my review focuses on, I can uncover students' experiences connected to spaces and the use of technology within spaces. This relates to my focus on studying the tripartite learning-technology-spaces intersection, as set out in chapter one.

Points of focus, as described above, arose out of a prolonged process of exploring the literature in which I attempted to define my scope in various ways, identified the nature and extent of literature available within that scope by searching within appropriate search engines, and then refined the focus further. For example, I expanded my review to include the broader category of healthcare students rather than specifically focusing on paramedic learners. This allowed me to mediate the fact that paramedic literature regarding student experiences vis-à-vis the learning-technology-spaces intersection is limited. At each stage, I carefully chose keywords based not only on my own knowledge but also on existing educational descriptors (e.g. *Australian Thesaurus of Education Descriptors*, n.d.). This allowed me to achieve search results best connected to my areas of interest. Finally, while looking at the role of educational spaces in the experiences of healthcare students I realized that scattered references to technology exist in this area of the literature. I thus decided to focus on the literature on the role of technology which is used within educational spaces in the experiences of healthcare students. These processes led to the two main areas of literature that are reviewed in my thesis.

Focusing my search on these two strands allowed me to obtain a reasonable balance between the number of encountered resources and the information they provided. In doing so I eliminated areas of literature that I could have reviewed. For example, I eliminated from my review literature from outside healthcare education and non-empirical research. This is a purposeful choice which helped me uncover answers already available in the literature about my theme of interest. Concomitantly, I was able to find enough literature for my review to be relevant, yet avoiding a gargantuan amount of literary works, which I could not feasibly review.

2.4 Searching for, filtering and reviewing literature of interest

Database searches using keywords and Boolean connectors focused on two areas of the literature: **“educational spaces in the experiences of healthcare students”** and **“using technology in educational spaces in the experiences of healthcare students”**. From these I included in my review articles of interest to my thesis.

Keywords matched intended purposes. Keywords were grouped into four categories. These are detailed in Table 2.1. First category was healthcare professions; here I included healthcare professions recognized by the United Kingdom, Australia, Canada and the World Health Organization (Australian Institute of Health and Welfare, 2020; Canadian Institute for Health Information, 2022; Commonwealth of Australia, n.d.; Ministry of Health & Ministry of Long-Term Care, 2019; National Health Services (NHS), 2022; World Health Organization, 2010). The next categories of keywords were, in order, focused on student experiences, technology and physical spaces. Using Boolean connectors amongst these keywords I searched SCOPUS (Elsevier B.V., 2017) and EBSCOhost (EBSCO Industries, 2022). This assured capture of most literature from MEDLINE (National Library of Medicine, n.d.), EMBASE (Elsevier Limited, 2022), CINAHL (EBSCO, 2022) and ERIC (*ERIC - Education Resources Information Center*, n.d.), databases essential in medical and general education (Haig & Dozier, 2003). Table 2.1 summarizes this process presenting keywords, search protocols, filtering criteria and database characteristics associated with this initial literature search.

Keywords, search protocols, filtering criteria and database characteristics associated with the initial literature search
Search protocol keyword category A: keywords representing healthcare professions:
Examples of keywords included in this category: • "ambulance attendant*" OR "emergency medical attendant*" OR "emergency medical responder*" OR "emergency medical technician*" OR "emergency medical technologist*" OR paramedic* OR "medical doctor*" OR "physician assistant*" OR physician* OR doctor OR "nurs* aide*" OR nurs* OR "practical nurse*" OR "registered nurse*" OR accupuncturist* OR "art therapist*" OR audiologist* OR "autopsy assistant*" OR "blood donor clinic assistant*" OR "cardiology technician*" OR "cast room technician*" OR chiropodist* OR "chiropractic assistant*" OR "chiropractor*" OR "clinical laboratory helper*" OR "dental assistant*" OR "dental hygienist*" OR "dental technician*" OR "dental technologist*" OR dentist* OR denturist* OR dietician* OR dietitian* OR dramatherapist* OR "exercise physiologist" OR "faith healer*" OR "genetic counsellor" OR homeopath* OR kinesiologist* OR "laboratory technician*" OR "ophthalmic lens grinder*" OR "massage therapist*" OR "medical laboratory technologist*" OR "medical radiation technologist*" OR "medical radiation practitioner" OR "medical sonographer*" OR midwive* OR "morgue attendant*" OR "music therapist" OR naturopath* OR nutritionist* OR "occupation* therap*" OR "operating department practitioner*" OR "ophthalmic laboratory technician*" OR "optical laboratory assistant*" OR optician* OR "optometrist* assistant*" OR optometrist* OR orderl* OR "orthopedic technologist*" OR orthoptist* OR orthotist* OR osteopath* OR "personal support worker*" OR pharmacist* OR "pharmacy technician*" OR physiotherapist* OR "physiotherapy assistant*" OR podiatrist* OR prosthetist* OR psychologist* OR psychotherapist* OR radiographer* OR "rehabilitation assistant*" OR "respiratory therapist*" OR "social worker*" OR sonographer* OR "speech-language patholog*" OR therapist* OR "therapist assistant*" OR "traditional Chinese medicine practitioner*" OR "traditional medicine practitioner*" OR "Aboriginal and Torres Strait Islander Health Practitioner*" • The above list of keywords is associated with healthcare professions recognized by the United Kingdom, Australia, Canada and the World Health Organization (Australian Institute of Health and Welfare, 2020; Canadian Institute for Health Information, 2022; Commonwealth of Australia, n.d.; Ministry of Health & Ministry

of Long-Term Care, 2019; National Health Services (NHS), 2022; World Health Organization, 2010)
Search protocol keyword category B: keywords representing student experience
Examples of keywords included in this category: • "student* attitude*" OR "student* behaviour*" OR "student* belief*" OR "student* experience*" OR "student* need*" OR "student* perception*" OR "student* preferences*" OR "student* reaction*" OR "student* response*" OR "student* understanding*" OR "student* happening*" OR "student* opinion*" OR "student* perception*" OR "student* perspective*" OR "student* sense*" OR "student* interest*" OR "learner* attitude*" OR "learner* behaviour*" OR "learner* belief*" OR "learner* experience*" OR "learner* need*" OR "learner* perception*" OR "learner* preferences*" OR "learner* reaction*" OR "learner* response*" OR "learner* understanding*" OR "learner* happening*" OR "learner* opinion*" OR "learner* perception*" OR "learner* perspective*" OR "learner* sense*" OR "learner* interest*" OR "pupil* attitude*" OR "pupil* behaviour*" OR "pupil* belief*" OR "pupil* experience*" OR "pupil* need*" OR "pupil* perception*" OR "pupil* preferences*" OR "pupil* reaction*" OR "pupil* response*" OR "pupil* understanding*" OR "pupil* happening*" OR "pupil* opinion*" OR "pupil* perception*" OR "pupil* perspective*" OR "pupil* sense*" OR "pupil* interest*" OR "apprentice* attitude*" OR "apprentice* behaviour*" OR "apprentice* belief*" OR "apprentice* experience*" OR "apprentice* need*" OR "apprentice* perception*" OR "apprentice* preferences*" OR "apprentice* reaction*" OR "apprentice* response*" OR "apprentice* understanding*" OR "apprentice* happening*" OR "apprentice* opinion*" OR "apprentice* perception*" OR "apprentice* perspective*" OR "apprentice* sense*" OR "apprentice* interest*"
Search protocol keyword category C: keywords related to technology.
Examples of keywords included in this category: • "technolog*" OR "learn* technolog*" OR "education* technolog*" OR "instruction* technolog*" OR "digital technolog*" OR "high technolog*" OR "patient care technolog*" OR "medical technolog*" OR "technolog* enhanced learn*"
Search protocol keyword category D: keywords related to physical spaces
Examples of keywords included in this category:

• Ambulance* OR “ambulance* space*” OR “ambulance* place*” OR “ambulance* environment*” OR “ambulance* landscape*” OR “ambulance* area*” OR “ambulance* design*” OR “ambulance* requirement*” OR “ambulance* planning*” OR “ambulance specification*” OR building OR “building* space*” OR “building* place*” OR “building* environment*” OR “building* landscape*” OR “building* area*” OR “building* design*” OR “building* requirement*” OR “building* planning*” OR “build* specification*” OR built OR “built space*” OR “built place*” OR “built environment*” OR “built landscape*” OR “built area*” OR “built design*” OR “built requirement*” OR “built planning*” OR “built specification*” OR “classroom* space*” OR “classroom* place*” OR “classroom* environment*” OR “classroom* landscape*” OR “classroom* area*” OR “classroom* design*” OR “classroom* requirement*” OR “classroom* planning*” OR “classroom* specification*” OR “clinic* space*” OR “clinic* place*” OR “clinic* environment*” OR “clinic* landscape*” OR “clinic* area*” OR “clinic* design*” OR “clinic* requirement*” OR “clinic* planning*” OR “clinic* specification*” OR “dedicated education* unit*” OR “dedicated education* unit* space*” OR “dedicated education* unit* place*” OR “dedicated education* unit* environment*” OR “dedicated education* unit* landscape*” OR “dedicated education* unit* area*” OR “dedicated education* unit* design*” OR “dedicated education* unit* requirement*” OR “dedicated education* unit* planning*” OR “dedicated education* unit* specification*” OR facility OR “facility space*” OR “facility place*” OR “facility environment*” OR “facility landscape*” OR “facility area*” OR “facility design*” OR “facility requirement*” OR “facility planning*” OR “facility specification*” OR “hospital* space*” OR “hospital* place*” OR “hospital* environment*” OR “hospital* landscape*” OR “hospital* area*” OR “hospital* design*” OR “hospital* requirement*” OR “hospital* planning*” OR “hospital* specification*” OR “school* space*” OR “school* place*” OR “school* environment*” OR “school* landscape*” OR “school* area*” OR “school* design*” OR “school* requirement*” OR “school* planning*” OR “school* specification*” OR space* OR place*OR “physical environment*” OR laboratory OR “laboratory space*” OR “laboratory place*” OR “laboratory environment*” OR “laboratory landscape*” OR “laboratory area*” OR “laboratory design*” OR “laboratory requirement*” OR “laboratory planning*” OR “laboratory specification*” OR ergonomics OR “learning space*” OR “learning* place*” OR “learning* environment*” OR “learning* landscape*” OR “learning* area*” OR “education* space*” OR “education* place*” OR “education* environment*” OR “education* landscape*” OR “education* area*”
Searching for and filtering the literature regarding “educational spaces in the experiences of healthcare students”:
Step 1: Searching for the literature: • Keywords from above Category A, Category B and Category D were combined using Boolean connectors. • Searches were performed using:

- **SCOPUS** (Elsevier B.V., 2017)
    - Captures literature from MEDLINE (National Library of Medicine, n.d.) and EMBASE (Elsevier Limited, 2022)
    - Search executed within: title/abstract/keywords
- **EBSCOhost** (EBSCO Industries, 2022)
    - Captures literature from CINAHL (EBSCO, 2022) and ERIC (*ERIC - Education Resources Information Center*, n.d.)
    - Search executed within: title/abstract/keywords (here called subject headings)

Step 2: Removing duplicates:

- Literature which was present in more than one database was removed. This assured that only one version of each work is kept.

Step 3: Filtering based on abstracts:

- Literature was manually selected based on predetermined inclusion criteria. I included works based on abstract if they:
    - Had a declared focus on the student experience
    - Had an implicit or explicit connection to elements of physical spaces affecting the student experience.
    - Had a focus on learning
    - Did not have a focus on pre/post-test interventions
    - Represented an empirical work

Step 4: Filtering based on entire content:

- Literature was manually selected based on predetermined inclusion criteria. I included works based on entire content if they met the same criteria as in Step 2 above.

Searching for and filtering the literature regarding "using technology in educational spaces in the experiences of healthcare students":

Step 1: Searching for the literature:

- Keywords from above Category A, Category B and Category C were combined using Boolean connectors.
- Searches were performed using:
    - **SCOPUS** (Elsevier B.V., 2017)
        - Captures literature from MEDLINE (National Library of Medicine, n.d.) and EMBASE (Elsevier Limited, 2022)

- Search executed within: title/abstract/keywords
- **EBSCOhost** (EBSCO Industries, 2022)
  - Captures literature from CINAHL (EBSCO, 2022) and ERIC (*ERIC - Education Resources Information Center*, n.d.)
  - Search executed within: title/abstract/keywords (here called subject headings)

Step 2: Removing duplicates:

- Literature which was present in more than one database was removed. This assured that only one version of each work is kept.

Step 3: Filtering based on abstracts:

- Literature was manually selected based on predetermined inclusion criteria. I included works based on abstract if they:
  - Had a declared focus on the student experience
  - Had an implicit or explicit connection to elements of physical spaces affecting the student experience.
  - Had a focus on learning
  - Did not have a focus on pre/post-test interventions
  - Represented an empirical work

Step 4: Filtering based on entire content:

- Literature was manually selected based on predetermined inclusion criteria. I included works based on entire content if they met the same criteria as in Step 2 above.

Table 2.1: Keywords, search protocols and database characteristics for the initial literature search.

After the initial search, I removed duplicates. At times, same references were encountered in both SCOPUS (Elsevier B.V., 2017) and EBSCOhost (EBSCO Industries, 2022). I removed duplicates from EBSCOhost (EBSCO Industries, 2022), if these were also present in SCOPUS (Elsevier B.V., 2017).

I then filtered search results. Details about searching for, removing duplicates and filtering literature referenced in sections 2.5 and 2.6 is detailed below and summarized in tables 2.1 to 2.3.

Filtering the literature on “educational spaces in the experiences of healthcare students” had the declared purpose of uncovering references specifically connected to my research. As discovered during the scoping process, best resource capture required manually filtering database searches. Filtering based on same criteria initially focused on abstracts and then on entire content. References were included in review if they were empirical in nature, not focused on pre/post-test interventions, were focused on the student experience, had an implicit or explicit connection to elements of physical spaces affecting the student experience and a focus on learning. Manually filtering for space connections was necessary due to terminological confusion within literature. For example, some articles discussing learning environments include matters of physical spaces, while others do not; the latter were not included in this review.

Filtering the literature regarding “using technology in educational spaces in the experiences of healthcare students” had the same purpose, used the same criteria and followed the same process as in the above paragraph. In this case, manually filtering for spaces was necessary as my search was not focused on spaces in this section; this would have duplicated above results, which were already not offering too much information. Concomitantly, not all technology-focused articles discussed matters of spaces. For example, technology is commonly associated with simulation; articles discussing simulation as a learning event but not discussing physical spaces which influence student learning in simulation were not included in this review.

Searching for and filtering the literature regarding "educational spaces in the experiences of healthcare students"			
Identification	Areas of search	SCOPUS (Elsevier B.V., 2017)	EBSCOhost (EBSCO Industries, 2022)
	Works after initial search	2516	4589
	Removing duplicates		
	Works remaining	2516	2190
Screening	Filtering based on abstracts		
	Works remaining	138	287
	Filtering based on entire content		
	Works remaining	11	18
Included	Total works included in the literature review	29	

Table 2.2: Searching for and filtering the literature regarding "educational spaces in the experiences of healthcare students".

Searching for and filtering the literature regarding "using technology in educational spaces in the experiences of healthcare students"			
Identification	Areas of search	SCOPUS (Elsevier B.V., 2017)	EBSCOhost (EBSCO Industries, 2022)
	Works after initial search	1057	910
	Removing duplicates		
	Works remaining	1057	550
Screening	Filtering based on abstracts		
	Works remaining	222	143
	Filtering based on entire content		
	Works remaining	12	13
Included	Total works included in the literature review	25	

Table 2.3: Searching for and filtering the literature regarding "using technology in educational spaces in the experiences of healthcare students".

A process of analysis followed. All selected articles were stored in NVivo. Each was analysed focusing on the following criteria:

a. "Aims or research questions"
b. "Location of study"
c. "Data collection methods" (Ridley, 2012)
d. Findings
e. Date of publication
f. Theoretical approaches used in research
g. Congruency between findings and spaces
h. Explicit or implicit nature of the focus on spaces
i. Professions forming the object of study

Parallels were then drawn between different parts of the literature looking for trends; this helped highlight themes present in the literature along with tensions and existing gaps. Within NVivo, articles were coded starting from above criteria and connections between codes were emphasized. Some articles presented one-off comments that did not form themes and were eliminated from the review. Figure 2.1 presents a screen capture of the article analysis process.

Name	Codes
'I feel like I sleep here'~ how space and place influence medical student experiences	11
Nursing students' learning dynamics with clinical information and communication technology~ A	4
Contact is not enough~ a qualitative study of how space and place impact on interprofessional e	4

Figure 2.1: Reviewing articles by means of a qualitative analysis software (Hawick et al., 2018, 2021; Lee et al., 2019).

The outcome of my analysis is presented in sections 2.5 to 2.7. Sections 2.5 and 2.6 show groupings of themes – as subsections – visible in the literature connected to healthcare student experiences related to educational spaces and healthcare student experiences related to the use of technology within certain spaces. Section 2.7 presents an analysis of theoretical perspectives used in references from the previous two sections. Section 2.8 maps the potential contributions of my thesis to the literature.

Sections 2.5 and 2.6 follow a similar structure. This assures the clarity of the narrative. Each section consists of subsections representing main themes visible within analysed literature. Each subsection starts with an introductory paragraph. This is followed by paragraphs presenting arguments which support each subsection’s theme. Each argument is italicised at the beginning of the paragraph in which it is described. Following these arguments, I present a summary of identified challenges within each subsection’s references; these are not italicized as they represent my own critique and not necessarily ideas from literature. I conclude each subsection by highlighting the connection between analysed literature and my thesis.

Sections 2.7 and 2.8 are different in tone and format. There, while I build upon existing literature, I critique challenges identified in literature and make suggestions for the rest of my thesis. Italicized sections are not used in these two sections as the critique does not come as main ideas visible in the literature; it rather represents my own interpretation of existing literature and the manner it connects to the rest of my thesis.

2.5 Literature about educational spaces in the experiences of healthcare students

Literature about educational spaces in the experiences of healthcare students suggests that educational spaces punctuate these experiences across the classroom-clinical continuum. Figure 2.2 illustrates these findings. In this section I describe those themes where student experiences are connected to spaces but not with technology (since I will focus on these in section 2.6). I present these themes as subsections, along with the main arguments that support them. Matters of classroom as well as clinical training are uncovered.

Healthcare student experiences related to educational spaces

- Theme 1: Space adequacy affects healthcare student experiences across the campus-clinical continuum
  - Key arguments
    - *1.1 Adequate facilities affect student learning*
    - *1. 2 Student express the need for adequate facilities on campus*
    - *1.3 Lack of adequate facilities for specific activities causes distress for students*
- Theme 2: Welfare facilities are essential in mediating student clinical learning experiences
  - Key arguments
    - *2.1 In clinical practicum, student specific welfare facilities are needed*
    - *2.2 Student specific welfare facilities comprise of spaces which serve a multitude of roles*
    - *2.3 Welfare facilities offer student refuge*
- Theme 3: Spaces can have unintended consequences for student experiences
  - Key arguments
    - *3.1 Spaces and places are interconnected but ideologically different concepts*
    - *3.2 Built spaces can lead to unintended place experiences*
- Theme 4: Student spaces focused on patient care impact learners' professional identity
  - Key arguments
    - *4.1 Student spaces focused on patient care are professionally oriented but separated from preceptors*
    - *4.2 Student spaces focused on patient care positively affect learners' sense of professional self*
- Theme 5: Spaces can impact student experiences negatively
  - Key arguments
    - *5.1 Spatial seclusion can legitimizes incivility*
    - *5.2 Spatial configuration can serve to separate students from professionals*

Figure 2.2: Themes – which are used as subsections below – and key arguments supporting these themes as they were found in the literature regarding healthcare student experiences related to educational spaces.

2.5.1 Space adequacy affects healthcare student experiences across the campus-clinical continuum

Reviewed literature highlights that space adequacy affects healthcare student experiences (Tharani et al., 2017). It is argued that students have a general need for adequacy in their learning. On campus, it is suggested that students need access to adequately sized rooms, available learning spaces and quiet facilities. In clinical training, it is suggested, the lack of physical facilities puts a physical strain on students. My analysis of the literature also highlights that spaces were noted in fragmentary ways, in studies whose research objectives and theoretical perspectives primarily focus on other issues.

Adequate facilities affect student learning. The literature recognizes that “adequate facilities are crucially needed to assist students to meet academic demands optimistically” (Tharani et al., 2017). No definition of adequacy is provided in reviewed literature. Yet, examples abound, such as “‘adequate space’ to rest” (Tharani et al., 2017), “a large space for all the students to observe what is being thought” (Anarado et al., 2016) or “24/7 study spaces” (Fajardo et al., 2021). These help portray characteristics of spaces that make them adequate in relationship to student experiences.

Students express the need for adequate facilities on campus. Within campus, students convey the need for adequately sized rooms, available learning spaces and quiet facilities*.* Small, noisy rooms, with inappropriate light and ventilation are inadequate for studying. This situation extends from classroom to simulation laboratories and other spaces of student learning such as libraries

(Anarado et al., 2016; Fajardo et al., 2021; Mthimunye & Daniels, 2019; Oguro et al., 2022; Takase et al., 2019). "Availability of computer facility and students' common room were reported as two major resource factors that impact students' performance and emotional health" (Tharani et al., 2017). In regards to libraries, students "desire a "space" that is in close proximity to other […] buildings, provides an attractive setting and natural light, is conducive to quiet study, and operates 24/7 to support their needs" (Fajardo et al., 2021). When students learn after hours, they "desire 24/7 study spaces"; libraries are essential in this case as they can provide access to these spaces for students (Fajardo et al., 2021).

Lack of adequate facilities for specific activities causes distress for students. In clinical training, the lack of student specific facilities puts a physical strain on learners. The lack of student dedicated spaces seems to enhance the hierarchical separation between learners and instructors. The lack of student dedicated spaces, especially in situations where students are perceived as being hierarchically lower than their preceptors, adds to student stress. Nursing students are perceived as having "the lowest position in the hierarchy, and they assert that the hierarchical relationship is maintained during their learning process" (Lee et al., 2018). Students, as well as working nurses, are continuously standing for extended hours while caring for patients; this puts a certain degree of physical stress on the human body. Disappointingly though, "nursing students are unable to rest due to their fear of the qualified nurses and a lack of designated rest areas" (Lee et al., 2018). Connections between personal worth, teaching and learning hierarchies and availability of student dedicated spaces thus become visible.

In summary, space adequacy affects healthcare students' experiences " (cf. Anarado et al., 2016; Fajardo et al., 2021; Lee et al., 2018; Mthimunye & Daniels, 2019; Oguro et al., 2022; Takase et al., 2019; Tharani et al., 2017). After reviewing literature connected to this section, the fragmentary nature of information about spaces struck me. To explain, when moving beyond what was said and looking at the logistics of each piece of research, it became evident that no articles from this section specifically explored the role of spaces in shaping the human action. While findings about space challenges exist within articles, there is a marked lack of discussions about space related solutions to these challenges within literature. Further, while reviewed literature presents existing circumstances, it provides little information of how student actions shape the status-quo. In most cases, the (in)adequacies of space were noted in passing, or in fragmentary ways, in studies whose research objectives and theoretical perspectives primarily focus on other issues. Section 2.7 draws upon the fragmentary nature of space related accounts and analyses theoretical perspectives in existing research.

My thesis recognizes the connection between "adequate facilities" and students' propensity for a positive experience (cf. Tharani et al., 2017). This fuelled my investigation, further justifying my learning-technology-spaces intersection interest. My findings and discussions describe situations where learning spaces inadequately serve student experiences. Students' solutions to these challenges also appear in my findings; this helps explore the role of learners in shaping the shadow learning landscape.

2.5.2 Welfare facilities are essential in mediating student clinical learning experiences

The literature presents students' clinical experiences as affected by student specific welfare facilities. These are private spaces, where students can change clothing, regroup and relocate.

In clinical practicum, student specific welfare facilities are needed. The literature acknowledges that spaces reserved for student use or "welfare facilities are one of the important factors affecting on clinical education" (Moonaghi et al., 2015). Within clinical sites, there seems to be a lack of such student dedicated facilities (Al-Dweik et al., 2021; Kapucu & Bulut, 2011; Moonaghi et al., 2015).

Student specific welfare facilities comprise of spaces which serve a multitude of roles. Student specific facilities allow students to change in privacy, safely store belongings, engage in academic learning and meetings and fulfil spiritual needs (Al-Dweik et al., 2021; Kapucu & Bulut, 2011; Moonaghi et al., 2015). According to Moonaghi et al.:

> "welfare facilities […] include conference halls, rest rooms, prayer rooms, changing rooms and drawers. Participant 1: "For example, we don`t have drawers […] I always think of my properties fearing somebody will steal them." Participant 4: "[…] At least a room is necessary for changing

dress or holding conferences or at least having a commode to decrease stress related to picking up our properties" (Moonaghi et al., 2015)

Welfare facilities offer student refuge. Donetto et al. present a "[d]edicated 'hub' room" used by students training for "leading and supporting interventions aimed at improving the health and social outcomes of children aged 0–5 years" (Donetto et al., 2017). This hub helped "facilitate the development of a professional identity" (Donetto et al., 2017) in students – I review this idea in subsection 2.5.4. Important for this section is the fact that when "a 'protected' space for students" exists, this seems to be "a safe haven […] that offered refuge when students needed to 'get away'" (Donetto et al., 2017).

To summarize, welfare facilities are positioned as essential in mediating student clinical learning experiences (cf. Al-Dweik et al., 2021; Donetto et al., 2017; Kapucu & Bulut, 2011; Moonaghi et al., 2015). Most references from this section suffer from the same fragmentation of information about spaces as described in subsection 2.5.1. Little is visible about the way student actions shape the status-quo, space related challenges identified in findings are not addressed in discussions and space (in)adequacies become evident in studies whose research objectives and theoretical underpinning focus on other issues. In opposition to this general trend, Donetto et. al (2017) present rich details regarding spaces and fluently address in their discussions, space related findings. What also sets their study apart is their use of spatiality, a theoretical framework which emphasizes the importance of "space and place in the learning experience and professional development of student[s]" (Donetto et al., 2017). By using such a theoretical underpinning, this article is one of the few which recognize that humans and non-humans – spaces and technology – are inextricably intertwined in shaping the student experience. I will highlight theoretical underpinnings demonstrating similar characteristics in upcoming sections. When authors use such theoretical frameworks, they can produce more nuanced accounts. I specifically discuss this in section 2.7.

In my thesis, I recognize “that welfare facilities are one of the important factors affecting on clinical education” (Moonaghi et al., 2015). This partly focused my desire to investigate students’ point of view and comment on challenges encountered due to facility inadequacies.

2.5.3 Spaces can have unintended consequences for student experiences

Despite the intent of designers and planners, spaces can have unintended consequences for student experiences. Reviewed literature admits that spaces do not always match their intended purposes. This is evidenced by two articles from the same team of researchers. Both articles, stand out in literature as being “broadly concerned with intended and unintended consequences of the space and place of learning” (Hawick et al., 2021). A medical school building aimed at providing interprofessional training close to patient care spaces induced unexpected feelings of segregation amongst students. My thesis expands the discussion of “intended and unintended consequences” (Hawick et al., 2021) into, for example, the manner in which ambulance patient care compartments are used by students for academic studying.

Spaces and places are interconnected but ideologically different concepts.

Each term is used, in literature, to portray different concepts: “space is objective (physically/geographically bound), while place is subjective (peoples' experience of a space)" (Hawick et al., 2021). The articles by Hawick et al. (2018, 2021) present rich, clearly formulated discussion of terminology connected to the study of spaces. This assures ideological congruency between terminology and meaning. This also sets these articles apart from most of the other literature reviewed in this chapter, where discussions of spaces, places and even environments are used with varying meanings and degrees of terminological congruency.

Built spaces can lead to unintended place experiences. The literature acknowledges that student experiences are not always congruent with buildings' purposes. These are the unintended consequences that Hawick et al. (2018, 2021) explore in their works. As an example of unintended consequences, feelings of segregation were the unexpected results of a new medical building. Even though a new medical school building was meant to unite students in their learning, separation from the wider university life and inter-professional separation between students of different healthcare professions was unintentionally achieved (Hawick et al., 2018, 2021). "The new building allows teaching to be delivered in one place, rather than having students split between campuses as they had been previously" (Hawick et al., 2018). "However, an unanticipated and unintended consequence […] was that students felt disconnected and isolated from the wider university" (Hawick et al., 2018). Similarly, interprofessional education, one of the dedicated purposes of this same new building, was challenging; "Students experienced tensions and isolation because of […] separation from each other within the building" (Hawick et al., 2021).

To conclude, spaces can have unintended consequences for student experiences (cf. Hawick et al., 2018, 2021). While analysing these two articles a welcomed finding stood out: both articles provide rich discussions of theoretical underpinnings that support their focus on spaces and places. As such, both articles admit that "space and other non-human factors (e.g., desks, technology, equipment) can enable or inhibit learning" (Hawick et al., 2021); they also admit that these non-human elements need to be the focus of research. By focusing on matters of spaces, these articles achieve congruency between findings and discussion; space related challenges identified in findings are addressed in discussions. The connection between richness of detail and theoretical underpinnings is thus evident and will be addressed in section 2.7.

My thesis aligns with above presented nomenclature differences between spaces and places and adds to the dichotomy between "intended and unintended consequences of the space and place of learning" (Hawick et al., 2021). In my work, I was inspired by the terminological clarity of these articles. Concomitantly, even though I do not discuss newly built spaces in my thesis, I explore the dichotomy between a space built with a given purpose and its usage in students' life. This will for example be visible when presenting the fact that ambulances, built as patient care spaces, are sometimes used by students as academic learning places.

2.5.4 Student spaces focused on patient care impact learners' professional identity

Student spaces focused on clinical patient care impact learners' professional identity. I discuss here studies examining spaces whose physical properties allow students to act as professionals while achieving physical separation from their preceptors. The literature emphasizes that such spaces positively affect students' sense of professional self (van der Zwet et al., 2011; Vuckovic et al., 2021). My thesis remarks the lack of such spaces in paramedic education and suggests investigating their future feasibility.

Student spaces focused on patient care are professionally oriented but separated from preceptors. The physical properties of these spaces allow students to act as professionals while achieving physical separation from their preceptors. For example, in a "'clinical education ward'" nursing "students had access to their own physical space through a student reception and students' rooms and the students were presumed to care for their own patients in collaboration with their preceptors, the staff and each other through peer learning" (Vuckovic et al., 2021). Likewise, medical students have "a special room […] with a computer and access to patient records" which counts as "their own consultation room" (van der Zwet et al., 2011). These student specific patient care spaces are more than welfare spaces; they are a stepping stone towards professional recognition.

Student spaces focused on patient care positively affect learners' sense of professional self. Literature portrays students studying to become medical doctors as feeling a sense of empowerment when they are allowed to have "a special room for students with a computer and access to patient records" (van der Zwet et al., 2011). "Having their own consultation room gave students a clear status and enabled them to further develop their independence. This room symbolised their position within the practice and supplied them with a safe, private space" (van der Zwet et al., 2011). Similarly, nursing students taught on dedicated educational units feel like they are "Working as a Real Nurse" (Vuckovic et al., 2021). Here they have "access to their own physical space through a student reception and students' rooms […] [where] the students were presumed to care for their own patients in collaboration with their preceptors, the staff and each other" (Vuckovic et al., 2021). Both examples present situations, where the learning spaces are a symbol of trust and, in a sense, acceptance in the profession. Spaces where students can act like their professional mentors, seem to positively shape students' professional identity.

To summarize, student spaces focused on patient care impact students' professional identity (cf. van der Zwet et al., 2011; Vuckovic et al., 2021). The study by van der Zwet et al. focused on "[w]orkplace learning in undergraduate medical education" (2011) stands out as using a theoretical framework which helped it produce nuanced accounts of spaces. The authors identified that using an "explanation in terms of knowledge, skills, attitudes and single determinants of instructiveness is unlikely to suffice" (van der Zwet et al., 2011). Descriptions of learning obtained when such approaches are used represent "a fragmented reflection of the picture viewed through a socio-cultural lens" (van der Zwet et al., 2011). These authors then framed their study through a socio-cultural perspective which allowed them to assert the “intertwinement of workplace context, personal and professional interactions and emotions” (van der Zwet et al., 2011). While this study is still heavily influenced by human actions, the fact that it presented nuanced descriptions of spaces by deemphasizing the hegemonistic power of one human is inspirational for my thesis. I build upon this in section 2.7.

Practicum educational spaces are an integral part of the factors that help maintain a balance between “being ‘allowed’ to be a learner and […] the freedom ‘to really be a’” professional (van der Zwet et al., 2011). In my thesis I reflect upon the idea that student spaces focused on clinical patient care affect student learning and call for investigations into the possibility of enacting such spaces in paramedic learning.

2.5.5 Spaces can impact student experiences negatively

Spaces can impact student experiences negatively. Literature about student experiences captures spatial components to acts of “bullying and harassment whilst on clinical placement” (Capper et al., 2020). Seclusion can legitimize incivility. Spaces can also affect student exclusion form activities in which practitioners engage. Like previous literature, space related information presented in this section is marred by fragmentation. My thesis touches on and discusses the connection between negative student experience and spaces as seen in paramedic student interviews.

Spatial seclusion can legitimize incivility. Seclusion leads to increased isolation which, to some extent, legitimizes incivility. Articles from midwifery practice are quite telling in this case (Capper et al., 2020, 2021). Students learning in a maternity unit, which is somewhat self-sufficient and separated from the rest of the hospital, were bullied. The spatial separation of the maternity unit from the rest of the hospital, seemingly generated a “decreased likelihood of scrutiny […] [where] perpetrators feel comfortable amongst a relatively small cohort of known and trusted colleagues” to engage in tormenting behaviours towards students (Capper et al., 2020).

Spatial configuration can serve to separate students from professionals. Exclusion of students from certain activities in which the professionals engage has spatial implications. I categorize student negative experiences in this case not as bullying but rather as exclusion from the group at large. Student exclusion seems connected to working professionals’ desire to physically separate themselves during breaks. In these situations, instructors and students are present in the workspace but are taking a break from patient care. During these times, students “explain how they were asked to leave the break room” (Kristensen & Kristensen, 2021). The physical separation between students and instructors is then achieved and maintained by clear, physical, lines of demarcation. Asking students to leave a space or acting in a way that forces students to move from where preceptors are, highlights hierarchical group separation between professionals and novices (Kristensen & Kristensen, 2021).

In summary, spaces can impact student experiences negatively (cf. Capper et al., 2020, 2021; Kristensen & Kristensen, 2021). Reviewed literature, once again, suffers from fragmented space related details. Space related challenges exist but space related solutions are absent, students' role in shaping the status-quo is poorly presented and no articles adopt research objectives focused on spaces. Investigating factors related to this fragmentation of knowledge resulted in section 2.7.

My work recognizes that during clinical placements students can enter "a particularly tight knit and settled 'society'" (Capper et al., 2020) where a hierarchical distribution of power can exist; within this context, spaces can facilitate less positive experiences. My thesis captures a few such instances connected to paramedic student experiences. These instances, while not numerous, justify discussions about student dedicated spaces in preceptorship.

2.5.6 Summary

The analysed literature presents the status-quo of student experiences. Accounts from literature present the importance of adequate spaces and welfare facilities, highlight the unintended consequences of built spaces, and discuss the connection between spaces and students' professional identity as well as the negative experiences spaces can mediate. This portrayal of the status-quo is essential in determining those areas of research which my thesis adds to.

Knowledge regarding educational spaces in the experiences of healthcare students is mostly fragmented. While reviewed literature presents the status-quo, little is known about the way students shape their own experiences. (In)adequacies of spaces are noted in passing; usually, there is little follow through between space related challenges identified in findings and space related solutions or discussions. Information about spaces usually comes from studies whose research objectives focus on other issues.

Nuanced accounts of spaces are predominantly visible in studies using theoretical underpinnings which look beyond the individual. This connection was visible in a few studies analysed in this section. I further investigate and draw parallels between theoretical underpinnings and richness of detail regarding the role of spaces in student experiences in section 2.7.

My thesis adds to identified areas of research and completes the fragmented character of existing knowledge. This was achieved by using a theoretical framework specifically devised to provide nuanced accounts of my area of complex research interest.

2.6 Literature about using technology in educational spaces in the experiences of healthcare students

Literature regarding healthcare students' experiences related to the use of technology within certain spaces highlights the connection between technology and spaces in student learning. Section 2.5 presented matters of educational spaces. This section introduces a technology component to the discussion. Its narrative presents themes from literature showing that technology allows customization of student experiences across different spaces, customization is restricted by factors outside student control and access to realistic simulation is essential in shaping student experiences. Ambulance related space-technology connections in student experiences are evident as two themes: ambulance related spaces can be chaotic and ambulance related spaces affect student experiences during idle times. Themes and key arguments are summarized in Figure 2.3 and subsequently discussed.

Figure 2.3: Themes - which are used as subsections below – and the key arguments supporting these themes as they were found in the literature regarding healthcare student experiences related to the use of technology within certain spaces.

2.6.1 Technology allows customization of student experiences across different spaces

Technology allows customization of student experiences across different spaces. Analysed literature discusses that, within learning spaces, technological choices emphasize mobility. “The use of mobile devices such as tablets and laptops by students to support their learning is now ubiquitous” (Clarke et al., 2019). Students use mobile devices – laptops, tablets, phones – to communicate, access information and take notes. Personal devices are also used in clinical practicum. Students’ choices regarding devices used in learning are based on affordability and other factors. Space and technology influences on learning become visible. My thesis builds upon this when analysing the shadow learning landscape in healthcare student practice.

Technology influences student mobility within spaces. Reviewed literature, constantly expresses that: learners are “more or less continuously connected […] One study participant ascribed the moniker of “connectaholic”” (Clarke et al., 2019) to highlight this situation. Increased connectivity and portable electronic device ownership enhances students’ capacity to learn across various spaces. For example, “[t]he portability of the tablet – the fact that it could fit in a pocket – was viewed as helpful in enabling users to carry their tablets around and access information anywhere” (Witt et al., 2016). Similarly, “the portability of […] podcasts […] enhanced […] control over when and where” students learned: “I just found that it was another way of being able to learn without having to be sitting at a desk [...] so you could get on with your life […] while you were learning” (Meade et al., 2011).

Technology allows students to communicate, access information and take notes. Existing literature describes that, within learning spaces, students communicate using apps, access information through podcasts, internet and e-textbooks and take electronic notes (Altmann & Brady, 2005; Clarke et al., 2019; Emory et al., 2021; Lee et al., 2019; Meade et al., 2011; Shanahan, 2012; Willemse & Bozalek, 2015). Despite electronic devices' prevalence, multiple studies outline students' preference for paper textbooks (Baudains et al., 2013; Crane, 2015; Strother et al., 2009). Nonetheless, students seem to "appreciate the search function of" e-textbooks (Brunet et al., 2011) and admit "that if they were going to use an electronic version […] a PDF was seen as the ideal […] being potentially enhanced with interactive content such as video and hyperlinks" (Wardle & Sarris, 2014). Concomitantly, students see their devices as "useful in making notes, planning their work and saving time" (Johansson et al., 2014). Overall, the prevalence of mobile devices in learning seems sine-qua-non and is the starting point for many studies.

Students ubiquitously use personal devices in clinical practicum. While sometimes students could use computers available at clinical placements, reviewed works show that access to these is mostly prohibited (Lee et al., 2019) and, if allowed, insufficient (Mcnally et al., 2017). Most reviewed studies discuss students' use of personal handheld devices in clinical practice. Healthcare students use such devices to verify information that usually requires memorization, includes mathematical functions and relates to safe patient care: pharmacology, pathophysiology, drug calculations (Mcnally et al., 2017; O'Connor & Andrews, 2018). Studies present students' propensity for using personal devices in clinical practicum as “influenced by […] personal habits” (Clarke et al., 2019).

Students can exercise individual choice regarding the use of personal devices in learning. “Portable devices can provide students with a deluge of medical and educational resources almost instantly in a variety of contexts” (Clarke et al., 2019). As such, “[s]tudents have learnt to be in charge of their own technology and consequently their own learning rather than relying solely on institutionally sanctioned Web 2.0 tools” (Patterson et al., 2017). Student choices are mostly visible regarding personal devices. Literature discusses student choice regarding hardware (Clarke et al., 2019; O’Connor & Andrews, 2018) – different smartphones and laptop brands – and software (He et al., 2021; Wanner et al., 2019; Willemse & Bozalek, 2015; Witt et al., 2016) – communication and medical information apps. Within referenced works, student’s use of technology in learning spaces appears influenced by technological realities, socio-cultural factors and interpersonal relationships. Baudains et al. (2013) clarify reasons students invoke when choosing technology; in order, the top three reasons are “convenience”, “purpose” and “recommendation”. Convenience is equivalent to “[e]ase and speed of access to answers, portability, acceptability and cost”, purpose equates to “choice depends on what sort of information they seek” and recommendation relates to “guidance […] taken from years above” (Baudains et al., 2013).

In conclusion, technology allows customization of student experiences across different spaces. Nonetheless, I see little information in existing literature about the way student experiences in certain spaces connect with technology beyond personal devices (He et al., 2021; Lee et al., 2019; O'Connor & Andrews, 2018; Patterson et al., 2017; Wanner et al., 2019; Willemse & Bozalek, 2015; Witt et al., 2016). Interestingly, one study presents a conceptual model hinting towards the influence of spaces and technology on learning (Patterson et al., 2017).

Most discussions detail student experiences regarding the use of personal electronic devices within certain spaces. Little is known about student experiences connected to medical or non-digital devices and their space related usage. Deciphering the connection between such technology and student experiences would help clarify the way students influence their own learning landscape. My thesis will uncover such links.

Patterson et al. (2017) developed a conceptual model that hints towards the influence of spaces and technology on learning. These authors, build on the definition of a personal learning environment (PLE) offered by Shaikh and Khoja (2014), and conceptualize a personally significant learning environment (PSLE). PLE represents the "individual's online learning space premised on the personalisation and openness offered by Web 2.0 tools and social media; a workspace which is conceptualised, built, and controlled by learners in their quest to become self-reliant, connected, and lifelong learners" (Z. A. Shaikh & Khoja, 2014). Patterson and al. position PSLE as "an individual's learning state based on the inclusion, exclusion and interplay of learning modalities […] It is a pedagogical understanding of the relations between the individual and environment, for learning. This […] is sensitive not only to technological components but also recognizes the material, emotional and social elements to students' understanding of an effective learning space" (Patterson et al., 2017).

This model is represented by a picture where “Student’s Effective Learning Experience” is central and – based on the one-sidedness of relationship showing arrows – seems affected by, but not affecting, “Technologies”, “Learning Modalities” and “Influencing factors”. These three elements are connected by two-sided arrows, showing their interconnectedness. Further, “Influencing Factors” seem affected by the “Built Environment”, again, in a unidirectional fashion (Patterson et al., 2017, fig. 2). Even though not in a direct manner, this model acknowledges the possible connection between learning, technology and spaces. Probably due to its starting point, the PSLE seems overly focused on technology enabled learning and less on the influence of educational spaces in the student experience. I could not use this model in my thesis as it lacked theoretical depth and guidance regarding its applicability in concomitantly studying matters of learning, technology and spaces. Finding this model was nonetheless important for my thesis as it uncovered a category of literature concerned with modelling healthcare student experiences vis-à-vis the usage of technology in educational spaces.

My thesis resonates with above presented concepts. It also adds discussions of the role of medical and non-digital devices in student experiences and provides a model of the learning landscape students create which can be used for future research.

2.6.2 Customization of student experiences through technology is restricted by factors outside student control

Customization of student experiences is restricted by factors outside student control. To clarify, customization of student experiences through technology across different spaces is affected by technological, infrastructural and human factors. My thesis builds upon notions presented in this section and highlights the way students develop solutions to specific challenges thus co-creating their shadow learning landscape.

Customization of student experiences is affected by technological challenges. Costs, need for electricity, internet connectivity and software compatibility affect the use of personal devices in learning. Studies investigating e-textbooks' usage by students provide telling examples of these challenges. There, students lament the high price of resources, "dislike […] spending numerous hours reading from a computer monitor" (Strother et al., 2009) and are affected by logistical challenges related to using electronic devices for studying. "Lack of reliable Wi-Fi access and inadequate outlets to charge the device presented problems" as well as the different software versions different devices seem to be using (Crane, 2015).

Students' increasing use of personal devices relies on the provision of institutional infrastructure. Institutional infrastructure needs to support students' increased use of digital mobile devices (Crane, 2015; Gray et al., 2021; O'Connor & Andrews, 2018; Willemse & Bozalek, 2015). Personal devices, while increasingly mobile and permanently connected, cannot function without internet access and electricity. Institutional support for such devices is needed: “the majority of perceptions about a lack of support for wifi needs […] recharge facilities […] suggest that for some students […] institutions could be doing more to prioritize the consistency, efficiency and reliability of the digital systems” (Gray et al., 2021).

Students’ use of electronic devices in clinical practicum is affected by human factors. Despite being prevalent in students’ lives, the use of handheld electronic devices in clinical practicum depends on permission from instructors and perceived unprofessionalism. At times, students are explicitly prohibited to use personal smartphones in clinical practice (Lee et al., 2019). Most times though, this interdiction is tacit rather than explicit. Students face and internalize the perception that using smartphones in practicum is unprofessional: “Many students held the perception that using a smartphone may be viewed as unprofessional behaviour. Two words frequently used by participants were “lazy” and “naughty” when describing how a nurse manager may view smartphone use” (Mcnally et al., 2017). This limited use of smartphones is dichotomous to these devices’ capabilities. Thus, “smartphones' potential in clinical education remains largely unharnessed” (Beauregard et al., 2017).

Legitimization of smartphone usage in clinical practicum requires institutional support. Students perceive that smartphone usage should be allowed with “patient's approval” (Beauregard et al., 2017). This however, would require changes in societal attitudes, which, along with matters of infrastructure (O’Connor & Andrews, 2018) would necessitate institutional support (Mather et al., 2018; O’Connor & Andrews, 2018). Until hurdles connected to the use of technology at the point-of-care decrease, “there is a missed opportunity for learning […] that is hindering the potential for mobile technology and mobile learning to contribute to improving patient outcomes and enhancing student learning” (Mather et al., 2018).

As a summary, the customization of student experiences through the use of technology is affected by technological peculiarities (Crane, 2015; Strother et al., 2009), infrastructure (Crane, 2015; Gray et al., 2021; O’Connor & Andrews, 2018; Willemse & Bozalek, 2015) and human factors (Beauregard et al., 2017; Lee et al., 2019; Mcnally et al., 2017). Solutions to these challenges involve circumstances outside students’ control. This being said, I find existing literature excessively focused on digital devices but recognizing the need to diversify research perspectives.

Same as in the previous section, most studies focus on investigating personal electronic devices. Discussions of patient care or analog technology lack in reviewed studies. My thesis adds to knowledge by presenting students’ solutions to challenges with patient care and analog technology.

In their study, O’Connor & Andrews, recognize that “[e]ducational theories and frameworks […] need to be developed or adapted to strengthen how mobile technology is applied to aid learning” (O’Connor & Andrews, 2018). This signals that authors are starting to recognize the need to diversify theoretical perspectives. This is a welcomed finding as most other studies do not comment on such perspective changes. I resonate with these comments; they energized my investigation of theoretical underpinnings detailed in section 2.7.

My thesis resonates with above notions and specifically recognizes that "personal smartphones already play a significant role in clinical practicum. However, the use and the appropriateness of personally owned handheld referencing technology in clinical practicum requires further research" (Mcnally et al., 2017). In response, I add examples of the way students customize their own learning by personally mediating factors seemingly outside their control. Nonetheless, students cannot rectify all technology and space challenges; institutional help is thus still needed to mediate areas essential to student experiences. I detail this idea in my thesis.

2.6.3 Access to realistic simulation is essential in shaping student experiences

There are troves of medical education works written about simulation; many lay outside the scope of this review. My analysis of literature about using technology in educational spaces in the experiences of healthcare students highlights several themes. Simulation needs to be realistic; this means that simulation needs to make use of physical spaces and technologies which would mirror real-life situations. Individual practice with simulation requires access to realistic spaces and technologies. My thesis accounts for matters of simulation as visible in the student experience.

Realistic experiences involve equipment and physical spaces which mimic the real world. The pure essence of simulation is based on an imitation of real life. Realism is then akin to authenticity. "Authenticity seems to be especially important to the students, who valued the ability to train in surroundings that resembled the environment of their future workplace" (Haraldseid et al., 2015). Unrealistic spaces, actions and "old, reused or unavailable" (Haraldseid et al., 2015) equipment have negative effects on learning.

Students crave realistic experiences. Realism confers simulation the capacity to prepare students for real-life patient encounters. Realism is appreciated not only during learning but also during testing situations (Aldridge & Hummel, 2019; Awad et al., 2019; Ewertsson et al., 2015; Lanzara, 2014). "A truthful and accurate scenario was deemed essential for allowing students to take the simulation seriously" (Watson et al., 2021). "Asking students to "just pretend" and to skip steps […] interferes with […] learning" (Aldridge & Hummel, 2019)

Sometimes simulation meets users in their space. Most literature discusses simulation laboratories built as stationary spaces. In these cases, while equipment is movable, the simulation laboratory space is not. On the other hand, literature also presents student experiences regarding a mobile simulation unit. This is a simulation lab housed inside a truck which can easily be deployed in different spaces and has, as presented, been positioned outside hospitals for surgical simulation training (F. M. Shaikh et al., 2011).

Students engage with simulation as a means of individual practice. Simulation used by students to practice outside classroom time, enhances their knowledge and generates "a feeling of familiarity with the equipment" (Ewertsson et al., 2015). This usually takes place in groups, outside normal learning hours and seems affected by similar matters of realism of technology and facilities as practicing during instructor mediated training (Haraldseid et al., 2015).

To summarize, access to realistic simulation is essential in shaping student experiences (cf. Aldridge & Hummel, 2019; Awad et al., 2019; Ewertsson et al., 2015; Haraldseid et al., 2015; Lanzara, 2014; F. M. Shaikh et al., 2011; Watson et al., 2021). Nonetheless, the existing literature misses detailed descriptions of realism insofar as student actions are concerned.

I find that the existing literature misses descriptions of simulation realism insofar as student actions are concerned. To explain, the above paragraphs, emphasize that access to realistic simulation is essential in shaping student experiences. Nonetheless, existing literature fails to capture students' own actions aimed at mediating realistic simulation experiences, especially amidst institutional failures. For example, an article presents learners booking a laboratory for clinical skills practice, but unable to use it due to it being overbooked (Haraldseid et al., 2015). Nonetheless, the article does not detail student actions aimed at mediating this challenge. My thesis adds accounts of such student-driven actions to existing knowledge.

My thesis recognizes "[t]he importance of fidelity during skills learning" (Aldridge & Hummel, 2019). My findings present student accounts related to simulation, emphasising the need for realism and exemplifying students' role in mediating access to realistic simulation resources.

2.6.4 Ambulance related patient care spaces can be chaotic

Ambulance related patient care spaces can be chaotic. Paramedics and their students perform in chaotic, uncontrolled situations. Here, they use technology to assess and treat patients. Chaos though brings forth a need for practitioner flexibility and a structured approach to calls. To this, I add discussions regarding the manner in which students setup their uniform to help them achieve structure and support while involved in chaotic ambulance calls.

Paramedics care for patients in chaotic and uncontrolled situations. Literature shows that spaces of ambulance related patient care are unlike organized hospital rooms. Chaos and danger associate with out-of-hospital patient care: “the prehospital environment could be unpredictable, violent and pose a threat to personal safety” (Melby, 2001). Nursing students riding out in ambulances determined that, unlike in a hospital, the prehospital “learning environment […] makes demands […] they cannot create security by being familiar with the room where the care is provided” (Nilsson & Lindström, 2017).

Chaos requires student flexibility and structured approaches to calls. Literature admits that “the learning environment in the ambulance service increases the demands on flexibility for […] students since they never know what kind of scene and patient illness they will encounter during their shift” (Nilsson & Lindström, 2017). Flexibility is connected to expectations regarding patient care and assessment, and the capacity to adapt to different calls; to mediate flawless assessment and care during unpredictable, chaotic environments, calls are approached in a structured, non-haphazard way:

> “According to the students' descriptions about prioritization of care and treatment, the teaching about prioritization was done in a structural way by using the A-E concept. If the patient was suffering from a breathing (B) problem, they did not focus on anything else until the B-problem was resolved. After resolving or alleviating the patient's B problem the students continued by assessing the patient's circulation (C). By using the A-E concept the students were given an opportunity to learn and practice their readiness to act in different situations” (Nilsson & Lindström, 2017).

Psychomotor skills and technology are connected. Patient care is of utmost importance in an ambulance (Nilsson & Lindström, 2017). Patient care in ambulances relates to psychomotor skills which involve patient care technology:

> “The doctor applied the electro-cardiograph (ECG) leads and defib pads, the nurse drew up the required drugs and the paramedic intubated the patient, while I commenced CPR – the first time that I had done this on an actual person” (Melby, 2001).

The chaos of ambulance related spaces is visible above (cf. Melby, 2001; Nilsson & Lindström, 2017). As in previous sections, references associated with this section show the same lack of detail regarding the way in which students develop their own experiences. Analysed literature also demonstrates a sense of wonder about patient care and learning inside ambulances. Sources reviewed in this section were not theoretically rich. This acknowledgment conveys the message that above presented literature does not adopt clear theoretical stances while investigating specific elements of paramedic student practice; it rather focuses on the general aim of understanding the student experience while learning in ambulance services. Nonetheless, these sources present an excellent introduction to student training in the ambulance setting. Especially important to me is that both articles reviewed above highlight the overall lack of knowledge about students learning inside ambulances; demoralizing though is the fact that the same challenge is identified both in 2001 and in 2017. In 2001, Melby acknowledges:

> “To most of us an emergency ambulance is a large van with blaring sirens and flashing lights that flies down the road to an emergency of some kind. We don't know much about the inside of the vehicle, nor do we generally know what training is required to navigate this vehicle at such harrowing speed. We know less again about what ambulance personnel actually do when they arrive at the scene of an emergency” (Melby, 2001).

In 2017, Nilsson & Lindström present a similar idea: “there is little knowledge about the ambulance service as a place for clinical education” (Nilsson & Lindström, 2017).

My thesis adds additional detail to information about paramedic student training. I especially highlight ambulance design failures students identify and the way students setup their uniform to mediate chaotic patient care spaces.

2.6.5 Ambulance related spaces affect student experiences during idle times

Ambulance related spaces affect student experiences during idle times. Analysed studies show that paramedics and their trainees do not interact with patients for the entire duration of a shift. During idle times, students can engage in academic or skill learning. Activities during these idle times can be affected by interpersonal relationships between paramedics and students. My thesis captures matters of student experiences during idle times.

Paramedics and students have moments of rest. Literature shows that these are idle times when no patient interactions happen. The frequency of ambulance calls is unpredictable (Axelsson et al., 2016; McCall et al., 2009; Melby, 2001). When pauses in providing care exist paramedics and students are together in ambulance stations where they engage in "the 'Waiting Game': sitting drinking tea and jumping to attention when the emergency call eventually came" (Melby, 2001).

Idle times have the potential to be used for practice. A study by Boyle et al. shows that "Sixty nine percent of students felt there was a lot of unproductive down time during the placement. Thirty seven percent of students were not given the opportunity to undertake clinical scenarios or practice skills during downtime" (Boyle et al., 2008). Nonetheless, "[s]tudents who use downtime to train with equipment and read the guidelines increase their awareness in their approach and in their treatment" (Axelsson et al., 2016).

Idle times can be affected by negative experiences. Matters of negative behaviours and incivility exist in ambulance stations (Axelsson et al., 2016; Boyle et al., 2008); this situates a theme previously discussed – subsection 2.5.5 – into ambulance related spaces. These negative behaviours can adversely impact students' learning: "some students were not made welcome at the ambulance station, were ignored, made to feel like a burden on the crew, were not provided any guided skills instruction during downtime" (Boyle et al., 2008).

To summarize, during idle times, ambulance related spaces have the potential to affect student experiences (cf. Axelsson et al., 2016; Boyle et al., 2008; McCall et al., 2009; Melby, 2001). In my interpretation, analysed resources suffer from challenges similar to those identified in subsection 2.6.4. Students' role in mediating their own experiences is mostly unknown and little previous knowledge regarding paramedic practice exists.

My thesis recognizes the paucity of paramedic related research and adds a more theoretically focused approached to studying paramedic student experiences vis-à-vis the learning-technology-spaces intersection. In doing so, I point to students' active role in co-creating their experiences.

2.6.6 Summary

Similar to section 2.5, analysed literature presents the status-quo of student experiences. References show student experiences customized by technology and customization affected by factors outside student control. Further, access to realistic simulation shapes student experiences, ambulance related patient care spaces can be chaotic and ambulance related spaces affect student experiences during idle times. Knowledge of the status-quo is essential in determining those areas of research which my thesis can add to.

Akin to section 2.5, knowledge about using technology in educational spaces in the experiences of healthcare students is mostly fragmentary. This fragmentation is largely due to incomplete details of the student experience. Reviewed literature presents the status-quo and little is known about the way students shape their own experiences. In my thesis I decrease this fragmentation by accounting for elements of student experiences which are shaped by students themselves.

From a theoretical perspective, the authors whose works were reviewed in this section recognize the need to diversify theoretical perspectives used in research (O'Connor & Andrews, 2018). This motivates my search for an appropriate theoretical framework for my thesis and justifies section 2.7 and chapter three.

My thesis aligns with and adds to the major areas of knowledge identified in literature. I also present a more complete presentation of student experiences by using a theoretical framework devised to provide nuanced accounts of my area of complex research interest.

2.7 Theoretical perspectives within the literature on the healthcare student experiences regarding educational spaces and the use of technology within certain spaces

While analysing the literature above, it seemed that research emphasizing the role of materials in shaping student experiences provides more nuanced results than the rest of the literature. Therefore, I decided to review the literature again with a specific focus on theoretical concerns in order to explore parallels between richness of descriptions and type of theoretical underpinnings research adheres to.

When reviewing the literature from sections 2.5 and 2.6, I was bewildered to find that most student experiences regarding spaces and the use of technology within spaces are described in a fragmentary manner. This means that most research only notices space (in)adequacies in passing, rarely addresses within discussions challenges identified in findings and presents little information about the way students shape their own experiences. Nonetheless, three articles stood out where descriptions of student experiences were more nuanced.

Being intrigued, I investigated the rationale for such differences. My conclusion was that, unlike the rest of the literature, the three articles showing nuanced descriptions are underpinned by theoretical perspectives which recognize materials as essential in shaping student experiences. Theoretical approaches to research used in these articles did not exactly match my research needs.

Yet, I was enthused by the possibilities offered by such theoretical underpinnings.

In the following subsections I analyse from a theoretical perspective literature already reviewed in sections 2.5 and 2.6. I first summarise theoretical perspectives. I then present connections between theoretical underpinnings and richness of descriptions visible within this previously reviewed literature.

2.7.1 Summary of theoretical underpinnings

Literature analysed in sections 2.5 and 2.6 is not usually underpinned by an explicit or extensive theoretical frameworks. As Table 2.4 shows, less than 30% of references align with one or more theoretical perspectives. More than double this percentage, do not demonstrate such alignment.

Theoretical framework	Number of papers	Details
None	38	
Constructivism	4	Constructivism, especially as connected to constructivist grounded theory, is cited by a few papers as influencing the research process (Crane, 2015; Kristensen & Kristensen, 2021; Lee et al., 2018, 2019). Most explicit details about constructivism are offered by Crane (2015):

Theoretical framework	Number of papers	Details
		“The construction of new knowledge is accomplished through experience and reflection. Because this is an active process, knowledge acquisition is the result of questioning, exploring, and assessing what is already known” (Crane, 2015) and “Constructivism requires that learners take responsibility for their own learning, use prior experience to construct new knowledge, and demonstrate problem-solving to accomplish learning. Technology innovations such as the e-textbook enable users to reflect and place meaning on the learning process” (Crane, 2015).
Phenomenology	4	Phenomenology is cited by a few papers as influencing the research process (Aldridge & Hummel, 2019; Lanzara, 2014; Sundler et al., 2015; Watson et al., 2021). Most explicit details

Theoretical framework	Number of papers	Details
		about phenomenology are offered by Lanzara (2014): “Phenomenology is a philosophical approach used to study experiences […] Phenomenology allows the researcher access to the lived experiences of others. […] Phenomenology is considered both a philosophy and a research method. The phenomenological approach is used to study human experience through the description of everyday life” (Lanzara, 2014).
The active role of spaces and places in shaping student experiences	**3**	**Three papers discuss matters related to the active role of spaces and places in shaping student experiences.** **Gray (2003, cited in Donetto et al., 2017) “suggests we examine spatial experience as having three dimensions: proximity — referring to any relationship of distance; mobility — the possibility of action over distance; and possession — the relationship between personal and**

Theoretical framework	Number of papers	Details
		collective experiences of spatiality determined by the power relations permeating space" (Donetto et al., 2017). **Hawick et al. (2018, 2021) align with the role of spaces and places in shaping student experiences and especially the unintended consequences of spaces. They admit that:** **"Buildings and learning spaces contribute in crucial ways to people's experiences of these spaces. However, this aspect of context has been under-researched in medical education. We addressed this gap in knowledge by using the conceptual notions of space and place as heuristic lenses through which to explore the impact of a new medical school building on student experiences" (Hawick et al., 2018)** **and** **"space is objective (physically/geographically bound), while**

Theoretical framework	Number of papers	Details
		place is subjective (peoples' experience of a space)" (Hawick et al., 2021).
Sociocultural perspectives	2	Sociocultural perspectives are cited by two papers as influencing their research process. Haraldseid et al. (2015) recognize that "[i]n a sociocultural learning perspective learning is situated in an environment" (Haraldseid et al., 2015). Further, Johansson (2012, cited in Haraldseid et al., 2015) "points out that since learning is always situational, where the learning takes place is just as important as how. From a socio-cultural learning perspective, the […] environment is therefore vital since it constitutes the context in which learning occurs" (Haraldseid et al., 2015). van der Zwet et al. (2011) recognize that "[s]ocio-cultural learning perspectives contrast with cognitive theories by relying on (at least) a two-way relationship between individual learning and culture. […] In other words, what

Theoretical framework	Number of papers	Details
		and how medical students learn during clerkships depends on the nature of their (interactive) experiences and activities and the meaning that they, and others, attach to these experiences […] when a research topic involves people and their behaviour it is impossible to identify a fully objectifiable truth. It seems more appropriate to speak of multiple truths or realities, which are socially and experientially based and dependent on individuals. By analysing insiders' views we can bring to the surface their experiences and opinions, analyse them and compare them with existing theories. The knowledge resulting from this process is again hypothetical" (van der Zwet et al., 2011).
Affordances of mobile technology	1	Willemse & Bozalek (2015) are inspired in their work by the affordances of mobile technology. Bower (2008, cited in Willemse & Bozalek, 2015) "matches teaching and learning tasks with appropriate learning technologies by

Theoretical framework	Number of papers	Details
		looking at the action potential of the technology. […] The affordance framework […] defines not only technological affordances, but includes social and educational affordances" (Willemse & Bozalek, 2015).
Cognitive load theory	1	Cognitive load theory influenced Aldridge & Hummel (2019). Reedy (2015, cited in Aldridge & Hummel, 2019) "posits that there is a limit to how much information the brain can process at once" (Aldridge & Hummel, 2019). Further, Gonzalez et al. (2017, cited in Aldridge & Hummel, 2019) admit that "[n]ovice learners can easily be overwhelmed by the number of steps in a skill, which can inhibit learning" (Aldridge & Hummel, 2019).
Deliberate practice	1	Deliberate practice also inspired Aldridge & Hummel (2019). Inspired by Ericsson et al. (1993, cited in Aldridge & Hummel, 2019) and Gonzalez et al. (2017, cited in Aldridge & Hummel, 2019), they explain that deliberate practice "involves focused practice combined

Theoretical framework	Number of papers	Details
		with timely feedback and coaching until a mastery level is achieved" (Aldridge & Hummel, 2019).
Goffman's theory of backstage access	1	Goffman's theory of backstage access influenced Kristensen & Kristensen (2021). Goffman (1959, 1983, cited in Kristensen & Kristensen, 2021) guides their explanation that "[b]ackstage members must share ties of backstage solidarity, that is, display signs of mutual trust that their secrets are kept and by being able to rely on each other's mutual support. Backstage behavior is also associated with high levels of vulnerability. Displaying backstage behavior places individuals in a vulnerable position, and backstage behavior allows signs of weakness to be displayed. […] Furthermore, actors must also trust their co-performers not to bring their backstage behavior frontstage" (Kristensen & Kristensen, 2021).

Theoretical framework	Number of papers	Details
Personal learning environment	1	Patterson et al. (2017) cite Shaikh and Khoja (2014, p. 202), and define a personal learning environment as “an individual’s online learning space premised on the personalisation and openness offered by Web 2.0 tools and social media; a workspace which is conceptualised, built, and controlled by learners in their quest to become self-reliant, connected, and lifelong learners” (Patterson et al., 2017).
Systems framework	1	Notions of systems framework inspired an article by Mather et al. (2018). While, the idea of systems is not clearly defined, the article does recognize complex interactions that shape the use of technology at point of care. As such this article states that: "Using a systems framework, the authors have researched the barriers, risks, challenges and benefits of mobile learning at point of care in two Australian States" and findings show that "undergraduate students, through a range of attitudes and behaviours at systems,

Theoretical framework	Number of papers	Details
		organisational and individual levels, are generally actively dissuaded from using mobile technology for learning or to advance nursing practice at point of care" (Mather et al., 2018).
Technology Acceptance Model	1	Crane (2015) was partly inspired by the technology acceptance model (TAM). "The TAM describes how use of the system is affected by attitude toward the system; therefore, attitude is derived from the perceived usefulness and ease of use of the system. If these factors allow for greater achievement of the users' goals, then overall productivity or engagement is accomplished by using the system" (Crane, 2015).

Table 2.4: An overview of theoretical underpinnings used in analysed literature. The total numbers of literary works that subscribe to theoretical perspectives is 16. However, some papers subscribe to more than one theoretical underpinning. As such, when summating the total number of references from the middle row of the table, it creates the impression that more than 16 papers have been reviewed.

The role of materials in shaping student experiences, separates theoretical underpinnings in two broad categories: those explicitly foregrounding materials – e.g. spaces – as elements that "enable or inhibit learning" (Hawick et al., 2021) and those that are not explicitly engaging in such foregrounding. In Table

2.4, only bolded rows relate to theoretical underpinnings from the former category.

2.7.2 Failure to foreground materials associates with fragmentary findings

Within sections 2.5 and 2.6, research which fails to foreground materials, exhibits fragmentary findings. Two types of research fail such foregrounding: research that ascribes to no theoretical underpinnings and research that ascribes to non-material focused underpinnings. I will exemplify this connection between fragmentariness and failure to foreground materials in the following two examples.

First, an article which does not specifically ascribe to any theoretical underpinnings omits to address within discussions challenges identified in findings. Capper et al. were looking to understand "[m]idwifery students' perceptions of the modifiable organisational factors that foster bullying behaviours whilst on clinical placement" (2020). The article does not ascribe to a material-focused theoretical framework since it fails to ascribe to any theoretical underpinning. This article presents elements of physical spaces which might be connected to bullying, yet solutions to bullying do not specifically address physical spaces. To detail, "midwifery students […] undertake clinical placement within a single relatively enclosed maternity unit". Here, the mentors, which are "perpetrators of bullying […] appear to take advantage of the decreased likelihood of scrutiny and transparency in the 'privacy' of the birth suite". As a solution, "[s]tudents acknowledged that they needed to do 'something' to strengthen the relationships they build with their mentors” (Capper et al., 2020). Nonetheless, the physicality of the “**single** relatively **enclosed** maternity unit” (Capper et al., 2020) does not seem to be explored as part of the solution to bullying.

Second, a work underpinned by constructivism and technology acceptance model suffers from lack of detail regarding student experiences as influenced by spaces and by students’ own actions. To clarify, this work demonstrates that “convenience and portability of […] e-textbook allowed students to grab their book and go, creating individualized study environments” (Crane, 2015) and “charging the device, required students to adjust how long they studied at one time” (Crane, 2015). Yet, the research does not detail the physical, space related, characteristics of the “individualized study environments” (Crane, 2015). It also does not clarify the manner in which the students’ capacity to “grab their book and go” shapes the physicality of their experiences (Crane, 2015).

Fragmentary descriptions seem associated with a lack of foregrounding materials as essential in shaping student experiences. Above presented literary works neither focus on the physicality of spaces nor adopt material-focused theoretical underpinnings. Both examples then do not foreground materials in their research; their focus lies elsewhere. As a reader, I am left wondering whether a focus on materials would have forced authors to present more nuanced details about the physicality of student experiences. To me the answer seems to be yes; I will explain why in the next subsection.

2.7.3 Rich findings associate with material-focused underpinnings

Articles which have theoretical underpinnings explicitly dedicated to foregrounding the role of materials in research, present rich, nuanced findings. Three references seem to adopt clear theoretical underpinnings explicitly foregrounding non-human factors – e.g. spaces – as elements that “enable or inhibit learning” (Hawick et al., 2021); the rest of reviewed literature does not. These non-human factors represent “materials – in other words, the physical things” (Burm & MacLeod, 2020) that act on and are concomitantly acted upon by students. Much of the analysed literature though seems to not foreground materials as elements that “enable or inhibit learning” (Hawick et al., 2021). The three articles that stand out as presenting rich findings and having material-focused underpinnings, in chronological order, are: *New models to support the professional education of health visitors: A qualitative study of the role of space and place in creating ‘community of learning hubs’* (Donetto et al., 2017), ‘*I feel like I sleep here’: how space and place influence medical student experiences* (Hawick et al., 2018) and *Contact is not enough: a qualitative study of how space and place impact on interprofessional education* (Hawick et al., 2021). I will detail the richness of findings within each of these papers below.

New models to support the professional education of health visitors: A qualitative study of the role of space and place in creating ‘community of learning hubs’ (Donetto et al., 2017), exhibits both richness of detail and continuity between findings and discussions. The role of spaces in student experiences is richly presented, with much detail visible in chosen quotes. Pictures support student interviews. Through this triangulation, the reader is thus not only hearing but also bearing witness to elements under discussion. The article also addresses within discussions challenges identified in findings. Findings turn into actionable items with clear space connections. For example, the authors recognize that: “our analysis highlights the need for learning spaces in the workplace to accommodate students' experience in a way that does not make them feel alienated or excluded” (Donetto et al., 2017). Especially telling are also the paper’s conclusions: “attention to spatiality can shed light on important aspects of teaching and learning practices in professional education more broadly and on the professional identities these practices shape and support” (Donetto et al., 2017). I was inspired by this ethos of spatial interest in my thesis.

‘*I feel like I sleep here’: how space and place influence medical student experiences* (Hawick et al., 2018) and *Contact is not enough: a qualitative study of how space and place impact on interprofessional education* (Hawick et al., 2021) exhibit the same inspiring characteristics. Through pictographic evidence, authors immerse the reader into their work and make them engaged with the space. For example, a “[p]hotograph of lecture theatre space” offers a snapshot into student learning spaces and helps explain how rows of seats and columns that obstruct student view create an experience of segregation between students within this space for learning (Hawick et al., 2021). Again, these details inspired me and helped shape not only my search for a theoretical framework but also my choice of research instruments. In my thesis I will use pictograms to depict student experiences, thus enhancing reader engagement with the presented material and triangulating information from multiple sources of information.

The material-focused theories underpinning these three articles, differentiate them from the rest of the literature. By breaking from the norm, these articles seem to respond to an ethos of change which calls for congruency between theoretical underpinnings and the intricacies of student experiences, technology and space connections. Statements by O’Connor & Andrews (2018) and van der Zwet et al. (2011) are especially supportive of this change mindset. While discussing the use of smartphones in nursing practicum, O’Connor & Andrews (2018) recognize that: “[e]ducational theories and frameworks […] need to be developed or adapted to strengthen how mobile technology is applied to aid learning”. van der Zwet et al. recognize the overreliance on descriptive research approaches to learning environments and chose a socio-cultural approach in their work:

> “Workplace learning in undergraduate medical education has predominantly been studied from a cognitive perspective, despite its complex contextual characteristics, which influence medical students’ learning experiences in such a way that explanation in terms of knowledge, skills, attitudes and single determinants of instructiveness is unlikely to suffice. There is also a paucity of research which, from a perspective other than the cognitive or descriptive one, investigates student learning in general practice settings, which are often characterised as powerful learning environments” (van der Zwet et al., 2011).

Works with a declared focus on materials are however limited. As already stated, only three articles stand out as explicitly adopting material-focused theoretical perspectives. This low number of material-focused studies is not surprising. It aligns with discussions from medical education which acknowledge that: “[m]aterials tend to be ignored as part of the backdrop for human action, dismissed in a preoccupation with consciousness and cognition, or relegated to the status of brute tools subordinated to human intention and design” (Fenwick, 2014).

While I was enthused by the rich findings associated with material-focused research, the precise frameworks deployed in these papers did not match my research needs because they did not concomitantly foreground learning-technology-space connections. To explain, the above three articles explicitly focus on spaces, and not the learning-technology-space intersection. While these articles foreground “things (materials)” (Lefroy & Yardley, 2015), they all have a dedicated focus on spaces (and places). Technology, and more specifically the technology-space intersection, while examples of things, are not at the foreground of encountered research.

At this point I started to recognize that works that have a non-human focus in the reviewed literature aligned with my intentions. Yet, they did not provide a ready-made, pre-tested theoretical framework that I could use in my thesis. The next chapter will detail how this challenge was managed and what shape my theoretical framework took.

2.7.4 Summary

An analysis of theoretical perspective in the reviewed literature highlights that three articles adopt theoretical perspectives foregrounding the role of materials in student experiences. While these articles are mainly focused on spaces, the possibilities offered by their theoretical underpinnings are inspiring for my work.

2.8 Mapping the potential contributions of my thesis to the literature

At the end of my literature review it is evident that literature about spaces and the use of technology within spaces in the experiences of healthcare students provides important information, yet it is marred by several insufficiencies. Interestingly, the most detailed accounts of student experiences come from studies using material-focused theoretical frameworks.

My thesis can contribute to the literature on student experiences by providing explanations of the intricacies of student actions that shape the student experiences. In doing so I aim to provide an additional level of detail to the accounts visible within analysed literature. My thesis will thus describe student actions as well as their decisions and choices along with the forces that influence them. Such a level of detail is not currently encountered in references from sections 2.5 and 2.6.

My thesis will pursue its contribution to literature by using a theoretical framework inspired by frameworks underpinning reviewed articles which present the richest descriptions of student experiences. I described above that rich accounts of student experiences are associated with material-focused research perspectives. While frameworks underpinning reviewed literature did not satisfy my research needs, they were nonetheless inspirational. My thesis builds upon these ideas and sets to uncover a theoretical framework that offers strong support for the concomitant study of learning, technology and spaces.

In the next two chapters I detail the theoretical framework and the research methodology used to gather and analyse my data. Afterwards, a presentation of my findings, followed by discussions and conclusions will follow.

Chapter 3: Theoretical Framework

3.1 Introduction

At the end of my literature review I was enthused by the richness of findings associated with material-focused research, but I was unable to locate within analysed references a theoretical framework to match my research needs. I turned to sociomaterialism in the hope of finding a means to explore how paramedic students' experiences are influenced by interplays of physical spaces, technologies and learning practices. This led me to complexity thinking, a branch of sociomaterialism, which ascertains that humans and non-humans intersect and interact thus forming systems in which all are equally important (Moura & Bispo, 2020). Together, sociomaterialism and complexity theory, helped craft my theoretical framework which draws heavily on works by Davis, Fenwick, Goldstein, Johnson, Mason, Simmt and Sumara (Davis & Simmt, 2003; Davis & Sumara, 2006, 2008; Fenwick, 2012, 2014; Fenwick et al., 2011; Fenwick & Dahlgren, 2015; Goldstein, 1999; Johnson, 2012; Mason, 2008b) and is expressed as:

> Diversity, redundancy, decentralized control, neighbour interactions and enabling constraints, could influence the emergence of diverse phenomena, in a system formed of equally important humans, non-humans and their interactions.

I chose to engage with complexity thinking as a means to provide those conceptual "directions along which to look" (Albert J. Mills, 2012) while exploring student experiences regarding the learning-technology-spaces intersection. Sociomaterialism, through the works of Fenwick and colleagues (Fenwick, 2012, 2014; Fenwick et al., 2011; Fenwick & Dahlgren, 2015) sensitized me to look at humans and non-humans as concomitantly interacting in student experiences. Complexity thinking, especially as presented by Davis, Goldstein, Johnson, Sumara, Simmt and Mason (Davis & Simmt, 2003; Davis & Sumara, 2006, 2008; Goldstein, 1999; Johnson, 2012; Mason, 2008b) sensitized me to look for the emergence of new phenomena within student experiences by focusing on diversity, redundancy, neighbour interactions, decentralized control and enabling constraints.

I will now detail the way each of the above concepts influenced my theoretical framework and exemplify their implications by using the vignette presented in section 1.2. Some notions have been simplified or even eliminated; this brevity aligns with the need to succinctly and coherently present a focused argument in my thesis.

3.2 Theoretical influences

3.2.1 Sociomaterialism

Sociomaterialism is the first major influence on my theoretical framework and is responsible for the ethos of my thesis: to consider humans, non-humans and their interactions as directly influential in the context of everyday life. Sociomaterialism, which is shaped in its current form initially through the works of Wanda Orlikowski (2007) and then others, admits that “materials (objects […] technologies, bodies, settings) move in practice and learning, and […] are related to the social (texts, symbols, meanings, intentions) in complex systems”

(Fenwick & Dahlgren, 2015). Materials interact with surroundings and shape "human activity in everyday practices" (Fenwick, 2014). Consequently, "gatherings of heterogeneous natural, technical and cognitive elements" (Fenwick, 2014) are formed.

These "are not […] complete 'things' (that we can point to […]); they are processes of ongoing becoming in order to achieve certain accomplishments" (Introna, 2013) which achieve meaning by complex "sociomaterial practices […] where […] both […] human and […] [non-human] operate together" (Bjørn & Østerlund, 2014). As such, "students' […] activities are performed into being, in relation with the material objects and technologies that act to configure particular practices" (Fenwick, 2014). "Humans are fully interconnected with other material elements of the systems that are constantly acting upon each other. No clear lines of causation or human intention can be traced from these interactions to their outcomes" (Fenwick, 2012). Sociomaterialism is then about the fact that "[m]atter [m]atters" (MacLeod & Ajjawi, 2020). This focuses researchers to look for "materials as dynamic and enmeshed with human activity in everyday practices" (Fenwick, 2014) and to see "all things – human and non-human, hybrids and parts, knowledge and systems – as effects of connections and activity" (Fenwick, 2014). "Sociomaterial approaches […] help to make visible the material dynamics in practice situations – the relationships among bodies, tools, technologies and settings as well as human intentions, expertise and communication" (Fenwick & Nimmo, 2015).

In my thesis, sociomaterialism helped conceptualize that humans, as well as learning circumstances, technology used while learning and physical spaces in which learning takes place, concomitantly intersect and become responsible for student experiences. I present a sample of this intersection in the vignette introduced in section 1.2. There, learning, technology and spaces concomitantly shape students' classroom experience. Practically, as I will detail in chapter four, sociomaterialism motivated me to use tools which helped gather data about the non-human components of my research – desks, computers, social interactions – and to account for these non-human elements in data analysis. While sociomaterialism motivated me to concurrently investigate all components – humans, non-humans and their interactions – connected to my field of interest it did not provide the specific elements which my investigation can focus on. These came from complexity thinking.

3.2.2 General notions of complexity

Complexity thinking focused my data gathering and analysis. Complexity is part of the sociomaterialistic spectrum, where it sits equidistantly between humanist and materialist extremes (Moura & Bispo, 2020). Complexity thinking is new to educational research and comes to us from other areas – physics, biology, computer science, etc. Complexity thinking stays true to its sociomaterialistic backdrop and acknowledges that humans and non-humans intersect and interact thus forming systems in which all are equally important (Moura & Bispo, 2020). Sometimes, complex systems appear. These are systems – formed from humans, non-humans along with their intersections and interactions – that cannot be understood by looking at each of their components and deriving linear connections between them. Such complex systems need to be seen as a gestalt of sorts from which new and interesting phenomena emerge as a direct result of system properties; complexity thinking calls these emergences.

Educational researchers widely focus on five system properties that could lead to emergence: diversity, redundancy, decentralized control, neighbour interactions and enabling constraints (Davis & Simmt, 2003; Davis & Sumara, 2006, 2008; Fenwick, 2012; Mason, 2008b, 2008a). Within a complex system, emergence is mediated when certain proscriptive rules are followed (enabling constraints), the right amount of internal variety (diversity) is present, the possibility exists that some elements can compensate for others (redundancy), elements within the system interact (neighbour interactions) and a bottom-up approach allows the system to exercise its own will (decentralized control). As exemplified in my vignette – section 1.2 – paramedic students operated under the same rules; they all used same professional standards to devise care plans for the same patients. Nonetheless, differences in procedural sequence and in the usage of laptops, printed books and flipcharts became visible in the classroom. Group specific behaviours and even the fact that, eventually, care plans became carefully designed to only occupy one side of a single flipchart paper were not imposed by me as the instructor. They were decided upon by students, based on their tasks, available resources, number of plugs in the classroom, laptop battery charge and, likely, a multitude of other factors. A look at enabling constraints, diversity, redundancy, neighbour interactions and decentralized control can help explore the manner in which these behaviours emerge.

The next few sections unpack the meaning of complexity for my thesis. I will first define and clarify notions of systems and emergence. I will then detail matters of diversity, redundancy, neighbour interactions, decentralized control and enabling constraints.

3.2.3 Systems and emergence

A *system* is "any assortment of entities – material and virtual, human and technical, seen or unseen – held together by some kind of interrelations with one another to form a collectivity: a classroom of children, a team of professionals, a Facebook site" (Fenwick et al., 2011, p. 19).

A *complex system* is a system whose behaviours cannot be analysed by separating the system "into its parts and studying the linkages among them. A complex system resists this kind of analysis because its behaviours exceed the sum of its parts" (Fenwick et al., 2011, p. 22). A complex system is a gestalt of sorts, where "the interaction among constituents of the system, and the interaction between the system and its environment, are of such a nature that the system as a whole cannot be fully understood simply by analysing its components" (Cilliers, 1998, pp. viii–ix). Complex systems "are *open* in the sense that they continuously exchange matter and energy with their surroundings (and so judgments about their edges may require certain arbitrary impositions and necessary ignorances)" (Davis & Sumara, 2006, p. 5). "The term *environment* must [then] be used carefully", as Davis and Sumara caution us, since sometimes we cannot "determine with certainty which components are part of the system (i.e., "inside") and which belong to the setting (i.e., “outside”)” (Davis & Sumara, 2006, pp. 14–15). Researchers then need to define boundaries of studied complex systems and acknowledge that relationships between the system and the environment as well as between researchers and their work are defined not by linear processes but rather by “nested, co-implicated, ambiguously bounded, dynamic” relationships (Davis & Sumara, 2006, pp. 14–15).

A *complex adaptive system* is a complex system which can “scan and sense the external environment and then make internal adjustments and developments in order to meet the demands of the changing external environment” (Waldrop, 1992, pp. 294–9 as cited by Mason, 2008). The system then goes through a process of self-organization – more on this in a few paragraphs – which allows it to adapt to diverse needs. Adaptation then becomes a quintessential property of complex adaptive systems that want to survive (Cilliers, 1998, p. 93). To achieve and to retain the capacity to adapt, complex systems need to have and maintain “relationships [that] are not fixed, but shift and change” (Cilliers, 1998, pp. viii–ix).

“*Emergence* […] refers to the arising of novel and coherent structures, patterns, and properties during the process of self-organization in complex systems” (Goldstein, 1999).

> “In these systems, agents residing on one scale start producing behaviour that lies one scale above them: ants create colonies; urbanites create neighbourhoods; simple pattern-recognition software learns how

> to recommend new books. The movement from low-level rules to higher-level sophistication is what we call emergence" (Johnson, 2012).

Complex adaptive systems, "solve problems by drawing on masses of relatively stupid elements, rather than a single, intelligent "executive branch" (Johnson, 2012). If in these systems, the right conditions – I will detail these soon – exist, the system will self-organize and new phenomena – e.g. patterns, properties, behaviours – will emerge. In this sense, "complex systems are […] constantly exchanging matter and/or information with their contexts […] usually arise from and are part of other complex systems […] and […] distinguishable but intimately intertwined net-works can and do exist" between the systems of interest and their interconnections (Davis & Sumara, 2006, p. 94). Complexity theory recognizes "that, given a significant degree of complexity in a particular environment, or critical mass, new properties and behaviours emerge that are not contained in the essence of the constituent elements, nor can be predicted from a knowledge of initial conditions" (Mason, 2008b, p. 36).

From the many conditions responsible for emergence in a complex system, a few are widely referred to by educational researchers: diversity, redundancy, neighbour interaction, decentralized control and enabling constraints (Davis & Sumara, 2006, 2008; Fenwick, 2012; Fenwick & Dahlgren, 2015). As previously stated, within a complex adaptive system the emergence of new phenomena is influenced by the proscriptive rules the system follows (enabling constraints), its internal variety (diversity), the possibility that some elements compensate for others (redundancy), the interaction within elements of the system (neighbour interactions) and the system's capacity to exercise its own will (decentralized control).

Complexity thinking principles guided my data gathering and analysis. To clarify, as I will detail in chapters four and five, diversity, redundancy, decentralized control, neighbour interactions and enabling constraints, guided my analysis of data generated from interviews-to-the-double, drawings and screen-captures. In chapter six, emergence guided subsequent analytical work uncovering higher-level themes that drew these initial concepts together. Especially important for my thesis were above described images and notions associated with emergence – i.e., "ants create colonies; urbanites create neighborhoods" (Johnson, 2012) and the idea of "novel and coherent structures, patterns, and properties" (Goldstein, 1999). In my vignette, such images and notions can lead to the extrapolation that students exhibit behavioural changes, thus becoming problem solvers adeptly building their own experiences amidst spaces which are not conducive to learning with electronic devices and presenting by using flipcharts sat on desks. I will undergo a similar extrapolation in chapter six where I synthesize empirical findings presented in chapter five.

After introducing broad ideas of systems and emergence, the next sections will focus on complexity thinking principles essential not only for my theoretical framework but also for the nature of emergence itself. I will now present diversity, redundancy, neighbour interactions, decentralized control and enabling constraints.

3.2.4 Diversity

Diversity is used in my thesis as a term that refers to that internal characteristic of a complex system which mediates emergence by means of "*diversity* of types, such as different types of stores in a mall" (Page, 2010, p. 16). While my thesis only highlights this facet of diversity, two other interpretations of diversity exist in complexity thinking: "*variation* in some attribute, such as differences in the length of finches' beaks [… and] differences in *configuration*, such as different connections between atoms in a molecule" (Page, 2010, p. 16). Diversity can neither be imposed in a "top down" manner nor can it "be recognized and valued if the task set for a collective is trivial" (Davis & Sumara, 2008, p. 39).

Diversity is visible in the vignette. For example, group work was supported by diverse resources, discussions were based on different case study solutions and one laptop allowed the completion of multiple tasks. Without diversity, the different behaviours students develop when crafting and presenting their care plans would not be able to emerge.

To explain, in a complex system, diversity – usually expressed as internal diversity – "defines the range and contours of possible responses" (Davis & Sumara, 2008, p. 39), "is outward-oriented, in that it enables novel actions and possibilities in response to contextual dynamics" (Davis & Sumara, 2006, p. 139) and assures "continual creative adaptation to changing conditions" (Fenwick et al., 2011). Diversity drives a system's capacity to use internal resources to survive. Much like my students performed varied activities with the same laptop, a system that benefits from great internal diversity, will use its many constitutive elements to survive whatever its surroundings expose it to. This “continual creative adaptation” (Fenwick et al., 2011) is not possible if the system consists only of elements able to iterate the same response. Systems that lack internal diversity are not able to produce a swift response to specific situations or stressors and may, until these diverse specializations are acquired, disappear.

Three ways of characterizing diversity stand out in the literature: “differences across types”, “differences within a type”, and “diversity of composition. This refers to differences in how types are arranged” (Page, 2010). When referring to diversity, the notion of *type* is prevalent; Merriam-Webster defines *type* as “a particular kind, class, or group” (Merriam-Webster, n.d.). This is the definition that I will use in my thesis. Nonetheless, type classifications are subjective: “One person’s piece of tile is another person’s green, Pewabic, craftsman tile” (Page, 2010, p. 56). For clarity purposes, in my thesis I will explain and exemplify each instance of diversity I present.

In my thesis I focus on diversity of types. “When people speak of diversity, they tend to mean differences of types” (Page, 2010, p. 26). For example, in my vignette paramedic students are depicted as presenting their patient care plans but it is unclear if they use pictograms or words in their presentations; each are types of visual aids which can “have different functions” (Page, 2010, p. 26). It is this connection between function and type that I mostly focus on when investigating diversity in my thesis. Differentiation in regards to diversity of types will refer to learning-technology-space intersections that have different functions in student experiences.

In my thesis I do not focus on "*variation* in some attribute [… or] differences in *configuration*" (Page, 2010, p. 16). As my thesis is a first-time exploration of paramedic student experiences regarding the learning-technology-spaces intersection, I chose to highlight diversity of types in my narrative. This streamlines my presentation and avoids confusion. "Diversity within a type, or variation, is often defined along dimensions, such as length, width, height, circumference, or color" (Page, 2010, p. 26). Members of the same species could be smaller, taller, heavier or lighter. This allows for individual-based aptitudes which not only confer individuals a certain position within a community but also allows the community "to adapt to a changing environment" (Page, 2010, p. 26). Diversity can also be categorized regarding composition or configuration. "Water (H2O) hydrogen peroxide (H2O2) and trioxidane (H2O3) all consist of combinations of hydrogen atoms and oxygen atoms, but differ in their relative amounts" (Page, 2010, p. 27).

In my thesis, diversity sensitised data gathering, analysis and helped present my findings. In my research, I focused on identifying the functions different learning-technology-space intersections hold in student experiences. Additional explorations of "*variation* in some attribute [… or] differences in *configuration*" (Page, 2010, p. 16) could form the basis of future work.

3.2.5 Redundancy

Redundancy is used in my thesis to denote how complex systems exhibit duplications and excesses in their constituent elements. Such redundancy, which relies on the excess or duplicated elements to be sufficiently similar to each other, is typically viewed in the literature as necessary for “complex co-activity” (Davis et al., 2010) to persist where particular elements of the systems fail.

In the vignette, redundancy is visible in the way students completed the same activity by different means. For example, information was researched using books, previous notes or laptops and presentation were made using laptops or flipchart paper. The capacity to complete the same activity by different means, helped mediate classroom activities when laptop batteries were running out.

To detail and explain then, redundancy means that constitutive elements of a system have some degree of similitude which directly mediates interaction (Davis & Sumara, 2008, p. 39), while also allowing the elements that interact to “compensate for one another’s failings” (Davis et al., 2010). For examples, when discussing “a social grouping, redundancies […] include common language, similar social status, constancy of setting, sense of shared purpose, and so on” (Davis et al., 2010). Without redundancies complex systems are gatherings of things that can neither communicate nor compensate when failures start happening. Continuing the above example, people not speaking the same language, or not sharing the same symbolism lack a certain degree of redundancy which makes communication difficult.

Redundancy helped guide data collection and analysis. In my thesis I focused on, and emphasized in my narrative, those characteristics that define redundancy: matters of common traits within learning-technology-space combinations and the manner in which these mediate interaction and compensation within student experiences (Davis & Sumara, 2008; Mason, 2008a).

3.2.6 Neighbour interactions

Neighbour interactions denote those relationships – or interactions – which could lead to emergences and that exist or form amongst – physical and/or non-physical – elements that are adjacent – and thus seen as neighbours.

The vignette describes how students worked in groups using laptops, markers and flipcharts for their patient care presentations. In this way, students and their tools remained together. Student togetherness allowed for ideological interactions, essential in devising a patient care plan. Physical proximity with laptops and flipcharts allowed for the conversion of ideas into cohesive presentations, artefacts which can be shared with other groups. Without this togetherness, students would need other tools and other means of interacting to formulate their patient care plans.

System elements cannot generate emergence if they do not interact. Interaction is mostly exercised at a “fairly short range, i.e. information is received primarily from immediate neighbours” (Cilliers, 1998). Long-range interactions, while possible, are usually a “wide-ranging *influence*” which “gets modulated along the way. It can be enhanced, suppressed or altered in a number of ways”

(Cilliers, 1998). In this sense, depending on how far we are from our target we might see more or less detail (Cilliers, 1998). When discussing neighbour interactions, a distinction can be made between elements that are dominated by a certain materiality and elements that mostly exist within the ideological realm. In this sense, neighbours can be both physical – chairs, classrooms, computers – and non-physical entities – “ideas, hunches, queries, and other manners of representation” (Davis & Sumara, 2006, p. 142). Within education, neighbour interactions are then not mandatorily “physical; they can also be thought of as the transference of information” (Cilliers, 1998). Physical entities, interact when in the same place at the same time – e.g., a chair found in a certain spot in a classroom. Non-physical entities, interact when in an environment where “bumping, colliding, and juxtaposition” (Davis & Sumara, 2006, p. 142) can happen; this can be achieved “for example, as oral expressions at conferences or as written statements in published texts” (Davis & Sumara, 2006, p. 143). A “sufficient density” of neighbours within the same location (Davis & Sumara, 2006, p. 143) will mediate “the potential for novel, innovative, and insightful knowledge to emerge” (McMurtry, 2008).

The concept of neighbour interactions influenced my study by setting the stage for various interview questions and thus affecting data collection. The same concept sensitized parts of data interpretation. My thesis highlights the way certain interactions appear in student experiences.

3.2.7 Decentralized control

Decentralized control denotes a “distributed form of organization” (Fenwick et al., 2011, p. 28), where the “system itself “decides” what is and is not acceptable” (Davis & Sumara, 2008) through a bottom-up decision making style.

The vignette recounts changes in classroom activities. Initially laptops were used for most classwork. In the end, laptops were tethered to walls, printed books used to find information and flipcharts utilized for presentations. None of these were a result of my imposition. All of these were the direct result of students working by themselves to choose best options for staying on task – completing classwork – when challenges appeared – lack of battery power.

When power is decentralized, systems are empowered to make own decisions and new possibilities or ideas are discovered which are not unilaterally, top-down, imposed. Control decentralization leads to the emergence of new possibilities attuned to system needs. Within a system, “[g]reater degrees of decentralized control are associated with enhanced neighbour interactions” (Mason, 2008a, p. 44). This is not to say that chaos should be allowed to reign supreme while observing emergences; it rather emphasizes that ideas, notions, new and unexpected outcomes cannot be imposed. This being said, control decentralization sets “the collective as a knowledge-producer” (Davis & Sumara, 2008) while centralization forces system emergences to a screeching halt.

In my thesis, decentralized control, readied me to investigate matters of decision-making during data gathering and analysis. The idea of shared control is something that I searched for (Davis & Sumara, 2006, p. 145). When analysing student presented experiences, I looked for decentralized control along with its outcomes and promoting factors.

3.2.8 Enabling constraints

Enabling constraints are rules which a complex system "must avoid in order to remain viable" (Davis & Sumara, 2006, pp. 147–148) and which mediate emergence in the system by assuring its unity along with its capacity to develop varied responses. Otherwise said, enabling constraints are proscriptive rules mediating emergence within a complex system through a delicate balance between coherence and randomness. Enabling constraints are "a set of limiting conditions […] intended to define the field of play in a collective engagement. By way of familiar example, a sport's rules […] are enabling constraints that operate […] by defining what cannot be done – thus opening the door to endless possibility by permitting everything else" (Davis et al., 2010). In football, when two teams are playing, there are a few rules to be followed, but no one dictates the exact ways an individual player can kick a ball to score a goal. For a complex system, rules, or enabling constraints, "are not prescriptive, but proscriptive. They are not imposed rules that one must obey in order to survive, but conditions that one must avoid in order to remain viable […] for instance, a human must not leap off tall buildings, assault other humans, or ingest poisons" (Davis & Sumara, 2006, pp. 147–148). Enabling constraints then are that state in which the complex system has enough "coherence to orient […] actions and sufficient randomness to allow for flexible and varied response(s)" (Davis & Sumara, 2006, pp. 148–149).

In the vignette, students needed to follow certain rules to successfully complete patient care plans: remain in the classroom, follow the case studies, abide by professional standards. Within these enabling constraints though, the students had many choices: what notes to take, how to present their work, who will lead the presentation, etc.

I first encountered the notion of enabling constraints in the writings of Davis and Sumara (2006, p. 147) and then I saw it adopted by others (Fenwick et al., 2011; Mason, 2008a; McMurtry, 2008). Unlike the previous four concepts – diversity, redundancy, neighbour interactions and decentralized control – which started and are presented in this thesis as standalone notions, enabling constraints started as two separate notions – coherence and randomness – but came to develop meaning as an intertwined complementary pair (Davis & Sumara, 2006; Fenwick et al., 2011; Mason, 2008a; McMurtry, 2008). Coherence sets "the conditions for group identification" (Davis & Sumara, 2006, p. 148) allowing the "collective to maintain a focus of purpose/identity" (Davis & Sumara, 2006, p. 147), much like a common goal helps a group act with similar intent. Randomness, represents those "sources of disruption" (Mason, 2008a, p. 44), that "unexplored space of possibility" (Davis & Sumara, 2006, p. 148) which helps "compel the collective to constantly adjust and adapt" (Davis & Sumara, 2006, p. 147) thus allowing a certain reality to emerge based on those situations that allow for "diverse ways of addressing them" (Thompson, 2016, p. 197). Enabling constraints are then a standalone entity, where a set of rules helps mediate the balance between coherence and randomness within a system. Further, to best facilitate this balance, these rules need to be proscriptive. A set of prescriptive rules would be too restrictive and would diminish the system's complexity. This being said, "[s]ome constraints are dictated by context, others by the structures of the unities, still others through co-implicated action of agents and setting" (Davis & Sumara, 2006, p. 147).

In my thesis, enabling constraints, focused data collection and analysis. In doing so, I investigated and highlighted in my narrative those proscriptive rules within which student experiences regarding the learning-technology-space intersection can form.

3.3 Theoretical framework implications

I have so far presented the theoretical framework for this thesis as stemming from sociomaterialistic and complexity sensitizations. Sociomaterialism and complexity thinking organically connect and shape my ontology and epistemology. Coming to see the world through my theoretical framework means that I developed a specific understanding of "what we can know (an ontological concern) and how we can know it (an epistemological question)" (Mason, 2008a, p. 170).

Ontologically then, I see reality as emergent and, epistemologically, I see knowledge as emerging from engagement in complex system interactions (and intra-actions) (Fenwick, 2014). This forms an "onto-epistemological framework" where humans, non-humans, "context […] and events are mutually constitutive and mutually dependent, and they emerge together in dynamic structures"

(Moura & Bispo, 2020). These ontological and epistemological beliefs directly connect to matters of practice where one needs to look for these emergences with emphasis on interactions between humans and non-humans alike and focus “not on an individual learner or an individual’s skills, but on the collective” (Fenwick & Nimmo, 2015).

Chapter 4: Research Design

4.1 Introduction

This chapter describes and justifies my research design. My thesis is the result of a qualitative case study focused on student experiences regarding the learning-technology-spaces intersection. The previous three chapters were theoretically rich; they introduced my impetus for studying the learning-technology-spaces connection, summarized existing literature, identified areas which this study contributes to and identified the theoretical framework that I developed for my thesis. This chapter is matter-of-fact: it presents the shape of my study.

This project is a single case study – paramedic student experiences regarding the learning-technology-space intersection – chosen due to academic, political and personal realities. Practically, notions of complexity and sociomaterialism, influenced at least five parts of my work (Creswell & Poth, 2018). First, notions of sociomateriality and complexity theory shaped the research question. Second, the same notions helped devise interview questions; these "[f]ocus [… on] relationships among things, spaces, bodies […] and human action that together" (Fenwick & Nimmo, 2015) relate to the scope of this thesis. For example, students detailed learning that would be impossible without being in a given space and using a given technology and presented the manner in which their use of technology in a given space evolved throughout their school enrolment (cf. Bradfield, 2016). Third, the thesis emphasized "gathering data about materials" (Fenwick & Nimmo, 2015). This was achieved by asking research participants to "narrate what they do in everyday practice, as if giving […] instructions to someone" (Fenwick & Nimmo, 2015), and by gathering student-generated visual artefacts during interviews – i.e. drawings of learning environments and screen-captures of learning apps or software. Fourth, complexity thinking provided sensitizing concepts for the “qualitative content analysis” (Schreier, 2012). Fifth, previously described epistemological implications, informed data analysis – data was analysed as a collective source rather than focusing on individuals as sub-cases – and presentation of results in the thesis – which will not be presented learner-by-learner but rather by mapping the forms of complexity that are discovered across the whole data set.

For the remainder of this chapter I will present matters of research logistics – study type, site, mediation of insider research challenges, participants – data gathering and analysis as well as ethics and study limitations. At this chapter’s conclusion I will move towards presenting my findings.

4.2 Logistics

4.2.1 Study type

My thesis is a case study. My understanding of case study comes from the works of Tight, Stake, Merriam and Miles and Huberman (Merriam, 1998; Miles & Huberman, 1994; Stake, 1995; Tight, 2010, 2017). While definitions and approaches to case studies vary, Tight (2010, p. 337) offers a much needed clarification: a case study is in essence “the detailed examination of a small sample […] of an item of interest […] from a particular perspective” (Tight, 2010, p. 337). My “item of interest” (Tight, 2010, p. 337) is a phenomenon (Miles & Huberman, 1994, p. 25) which I define as: the manner in which a community of paramedic students learns, while using technology and traversing diverse physical spaces. I research this phenomenon thought the eyes of 28 paramedic students – a small sample – involved in the same cohort. In the end I present detailed information about the way this body of students, as a collective, perceives this phenomenon. My theoretical framework guided my inquiry and qualitative content analysis focused my data analysis.

My case is a phenomenon "around which there are boundaries. I can "fence in" what I am going to study" (Merriam, 1998, p. 27). Boundedness (Merriam, 1998; Stake, 1995; Tight, 2010, 2017) is essential in defining the case. My case's boundaries are verifiable, tangible in a sense, but easier defined by exclusion: those things or entities that do not represent the learning-technology-spaces intersection. My case's interconnected working parts (Stake, 1995, p. 2) – learning that paramedic students undertake, the technology they use and the spaces they traverse – can then be conceptually separated from the rest of the world. Paramedic students taking notes while listening to a lecture in a classroom are not the same as paramedic students commenting the latest movie while commuting to school with colleagues; the former I am interested in, the latter I am not. The former is about learning-technology-spaces, while the latter is not.

My thesis is a descriptive and intrinsic case study. My case is descriptive because – even though I devise my own theoretical framework – I am detailing "information about areas of education where little research has been conducted" (Merriam, 1998, p. 38). My case is also intrinsic. I am "interested in it, not because by studying it [I] learn about other cases or about some general problem, but because [I] need to learn about that particular case" (Stake, 1995, p. 3). In order to do so, I will instantiate my research by studying paramedic students, focusing on their opinion and offering a detailed presentation of my findings.

4.2.2 Research site

My research site is Durham College's Primary Care Paramedic programme, especially its second year (Durham College, n.d.). This site allowed me access to the population needed to answer my research question. At Durham College, students' education culminates with the second-year ambulance preceptorship – section 1.5. Precepting students have engaged with all types of learning, technology and spaces encountered in paramedic education. Their experiences thus reflect a wide range of learning-technology-spaces interactions and are particularly interesting to me. While studying this site allows me to answer my research question, Durham College is also my employer; I will address insider research in subsection 4.2.4.

4.2.3 Participants

I aimed to recruit 22 second-year paramedic students, which have completed at least three hospital and three ambulance shifts. These criteria were needed to assure that study participants present experiences connected to all paramedic training spaces.

Participants were purposively recruited (Hennink et al., 2011) from a class of 32 students during the first two weeks of the fall 2019 semester through class visits prescheduled with paramedic faculty. Students consented in writing to their participation based on documents approved by Lancaster University and Durham College.

28 students – 13 females, 15 males – native English speakers, between 20 and 30 years old, participated in my study. No students withdrew or were eliminated from the study. My thesis is based on data collected from all participants.

4.2.4 Insider research

My employment in the Paramedic programme positioned my thesis as insider research. This brought benefits – mainly logistical – and challenges – mainly ethical (Mercer, 2007). Logistically, there was less "travelling involved and greater flexibility with regard to interview times" (Mercer, 2007) because I work where study subjects learn. Ethically though, institutional guidelines discourage studying one's own students (Durham College, 2015), I needed to be clear about acknowledging and preventing personal biases from influencing – as much as possible – the research and had to ensure that existing power relationships and agendas within the institution did not unduly influence the research project (Goverment of Canada, 2017). To mediate this delicate balance I: did not teach second-year primary care paramedic students throughout the duration of the study, used predetermined study protocols and assured the paper's reflection of reality by explicitly discussing my biases and "*Corroborating evidence through triangulation of multiple data sources*" (Creswell & Poth, 2018).

4.3 Research process overview

My research was guided by my research question and the theoretical framework and followed a "qualitative content analysis" (QCA) process (Kuckartz, 2019; Schreier, 2012) for data analysis. Data generation included data gathering through interviews, artefacts and fieldnotes and data processing. Data immersion resulted in a coding frame. The next steps were coding based on the coding frame, coded data analysis and data presentation resulting in my thesis. Ongoing quality assurance took place throughout my research. This made use of *"Clarifying researcher bias",* *"Corroborating evidence through triangulation of multiple data sources", "debriefing of the data and research process"* (Creswell & Poth, 2018) and re-coding some of my data (Schreier, 2012). Figure 4.1 depicts my research process; this was inspired by and builds upon the "phases of qualitative content analysis" presented by Kuckartz (2019, fig. 8.2) (CC BY 4.0) (*Creative Commons - Attribution 4.0 International - CC BY 4.0*, n.d.).

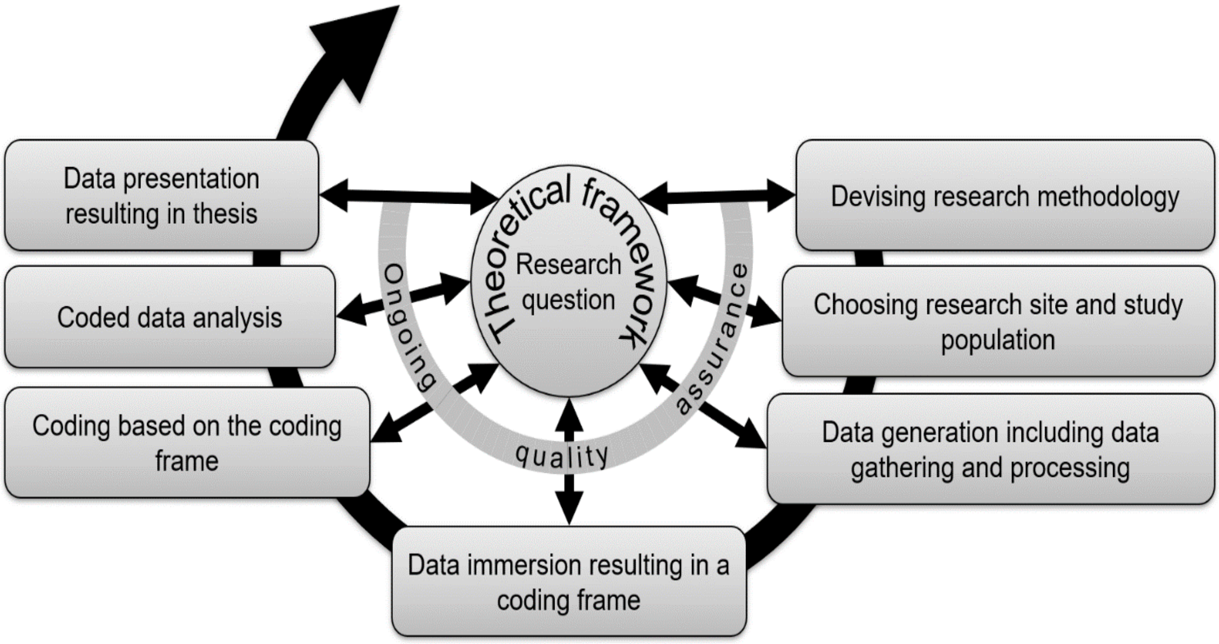

Figure 4.1: Research process overview adapted from Kuckartz (2019, fig. 8.2) (CC BY 4.0)(Creative Commons - Attribution 4.0 International - CC BY 4.0, n.d.).

4.4 Data generation

4.4.1 Research instrument choices

During individual interactions with second year paramedic students, data were gathered using three types of instruments: individual interviews, visual artefacts and interviewer field-notes. Research instrument choices attempted to account for the realities of paramedic student practice and my interest in "[b]oth humans and non-humans" (Moura & Bispo, 2020) in my work.

Only one individual encounter with each student was possible. Students qualifying for participation in my research were extremely busy. During the second year of their programme, students engage in schoolwork while also preparing for hiring processes and provincial certification exams. This made group sessions, or multiple interactions with same student, impractical.

Privacy laws made it extremely challenging to engage in student observation during clinical training and/or ambulance preceptorship (Personal Health Information Protection Act, 2004, S.O. 2004, c. 3, Sched. A, 2004). Given my thesis timeframe and my pecuniary resources, I neither had the possibility, nor the resources to obtain approval for and to engage in student observations. Data was thus gathered from students outside of clinical and preceptorship.

Research instrument choices reflect my theoretical framework. My research has a declared focus on "[b]oth humans and non-humans" (Moura & Bispo, 2020). Research instruments facilitate this focus while attempting to capture student experiences regarding the learning-technology-spaces interaction. Data was gathered through three research instruments: *individual interviews* with students, *artefacts* consisting of drawings of discussed spaces and pictures of students' different electronic devices and interviewer *fieldnotes*. Each instrument is detailed below.

4.4.2 Individual interviews

Open-ended questions were focused by my theoretical framework. Interviews were aimed at understanding the concomitant role of humans and non-humans connected to enabling constraints, neighbour interactions, decentralized control, diversity and redundancy regarding the learning-technology-spaces interaction in paramedic student experiences. To probe these notions, I devised "predetermined open-ended question" (DiCicco-Bloom & Crabtree, 2006) based on my theoretical framework. Diversity uncovered matters of differences regarding learning, spaces and technologies students used. Redundancy identified matters of interchangeability within student experiences. Decentralized control helped pinpoint student decisions and neighbour interactions revealed patterns of material-human interactions situated within the learning-technology-spaces intersection. Enabling constraints identified proscriptive rules which mediated learning within their constraints.

Semi-structured interviews used the "interview to the double" (Nicolini, 2009) technique. According to Nicolini (2009), "practice is, by definition, a complex affair" which "needs to be brought to the fore, it needs to be made visible, articulated […] in order to enter discourse". As Fenwick and Nemo (2015) present, Scoles (Scoles, 2017) identified that the interview to the double is "very useful for illuminating the small tasks and connecting materials that make up […] everyday work" (Fenwick & Nimmo, 2015). During interviews, I initially used the open-ended questions I devised based on my theoretical framework. I then allowed the dialogue to continue naturally "with other questions emerging from the dialogue between interviewer and interviewee⁄s" (DiCicco-Bloom & Crabtree, 2006). Semi-structured interviews were thus used. Whenever an act of doing was encountered – where students were describing something that they would be involved in – I used the "interview to the double" (Nicolini, 2009) technique. This aligns with my theoretical framework and was done to achieve a detailed understanding of learning-technology-spaces as experienced by paramedic students (Fenwick & Nimmo, 2015; Moura & Bispo, 2020). The interview to the double "technique […] requires interviewees to imagine they have a double who will […] replace them […] the next day. The [… interviewee] is […] asked to provide […] detailed instructions which will ensure that the […] double is not unmasked" (Nicolini, 2009).

I chose to use the interview to the double because of its capacity "to provide a multifaceted representation of practice" (cf. Nicolini, 2009). The interview to the double "turns practitioners into observers of their own activity" (Nicolini, 2009). During the process of instructing their double to take their place, the interviewees examine their own doings and provide intricate details of their activities.

I built upon the principles of the interview to the double technique during the data gathering phase of my project. I presented above the interview to the double technique as described by Nicolini (2009). During my student interviews, whenever the participants would reveal a matter “of practice” (Nicolini, 2009) regarding the learning-technology-space intersection, I would engage in questioning consistent with the interview to the double. Specifically, I would ask my study participants to consider that they have a twin and that they want to train their twin to take their place and do exactly what they do so that no one realizes that they are not partaking in their learning. They will then be asked to please “provide the necessary detailed instructions which will ensure that the ploy is not unveiled” (Nicolini, 2009). To now exemplify the evocative power of the interview to the double in my work, I present below a short excerpt from one of my interviews; similarly detailed accounts dominate the gathered data and form the foundation of information I present in my Findings chapter – chapter five of my thesis. In the following excerpt – which is presented in context in section 5.6.2 – Phoenix, one of the students participating in my research, details the meticulous room scoping behaviour they exhibit, which helps them identify and select study rooms that are best suited for their needs:

> “We would kind of just take a walk and look at what has the best lighting? Does it have a router? Does it have a whiteboard? How many tables are in there? […] We kind of analyse […] How many plugs are in the room?”

The interview to the double “process reveals judgements, tacit knowing, hidden meanings, use and organisation of materials, and dimensions of informal learning” (Dean, 2015) which would otherwise remain unheard (Lloyd, 2014). It was this capacity of the interview to the double to uncover hidden meanings that made me especially interested in using it to capture the intricate details of student experiences regarding the learning-technology-spaces intersection.

I carefully employed the interview to the double during data generation so as not to deviate from the scope of my research. The interview to the double has the capacity “to be fun”, generate student engagement and mediate “a relaxed atmosphere” (Dieumegard & Cunningham, 2019). Yet, it could produce “long monologues, often lasting hours” (Pretorius, 2013) which might lead to research participants that “struggle to remain at the micro-level” (Fenwick et al., 2015) of detail throughout the entirety of their interview. As I was hoping to benefit from the former and reduce the latter, I strategically employed the interview to the double in my research. In doing so, I learned from previous researchers which obtained “greater detail and more instructions” when “direct[ing] the participants to describe a particular practice” (Fenwick et al., 2015).

As such, I carefully engaged in semi-structured interviews focused on matters of diversity, redundancy, neighbour interactions, decentralized control and enabling constraints regarding the learning-technology-spaces intersection in paramedic student experiences. When, during the interviews, students would point to a matter “of practice” (Nicolini, 2009) I would ask them to provide detailed instructions to their double regarding this matter. For example, if students were to say that they own a laptop, I would make note of this device on my fieldnotes and continue to investigate actions connected to this ownership in my interview. If students were to say that they used a laptop to study in the back of an ambulance, I would identify this as a matter “of practice” (Nicolini, 2009) and ask students to engage in carefully instructing their double about this act of doing. By employing this strategy I was hoping to build trust and rapport with the interviewed students and engage in deep investigations connected to my area of research interest. This would also offer “concrete focus and boundaries” while “helping participants to recognise and verbalise a range of small tasks that make up their everyday practices, tasks that they often take for granted when simply asked to describe their […] practice” (Fenwick et al., 2015). I will reflect on the effects of the interview to the double in the end of my thesis – section 7.6 – when I will detail that it achieved its intended contribution to my research, I perceive it as a valuable tool and I recommend it for future research.

Interviews were recorded and transcribed. All interviews were audio recorded and transcribed verbatim partly by myself, partly by a third party. I verified the interviews transcribed by the third party for accuracy by reading the transcript while listening to the interview recording. No challenges were identified. Recorded interviews along with their transcriptions were stored in an electronic format.

4.4.3 Student artefacts

During interviews, students used pencils and paper to draw discussed spaces and/or technologies. Drawings represent visual portrayals of students’ interaction with the material world. Drawings were photographed thus becoming digital pictures.

At their discretion, students emailed me screen-captures of their learning apps/software. Screen-captures represent the technology students use.

Together, the above represent student visual artefacts, “support or challenge other data […] and […] provide thick description(s) of […] settings” (Norum, 2008) while helping triangulate information obtained from interviews and interviewer fieldnotes. Visual artefacts were stored in a digital format.

4.4.4 Researcher fieldnotes

During and shortly after interviews, I wrote fieldnotes. These helped track my thoughts, identified topics to be followed-up and pinpointed “paralinguistic features” of interest (King & Horrocks, 2010). Fieldnotes served to “[e]ncourage researcher reflection and identification of bias” and to “[i]ncrease rigor and trustworthiness” (Phillippi & Lauderdale, 2018).

Most fieldnotes were taken during interviews using pen and paper. Matters of body language or perceived interviewee comfort were summarized post interview in electronic format. Pen and paper fieldnotes, were photographed and turned into digital pictures. These, along with the electronic fieldnotes, were digitally stored.

4.5 Data analysis

4.5.1 Qualitative content analysis overview

My thesis used qualitative content analysis to extract meaning from collected data. Qualitative content analysis “is a method for describing the meaning of qualitative material in a systematic way” (Schreier, 2012). In order to do so, researchers develop a coding frame and then “verbal or visual” material is coded based on this frame (Schreier, 2012). The development of the coding frame requires engaging “the data intensively” (Kuckartz, 2019, fig. 8.2). The developed coding frame, helps focus data interpretation on those aspects that the researcher is interested in; in doing so though it helps build understanding “*across cases*, telling you how your cases compare to each other with respect to the categories in your coding frame” (Schreier, 2012).

4.5.2 Data immersion and coding frame development

Through immersion I intimately engaged with data. I started engaging with data the moment it was generated. I transcribed part of interviews, digitized photos and fieldnotes, I spent countless hours listening and reading the interviews. I used pen and paper as well as digital technology – NVivo, etc. – during this process. Overall, from the moment data was generated until my coding frame was finalized it took a few years. This assured that I accumulated a deep understanding of my data.

The coding frame was built using a combination of “concept-driven” (or deductive) and “data-driven” (or inductive) steps (Schreier, 2012). The five categories of data which I include in my coding frame – Table 4.1 – and later detail in chapter five – enabling constraints, neighbour interactions, decentralized control, diversity and redundancy – stem from a deductive process. Their subcategories, which are also visible in Table 4.1 and detailed in chapter five, are the direct result of inductive data analysis.

I started building my coding frame process with a concept-driven step; I mined data for diversity, redundancy, neighbour interactions, decentralized control and enabling constraints related to matters of learning-technology-spaces seen through the eyes of paramedic students. In doing so, I effectively separated data into these five main categories.

A data-driven process followed; I used data from each of these five main categories to generate subcategories. As part of this process, I found an initial series of inductive subcategories – e.g., students are in the same programme, students have to complete the same assignments or students follow the same timetable. I then grouped and re-grouped these together until the inductive subcategories I initially found merged into the inductive subcategories the reader can see summarized in Table 4.1 and developed in the subsequent chapter. For example, the initially found subcategories which are mentioned directly above, merged into the subcategory titled *Programme requirements cohere student practice but allow varied learning, technology and space choices* which is detailed in subsection 5.2.1.

Throughout these steps, I continued to engage in structuring and restructuring my coding frame keeping in mind the intent of my research, my theoretical framework and feedback from my thesis supervisor who was essential in the *“debriefing of the data and research process”* (Creswell & Poth, 2018). Choosing the categories and subcategories was an informed decision stemming from my research question and theoretical framework.

The coding frame had many instances; its final version is visible in Table 4.1. As I was consolidating my coding frame, I engaged in coding data from participants. Essentially, this was a pilot phase. Nonetheless, due to the length of time it took me to finalize my coding frame, this pilot phase saw me code most of my data. I used pen and paper to do so, keeping NVivo as a repository of information, Excel to track my progress, MindManager to order my thoughts and Word to put it all together. During this process, modifications were made to different categories and subcategories as needed to assure the quality of my coding frame. The final version visible in Table 4.1.

Categories inspired by theoretical framework	Subcategories developed from data
Enabling constraints	
	Programme requirements cohere student practice but allow varied learning, technology and space choices
	Temporal and pecuniary constraints encourage efficient use of space and technology while learning
	Professional norms affect learning with technology during idle times in preceptorship
Neighbour interactions	
	Students consciously recognize the mutual influences between space, technology and their learning practices
	Comfort affects interactions amongst learning, technology and spaces
	School related space failures inhibit learning
	Technology affects learning across many spaces
	Ambulance design affects learning with technology

Categories inspired by theoretical framework	Subcategories developed from data
	Social norms influence how technology is used for learning in patient care spaces
Decentralized control	
	Students monitor their learning needs and develop behaviours for best performance
	Student control over spaces tries to bring comfort to learning with technology
	Student control over some of the technology used to study affects learning in different spaces
	[redacted]
Diversity	
	The paramedic lab is a hub of student existence which serves multiple roles
	Technology generates customized experiences through personalization of learning in classroom spaces
	The connection between technology and spaces helps students craft learning places for academic learning outside the classroom
	The uniform setup supports practical learning by introducing an air of familiarity into different patient care spaces
	The learning-technology-spaces intersection maximizes the immersive character of education
Redundancy	
	Students recognize matters of practice which require no change regarding their capacity to compensate for deficiencies
	Students develop networks that allow them to achieve common goals
	Students choose and use technologies and spaces that compensate for shortcomings in their experiences
	During idle times, students can use the back of the ambulance as a private study space

Table 4.1: Coding frame used in data coding. Coding frame shows categories and subcategories. Explanations will be given as part of chapter five where this framework is used to structure the narrative.

The coding frame consists of five categories and multiple subcategories; the subcategories explain “what is said about the aspects that interest you, i.e. your main categories” (Schreier, 2012). I will incorporate categories and subcategories as headings and include their definitions in chapter five. In doing so, I highlight the coding frame as essential in developing key outcomes in the findings chapter.

When building my coding frame, I made sure that it was unidimensional, mutually exclusive, exhaustive and saturated (Schreier, 2012). These are characteristics which Schreier (2012) associates with a coding frame that allows for clear, purposeful, coding of the intended data.

“Unidimensionality means that each dimension in your coding frame should capture only one aspect of your material” (Schreier, 2012). This allows clear distribution of data amongst all codes; the manner in which different categories and subcategories connect to each other is not captured here but rather “in a subsequent step of data processing, following upon the actual content analysis” (Schreier, 2012, p. 75). More about this in a few paragraphs in section 4.5.4. I now need to mention that the category of neighbour interactions connected to the learning-technology-spaces intersection is discussing relationships amongst these three elements but not relationship amongst categories and subcategories from Table 4.1.

“Mutual exclusiveness refers to the subcategories within one dimension. It means that a unit of coding can be assigned to one of these subcategories only” (Schreier, 2012). This means that the same unit of coding – defined here as a word, a group of words, a part of a picture or a picture that could be coded under one subcategory (Y. Zhang & Wildemuth, 2009) – “should be assigned to only one subcategory” (Schreier, 2012).

“A coding frame is said to be exhaustive if you are able to assign each unit of coding in your material to at least one subcategory in your coding frame” (Schreier, 2012). This allows detailed representation of data in codes.

“The criterion of saturation requires that each subcategory is used at least once during the analysis, i.e. that no subcategory remains ‘empty’” (Schreier, 2012); this contributes to the quality of the coding frame. Sometimes concept-driven frames have categories that no data is coded to; this needs to be discussed as an important finding as “in order to arrive at this result, the categories must be part of your coding frame to start with – otherwise you would not have the chance to find out that nothing in your material corresponds to them” (Schreier, 2012). In my thesis, no category or subcategory remained empty.

After I determined that my coding frame meets my needs, I introduced all of its components as nodes in NVivo.

4.5.3 Coding based on the coding frame

After a trial phase, I coded all data. Using NVivo, I trialled my coding frame on 25% of data. As no frame changes were needed, I coded all data using the developed coding frame. I chose trialling my coding frame on 25% of data. This exceeds the recommended inclusion of “between 10% and 20% of your material in the trial coding” (Schreier, 2012, p. 151). My trial was overly cautious because I was already intimately connected with data after developing my frame and I wanted to assure the relevancy of my findings.

Coding stopped after recoding another 25% of data. 14 days after coding all data, I used pen and paper to recode data from seven participants. I was, once again, overly cautious. Since recoding and coding showed similar results, I stopped coding my data.

4.5.4 Coded data analysis

After coding, an inductive analysis process followed. It emphasized how students experience the learning-technology-spaces intersection and clarified matters presented in chapters five and six. Throughout, I used image editing software to combine visual artefacts into a cohesive visual story, of spaces and technologies in learning (Chiriac, 2015; Fenwick & Nimmo, 2015; Laine-Hernandez & Westman, 2006). As a result, interviews were triangulated with data from visual artefacts and interviewer fieldnotes (Creswell & Poth, 2018).

To answer my main research question, I started “doing additional data exploration and analysis and presenting these results” (Schreier, 2012, p. 220) in chapter six. In doing so I especially “look[ed] for patterns and co-occurrences” with a clear “focus […] on the interrelation between […] codes” (Schreier, 2012, p. 228).

4.5.5 Data presentation

All the above led to a final, cohesive narrative presented in the next two chapters. In the end this explained a poorly understood situation, thus generating a new and “original contribution to knowledge” (Lancaster University, 2021). Procedures discussed in the ongoing quality assurance section assured my thesis’ reflection of reality.

In my writing I gave voice to the complex sociomaterial findings that my thesis highlights. “From a sociomaterial perspective, there is no unique, essentialist subject who can produce ‘voice’, nor can voice be separated from the enactment in which it is produced, an enactment among researcher-data-participants-theory-analysis” (Hultin, 2019). To recognize this interconnected reality, I clarify my bias – subsection 4.7.1 – and my theoretical framework – three. Equally important, I also focus my attention not only on the student voices but also on the material voices that transpired through the use of the interview to the double and gathered artefacts. My data presentation honours these voices by presenting detailed excerpts from interviews, highlighting the intersection between spoken word and collected artefacts and by, very importantly, making a dedicated effort to present my students as living humans, speaking for themselves and for their practices. In committing to achieve the latter, student names were changed to gender neutral pseudonyms rather than codenames such as Participant 1 or Participant 2. “This [… allowed] data to be de-identified without being de-personalized” (Heaton, 2022) and best reflected my commitment to student voices.

In my data presentation I specifically emphasized the richness of findings. In order to maximize the evocative power of the interview to the double, combined with the artefacts collected from students and with my own fieldnotes, I carefully engaged with all these data sources. In writing, I emphasized connections between different types of data, assured that “original linguistic features are faithfully preserved“ (Nicolini, 2009) and used, whenever possible, descriptors, to locate quotes within the different interviews. In this sense, my “text articulates practice in terms of (some of) the main practical concerns governing the activity” (Nicolini, 2009) students engage in and helps the reader understand the shadow learning landscape students generate.

4.6 Ethics

My research received Ethics Board approval from Lancaster University and Durham College. This assured that matters of expertise needed to complete the study, conflict of interest, risks, withdrawal, anonymity, confidentiality and data storage were accounted for before the research started. The project proceeded as initially approved, with two minor modifications that received board approval partly through the research process. First, as I noticed that I cannot complete transcription on my own, I received approval to have some interviews transcribed by a third party which had to adhere to the same stringent rules as the rest of the project. Second, I initially planned to use ”codenames” (Heaton, 2022) – e.g., Participant 1 – for my study participants. However, I then realized that gender neutral pseudonyms would help bring my findings to life and reflect my commitment to student voice. Approval for using such pseudonyms was sought and allowed for my thesis. I chose these pseudonyms myself after data collection. Any similarity between pseudonyms and the participants' characteristics or real names, chosen, given or otherwise, is purely coincidental. Amongst the many details covered by the Ethics Board approval process, a few stand-out as specific to my thesis; I will emphasize them below.

In regards to the expertise needed to complete the project, the Boards agreed that under the guidance of my supervisor, I had enough support and would benefit from a wealth of experience to complete my thesis.

The matter of insider research was seen as a possible conflict of interest that needed to be mediated. I already discussed pros and cons of insider research in a previous section. Ethically, my dual position as instructor and researcher was seen as possibly placing undue influence on my students: studying and teaching same students might lead to them feeling coerced to partake in my research due to our relationship and a perceived fear of reprisal in case they chose not to participate in their instructor's research. To mediate this, I did not teach the students I was studying. Further, student recruitment took place through face-to-face sessions to which no instructor teaching recruited students had access.

Student safety was prioritized during my research. Matters of risk, withdrawal, anonymity and confidentiality were covered in documents approved by the Boards. My study involved no experiment that could pause physiological risks to students. Discussions about student experiences were however considered as being potentially capable of inducing psychological stress on participants. To minimize this stress, students remained anonymous in my thesis, volunteered for interviews and only answered questions if comfortable to do so. Further, I used my Mental Health First Aid training to monitor students for any signs of distress and need of help from available resources.

Data is stored as per University and College guidelines. Electronic data will be stored for a 10-year period on password protected devices. Physical copies will be stored in a locked safe place for the same period.

4.7 Ongoing quality assurance

Efforts were made to assure that my research is credible and dependable. In my thesis, credibility means that my “study findings are accurate […] from the standpoint of the researcher […] and the readers of the study” and dependability means “that the process of the study is consistent over time and across different researchers and different methods or projects” (Yilmaz, 2013).

4.7.1 Credibility

To assure that my “findings are accurate (or are plausible)” (Creswell, 2015, p. 409) I focused on *“Clarifying researcher bias” and “Corroborating evidence through triangulation of multiple data sources”* (Creswell & Poth, 2018).

I am biased to see learning, technology and spaces as interconnected. My “past experiences” (Creswell & Poth, 2018, p. 341) of practicing and teaching paramedicine convinced me that student experiences are based on an interplay of learning, technology and spaces. To avoid this conviction’s undue influences on my research, I used a clearly defined theoretical framework, a detailed research design and I specifically used triangulation and *“debriefing of the data and research process”* (Creswell & Poth, 2018).

“Corroborating evidence through triangulation of multiple data sources” (Creswell & Poth, 2018, p. 340) allowed me to verify the same findings from multiple vantage points. My research combined interviews, artefacts and fieldnotes to examine student experiences. These methods complemented each other and cohesively combined to justify my findings.

4.7.2 Dependability

To mediate the dependability of my research, I strived to “work in a systematic way and make […] transparent to […] readers how […] interpretations and conclusions” were reached (Schreier, 2012, p. 34).

In my thesis, “the process of selecting, justifying and applying research strategies, procedures and methods is clearly explained” (Yilmaz, 2013). This is visible in the previous sections which assured the existence of an unambiguous research process which can easily be followed by readers.

My research was constantly scrutinized by my thesis supervisor and, in this sense, an “audit trail” exists (Yilmaz, 2013). During my thesis I thoroughly engaged in *“debriefing […] the data and research process”* (Creswell & Poth, 2018) with my supervisor. This helped assure a constant audit of my findings and increased the trustworthiness of my data (Yilmaz, 2013). This is especially important as I could only engage with the students once – subsection 4.4.1 –

and I could not use assure that my study's "conclusions [are] considered to be accurate by the participants" (Yilmaz, 2013).

4.8 Limitations

My study is affected by at least three limitations: previous knowledge, time constraints and the intricacies of studying students while performing patient care. These are challenges arguably outside my control which influenced my research design, findings and future work. I comment on the influence of limitations on research design here and will discuss limitations connected to the overall project in chapter seven. This two-prong approach reflects the integral part of limitations in the research process and assures thesis transparency (Lingard, 2015; Theofanidis & Fountouki, 2018).

The nature of previous knowledge determined the investigative character of my thesis. Prior scholarship highlights healthcare student experiences regarding educational spaces, and technology usage within those spaces. That scholarship emphasizes space as the background and technology as the mediator of customized student experiences, to some extent acknowledges spatial (in)adequacies, and (rarely) presents detail regarding how students shape their own experiences in spaces. Also, reviewed literature largely underemphasizes the importance of materiality in student experiences. Overall, previous knowledge does not describe a clear picture of how students experience the learning-technology-spaces intersection. This focused my thesis on adopting a descriptive, qualitative approach.

Time constraints limited my interaction with students. My research was affected by multiple temporal constraints: the duration of my PhD, the time students spend in the paramedic programme, my capacity to only teach certain courses for a limited period, etc. Overall, these generated scheduling challenges which meant that I could only study one cohort of students and that I could not engage with students more than once or in groups. This affected my research instrument choices and my capacity to engage study participants in checking my findings (Yilmaz, 2013).

Privacy constraints also influenced my research instrument choices. The paramedic students' involvement in patient care raised privacy challenges connected to observations of student performance in the field. As these could not have been mediated within my temporal constraints, I was not able to use participant observations within my study.

4.9 Summary

By this point in my thesis I have provided an introduction to my research, reviewed literature and detailed my theoretical framework and research design. The next chapter will present my research findings and thus provide content for the discussions and conclusions presented in chapters six and seven.

Chapter 5: Findings

5.1 Introduction

This chapter presents my research findings in the form of themes centred around five principles: enabling constraints, neighbour interactions, decentralized control, diversity and redundancy. These stem from paramedic student interviews regarding the way they experience learning, while using technology and traversing physical spaces. To answer my main research question – “How do paramedic students experience the relationships amongst their learning practices, the technologies they use and the physical spaces they traverse?” – I used an approach sensitized by complexity thinking. I first focused on interviewing students about five elements of complexity thinking that were of interest to me; the results of these interviews are what I present in this chapter. In the next chapter, emergence will guide subsequent analytical work which will help answer my research question by zooming out and using an overall look at all chapter five findings to identify overarching themes.

The findings presented in this chapter are separated into five categories and 22 subcategories; numerous connections are visible amongst these. These are the exact same categories and subcategories introduced in Table 4.1 as part of the coding frame used in data coding. As previously explained in section 4.5.2, the five categories – enabling constraints, neighbour interactions, decentralized control, diversity and redundancy – stem from a deductive analysis process where I mined data for these exact five complexity thinking principles. All subcategories, are the direct result of an inductive analysis process where I used data from each of these five main categories to generate subcategories. Figure 5.1 is a visual introduction to the intricacies of this chapter showing the categories and subcategories that will be elaborated in upcoming sections. Connections are purposefully greyed so as not to overwhelm. To not diminish from the intent of complexity, connections need to be seen as influences and not as cause and effect. That is why arrows and colours were avoided. Before moving to detailed presentations of these sections I present a short chapter summary below.

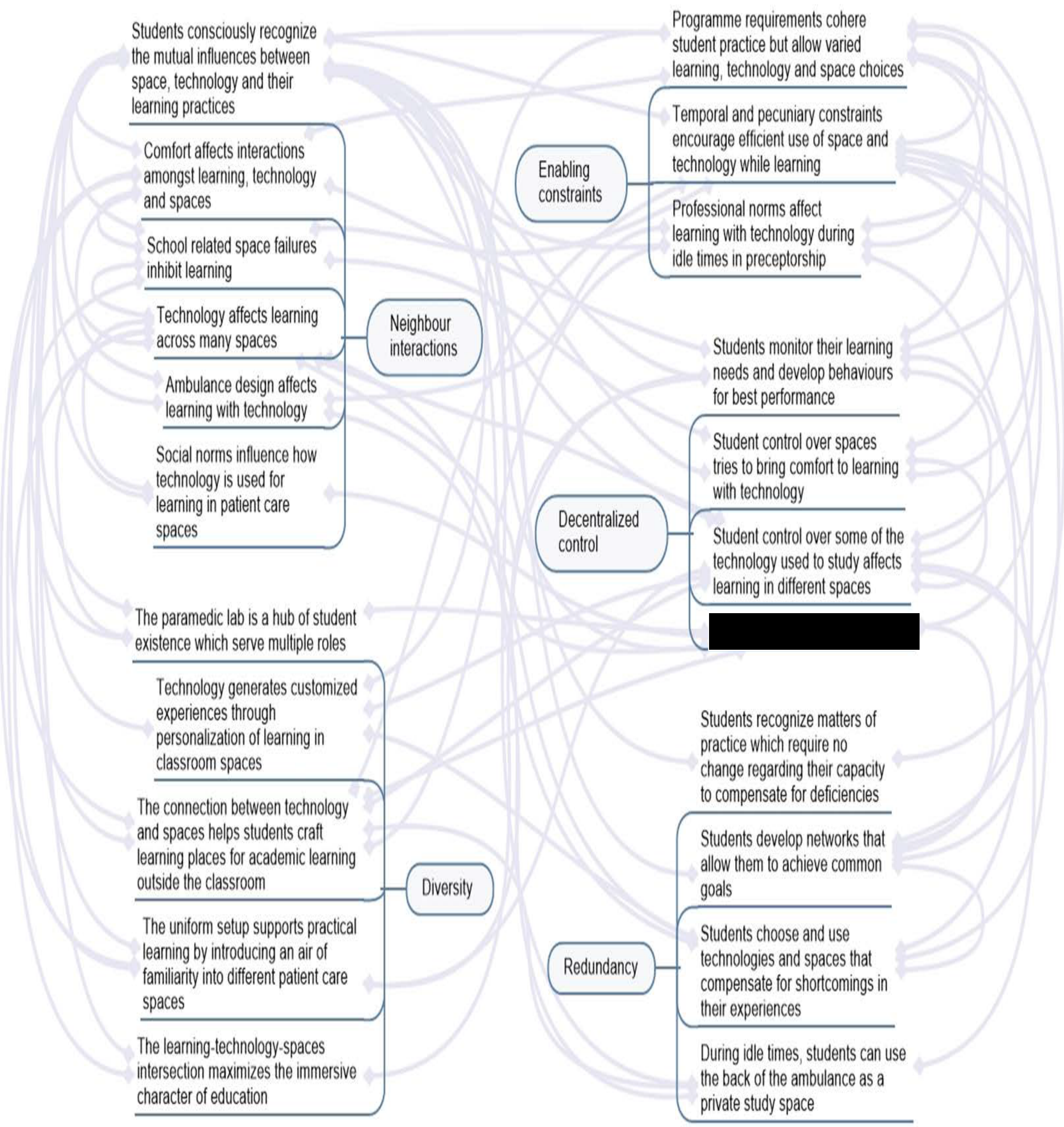

Figure 5.1: Connections between ideas presented in chapter five.

Students operationalize the learning-technology-spaces intersection under a specific set of proscriptive rules which need to be followed for success in the programme. Programme related requirements cohere but do not dictate student practice. Temporal and pecuniary constraints encourage efficient use of space and technology to maximize learning. Professional norms affect learning with technology during idle times in preceptorship.

While interactions between learning, technology and spaces have different degrees of physicality, they all are part of “mechanisms […] to ensure that ideas will stumble across one another” (Davis & Sumara, 2006, p. 143). Students consciously recognize the mutual influences of space, technology and their learning practices and have a hard time conceptualizing education without this tripartite interaction being present. Students recognize that comfort affects the learning-technology-space interaction. Within the context of learning-technology-space interactions, students seem aware of those specific conditions which maximize some of the learning they are faced with – academic, simulation and preceptorship. Students easily verbalize challenges on the path to success. As such, students are aware that school related space failures inhibit learning, technology affects academic learning across many spaces, ambulance design affects learning with technology and social norms influence how technology is used for learning in patient care spaces.

Students can only control parts of their education. The above rules and interactions directly affect matters of bottom-up, student reached decisions regarding the intersection of learning, technology and spaces. Further, students have varying degrees of control over their own experiences. As students aim to achieve success, they monitor themselves and develop behaviours for best performance, control spaces thus trying to bring comfort to learning with technology and control some technology used to study in different spaces. Students seem willing [redacted] when these affect their physical or psychological comfort or basic physiological needs.

Students identify diverse embodiments of the learning-technology-spaces intersection which have specific functions. Students appear aware of those learning-technology-space matters which mediate maximum learning but they also seem to perceive that a gap exists between these and institutional provisions. At this point, students seem to develop much needed responses to this gap. These are limited by their reduced decision-making powers and the proscriptive rules they operate under. The responses that students develop generally take the form of different learning-technology-space embodiments which serve specific functions. Students are thus using the paramedic lab as a hub of their existence, using technology to personalize classroom spaces, crafting learning places for academic learning, using the uniform setup to support their practical learning and using the intersection of learning, technology and spaces to maximize the immersive character of education.

Redundancy is mostly student built. Students develop networks that allow them to achieve common goals, choose and use technologies that compensate for shortcomings in their experiences and judiciously use the back of an ambulance as a private study space. Amidst these, students recognize that some areas of their training require no change regarding their capacity to compensate for deficiencies.

In the following sections I will unpack each of enabling constraints, neighbour interactions, decentralized control, diversity and redundancy. I present them in this order as it supports the narrative visible in data. For each category I present its main highlights and make clarificatory comments as needed to maintain the fluency of the narrative. The collective has many voices but it seems to speak a cohesive story through the words of each of its many constituents.

5.2 Enabling constraints

In this section, I highlight those aspect of students' accounts that drew attention to *enabling constraints*. These represent proscriptive rules which students cannot ignore – subsection 3.2.8. Such enabling constraints are typically regarded in the literature as important because they describe "what cannot be done – thus opening the door to endless possibility by permitting everything else" (Davis et al., 2010).

My analysis identified three prominent forms of enabling constraints that students highlighted in their accounts. These are as follows:

- Programme requirements cohere student practice but allow varied learning, technology and space choices. This means that within wide programme impositions, students can develop answers to their leaning needs.
- Temporal and pecuniary constraints encourage efficient use of space and technology while learning. This emphasizes time and fiscal challenges as affecting student experiences.
- Professional norms affect learning with technology during idle times in preceptorship. This highlights influences on student learning taking place during ambulance preceptorship but outside patient care interactions.

In the subsections that follow, I elaborate each enabling constraint in turn.

5.2.1 Programme requirements cohere student practice but allow varied learning, technology and space choices

Saying that programme requirements cohere student practice but allow varied learning, technology and space choices conveys the message that school imposed proscriptive rules constraint student action, but lack of individual level prescription mediates “an unexplored space of possibility” (Davis & Sumara, 2006, p. 148) through personal choice. While following the same pathway to graduation, students are enabled to make learning, technology and space choices.

Meeting school requirements leads to graduation. School – and associated agencies – impose curriculum, built environment, placements, patient care technologies, learning management system and other paramedic programme elements. Students understand that graduating requires following existing constraints. As an example, while explaining the outside forces which influence the usage of different spaces, Rain indicates:

> “I guess the profs – I mean whoever makes the course curriculum, they control what we learn at the end of the day. But the profs control how we learn it. […] Because it’s like you guys write the material […] At the end of the day, you have to hit these marks, right? […] So, the reality when we’re in an institution like the school, the school controls how most things work”.

Paramedic students are diligent learners, driven not by a simple desire to graduate but by a larger, more noble goal: to provide outstanding patient care. This is a matter of psychological comfort for students – subsection 5.3.2; to achieve it, students invest countless hours in their studies. It is a sense of duty that drives them.

Becoming competent paramedics, is the driving force; graduation is a means to an end. For example, River, reflects on the motivations underpinning their behaviours in the following way:

> "I know if I don't apply myself to this, it's not an easy programme and the competition for a job is hard, so I want to be actually prepared. Plus, there's the stress of – like I just don't want to be hired. I want to be comfortable on the road when things are […] if something's thrown at me and I was like, "I don't know. We learned it." But yeah, I like – I'll occasionally stop and think and be like, would I want me responding to a family member or something? I want to be able to be comfortable in the crap that we're going to […] like I don't want to get to a call and someone is having a stroke and we completely miss it somehow and just not be comfortable with how things are progressing […] Like know what to do"

Students have control over academic learning technology, do not look to change the curriculum and recognize the inextricable learning-technology-space connection – subsections 5.3.1, 5.4.3 and 5.6.1. These three ideas will be detailed in neighbour interactions, decentralized control and redundancy; it was there that they became visible. I introduce them here though, as, together with the idea expressed in the previous paragraph, they help rationalize many student actions and allow the narrative to cohesively unfold.

Overall, while acting within proscriptive rules, students portray themselves as enabled – almost responsible – to control their own education. This is a preamble to subsection 5.4.1 which needs to be included here for the sake of clarity. Zephyr, for example, reflected on their sense of responsibility to understand how to learn and assume a sense of control over their education:

> "I'd say for the most part we have to figure out how and it always will be we need to learn how we learn, but we need to bring something to the table to supplement, I would say, for the most part. […] The nature of the programme, too, I don't know if this is the way it's intended, but really it's guidelines. This is what you should learn, you need to learn it by this time, but we are so limited for time and so dense for curriculum, sometimes it's like, "here's a brief overview. Now you know what you need to know […] go teach yourself." […] I would say for the most part our education is our own, we own our education. The onus is on us to have it learned".

In this context, various learning-technology-space combinations are possible within existing constraints. "At the end of the day" (Rain) school impositions have widespread influences but do not dictate each student move. Students have choices on how to meet their needs: how to take notes, where to sit in classrooms, what laptops to buy, etc. At each point, and within programme requirements, changing one element of learning, technology or space modifies the purpose and outcome of the intersection; cause and effect relationships are elusive and a sense of complexity dominates. A few examples highlight the randomness of learning-technology-space intersection possible within programme requirements:

- Notetaking, a part of learning, involves space and technology combinations which respond to diverse needs. While in classroom, most students take detailed notes using computers, tablets or pen and paper. Cedar doesn't: "I don't take notes in class. That is one of my tricks. I just listen and absorb and then I use other people's notes".
- When students undergo group work, random associations of laptops, students and learning events are possible. This is accentuated by the fact that while Apple laptops represent the academic learning technology most favoured amongst students, some like PCs: "I've also tried using the Macs in the Computer Commons. I don't know. I don't

really like it, like the mouse and everything. I mean, I could probably get used to it if I had the money and bought a Mac, but I grew up on PCs" (Sparrow).

- Scheduling determines rooms used for each class; students pick their own after-hours study rooms and move from one room to another based on needs: "I go to SW 208 cause that is where scheduling tells me my class is but I choose my SW 201 B or A cause that is a study room and if I don't like it I can go home and study" (Fox).

Paramedic learning is not haphazard; it has clear requirements. Within its constraints, choice exists, is cherished and allows learning in a manner that helps students most. Students recognize the need to harness the power of the many possible learning-technology-space combinations to their own advantage. This is for example visible when Storm highlights the emphasis on choice that is present within the intricate constraints of paramedic student practice:

> "honestly as a student, this is our time to really appreciate the education that we're getting and to really utilize it to our best ability because we're all here because we want to have a career as a paramedic. Why else would you take Primary Care Paramedic, right? So, honestly, I feel like a lot of it has to do with yourself. Like, if you're in a space that you don't feel that you're getting the best knowledge, the best learning, then I feel like it's up to you to make that – to realize that is happening and then to make the decision to change that or if you feel like you're not getting the best learning, I feel that you should take that into your own hands to really go about that".

5.2.2 Temporal and pecuniary constraints encourage efficient use of space and technology while learning

Time and money are finite resources which students judiciously use. Minimizing their loss coheres student action and enables a search for efficiencies within learning-technology-space combinations. This is what I mean by saying that temporal and pecuniary constraints encourage efficient use of space and technology while learning. Efficiency changes based on need. This means that, within temporal and pecuniary constraints, students have choices: when to study, where to study, what electronic devices to buy, etc.

Time and money are interconnected. Under the influence of programme requirements – subsection 5.2.1 – students dedicate most time to schoolwork. Gainful employment then receives less priority and finances are affected. Paying for technology, food, gas or lodging needs to be carefully balanced by students. This highlights student experiences regarding the time-money connection which can affect many aspects of student life. As an example, when detailing activities of daily living, August highlights instances where the interconnection between time and money is clearly visible:

> “I also too need to leave school at a certain time to like go home and eat cause if not I am buying three meals a day at school and then I pay for gas for a forty five minute drive home and I am not working much cause I am at school all of those days. And then so the money comes into it so I have to organize my time so I am not always eating out so I can be home to do all my school stuff and eat and save money”.

Students emphasize efficient use of time. The “twenty-four hours in a day” (August) cannot concomitantly accommodate curricular impositions, family and work. Efficiency is then about prioritizing actions and developing specific responses to urgent needs. The following examples highlight the complex learning-technology-space relationships formed in the search for efficiency:

- Students monitor themselves carefully determining best learning-technology-space combination for the learning task at hand – subsection 5.4.1. Preparing for a test might involve group work, working in study rooms or using computers – subsection 5.5.3. Learning spaces are limited though – subsection 5.3.3. To book a room then students [redacted] – subsection 5.6.2
- Temporal efficiency influences the use of the library – subsection 5.4.4: students reject the library website due to its slowness, seemingly caused by password protection and search engine design. [redacted] – subsection 5.4.4.

Fiscal responsibility directs expenditure. Money related challenges are mediated by students in inventive ways. Subsection 5.4.4 presents such examples:

- To support physiological needs in a fiscally responsible way, students avoid buying campus food. [redacted]
- [redacted] As explained by Storm when detailing matters of financial constraints that affect behaviours, [redacted]

Judicious use of time and money is a proscriptive rule which cannot be broken. This empowers students to search for efficiencies within its constraints. In doing so, the connection between learning, technology and spaces – subsection 5.3.1 – is omnipresent.

5.2.3 Professional norms affect learning with technology during idle times in preceptorship

Saying that professional norms affect learning with technology during idle times in preceptorships, conveys the message that whenever ambulances are not involved in calls, students – fuelled by the ethos of continuous studying uncovered in section 5.2.1 – can engage in academic learning. In doing so, students need to follow unwritten expectations paramedics have of learners.

Students are constrained by professional norms to be out of the way of working professionals. When ambulances are waiting for a call, they are usually parked at paramedic bases. During these idle times, working paramedics enjoy a moment of relaxation – talking, watching TV, eating, cooking or other activities. Students though do not seem to relax; they are expected to maintain a professional, friendly attitude, complete ambulance chores and only then engage in personal activities. A general sense of being out of the way dominates paramedic-student interactions during these idle times. For example, while detailing professional norms that affect behaviours inside an ambulance station, River reveals the following:

> "They're all working medics. I'm just a student. If someone wants that seat, it's theirs. We don't sit on the comfy chairs … That's just something that it's always been drilled into our [redacted], and it's just the culture of how it is. You don't – and it's kind of like a respect thing, too, right? If there's limited comfortable chairs, I'm just a young student that doesn't know anything. This guy's got the seniority and you notice it among them as well. [...] they have their seniority of who gets the

couches, who's in chairs. It's always the same. […] it's just you're used to it. It's just how everyone functions and you just accept it's part of it. It's like a seniority thing, but that and the students, I don't sit in the comfortable chairs, really. I'd rather sit at the table. I can always be studying or something".

Professional norms enable students to find spaces where they can engage in personal activities outside the presence of their preceptors. Subsections 5.2.1 and 5.2.2 portray students as always looking for time and, implicitly, space to study. When this time is found in the context of idle times during preceptorship a question of space is raised. Usually – as I will later discuss in subsections 5.5.3 and 5.6.4. – even if students start learning in the crew room of an ambulance station, they end up using the back of an ambulance as their own private study room. There, technology mediates a melange of learning and relaxation. Nonetheless, the back of ambulances is not designed for studying; it is designed for patient care – subsection 5.3.5. Continuing the above excerpt, River seems to associate moving to the back of the ambulance with a transhumance which mediates student learning while not bothering their preceptors:

"I can always be studying or something. […] It's more reviewing stuff on my computer. Like, I'll go to like "Life in the Fast Lane" or something or open a PDF or something. I don't like to spread out all my notes and shit like that. I like to be – it's again just a seniority and respect thing. I like to be able to close my laptop, shove it in my bag and the only obstruction from me is my bag, off to the side. […] Once the lights all go out in the station and people are sleeping, I'll just go in the truck. I plug it in so I have control of the lights. I put on my music in there [...] I have my feet up on something. Like, either the little table thing. Occasionally I'll rest my leg up on the stretcher. Occasionally I'll rest my leg up on the stretcher" – "Life in the Fast Lane" (*Life in the Fast Lane*, 2022) refers to a website River uses while studying.

5.2.4 Summary

Enabling constraints point to rules which students cannot break yet mediate a myriad of learning-technology-space possibilities for learners. In their proscriptive role, these rules set the stage for the rest of the narrative. Figure 5.2 highlights in turquoise connections associated with enabling constraints. Arrows were avoided as not to suggest cause-effect relationships uncommon in complexity thinking.

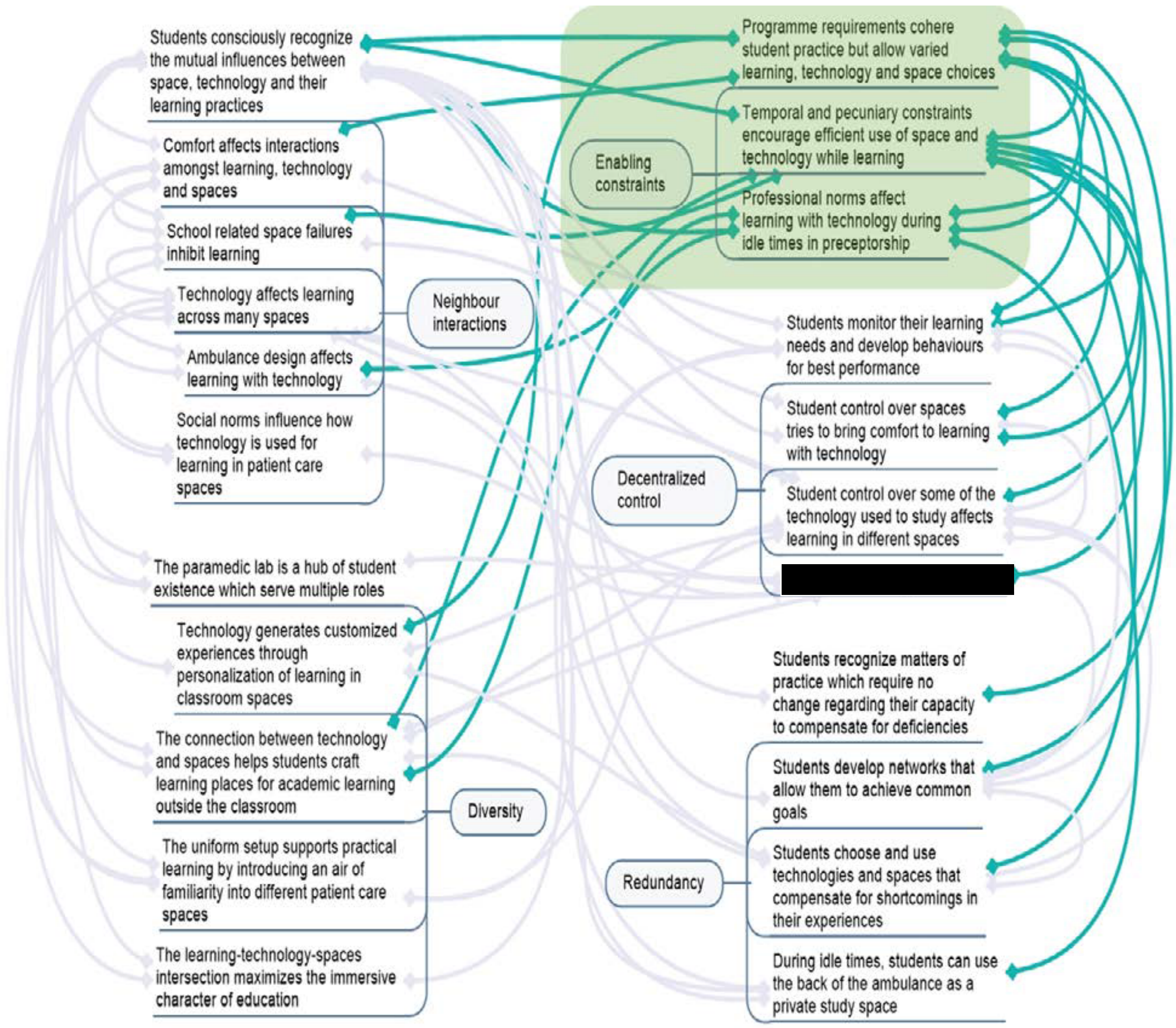

Figure 5.2: Enabling constraints and highlighted connections.

5.3 Neighbour interactions

This section presents those aspects of data which show n*eighbour interactions*. These represent learning-technology-space matters where closely related elements are "affecting others' actions, defined as interactions between neighbors. Interactions between neighbors involve not only people, but also ideas, questions, and other manners of representation" (Braga & Martins, 2019).

Neighbour interactions are important for new and interesting properties to appear. While looking for these interactions, I found that while some are purely physical – computers connecting to electrical outlets – others are at the level of "ideas, hunches, queries, and other manners of representation" (Davis & Sumara, 2006, p. 142) bumping into each other. Regardless of their degree of physicality, all highlighted "mechanisms […] to ensure that ideas will stumble across one another" (Davis & Sumara, 2006, p. 143).

Neighbour interactions point to failures of learning-technology-spaces. Interestingly while students are aware of neighbour interactions that have negative effects, they are not able to entirely fix these on their own. This highlights the connection between programme requirements, neighbour interactions, decentralized control and diversity – subsection 5.2.1, sections 5.4 and 5.5.

My analysis identified the following main ideas which will be elaborated below:

- Students consciously recognise the mutual influences between space, technology and their learning practices. Finding that students recognize the cohesiveness of these three elements substantiates the object of my investigation.
- Comfort affects interactions amongst learning, technology and spaces. The student declared importance of physical and psychological comfort is highlighted.

- School related space failures inhibit learning. After highlighting the need for comfortable student experiences, this section offers a direct look at discomfort created by school spaces.
- Technology affects learning across many spaces. Technology’s role as mediator or inhibitor of learning is highlighted here.
- Ambulance design affects learning with technology. The disconnect between the design of an ambulance as a patient care vehicle and its use as a learning space is highlighted here.
- Social norms influence how technology is used for learning in patient care spaces. This shows perceived expectations from outside the profession and their role in influencing technology use while caring for patients.

5.3.1 Students consciously recognize the mutual influences between space, technology and their learning practices

Saying that students consciously recognize the mutual influences between spaces, technology and their learning practices, sends the message that learning, technology and spaces form a triad where relationships and influences are visible. Students recognize the learning-technology-space intersection as a gestalt organically integrated in their existence.

The concomitant interaction amongst learning, technology and spaces is a constitutive element of students’ lives whose absence would lead to educational disruptions. Students clearly signal the fact that this intersection exists, and, while it has multiple and sometimes specific connections to the physical, its main purpose is to mediate the flow of ideas connected to learning. This is a turning point in data: students recognize that it would be pleonastic to think of someone studying, while not being located in a given space or not using technology. When I started investigating the learning-technology-spaces intersection I did not know whether students saw a connection between learning, technology and spaces or not. Now, this connection is evidenced in student words. To exemplify, Indigo explains the indissoluble meshing of learning, technology and spaces in their experiences:

> "So, I think they all kind of work hand-in-hand. Like, to be able to learn something, you need the technology that you like and you use in the spaces that you learn, right? I guess, if that makes sense".

Recognizing this intersection substantiates my object of investigation and helps solidify the system-like characteristic of the learning-technology-space intersection in student practice – subsection 6.2.2. Considering learning-technology-spaces as a system, means that modifications to one part of the system can change the system itself. Student accounts related to either learning, technology or spaces thus need to be considered as possibly affecting the tripartite intersection itself. This subsection is thus connected to all other (sub)sections of this chapter. This mantra helps understand the importance and rationale for including this theme in my thesis.

5.3.2 Comfort affects interactions amongst learning, technology and spaces

Students recognize that interactions amongst learning, technology and spaces are affected by physical and psychological comfort. Comfort, while not directly learning, technology or spaces, is interwoven in all of these; being uncomfortable decreases learning and connects to the interaction between spaces and technology. Student decisions are then focused on the desire to achieve comfort – parts of section 5.4 attest to this.

Physical comfort is seen as the lack of negative sensorial inputs. Data show examples of students wanting appropriate temperature, lighting and seating. Physical comfort is then closely associated with spaces and technology. As an example, Sparrow provides insight into the role of comfort in connection to spaces and technology when reflecting on their learning experiences:

> “I don’t like the chairs there, too. There’s the ones in the library that are like – I don’t really like the single study spaces. They’ve got the desk with the chairs. […] On the third floor there, there’s a few that are, like, boxed in like that. And I don’t know, the chairs are uncomfortable. […] I think they’re like too high or too low and I always find myself sliding down and then it just gets uncomfortable”.

Psychological comfort is ultimately associated with knowing how to care for patients. I presented this in subsection 5.2.1 as it helped set the tone for the thesis; I will reiterate it here since this is where it became evident. To add, the road students take to becoming paramedics is peppered with potentially psychologically uncomfortable situations: failing to respect programme requirements, not having time to study, being given negative feedback in a public manner, not being heard in a classroom, etc. The connection between psychological comfort and learning is then evident. As an example, Zephyr, when pondering on matters of learning, technology and spaces, eloquently draws attention to matters of psychological comfort:

> “I need physical spaces, things including plugs, projectors, screens, that kind of stuff, but at the end of the day, that’s what makes a space for me is it’s more intangible. It’s not […] I care more about who’s in the room, am I wanted in the room? Am I treated well in the room? Is my voice heard, that kind of stuff all matters to me”.

Despite recognizing the positive impact of psychological comfort, students appreciate being challenged in their education. This is how their knowledge progresses. Journey demonstrates the importance of being stimulated in their learning, when they passionately affirm:

> "It's very difficult, so I'm not quite comfortable because there's always something that you know is difficult, like if it's a test, if it's OSCEs, if it's just a project, there's always something that's – I'm not the most comfortable because there's always something that I'm – not struggling with, but I'm like working on or I'm trying to improve on. So, I think that comfort, I don't think I'm very comfortable in the programme. I don't think it's a necessity. I think if I'm comfortable, I'm probably not trying hard enough. […] I feel, like you know, I could push myself harder".

Physical and psychological comfort are interwoven in the learning-technology-spaces intersection. This interconnection is clearly exemplified in Zephyr's words, heard when they were contemplating elements that influence their experiences:

> "Comfort isn't just sitting in a chair being comfortable. It's sitting in a chair, in a room you're supposed to be in, that you're welcome in, that's set up for learning".

5.3.3 School related space failures inhibit learning

Student accounts depict elements of school related space failures which inhibit learning. Learning-technology-spaces form a gestalt – subsection 5.3.1. Space insufficiencies create discomfort – subsection 5.3.2. This disturbs learning, and, through interconnections, the learning-technology-space continuum. Routinely, students are tributaries to school provided spaces. While sometimes students can control space disturbances – subsection 5.4.2 – institutional intervention remains needed to improve discomfort caused by most space failures – subsection 6.2.4.

A few examples point to space related failures that directly impact learning. These re-enforce the need for comfort regarding learning-technology-spaces interactions. Space failures are mostly related to matters of infrastructure, architecture or ergonomics. Students can try to improve these but they cannot bring permanent change. Inappropriate temperature, classroom layout and noise negatively affect learning experiences by creating distractions and limiting engagement both inside the classroom and during individual study sessions. Students demonstrate the negative influences space related failures have on their overall learning experience:

> "You can't change the thermostat for each room. So, that's – I guess that's a big thing. Like, the school controls the heat in here. You don't get to control heat […] Like, you could be sweating and you couldn't do anything about it, so that would definitely affect the way I would – if I was sitting there sweating or really cold, it would take my focus away from my learning" (Indigo)
>
> and
>
> "Most classes do not have higher […] Like steps where they put another level for short people to see over the tall people […] So I cannot see like [redacted] would be teaching or you would be teaching and say like […] the really big guys are in front of me I have to go like this (moving head higher as if not seeing)" (Bay)
>
> and

> "I would get easily distracted if people were in front of me and talking and I could hear them or like they were kind of blocking my view of the whiteboard. I feel like I need to make the most of my learning, so I always sit up front because I don't want to miss anything" (Winter)

and

> "So like yeah it is supposed to be a quiet room but is it really? No. And that is what happens in a lot of study rooms. […] people who aren't studying […] taking up a study room from someone else who needs it and they are being loud and disrupting the studying for next door. It gets loud like […] it sucks when you are actually trying to study and people are just being loud" (Bay).

The lack of study rooms leads to inefficient learning opportunities. Students spend extensive time studying outside school imposed schedules. Study rooms are scarce and much sought after as places for after-hours learning. Students lament their scarcity and wish there would be more. For example, the need for study rooms and the challenges associated with the lack of such spaces are clearly revealed in Ocean's account:

> "I feel like if you're here throughout the day, like especially when most people have class nine to four, all of the study rooms are taken all of the time. So, I feel like we need more spaces where – those private study spaces where we can go".

5.3.4 Technology affects learning across many spaces

Saying that technology affects learning across many spaces sends the message that technology both allows and inhibits learning amongst a variety of spaces. Smartphones and laptops allow studying in multiple spaces. Absent electrical plugs limit computer usage and inhibit learning. When present and appropriately used, simulation technology mediates successful learning experiences. Examples of the balance between what technology allows and what technology inhibits are evident in data and presented below. Overall, similar to the previous section, while students control some matters of technology used in their studies – subsections 5.4.1 to 5.4.4 – institutional help is needed to solve challenges uncontrollable by students – subsection 6.2.4.

Technology allows academic learning to take place in a consistent manner across many spaces. Once a means of learning with technology is uncovered, this can easily be deployed in multiple spaces. For example, this is demonstrated by Zephyr when revealing patterns of using technology to study across different spaces:

> "Studying Patho, I'll do in the study rooms, at home in my apartment, I'll do it with [redacted] in the study rooms at our apartment. […] Or in lab. I'll do that in many different places, but always use the same notes, the same technologies and OneNote and then I'll use Facebook to set it up. You know what I mean, "hey, can we meet here and study this?" Yeah, then we go to whatever room they want to meet at, maybe let's go to SALS so we can use the whiteboard. "Hey, I'm home, can you just to come to the apartment and we'll study in the study room?"".

Smartphone portability allows learning in the moment regardless of space. Students recognize that technology allows easy access to information, not only in the classroom but also in the other educational spaces students traverse. Smartphones stand out as allowing easy access to information due to their portability. Lux, for example, when focusing on the technology used in learning, identifies smartphone portability as essential in accessing information in a multitude of places:

> "All depends on what I need it for so […] my phone is always going to be in my pocket, just in case I need to look something up directive, medication […] The easiness of my phone. Fitting in my pocket I guess. Whereas my laptop I don't really want it out, is fragile, my phone is broken already".

Google dominates the search for information. Learning in the moment is affected by the rapid access to information provided by Google. Googling is not haphazard; students use this search engine to find information from websites whose reliability they learn to appreciate through their studies – NCBI, Medscape, etc. (*National Centre for Biotechnology Information, National Library of Medicine*, n.d.; WebMD Health Corporation, 2015). As a continuation of the previous example, and in seeming connection to smartphone portability, Lux reveals how Google is used to find information housed on professionally accepted websites:

> "Google google it. [redacted] […]
>
> I don't use Wikipedia, I use like Medline or like […] there is healthline.org

> there is a bunch like a lot of the .orgs I would use" – Healthline (Healthline Media, 2022) refers to a website Lux uses while studying.

Overreliance on passwords deters students from using some school resources. Students seem excited to use smartphones to study, but they are not eagerly using the school learning-management-system or library to access information. An overreliance on passwords and cumbersome search engines deter students from using school sanctioned websites. As an example, Lux continues providing insights into their use of technology and positions the hurdles brought forth by passwords within the context of their previously presented statements:

> "For what it is worth and the struggle to even get into the website and to find stuff it is not logical for me. Like I have to […] like I would rather use that time to research on search engines I know already about".

The lack of enough electrical plugs to charge personal devices affects the use of technology for academic learning. This would affect any situation where a charger needs to be plugged in but is a source of enhanced challenges when classrooms or study rooms do not have electrical plugs. For instance, this is presented by Haskell when they clarify the lack of sufficient electrical plugs in classrooms:

> "Yeah cause there are no plugs in the walls no plugs in the back […] it was just where the computer was at the front".

Furniture affects comfort. This stands true regardless of location: classroom, study room, ambulance, etc. Within data, the effect of furniture on comfort is mostly evident in the classrooms where poor furniture choices multiply space design failures –

subsection 5.3.3. Students reflect on and voice their concerns about comfort related challenges brought forth by furniture insufficiencies:

> "Cause like I am short and sometimes I cannot reach the floor from the chairs so it is not comfortable for me […] I like … somewhere where I can put my feet cause my feet go numb and it is not comfortable. That is all I am focusing on" (Basil)
>
> and
>
> "when I am sitting in class all of the desks are this size regardless of how tall somebody is" (Bay).

The lack of whiteboards in study rooms affects learning. Whiteboards are used by students to mediate conversations. The lack of rooms with whiteboards negatively affects student interactions and their exchange of ideas. As an example, Berry, explains this challenge when addressing their exam related study experiences:

> "if I have a big test, I try and study here more than at home and like I try and keep myself at school […] I feel like I have the […] more technology I have the bigger whiteboards, I have a space where I hopefully I have a couple of classmates where I can bounce ideas off of. Where if I am at home it is just me and my thoughts and my whiteboard and I am not able to get those questions answered".

Usage of simulation technology affects instructor-led scenarios. Students are satisfied with laboratory facilities and simulation technology available during school hours. Nonetheless, simulation technology is not always used at its full potential.

During instructor-led scenarios, shortcuts are sometimes used; these decrease the realism of the simulation and generate missed learning opportunities. Students notice these situations and become frustrated by their presence. Cedar, for example, uses compelling language to challenge the inappropriate use of simulation technology in their learning:

> “Because we do not have stretchers in there. Like sometimes they only give us the stairchair and they actually expect us to put the patient on the stairchair. I hate the fact that [redacted] […] [redacted] You know? [redacted] because lifting is so important [redacted] and I get it preserves the back and all that stuff [redacted] … you are doing that wrong?”.

Unavailable simulation technology affects after-hours practice. Less simulation technology is available for after-hours practice than for instructor-led scenarios. Students recognize this lack of access as generating decreased learning experiences. The most discussed challenge is the use of older cardiac monitors during student-led after-hours practice. This, for example, is evidenced in Lake’s reflection on the availability of simulation technology:

> “Without the medical equipment and labs, like, if we didn’t have good monitors, I don’t know how we would function. Trying to use the old monitors that we have. […] the white ones, you can’t. Right, it just doesn’t work”.

Most students lament the unavailability of resources but find themselves unable to change this situation. [redacted]

Access to simulation equipment in ambulance stations affects preceptorship learning. Access to simulation at paramedic stations is reported by some students. This usually consist of medical equipment – already present in the ambulance – but also involves some sort of simulation mannequins – usually a torso and an injection pad – on which students can practice assessments and care. Most students report that preceptors are eager to share their knowledge during idle times when ambulances are parked at base; the presence of simulation equipment enhances these learning experiences. To exemplify, Piper describes how an earlier call was clarified through simulation performed at base later in the same day using a torso simulation mannequin:

> "But I had no idea and I was like, "I can't believe that someone who is having an ASA overdose has crackles." Like, that just never registered in my brain, I guess. I was talking to my preceptor about it. He was like, "Don't worry. I'll help you," and then later that night we ran the exact same call. […] There, with the little torso-man".

5.3.5 Ambulance design affects learning with technology

Ambulance design affects learning with technology; this means that the layout of an emergency vehicle influences learning activities that take place inside of it. The back of emergency vehicles is a patient care space with little of the learning amenities visible in spaces dedicated to academic learning. However, as detailed in subsection 5.6.4 students engage in academic learning in this space during idle times at base. The position of the stretcher inside ambulances affects how many people can concomitantly intervene on a patient; during high-acuity calls students might lose access to the patient when the stretcher is not located in the middle of the ambulance floor. Separating panels affect communication between the front and the back of the ambulance; these impact communication between students – usually located in the back – and preceptors – usually located in the front – while en-route to a call and sometimes during debriefing. While ambulance layout affects learning, changes to it mandate institutional intervention – subsection 6.2.4.

The back of an ambulance is a dedicated patient care space. This is a rectangular box which does not have desks, tables or whiteboards seen in academic learning spaces. This is a patient care space which houses a stretcher, a few seats, electrical plugs and a multitude of cabinets holding patient care equipment. Data present two types of ambulances named based on the stretcher setup in the patient care compartment. Side-mount ambulances have the stretcher positioned to the left side of the patient compartment floor – as looking through open back doors – with one seat at the head of the stretcher and one seat to its right. This is the configuration most reported by students; a collage of student drawings portraying representations of side-mount ambulances is depicted in Figure 5.3. Centre-mount ambulances have the stretcher positioned in the middle of the floor; this allows one seat to be present on each side of the stretcher and one seat to its head; this is represented in Figure 5.4. Only three students discuss centre-mount ambulances.

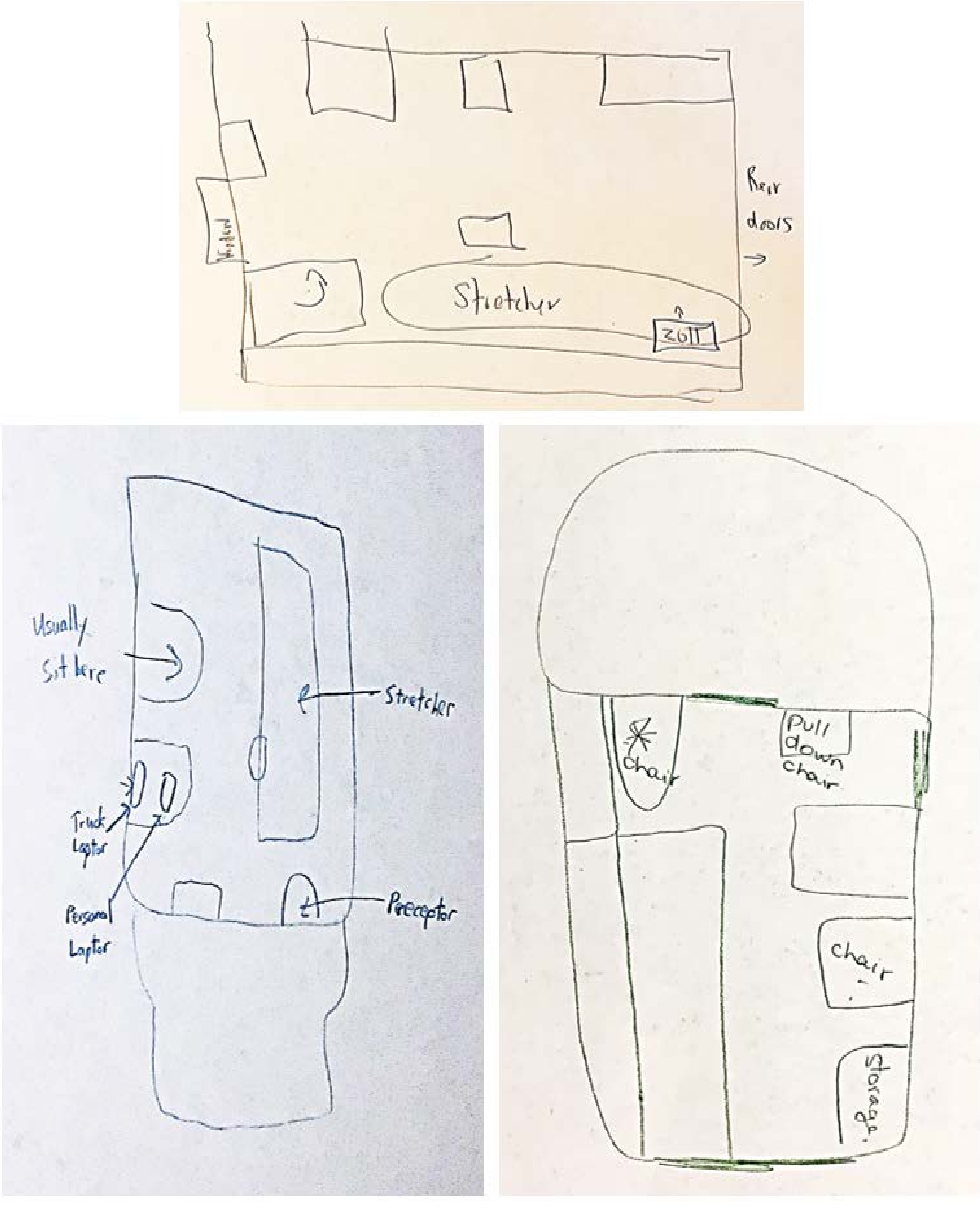

Figure 5.3: Side-mount ambulance. The stretcher is positioned on one side of the floor, next to a wall. The stretcher can be accessed from two seats: one to its side and one to its head.

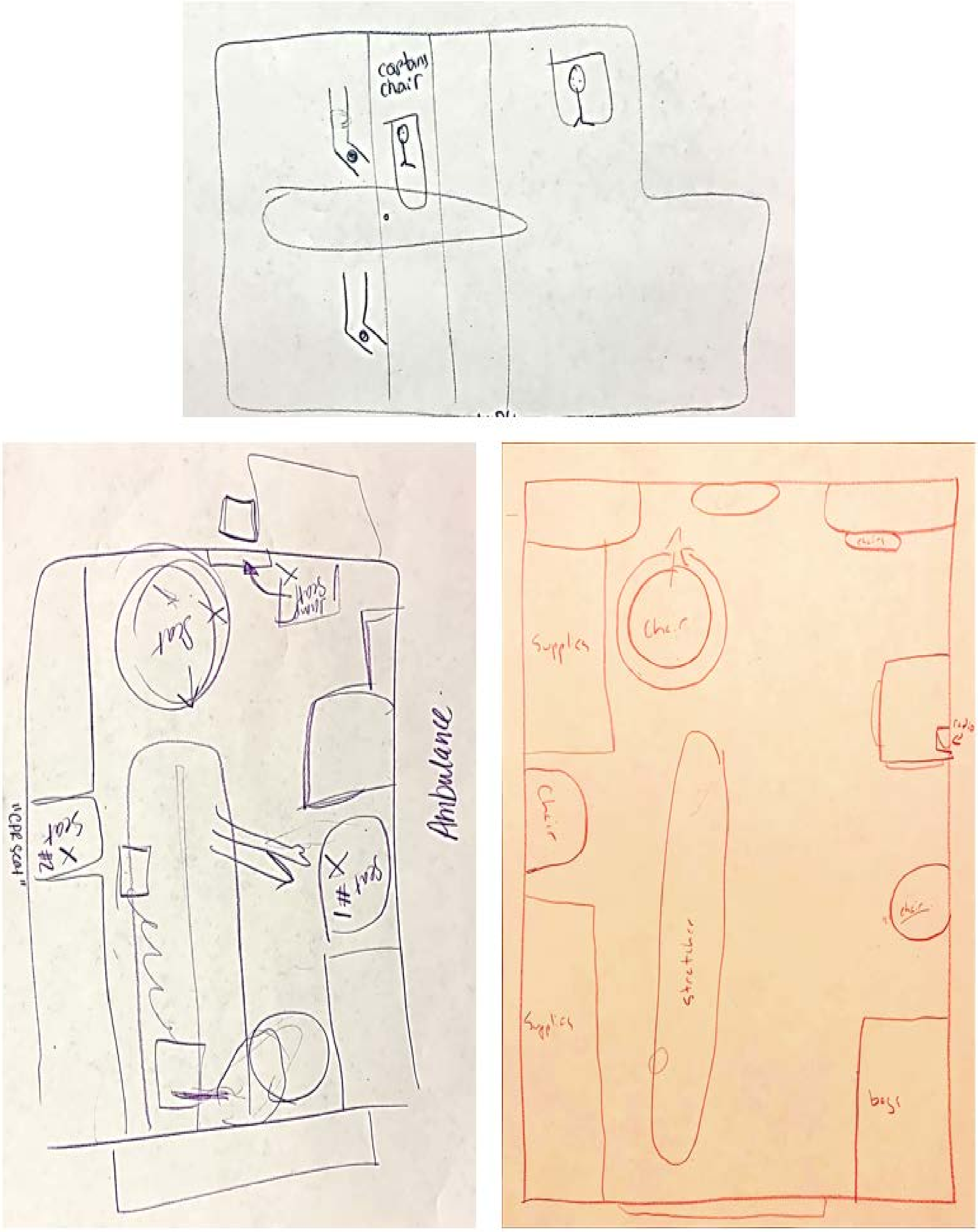

Figure 5.4: Centre-mount ambulance. The stretcher is positioned towards the centre of the floor. The stretcher can be accessed from three seats: one on each side and one to its head.

During high-acuity calls, students might have better patient access in centre-mount ambulances. Much like an emergency room on wheels, ambulances are spaces housing much patient care technology where students learn their craft hands-on. During low-acuity calls patient assessment and care are provided but no life-altering procedures are performed; preceptors usually sit at the head of the stretcher, only intervening if needed while students perform most assessments from the side of the patient. This is hands-on learning involving patient care equipment within the space of an ambulance. High-acuity calls see preceptors more involved in patient care by performing life-altering interventions. Patients are usually supine on the stretcher, while paramedics and students move in the patient compartment to provide care. During these calls, it is not uncommon to have back-up paramedics assisting the main crew. Two or more paramedics might concomitantly attend a patient. When access to patients is limited to only two sides – as in side-mount ambulances – paramedics are adjacent to the patient and students are left behind, barely able to see or assist. When access to patients is available from three sides – as in centre-mount ambulances – students could sit opposite from paramedics, thus benefitting from hands-on exposure to life-saving care. As an example, Winter's narrative about care in the back of a side-mount ambulance points to these failures [redacted]

> "So, last time we also had [redacted] on there with us, well, [redacted] was there and they – they were all just talking to her and I was attending. I'm attending and I'm like over here and I don't know what's going on. […] You know, so then they were like, well you kind of missed this and I was like, I didn't hear

> that. Like, you know, I need – this needs to change a little bit here because at like – if I'm attending, I want to come back in. […] I want to reconnect them to the monitor. […] I want to do the blood sugar and the 12-lead, you know?".

The opposite stands out about care in a centre-mount ambulance. As an example, Indigo, while drawing the picture on the bottom right side of Figure 5.4, seems to express their excitement with being able to have direct access to patient care due to the design of the ambulance:

> "So – and this is where it gets kind of cool, I'll start here. So, the stretcher goes like here. And then again, this is where this side is supplies and stuff and then it goes like this and then there's over – no, there's no overhead. It stops there and then it goes like this and then this connects. So, there's a chair here. […] So, there's another chair. So, you can have three people on – and then there's this chair here. So, you can do CPR, you can walk around".

Communication between front and back compartments of an ambulance is difficult; this leads to missed learning opportunities. The front compartment of an ambulance houses both paramedics when not servicing a call and only the driving paramedic when the attendant is in the back with the patient; radio and sometimes a dispatch connected computer are housed in the front compartment. Students usually sit in the back. Back and front compartments are divided by a wall; communication is possible through a rectangular sliding window roughly the width of an average adult's shoulders and slightly taller than wider. When both preceptors are in front, students sit in the chair located at the head of the stretcher, turn it around as much as possible and talk to the preceptors through the sliding window. Students usually report sitting with the chair at a 90-degree angle from the window in side-mount ambulances; centre-mount ambulances sometimes allow the chair to face the window. Nonetheless, communication between front and back takes place through the sliding window and is uncomfortable. Student access to the radio and/or the front computer are impossible from the back. This inhibits learning en-route to calls and sometimes debriefing after calls are completed. As an example, Winter's account clarifies such difficulties while en-route to a call:

> "My neck was hurting a lot from, like, looking over and reaching in there, and half the time I can't hear them. I have to stick my ear in because all the noise in the back and stuff when we're going. […] I can't hear them or I think, like, it would be nice even to have the dispatch code and stuff come into the back or for us to be able to see it because a lot of the times I go "what is it," and they go "oh, it's this," and I go "what?" You know, like you can't always hear […] So, and it would be nice to see and, like, as a student you spend most of your time here and then just attending everything, but you don't really get to see how the front works and like how the dispatching comes in or learn really anything like that […] and it would be nice to see […] So, definitely, I think like being back here isn't the best, but there's really no other place, I guess, for us".

A sense of despair and psychological discomfort is evident from the last phrase in the above quote. This connects to the idea of comfort, which dominates my thesis – subsection 5.3.2.

The back of the ambulance assures privacy in debriefing but when this takes place while driving, learning is lost due to communication failures. Students treasure debriefing in privacy. The back of an ambulance affords such privacy along with access to equipment in case on-the-spot demonstrations are needed. Challenges appear when debriefing takes place with the student in the back and the preceptors in the front of the ambulance; miscommunication and missed learning seem to coexist. Piper, while reflecting on debriefing inside the ambulance, points to the manner in which ambulance design enhances communication challenges that affect this important part of learning:

> "Last night when we were at ride-outs, my one preceptor […] was talking forward like this and he was like "[redacted], how do you think that call went?" And since there's such a large space between and he was mumbling towards the front, I was like, "What are you saying? I can't hear you." […] Never mind, I'm like, okay.".

5.3.6 Social norms influence how technology is used for learning in patient care spaces

Social norms influence show technology is used for learning in patient care spaces. This means that a series of unwritten expectations from outside paramedicine influence the way students use their technology – usually smartphones – while helping patients. Students perceive that, unless there is a life-or-death situation, the public has a general expectation of no electronic devices being used on scene during patient care.

Students discuss that when the situation calls, smartphones could be used on scene to access potentially life-saving information. This usually means that students – or working paramedics – use smartphones to verify treatment or medication information. Emery exemplifies this situation when summarizing the use of smartphones at the point-of-care:

> “if you are coming into like somebody is unconscious and you have no idea why and nobody knows anything […] And then you are looking and you are like the bottle is empty you can suspect an overdose and you might need to know what that is”.

Nonetheless, students perceive that using smartphones on scene might be seen as unprofessional. To exemplify, Emery points to perceived professionalism challenges when detailing their testimony about the use of smartphone during patient care:

> “I think it is more of a professional thing I think that if you see a paramedic pull out their phone while assessing the patient or asking questions, the patient might be like what is this person doing like why are you pulling out your phone? Where … if you pull out a notebook they do not question what you are doing”.

Therefore, even though technology could affect learning, academic in this case, during patient care – subsection 5.3.4 – its [redacted] – subsection 5.4.4.

5.3.7 Summary

Neighbour interactions helped identify student opinions about closely related learning, technology and space combinations. Overall, accounts start showing the complexity and adaptiveness of learning-technology-space groupings and the areas where institutional, rather than student, input is needed to maximize their utilization. Figure 5.5 highlights in turquoise connections associated with neighbour interactions which allow the narrative to unfold.

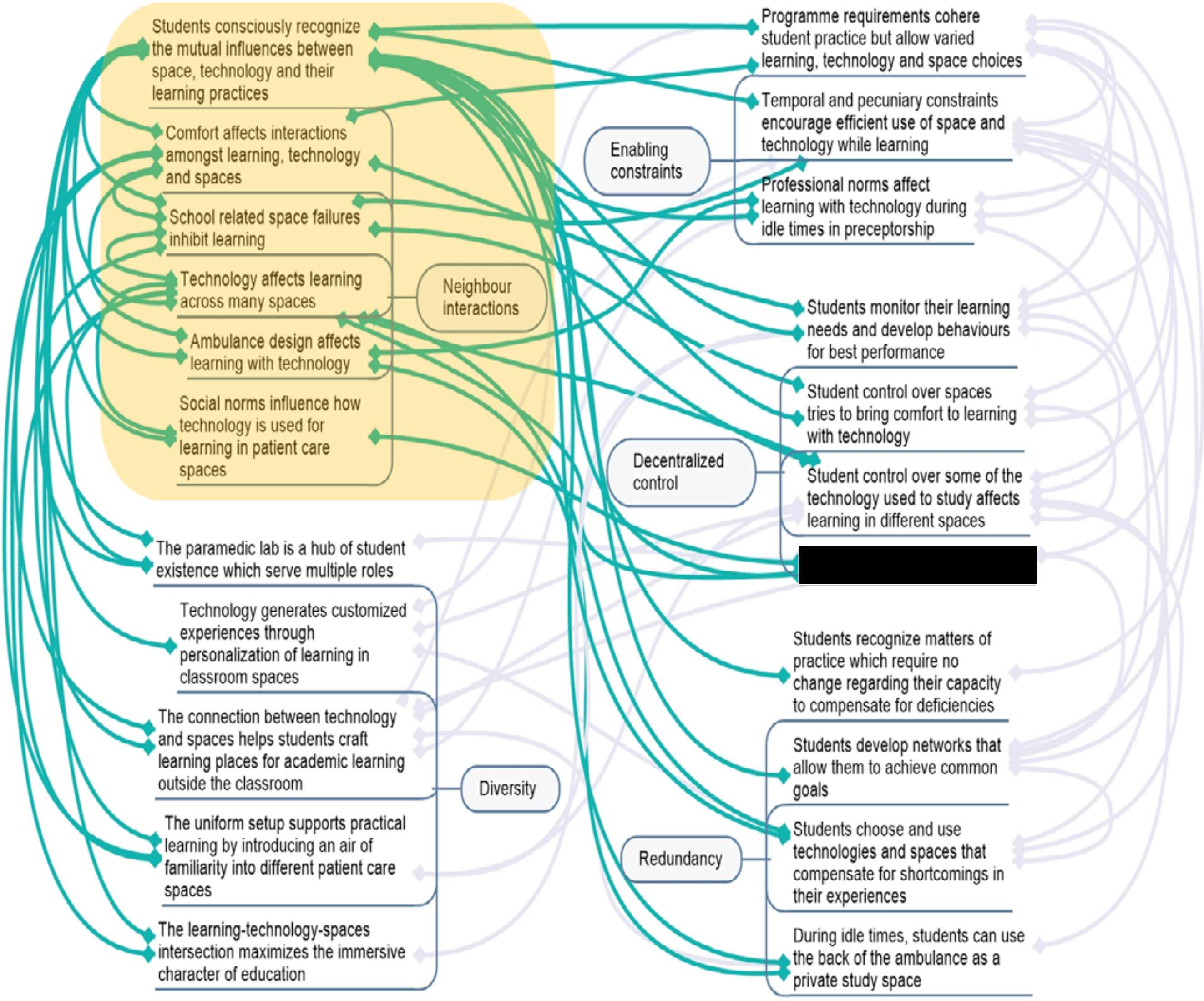

Figure 5.5: Neighbour interactions and highlighted connections.

5.4 Decentralized control

Decentralized control represents matters of bottom-up decision-making, where the system itself decides what is and what is not acceptable. For this section I specifically looked for and mapped matters of bottom-up decision-making which appear the most in data. A look at decentralized control helps understand the way students exercise control over technology, spaces and learning practices. Much like in the case of neighbour interactions the negative side of decentralized control is visible in data; student decisions show them having little influence over learning-technology-space failures.

The following ideas allow the narrative to unfold; these will be elaborated in the next sections:

- Students monitor their learning needs and develop behaviours for best performance. Students are thus pro-active about their education. This enhances their, mainly psychological, comfort.
- Student control over spaces tries to bring comfort to learning with technology. Students have limited control over space failures. On their own, students can ameliorate but not fix infrastructure challenges.
- Student control over some of the technology used to study affects learning in different spaces. By controlling technology – especially academic learning technology – students use the learning-technology-spaces intersection to match some of their needs.
- [redacted]

5.4.1 Students monitor their learning needs and develop behaviours for best performance

Saying that students monitor their learning needs and develop behaviours for best performance sends the message that students become astute connoisseurs of self and use this knowledge to decide their actions. This highlights students' capacity to understand what it is they need in their training and supplement as required. Students make changes to their behaviours that allow them to maximize benefits drawn from the learning-technology-space intersection. Overall, this enhances student comfort and leads to embodiments of learning-technology-spaces that serve student needs.

Students monitor themselves and identify own needs. Students admit to reflecting on their educational needs. This helps them understand conditions needed for best performance not only in individual courses but also in the overall programme. Connections to the learning-technology-spaces intersection are evident as each learning process has specific technological and spaces requirements. For example, Bay explains the process involved in determining the learning-technology-spaces intersection that would best fit their needs:

> "Well I think about what I need. So if I need to go and practice my skills, then lab would be the best place for that. That is what is designed for. If I am going to actually practice my skills on a real person and become confident then obviously I should use ride-outs for that. If I need to learn like something … there is no place other than class … the best option".

Students become aware of their study needs. Studying is a well-thought habit influenced by a vast curriculum, a desire to best serve patients – subsection 5.2.1 – and temporal and pecuniary constraints – subsection 5.2.2. To exemplify, Lux reflects on and expresses a keen awareness of their study needs when detailing activities they undertake during school holidays:

> "Like I don't like to take days off from school just because I mentally I get … I'll just freak out. Like oh God I am missing everything. So like I like to at least accomplish at least one task per day so if for example over the Christmas break I would do one task a day were I can get […] so I would be like oh I need to do 3 patho notes today. Like paper … sheets of paper and it is three is like 3 hours worth for me. Cause I need it".

Continuously studying relieves psychological discomfort – subsection 5.3.2. Students spend great amounts of time engaged in after-hours, non-school guided learning. While students recognize that some courses mandate independent practice, they seem to easily accumulate more time than what is required. Berry, for example, identifies the different timeframes associated with studying for various courses:

> "you know the next day I am going to go to B202 and sit in the study room for an hour and a half and just go over patho notes and then I am going to go to the lab for a couple of hours and just do scenarios".

Students articulate their learning needs. The connection with technology and physiological requirements is explained. For example, Sparrow while detailing the long hours they spent in school – and thus connecting to Berry's statement from above – highlights how they meet their physiological and technological needs:

> “I would just say bringing my own things that I need to make my notes right, like how I said I use sticky notes and I use highlighters and different things, so just making sure that I have those with me instead of leaving them at home and then that way I’m able to use my notes or, like, if I’m – if I know I’m going to be here for 12 plus hours, then making sure that I bring food because I can’t focus – I literally cannot focus or do anything if I’m hungry. That sort of thing. So, just making sure that I have those types of things for me to – if I have to be here to study or if I know I’m going to be in the lab, wearing comfy clothes”.

Students use patterns to focus. This means that students develop a series of patterns in their learning which, much like reflexes, allow them to focus on higher order thinking during high-acuity calls; one of the main patterns students develop is the way in which they setup their uniform – subsection 5.5.4. Other patterns are also visible in data; as an example of these other patterns, Basil talks about developing muscle memory associated with medication administration:

> “Like using it is muscle memory. So for example the other day we had a Ketorolac call and I looked at my watch and realized that the time is wrong on it and just when I was looking at the monitor without thinking and I pressed the event button and said that it was Ketorolac. So it is just like muscle memory you do not have to think about it on a hot call so you are just you just know how to”.

To increase efficiency, students become meticulously organized. Faced with scarce rooms, and competing interests, students use their organizational skills to avoid missing any opportunities. Accounts of their meticulously organized lives are supported by artefacts showing detailed calendars and carefully arranged notes. Collages of student generated pictures serve as examples; Figure 5.6 shows highly organized student calendars and Figure 5.7 depicts study material carefully organized on student computers.

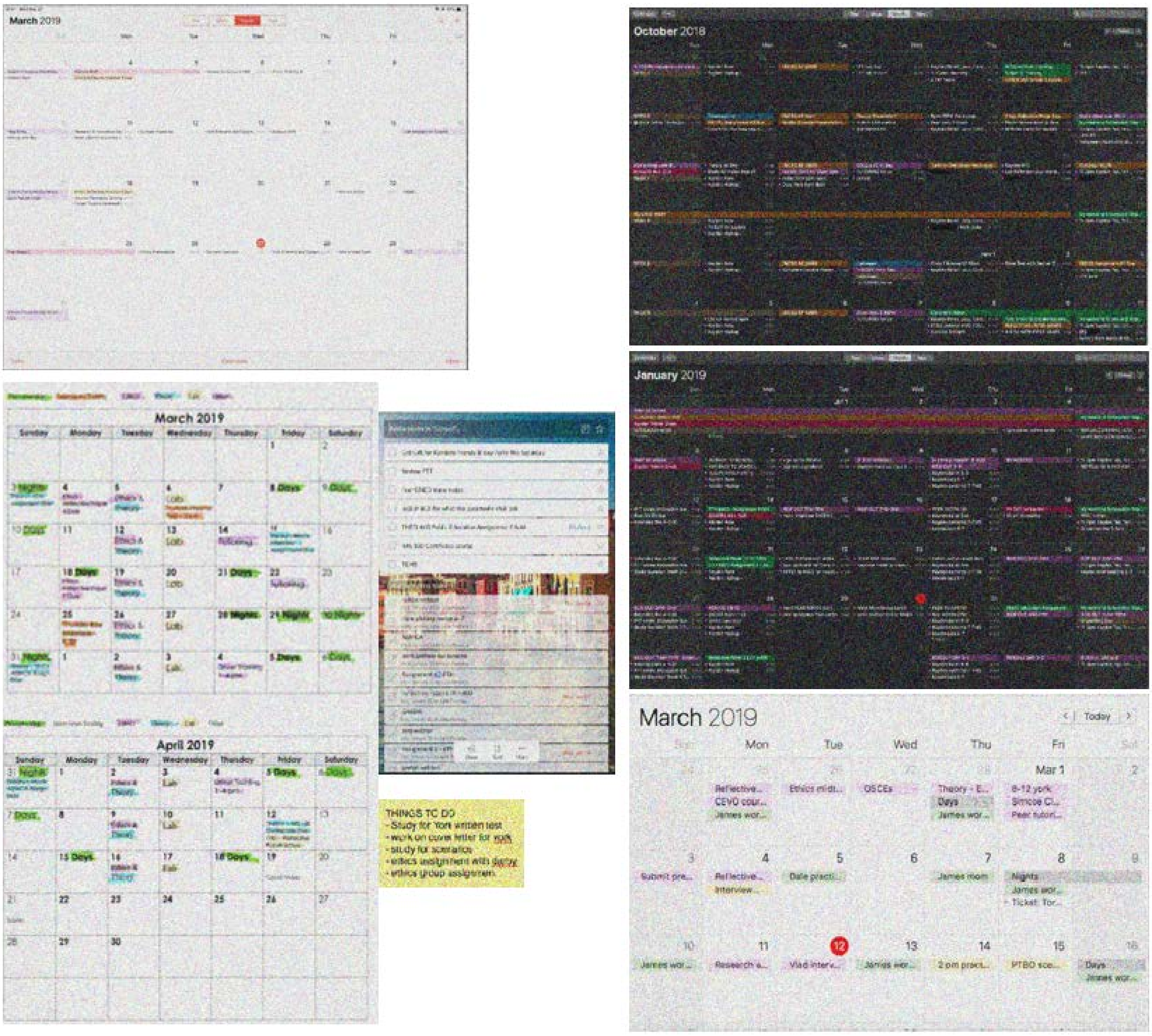

Figure 5.6: Collage of student shared calendars showing their meticulously planned lives. Names were eliminated and pictures were blurred to assure privacy.

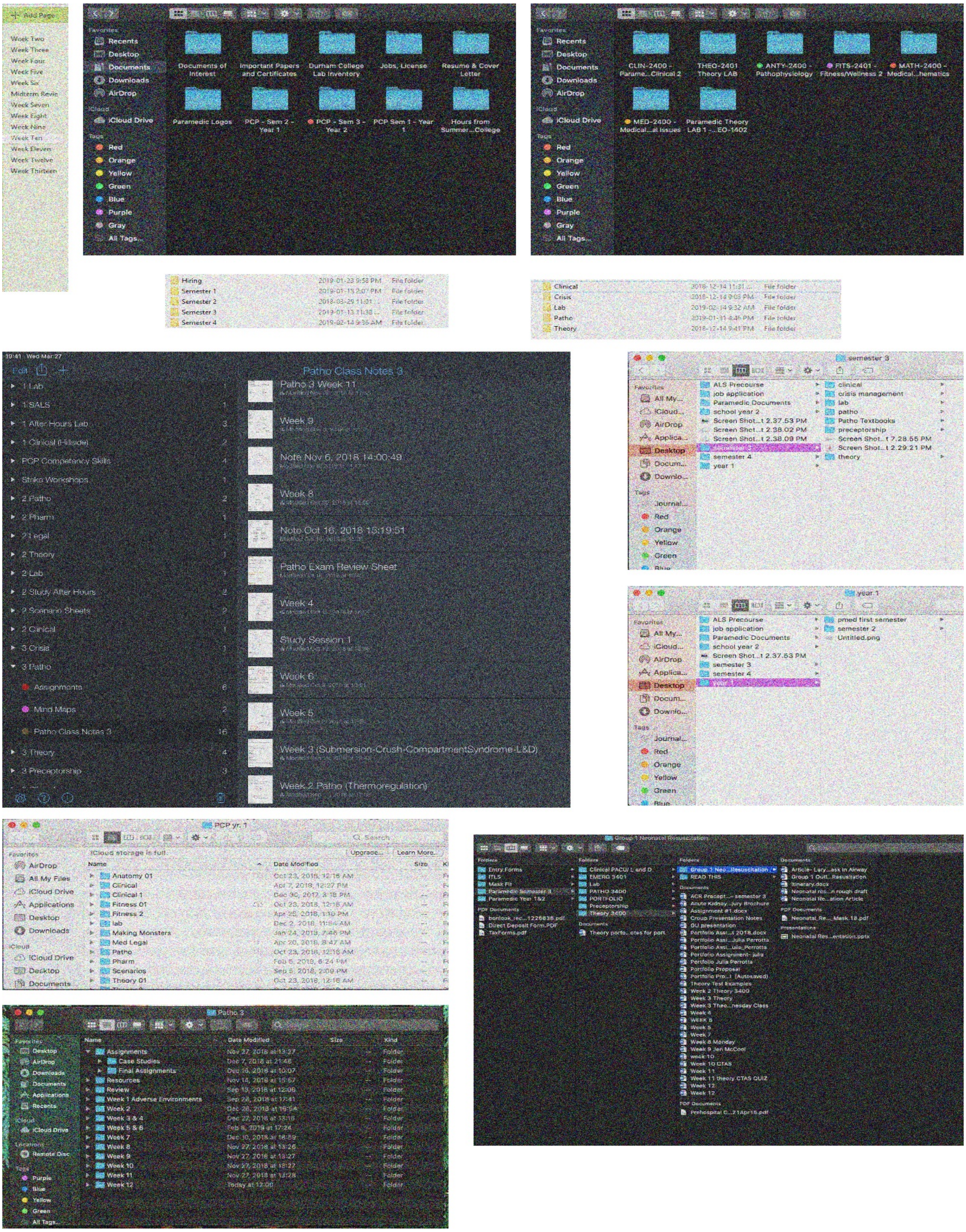

Figure 5.7: Collage of student shared screen captures showing carefully organized study material. Names were eliminated and pictures were blurred to assure privacy.

5.4.2 Student control over spaces tries to bring comfort to learning with technology

Students can make some decision about physical comfort by ameliorating but not changing space failures. This is what I meant by saying that student control over spaces tries to bring comfort to learning with technology. Students recognize space failures – subsection 5.3.3 – but it is not within their power to make infrastructure changes; institutional intervention is needed for this – subsection 6.2.4. Students can make personal and limited decisions: when rooms are cold, students can wear extra layers, when students cannot see the whiteboard they could change desk positions, etc. As learning, technology and spaces are interconnected, space failures affect the learning-technology-spaces intersection.

Students control temperature by layering. Students are forced to learn in spaces where the temperature is institutionally controlled. To assure a comfortable learning experience, students regulate own temperature. Cedar, for example, describes how they assure their physiological needs regarding temperature are met:

> “Yeah I used to bring this shawl and it is basically a blanket and I would huddle with that and stay warm”.

Students exert some control over classroom seating. Each student seems to have a preferred seat. Small modifications can be made to the classroom layout to maximize seating. For example, Bay, describes some of the modifications they make to assure that the learning-technology-space combinations they encounter meet their needs:

“Sometimes we can move desks, sometimes we can move chairs”.

Students prefer seating within direct line of sight to the whiteboards. Some seats are preferred over others. Figure 5.8 is a collage of student drawings attesting their preference for clear views of the whiteboard. Not every seat in the classrooms meets this requirement.

Students prefer seats close to electrical plugs. This is not always possible because some classrooms have limited electrical plugs. In subsection 5.4.3 I will present efforts students make to keep their devices charged. Regardless, discomfort, due to the inability to engage with technology as wanted, seems to increase in classes with little plugs. To exemplify, Figure 5.9 depicts a student sitting away from their laptop which is charging in the only electrical plug, thus having undisturbed view of whiteboards but not being able to use their device.

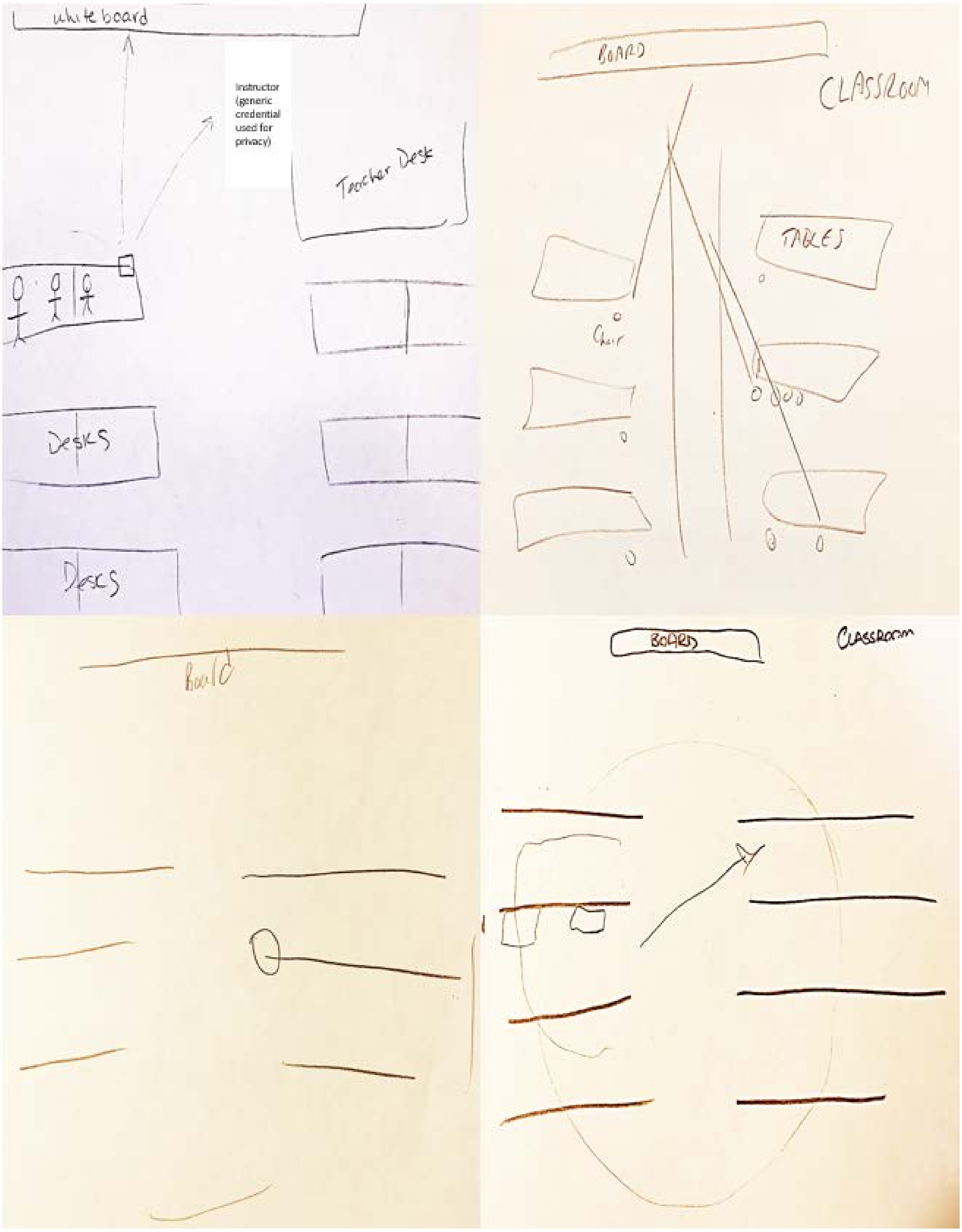

Figure 5.8: Position in classroom shows emphasis on direct line of sight to the board as a representation of comfort.

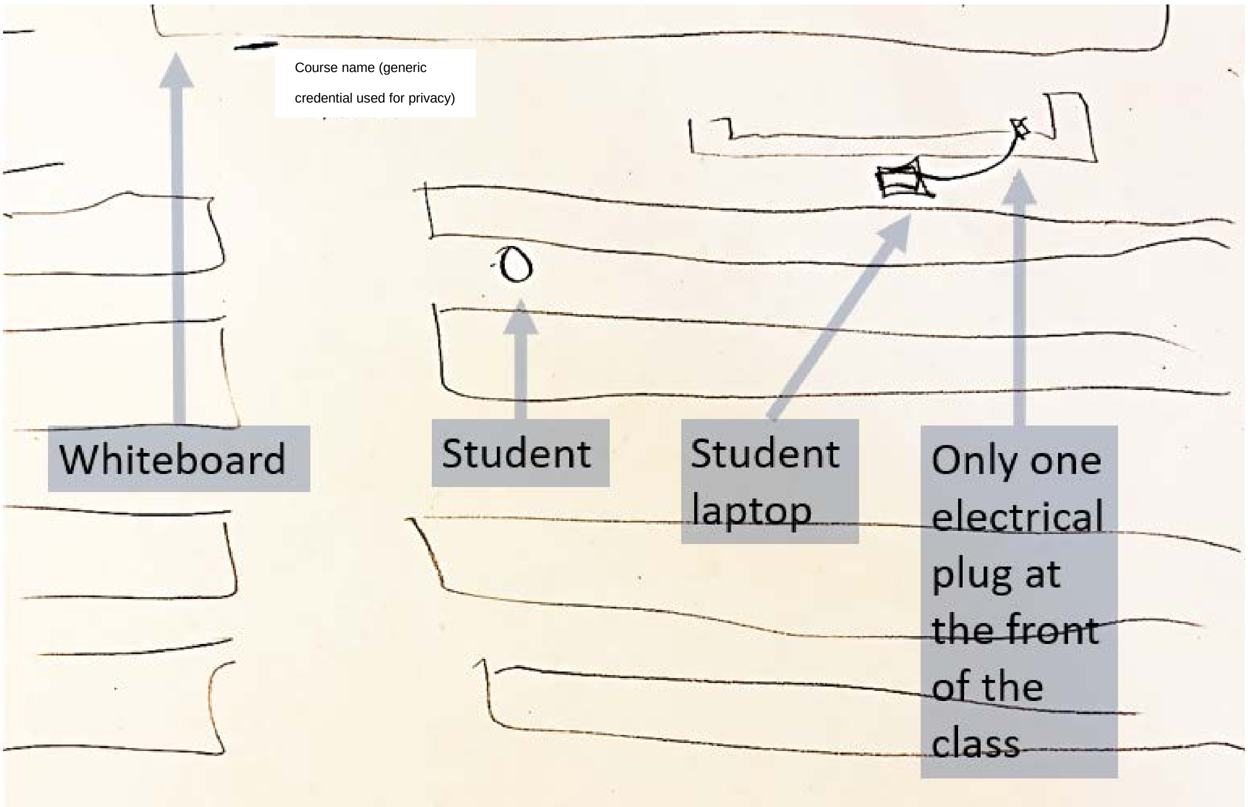

Figure 5.9: A student chooses to stay away from their device to maintain whiteboard visibility. The device is charging in one of the few reported classroom electrical plugs. The student cannot use the device during this time.

Students desire after-hours access to lab and study rooms to study. Students control learning outside the classroom. While this is more prevalent during second semester, it still exists the rest of the time. Connections to spaces are obvious in student narratives about after-hours learning. For example, Cypress highlights the different spaces they use in their learning and places specific emphasis on the need to access certain spaces to satisfy learning needs outside classroom time:

> "Ok so I find that like if I am trying to learn academically and for like patho or theory like more of the written stuff I would go towards kind of study spaces like kind of like smaller rooms and nothing too big with not too many people cause I don't like the loud noises or anything so for that I would go towards maybe my room at home or I will come to the school and go for a study space. And if I am trying to learn more like practical stuff I really like I can join

> the lab. So I usually go to the lab and kind of like go off with only a couple of people …] just like some people I know like I know well and I am comfortable with”.

Student control over spaces of studying is limited. Students cannot control what classrooms they study in. This is imposed by school scheduling – subsection 5.2.1. Within the limits of availability, students can control what study rooms they use. This is, for example, visible in Fox’s acknowledgement that they have different degrees of control over what spaces of learning they utilize:

> “I go to SW 208 cause that is where scheduling tells me my class is but I choose my SW 201 B or A cause that is a study room and if I don’t like it I can go home and study […] So you know what I mean like that to me … I have that power some I have some power, some I don’t have some power”.

5.4.3 Student control over some of the technology used to study affects learning in different spaces

Student control over some of the technology used to study affects learning in different spaces. Students control what personal academic learning technology they use, how they use it and, within limits, the manner in which they setup their own paramedic student uniform. Even though control is limited, students use the learning-technology-space intersection to suit their needs.

Students control own academic learning technology. While influenced by others – detailed in subsection 5.6.2 – decisions over own academic learning technologies ultimately rest with the individual. As Zephyr explains, students are aware of their role in controlling personal academic learning technology:

> "Every – for everything else, the learning and technology, I would say that benefits most of us as students are things that we bring to the table, not things the school brings to the table".

The school offers resources which would allow students to complete the programme without access to laptops, yet everyone prefers having their own devices. While the school does not mandate the use of laptops and offers computer labs which can be used to complete work, students prefer to use their own devices. This is for example visible in Cove's explanations:

> "I think I could finish the programme without my Mac and using my crappy DELL. I think that a computer is needed in this programme. […] It is not mandatory for you to have one. […] everyone technically has computer access because of the computer lab".

Students prefer Apple devices. Even though networks of friends seem to affect this preference – subsection 5.6.2 – the innate qualities of Apple devices seem to make them desirable. As an example, Stirling emphasizes those characteristics of Apple devices which make them more desirable in everyday student activities:

> "Because in my undergrad I went through two HPs and with PC and I just found that they were getting too slow [redacted] and I would get viruses and stuff where the Mac iOS, you don't need to buy

> anti-virus. […] So, I – and I worked when I first graduated from university, I worked for an IT company and I found that Lenovo's and HP are good business devices because you're not using those other platforms whereas in MacBook with the iOS, it has such big memory, such big RAM and they're great at – their iOS is so strong, it's perfect for a home device for any use. So, that's why I went with a Mac".

The preference for Apple also seems supported by the interconnectivity between devices. Cove describes this useful interconnectivity in their account:

> "My phone, my laptop are good resources cause always I have access to everything. […] I just got a Mac […] So I had an iPhone for a few years and for my birthday my parents bought me a Mac so I can change my crappy HP to a Mac. But it is so nice, everything is just so much more compatible now, it is […] I am enjoying it".

Students do not usually immerse themselves in the Microsoft environment, which is preferred by the school and, as very few students know, freely available to them. As an example, Bay, attest to the school's preference for Microsoft:

> "I know that it definitely directed to not Apple. Like every time I handed something in it had to be converted to Microsoft Word".

Students control the way they learn with technology. Multiple ways of learning with technology are visible in data. While curriculum is school imposed – subsection 5.2.1 – individual learning habits are the privilege of the students. This capacity to control own use of technology leads to redundancy – subsection 5.6.3 – and different embodiments of the learning-technology-space intersection in daily practices – subsection 5.5.2. Here is an example of how technology is used to take notes; Piper expresses what they – as an example of personal choice – do in a certain course:

> "Like my Patho notes. For Patho [...] I need to keep all my notes printed, […] I can write on printed. So, generally in class I'll write all my notes out really nicely and make them pretty and then when I go to study them, I'll print them out and I'll either re-write my notes like on pen and paper".

Students develop different means of assuring that their devices are charged when needed. Since much technology uses electricity, keeping technology charged is primordial for students. When classrooms have electrical plugs for all students, this is not a challenge. When electrical plugs are scarce – this resonates with subsections 5.3.4 and 5.4.2 – three methods are predominantly used to assure devices are charged when needed: buying new devices with better batteries, using extension cords to mediate the scarcity of plugs and developing charging patterns and schedules. The first is a prohibitive choice due to pecuniary constraints, the second is only reported once and the third is most widely used. This latter habit connects with the meticulousness students prove in scheduling their lives – subsection 5.4.1. For example, Piper, describes the effort they undergo to assure their devices are fully charged and ready to be used in learning:

> "For when we had Patho last semester for six hours straight, every Monday night I would make sure that my iPad – my Apple pencil was fully charged to 100 and then I would charge my iPad and I would wake up in the morning and I would make sure that it was fully charged".

Students purchase or improvise whiteboards when these are not provided by the school. Students' need for whiteboards was highlighted in subsection 5.3.4; these are extensively used but sometimes missing from study spaces. To compensate for their absence students can choose to personally purchase whiteboards which they carry with them and use as needed. This is for example exemplified by Lux and Ocean:

> "Not enough whiteboards. Whiteboards are going to be a paramedic's best friend. Student's best friend. They are the bomb.com and like […] bomb.com it is phenomenal […] but most of the study rooms do not have whiteboards […] a lot of our students this year bought a bunch or whiteboards, a bunch of markers" (Lux)

> and

> "I have a whiteboard in my car. […] it doesn't fit in my locker. It's big. […] Yeah, I – so I use it – like in a lot of the study rooms, there aren't whiteboards here, like maybe some of them like this one has one, but [...] Most of the little ones don't have whiteboards, but I have it just, like, if we are studying Patho, we might do that as well where we draw it on the board and teach it to each other" (Ocean).

[redacted]

> [redacted]

[redacted]

Another example of control over technology is introduced here as a concept, connects with the idea of patterns from subsection 5.4.1 and will be developed in subsection 5.5.4 as it leads to a standalone embodiment of the learning-technology-space intersection: students control the way they setup their uniform. This brings forth an element of familiarity in each patient care space students encounter and allows them to mediate comfort – mostly psychologic – while caring for patients in unfamiliar spaces.

As a different facet of control, once students identify a preferred way of working with academic technology, they do not like changing it. Once students adopt a certain learning technology they can easily deploy it in multiple spaces. Similarly, medical technology, over which students have no control, can be used in multiple spaces. As Winter exemplifies, students express why changing technology after having a set pattern is hard to do:

> "Yeah, because if I change that, then like I'll have notes this way and then I'll have notes that way and I might – like I'm very organized. So, I wouldn't want to switch that up".

[redacted]

[redacted] The connection with enabling constraints and neighbour interactions is visible: [redacted] students try to improve their comfort. [redacted]

[redacted] is a dominant feature of paramedic student experiences. [redacted] Nonetheless, [redacted] seem connected to a need for improved comfort. A few examples reveal the connection between [redacted] [redacted]:

- [redacted]

[redacted]

[redacted]

5.4.5 Summary

Looking at decentralized control helped me realize those areas of the learning-technology-spaces intersection which allow for bottom-up decisions to take place. While students point to areas that negatively affect their practices – section 5.3 – their capacity to enact change is quite limited. It is visible now that whenever possible students make decisions aimed at using the learning-technology-space intersection to mediate their needs and achieve comfort. Those areas which cannot benefit from student control, would need institutional help to improve – subsection 6.2.4. The connection between decentralized control and other areas of my thesis in visually represented below.

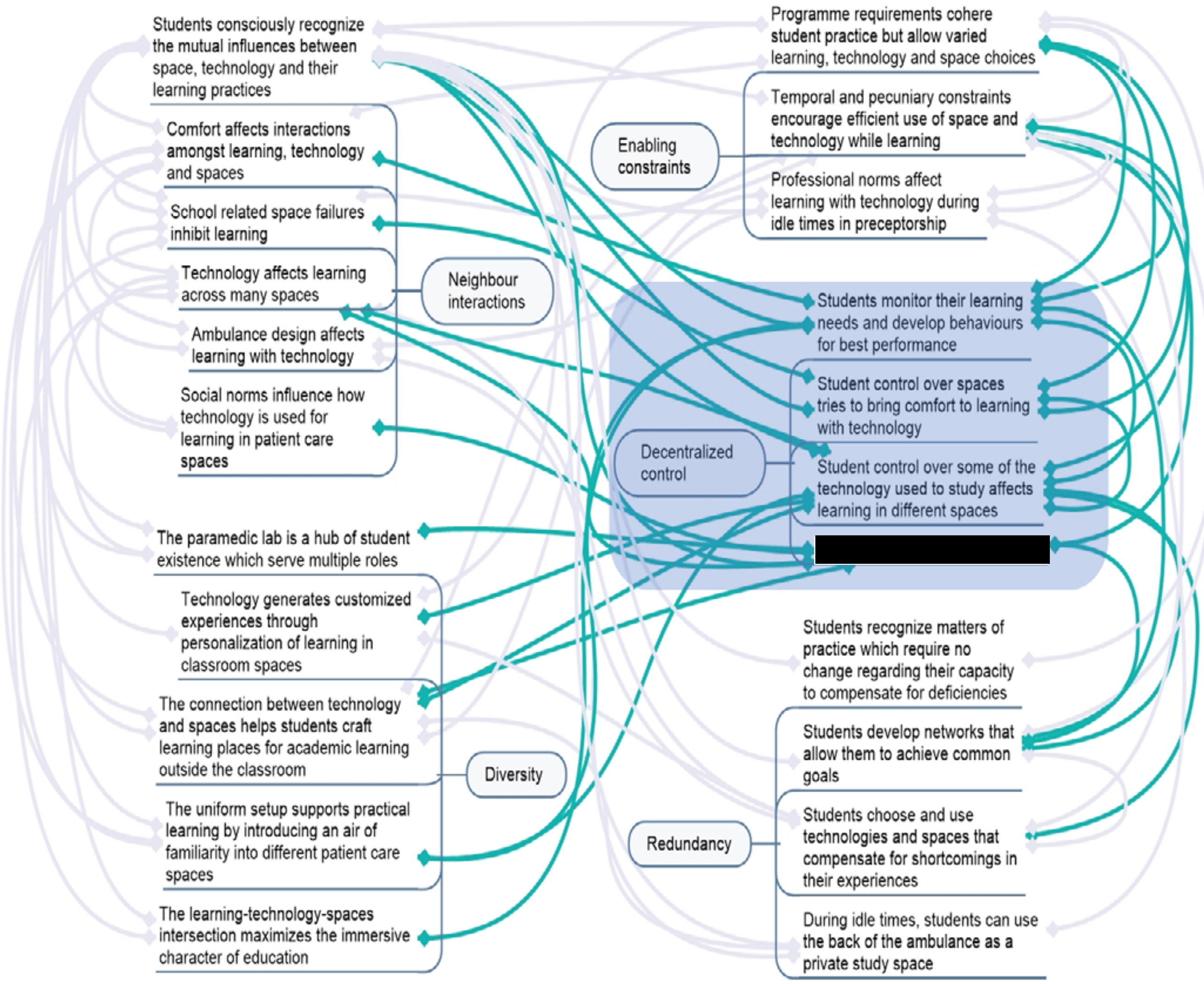

Figure 5.10: Decentralized control and highlighted connections.

5.5 Diversity

Diversity is used in my thesis to explore student opinions about the different embodiments of the learning-technology-spaces intersection which serve a specific function. Enabling constraints set the rules of engagement regarding the learning-technology-spaces intersection, neighbour interactions point to elements needed to mediate learning and decentralized control shows areas which students have control over. Together they prepare the terrain for the different learning-technology-spaces embodiments visible in data.

As this is a first time exploration of the learning-technology-spaces intersection in paramedic student practice, I was interested in diversity's meaning of "differences of types" (Page, 2010, p. 26); this is what my narrative highlights. Views of diversity as "*variation* in some attribute […] Or […] differences in *configuration*" (Page, 2010, p. 16) would need to be investigated in future works – chapter seven. Further, I defined type in my work as learning-technology-spaces embodiments with a specific function. This helped me simultaneously look for learning-technology-space intersections and understand functions students associate with them. I was thus able to realize "the range and contours of possible responses" (Davis & Sumara, 2008, p. 39) students have access to when they need to learn, using technology while being in certain physical spaces.

Five ideas stood out:

- The paramedic lab is a hub of student existence which serves multiple roles. This highlights student behaviours and challenges connected to learning in and within the area of this paramedic student dedicated spot.
- Technology generates customized experiences through personalization of learning in classroom spaces. Through technological choices, students individualize the learning-technology-spaces intersection to meet their needs.
- The connection between technology and spaces helps students craft learning places for academic learning. This highlights technology's role in allowing learning across many spaces. The idea of place signifies that element of familiarity which students bring to a space by using the same technology.
- The uniform setup supports practical learning by introducing an air of familiarity into different patient care spaces. An interesting method of turning spaces of patient care into places of learning is thus evidenced.
- The intersection of learning, technology and spaces maximizes the immersive character of education. Even though they use different mechanisms, students immerse themselves in education by using novel learning-technology-space combinations.

5.5.1 The paramedic lab is a hub of student existence which serves multiple roles

The paramedic laboratory is crucial to paramedic studies both during and after teaching hours. The learning-technology-spaces intersection turns the lab into a hub of student existence. It has everything needed for students to learn their craft: patient care equipment, whiteboards, chairs, electrical plugs, and the shell of a car with seats and windows. As a hub, the lab extends its influence on other areas of student existence: students seem to prefer parking, renting a locker and using study rooms close to the lab. As a central gathering spot, overcrowding affects the lab after hours. This forces students to modify their behaviours.

The paramedic lab influences student life. Students park and rent lockers close to the lab. This highlights the lab's hub-like nature. To illustrate this point, Lake, while reflecting on the manner in which the paramedic laboratory affects their experiences, clarifies the following:

> "It's our hub. Like it really is. All of our lockers are right there. Like that is our space, truly. Is that the SW on the second floor… Yeah, that's where we always go to eat, where we meet up, all of our lockers are there and because we can do the lab practice after hours and it's just – that's very much our space. […] I'd love it if our lockers could be reserved for just there. I would love that because there's not so many people in our programme. There's two years, right, at any time. […] 100 lockers which there definitely is there, I'm like, just give us that one section".

The lab is affected by overcrowding and not supported by adjacent structures. This dedicated student space houses all learning essentials: simulation equipment, desks, whiteboards etc. However, the lab is limited in size and is not supported by adjacent structures. When multiple cohorts simultaneously congregate, the lab gets busy. Overcrowding then decreases the role of the lab as a study space due to increased noise and decreased access to equipment. This forces students engaged in academic learning to move out of the lab in search of study rooms. Connections to subsections 5.3.3 and 5.3.4 are visible; when these rooms are found, a lack of whiteboards seems to impede student learning. As an example, Haskell reveals their challenges which are connected to lab overcrowding and insufficient support from adjacent structures:

> "Just cause well there is too many people in there it is too loud and I just cannot focus and that is when I would go to a study room and study just me and two other people […] And we would just study there. and then only one thing is that there is no whiteboard. And it is kind of hard to talk about. Cause sometimes we would test each other for labelling it. Like we did that for

anatomy. Ahh…so if we cannot do that … it is kind of hard to test each other on study. Cause it is kind of verbal questions”.

[redacted] Basil for example, clearly describes this conundrum:

> [redacted]

Students can use the lab 24/7. This circumvents some of the overcrowding seen at peak times but leads to other challenges; students [redacted]. Such instances are clearly presented by Cove when addressing their extended use of the lab which helped them prepare for different examinations but brought forth physiological needs which they inventively mediated:

> “on average within the last three semesters I have spent probably close to 12 to 16 hour days here so I get here at 9 and leave here at like midnight [redacted]

Human needs affect the way in which students use the lab. [redacted]

[redacted]

5.5.2 Technology generates customized experiences through personalization of learning in classroom spaces

Saying that technology generates customized experiences through personalization of learning in classroom spaces sends the message that by making technological choices, students can individualize the learning-technology-spaces intersection to meet individual needs. As per subsection 5.2.1, classroom spaces and classroom learning are much under the control of others – school and instructors. Students can use technology to customize their learning experience while undergoing academic learning during school planned activities. Both electronic devices and pen and paper are used. All are neatly placed on desks. Pen and paper are preferred for drawings and electronic devices for accessing information. In the end though, infrastructure failures limit the benefits of customization through technology.

Technology customizes the classroom experience. Students attend classes as scheduled. There, they engage in learning activities, which are carefully prepared by instructors. Technology though, is the prerogative of students. Technology introduces an element of customization to the classroom space and thus personalizes learning by allowing students to adapt classroom realities to their needs. Figure 5.11 substantiates the idea of customization; a collage of student drawn desks highlights individual preferences regarding combinations of digital and analog devices in learning. Device interchangeability is a form of redundancy detailed in subsection 5.6.3. Analog devices – pen, paper, books, handouts – are used to copy flowcharts or drawings instructors write on whiteboards. Books or handouts are used to gather information. Laptops and smartphones seem most prevalent and associated with checking information and working on in-class assignments.

Amidst technological customization, infrastructure failures still exist. Lack of electricity, poor visibility, uncontrollable temperature and others were previously discussed. Their existence limits technology's customizing power. An overall sense of frustration and questioning of the infrastructural status-quo reverberates from student accounts. Bay's account exemplifies this dissatisfaction with existing institutional structures:

> "I feel like when we are at school [redacted] and we spend so much time here we just want to be comfortable, [redacted]".

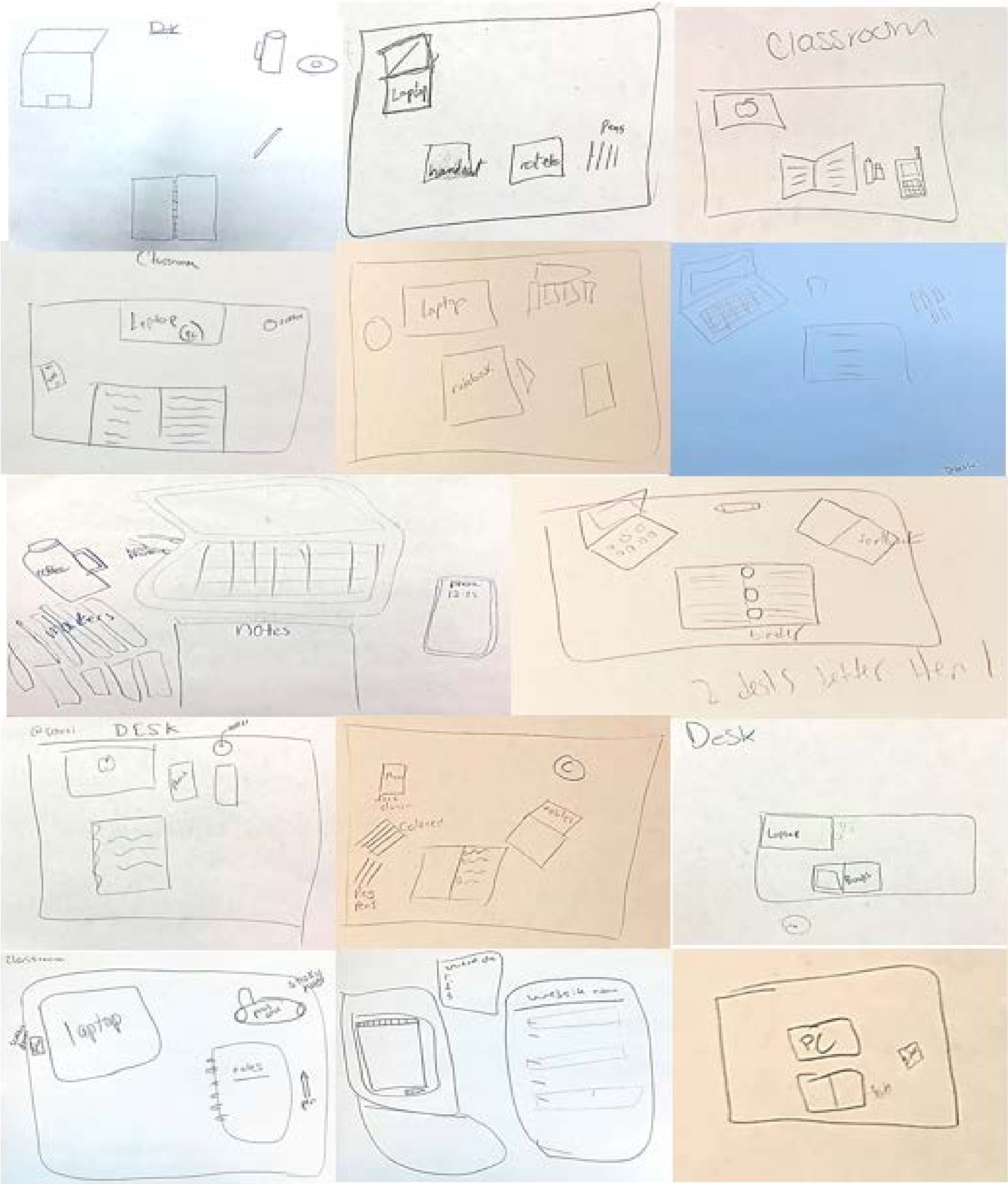

Figure 5.11: A collage of student drawn desks substantiates the idea of customization by highlighting individual preferences regarding combinations of digital and analog devices in learning.

5.5.3 The connection between technology and spaces helps students craft learning places for academic learning outside the classroom

Saying that the connection between technology and spaces helps students craft learning places for academic learning conveys the message that technology allows students to engage in academic learning while being located in diverse spaces, alone or with others. Four instances stand out in data: learning at home, learning at school, learning in paramedic bases and learning in the back of an ambulance. In all instances students use their technology to access information and/or engage in different forms of reviewing and connecting with academic material at their own pace.

The home promotes individual studying but limits the number of interactions. Figure 5.12 shows a collated version of student drawings portraying home study areas. These allow for detailed customization to meet individual needs. Double monitors, beds and sources of food and water are visible in these drawings. Different levels of noise or distractions are reported in student houses. The biggest challenge with studying at home seems to reside with the fact that home studying is mostly alone studying; this stops students from engaging in much needed discussions with their peers. As an example, Berry, exemplifies the loneliness of home studying in their reflection:

> “Where if I am at home it is just me and my thoughts and my whiteboard and I am not able to get those questions answered”.

The school allows for collective learning, but study rooms are limited, distractions abound and sources of food and water lack. Figure 5.13 shows a collated version of student drawings portraying study areas located in school study rooms – these can be found in dedicated study rooms, the library or unoccupied classrooms. When studying at school, students bring their laptops, smartphones, books and other tools to a room and deploy them for learning. At school, students can study either alone or in groups. Group work is not only focused on assignment completion; preparing for different academic events takes place in this format. Whiteboards are treasured for group work; as these are missing, students buy their own to mediate learning – subsection 5.4.3. To exemplify, Berry demonstrates how students use group work to study. In their account, group work is a dynamic, collective learning process which integrates spaces and technology in a cohesive manner. Interestingly, this is in stark contrast with the previous interview excerpt, where the same student, Berry, highlights the loneliness underpinning individual home studying:

> "So I mean study space […] here at school and it is usually a whiteboard to me, a whiteboard to [redacted] and a whiteboard to [redacted] […] and it is okay […] this is the pathology we are working on. Let us write down everything we remember about it and how we think it works. And we will all go and we will do it. And then we will all look at each other's and we will be like yeah ok we all have the same general idea […] and then we will usually go back to either the notes or the textbook or the slideshow and we will add whatever we are missing and then it is ok this is everything, and then let us erase and then do it again".

School study spaces are far from sources of food and water. To mediate this and to avoid high prices associated with campus or delivered food, [redacted]

[redacted] carefully plan their meals. Storm, for example, attests to this careful planning in their account:

> “if I know I’m going to be here for 12 plus hours, then making sure that I bring food because I can’t focus – I literally cannot focus or do anything if I’m hungry”.

School study spaces can be noisy. Some students mediate this by listening to music in their headphones. This, as Cove details, creates a barrier between students and the outside world allowing individual studying in noisy rooms:

> “If there is a lot of people and I do want to get any work done I will put the headphones in to distract myself from the noise that comes from lots of people”.

Students use the library as a learning place rather than a source of information. The library is not only a space where information can be found but also a place of quietness, solitude and available study rooms. When using the library, students can study in comfort – subsection 5.3.2. Zephyr, provides such insight when explaining their use of the library’s physical spaces in learning:

> “The library. I use the library mostly for the solitude. So, specifically for big assignments that I’ve procrastinated, which I have a habit of doing. So, like my Patho papers, I wrote every single one of my Patho papers entirely in one day […] You know what, it works for me. I got 100 on all of them except one and it works for me so I didn’t want to change it. But yeah, I would go get up at like 6 a.m., 7 a.m., go to the library. I’d get some snacks the night before. We weren’t

technically allowed to eat in the library, but I'd hide them under my bag and then I'd just sit there for five, six hours".

Studying in ambulance bases is affected by base design and professional norms. During idle times in preceptorship, students can engage in academic studying – subsection 5.2.3. However, in most bases, students share the same crew room with their preceptors. This leads to distractions, which students need to mediate considering professional norms. As such, students cannot use headphones to segregate themselves, and need to carefully inform preceptors about their use of personal technology – either by positioning themselves so that others can see their laptops or verbally announcing that they are studying – so as not to be construed as aimlessly surfing the internet. As an example, Cypress clarifies such instances when explaining their study behaviours while at the ambulance base:

> "With the computer at the base last semester we had lots of assignments to do so at the base if we had time off like if we hadn't been on a call and we are like the third ambulance up or the second ambulance up after I finish cleaning and I make sure like everything is ok and the base is clean and I feel like I am all right to kind of study I will get my laptop out and I will start doing assignments […] what I do I try to face everybody instead of the wall so they kind of see what I am doing and see that I am researching and then I am kind of just to make sure I would verbalize like a question to my preceptor just so everybody know I am doing like school work. I am like I am doing this assignment do you mind helping me with this? […] Just so the whole base knows I am doing an assignment. Just cause I don't want the perception that people think oh he is just sitting here playing on his computer or something".

As the crew room is distracting, students choose other spaces to study at base. If a secondary room is available students might use it for studying; this very fortunate occurrence is rare. Usually, students use the back of the ambulance to study. Figure 5.14 shows drawings of the back of the ambulance being used as a study space; this idea is introduced here but, since this is an example of redundancy, I will detail it in subsection 5.6.4.

Students can use mobile technology for on-the-spot learning during preceptorship. [redacted] study times students engage in; it rather allows referencing information in any space. Portability allows for learning to always take place. [redacted] Students develop behaviours [redacted]. Lux exemplifies [redacted] when explaining [redacted] to verify treatment plans [redacted]:

> “I would tell them yeah … I’ll be like I am not [redacted] […] so that they do not think I am [redacted] when they are seriously ill.”.

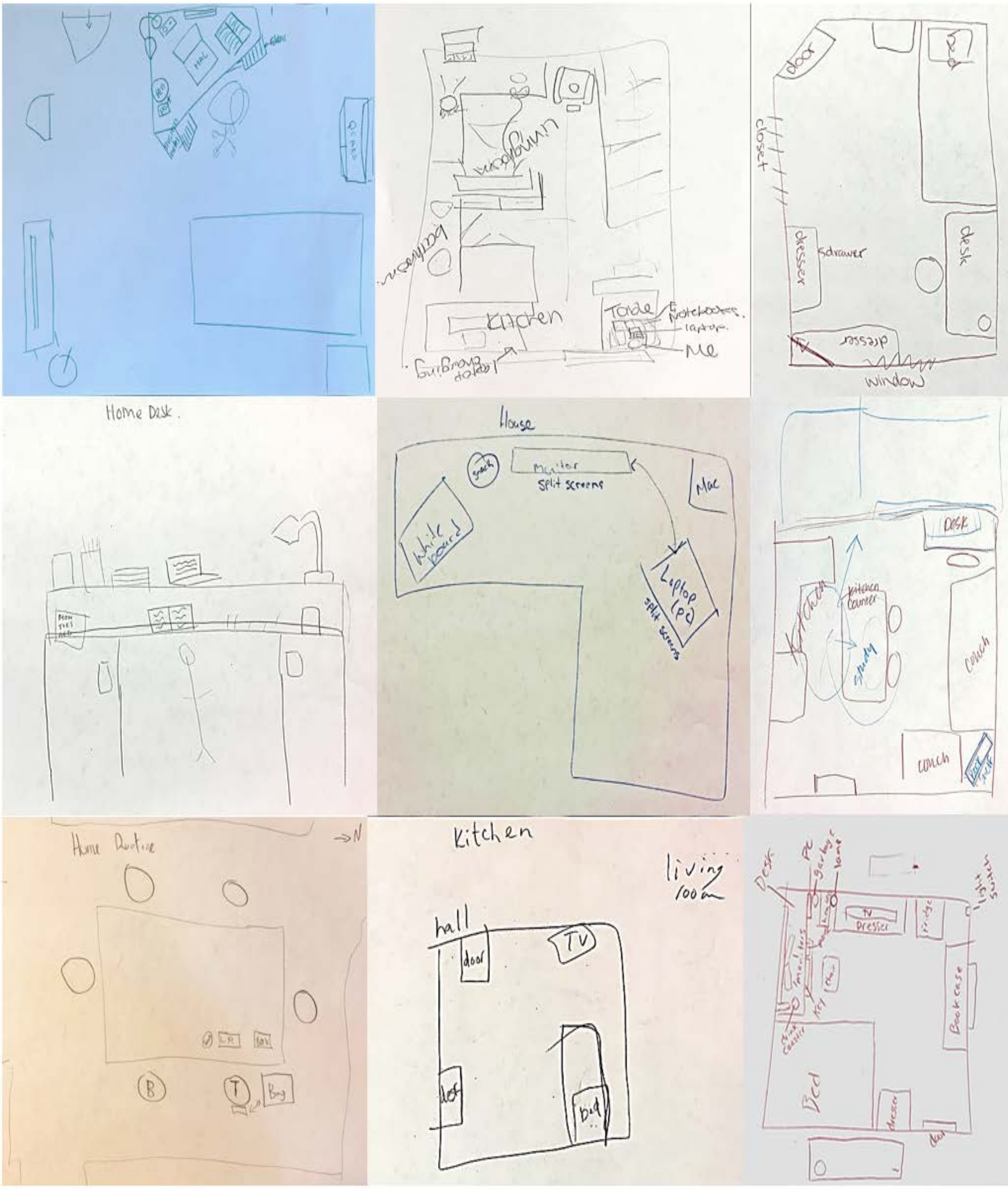

Figure 5.12: Home study areas. Student drawings show highly customized home study areas, close to food and water sources.

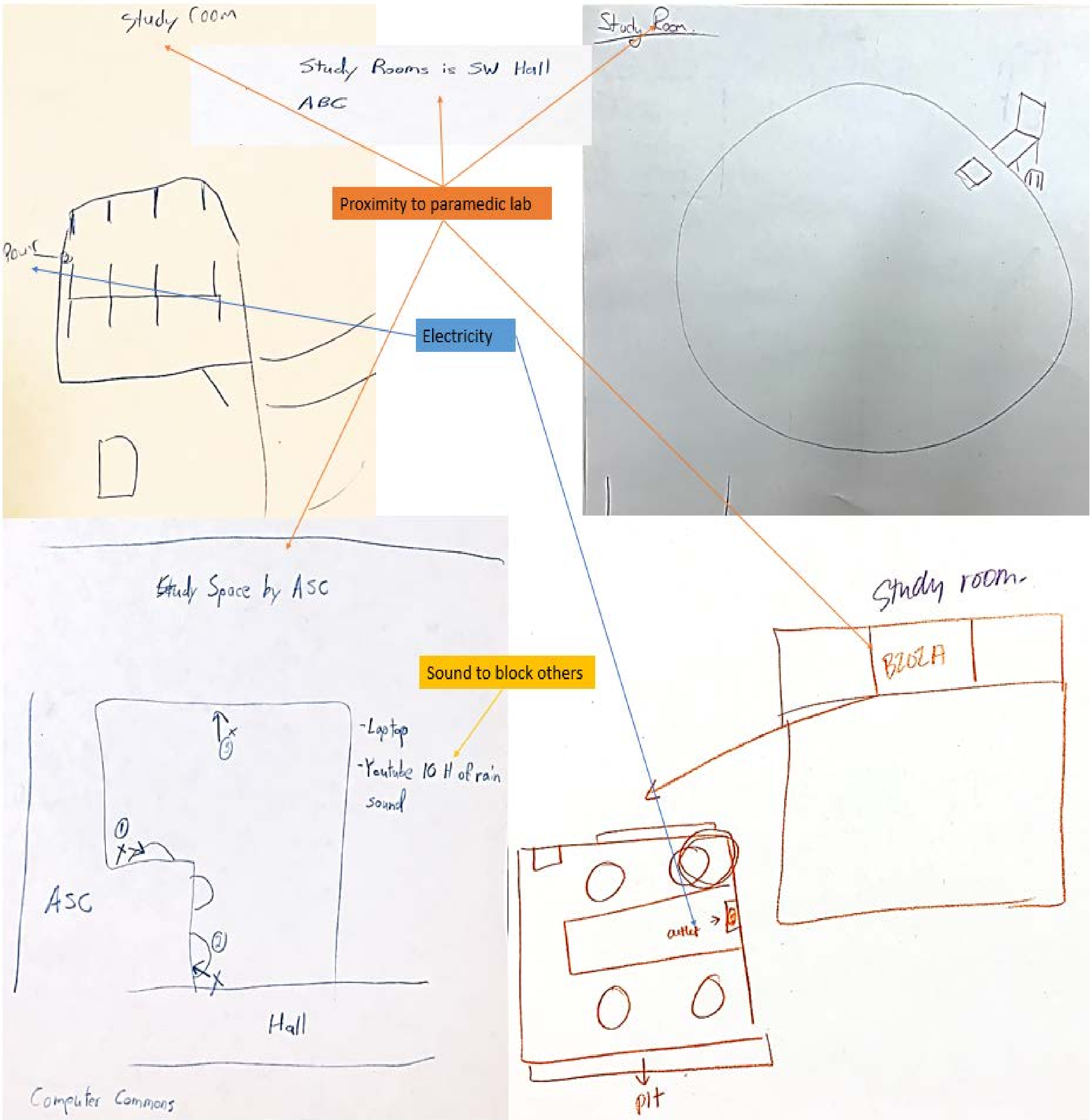

Figure 5.13: School study rooms. Drawings done by students show common trends in study rooms: quietness, the need for electrical outlets, using sound to block others.

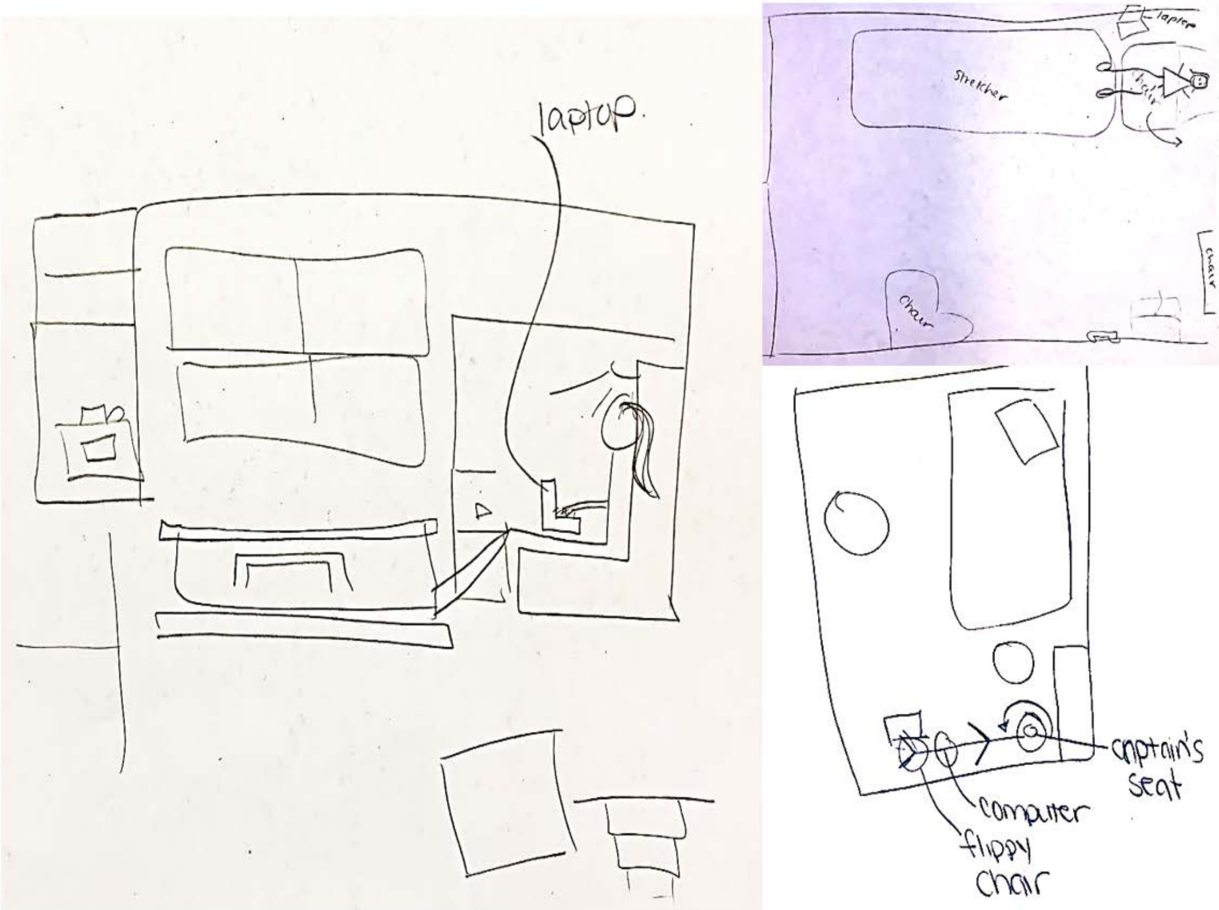

Figure 5.14: Using the back of the ambulance for learning. This patient care space presents an opportunity for students to focus on their studies while being away from others.

5.5.4 The uniform setup supports practical learning by introducing an air of familiarity into different patient care spaces

Saying that the uniform setup supports practical learning by introducing an air of familiarity into different patient care spaces sends the message that the way in which students setup their uniform creates a zone of comfort in every space they go. This allows students to focus on providing patient care rather than wondering where certain equipment is. The connection between learning-technology-spaces is visible: students can provide patient care, thus learning in the process, using technology which they can easily find, in all spaces patients are located – subsections 5.3.2, 5.3.4, 5.4.1 and 5.4.3.

Student drawings show that each uniform is setup to serve their wearer's needs. Figure 5.15 represents a collage of different student drawings showing that each student holds on their person a stethoscope, scissors, gloves, pen and paper for note taking, medical directives booklet and a smartphone – which they can use as reference during patient care events – along with other personal effects – wallet, money, etc. Some students carry emesis bags, N95s and other equipment on their own person. Each uniform reflects the needs of their wearer.

Students admit that the uniform setup facilitates muscle memory. This helps them decrease the discomfort of not knowing where something is located. In doing so it allows students to focus on providing care rather than fumbling while trying to find something in their pockets. By consistently using the same uniform setup students ground their experience into the familiar and decrease stress associated with the unknown of each patient encounter. As an example, Clay narrates the following as they are drawing their uniform setup:

> “I just like keeping everything in the same pockets all the time it just creates that muscle memory so that if I need to look over something like on a call or something I know exactly where my Base Hospital book is and then I just got an extra pair of gloves over there […] usually I keep money or something in this pocket […] my phone is in the other one and I like keeping everything separate I don’t like having everything in one pocket especially with having two books on the sides it is kind of like if you have two books on one side and then nothing in the other, one leg might feel really heavy […] I keep in my pocket and my pen for writing stuff down I keep in like a little pocket that I got in the shirt so I will draw that out”.

Figure 5.15: Collage of drawings showing students' individual preferences for setting up their uniform. This introduces an air of familiarity into different patient care spaces.

5.5.5 The learning-technology-spaces intersection maximizes the immersive character of education

Saying that the learning-technology-spaces intersection maximizes the immersive character of education points to a series of events which share the same characteristics: they allow students to always engage with paramedicine. In doing so, students mediate a state of continuous learning using unexpected spaces and technologies. Increased knowledge leads to increased comfort, and connects to students' capacity to control themselves, identify weaknesses and act on them – subsections 5.3.2 and 5.4.1.

Involving the whole family when learning allows students to practice their craft even when peers are not around. Lux portrays such an example when describing how learning takes place at home, involving family members, which despite their lack of paramedical knowledge become involved in the learning process:

> "like if I can't go to the lab my boyfriend God bless him. I would do all my scenarios on him if I cannot make it to the lab. […] I don't have equipment I will just verbalize everything […] And he has a checklist of stuff that I need to complete. […] He has no knowledge about the healthcare and he just goes for it like we were on the pregnancy and I was going through that so I got him on his knees and I … lifted … that really helped cause I now I really know the ALARM just because of my practice with him. So everything I feel like I can do any … any training. Like I have my manual blood pressure and my stethoscope on me so when I am doing those calls … like pretend".

Reflecting – an act of learning – while commuting in a car – which combines both space and technology – allows students to maximize travel time. Delta exemplifies this behaviour when they reflect on learning outside the classroom:

> "Well I definitely do a lot of reflecting on my commute […] Cause that is basically all that I have to do. An hour by myself. I drive by myself. I don't have anyone carpooling or anything so it is just me and my thoughts".

[redacted]

> [redacted]

Students generate and use cue cards in their learning; this increases engagement with learnt content. Stirling exemplifies the learning mediated by such study aids:

> "This is like a drug study sheet. It's got about 100 different drugs on it. And so, I made about 100 cue cards to go with it as well just to have the name of the drug and then flip it and then say, okay, Zoloft is an SSRI and stuff like that, so I can remember them".

5.5.6 Summary

Diversity helped identify embodiments of the learning-technology-spaces intersection as they appear in data focusing on their specific function. In connection with the other sections of the thesis – Figure 5.16 – students try to achieve comfort in learning whenever possible.

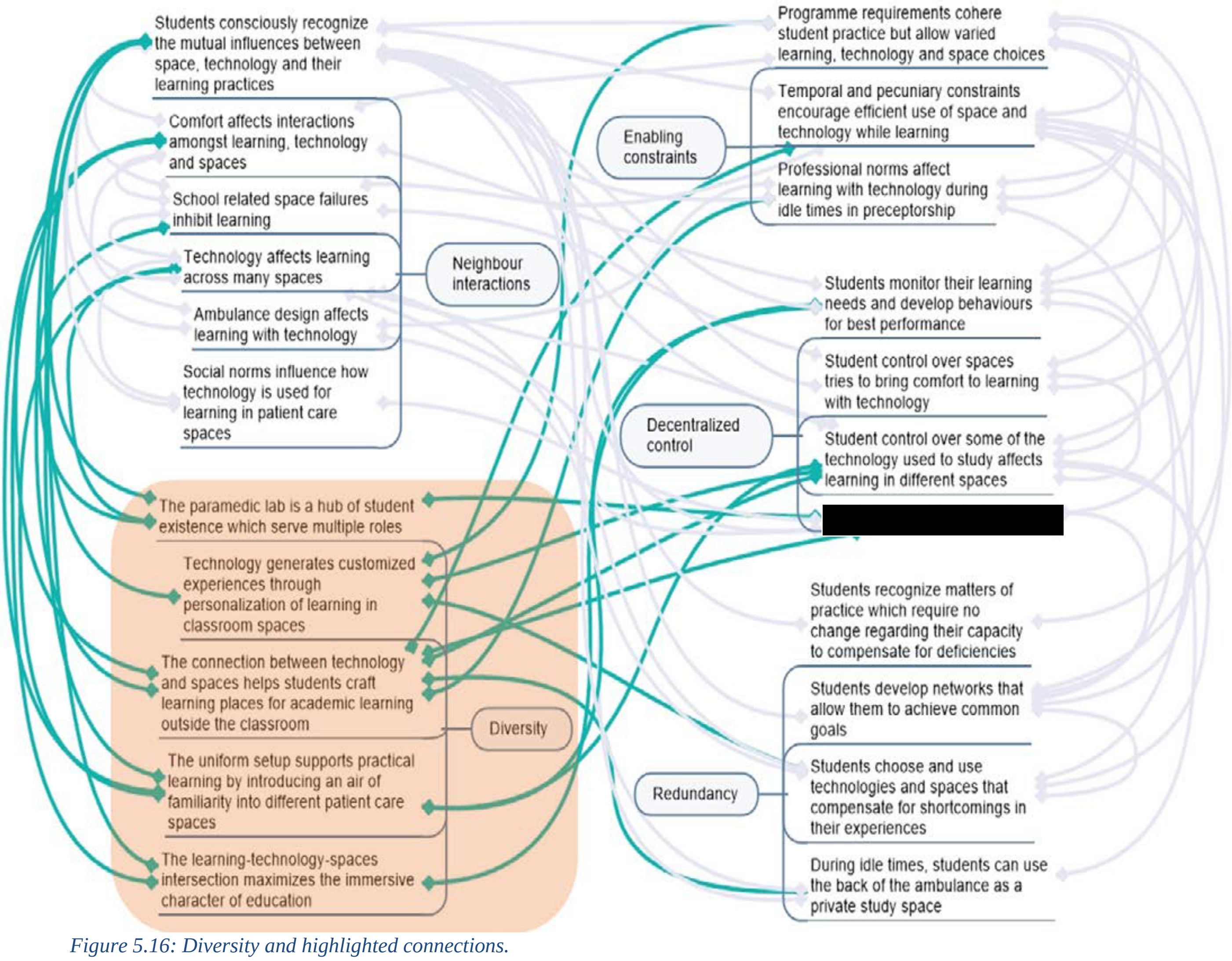

Figure 5.16: Diversity and highlighted connections.

5.6 Redundancy

Redundancy represents those similitudes or commonalities that mediate interaction (Davis & Sumara, 2008, p. 39), while also allowing interacting elements to "compensate for one another's failings" (Davis et al., 2010). Redundancy is recognized to have two main roles: "[f]irst it enables interactions among agents. Second, when necessary, it makes it possible for agents to compensate for others' failings" (Davis & Sumara, 2006, p. 139). A look at redundancy helps determine how failures of different aspects of physical spaces, technologies and learning practices are compensated for.

Four main ideas stand out:

- Students recognize matters of practice which require no change regarding their capacity to compensate for deficiencies. This verifies the well-develop character of the curriculum and available resources.
- Students develop networks that allow them to achieve common goals. Through networks, students manage challenges.
- Students choose and use technologies and spaces that compensate for shortcomings in their experiences. The ability of technologies and spaces to compensate for failures is evidenced.
- During idle times, students can use the back of an ambulance as a private study space. Psychological comfort is thus achieved and students' ethos of continuous studying is materialized. Physical comfort is questionable.

Above ideas show ingenious ways in which failure is mediated by students. Overall though a gap exists between student experiences and institutional offerings. The need for institutional intervention is once again evident – subsection 6.2.4.

5.6.1 Students recognize matters of practice which require no change regarding their capacity to compensate for deficiencies

Students recognize that curriculum and equipment used for simulation are well setup and require no changes. These are institutional impositions – subsection 5.2.1 – which students identify as being able to compensate for their own deficiencies.

Students appreciate that material (un)covered in one class is then developed and enhanced in others. This allows for repetition and scaffolding of knowledge across courses. To exemplify, August describes how material introduced earlier in the programme helps subsequent courses; encountering a specific diagnosis in a patient during the third semester preceptorship was helped by previous theory, pathophysiology and laboratory courses:

> “learning it in theory and patho I understand it but then being able to make it practical was a little bit harder but that is what lab I thought lab was doing a great job at doing. […] Now reflecting back to what I learnt in patho I am like “Yeah””.

Students appreciate having access to different brands of the same type of patient care equipment. Students practice with multiple kinds of cardiac monitors, airway devices and so on. This enhances students’ job readiness as it accounts for equipment differences between different employers. In their account, Basil reveals that they are thankful for the diverse resources they have available in their programme; this offers them a competitive advantage over students from other schools:

> “the monitor is important too cause like I have seen the other students like because they are from different … cause I do not know but like we talk to each other and […] so we like we talk to each other and some of them have never seen the monitors before the rideouts […] So that is a learning curve that they have to have as well. When we got like… generally wherever we go we are proficient in the monitor cause we have both here so that is something good. So we are using the Zoll here and by the way the other services are using a different monitor … we have both we are proficient in both. We can go back and forth. […] And other students that I have talked to have none. And that is like a learning curve for them”

Adding to Basil’s account, Haskell details that being able to engage in practice with real equipment enhances their preparedness:

> “Cause like yeah […] like pretty much one of the biggest ones is probably the medical equipment. Cause if we didn’t have that. That was all just talking about it, there is no way […] Cause I don’t know for me at least…I like to be hands on with it. It just helps me get more familiar with it […] Rather than somebody explain it to me. Like how you do this for that. But just […] so you go through like here is the monitors and you spend five minutes with it. Like I get familiar with”.

5.6.2 Students develop networks that allow them to achieve common goals

Students develop networks that allow them to achieve common goals. Working together, students manage failing infrastructures and build a shared repository of knowledge which helps them progress through the programme. Students can depend on others; if a student needs help, help is rapidly available from classmates.

Student networks use technology to allow resource sharing. [redacted]. Students prefer resources [redacted]:

> [redacted]
>
> and
>
> [redacted]

Students use their networks to solve challenges related to insufficient study rooms. As a network, students identify rooms that fit their needs. As an example, Phoenix illustrates this meticulous room scoping behaviour in their account:

> “Yeah, so […] last year […] we were in a lot of study rooms, we kind of scoped out before. We would kind of just take a walk and look at what has the best lighting? Does it have a router? Does it have a whiteboard? How many tables are in there? […] We kind of analyse […] How many plugs are in the room? That kind of thing. Where is it to the closest coffee shop, if I want coffee later? You know what I mean, everything”.

[redacted]

> [redacted]

Networks are connected by social media. The role of social media in mediating the formation of these networks is evident. Facebook – through its WhatsApp or messenger embodiments – connects students and gives groups an electronic, virtual means of shortening physical distances. This compensates for the need to constantly remain informed amidst a very busy schedule. Students work together face-to-face on assignments but background communication is handled by electronic means. An example of the manner in which such communication is mediated by social media is provided by Zephyr:

> "Facebook is an absolute network. I have probably like 10 to 15 group chats with different groups of students. I have a one-on-one chat with probably every student in the programme. We have our Facebook group where we post things that we think everybody would benefit from".

Networks allow students to make-up missed content. Students monitor themselves – subsection 5.4.1. When they miss content, peer-based group study sessions can be used to make it up. Cedar reflects on the manner in which their network of peers helps them assure familiarity with school content:

> "I have missed far more classes than I have study sessions with my friends. […] Because sometimes I just need a day. […] Like lab if I missed a lab day, I'll text my friends like I am going to miss lab and they take notes. […] they'll take notes for me and then at the end of the day I'll come after school and they'll run me through all of the scenarios and they will give me the same feedback that the teachers gave them".

Networks affect technology purchases by students. Students can decide the technology they use for academic learning – subsection 5.4.3. An overall preference for Google and Apple stand out. Amongst other influences, networks of friends and co-workers seem to impact students' technological choices. As an example, Clay highlights such influences in their narrative:

“this is just my friends that had the iPads said there is two different apps you can use there is […] OneNote […] no there is Notability or Good Notes. And I think you have to pay like I think at most it is like 10 dollars for each of them. There are both equally as good but I use Good Notes cause it is a little bit cheaper”.

5.6.3 Students choose and use technologies and spaces that compensate for shortcomings in their experiences

By saying that students choose and use technologies and spaces that compensate for shortcomings in their experience I mean to send the message that students maintain and develop access to multiple spaces and technologies aimed at helping mediate educational challenges. Students report using different means of accessing patient care treatment standards; this allows for back-up in case one technology fails. Students also report accessing information over the internet; this is a widespread practice but overreliance on internet leads to accessing information which is not curated by faculty. When students take electronic notes, they can access information from multiple devices; pecuniary constraints might prevent some students from using electronic notes. Students can use different rooms for individual studies; study room limitations though inhibit this practice.

Students use physical and electronic copies of same medical directives – document outlining paramedic treatment standards. This redundancy helps students access same information by different means. Cove, while detailing their uniform setup and the use of different technology to clarify patient care plans, exemplifies this redundancy:

> “And then on my left side […] I’ll put my [directive …] book […] I have used […the phone …] to look into the [directive …] app”.

Students access the same digital information through multiple internet-connected devices. Throughout training, students develop an understanding of what resources are trustworthy and build a repository of internet accessible resources serving their study needs. These can be accessed from whatever internet-connected device students have access to. A smartphone can be used to reference information in the back of an ambulance. A laptop can be used to reference the same information in a classroom. While students rely on Google to search and store information, they preferentially access well-known resources: NCBI, Medscape, etc. (*National Centre for Biotechnology Information, National Library of Medicine*, n.d.; WebMD Health Corporation, 2015). [redacted] – but risk accessing information which was not curated by programme instructors. This is visible in Cove’s account:

> “Cause […] let us say in the back of the ambulance you say I want some information about the king LT. I am not going to go into THEO 1401, week 5 and open it. I will just go to Google”.

Notes can be taken by different means but note-taking is affected by pecuniary constraints. Paper-based notes – Figure 5.17 – appear similar to digitally written notes – Figure 5.18. Nonetheless digital notes can have added benefits: they can be typed, can include pictures – Figure 5.19 – and can easily be shared with friends –

subsection 5.6.2. Cedar exemplifies the capacity to share electronic notes in their narrative:

> “[redacted] takes amazing notes […] and he just sends me the notes after class everyday and then if I am […] if I am bored or I have nothing to do I would just scroll through my phone and look at his notes”.

However, digital notes are inconsistently reported by students and, when reported, they seem to be used by students who use multiple digital devices in their learning. Pecuniary constraints – subsection 5.2.2 – thus possibly affect the generalized use of digital notetaking amongst students.

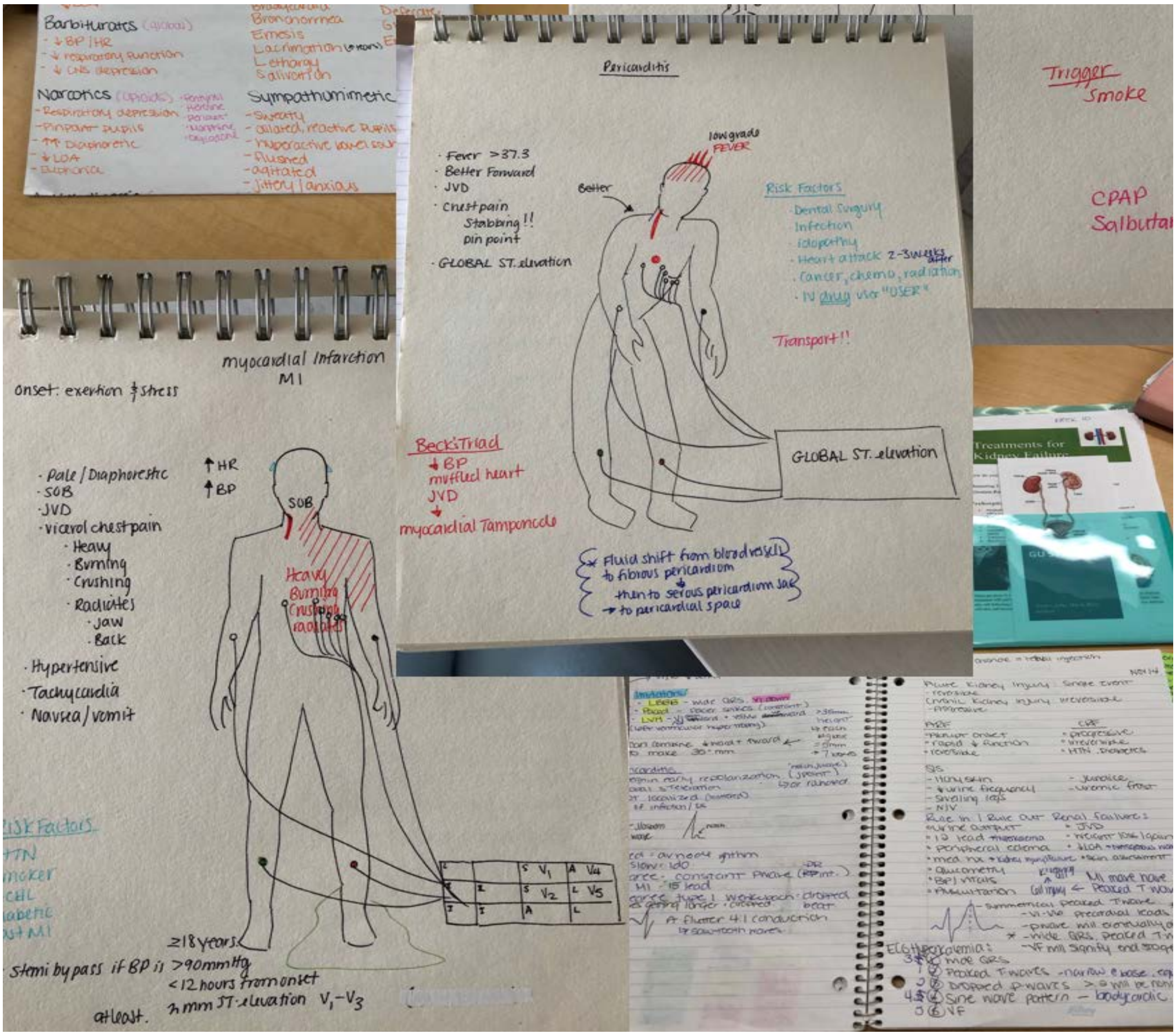

Figure 5.17: A collage of paper-based notes.

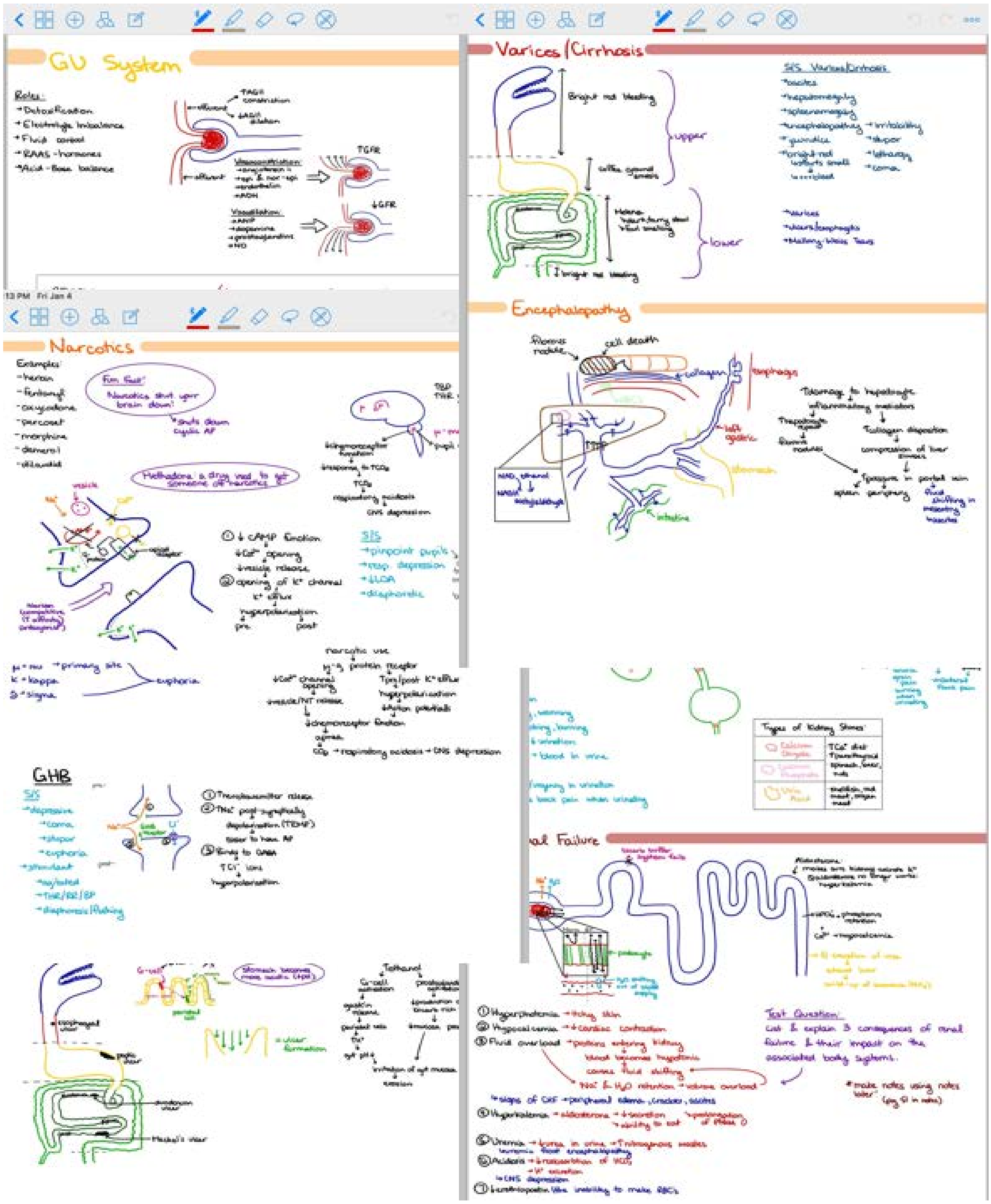

Figure 5.18: A collage of digitally written notes.

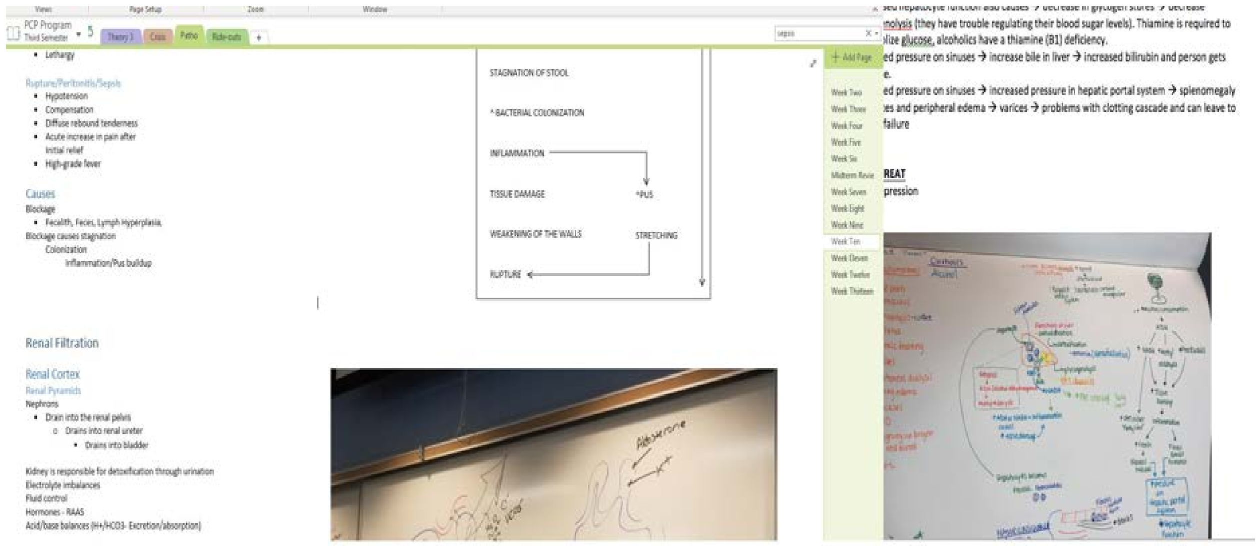

Figure 5.19: Digital notes combining typing with pictures of the board or notebooks.

Students can utilize different rooms for individual studying purposes. Students can interchangeably engage in after-hours studying using the lab, study rooms or empty classrooms. This redundancy helps students choose the best space for their needs. For example, Winter describes moving to a different room due to noise inside study-rooms found close to the lab:

> "So, even those study rooms near the lab. There's always people congregating or they see you in there and they come and they open your door. And they come in there and they want to talk to you. And I'm like, I'm trying to study. That's why I'm not here anymore. I never stay here. So, it's all in location and how many people are around".

5.6.4 During idle times, students can use the back of the ambulance as a private study space

When ambulances are parked at bases waiting for another call, students can use the back of these emergency vehicles as their own private area. During these idle times students engage in learning in the back of the ambulance. A sense of redundancy is evident: when students do not want to stay inside the crew room, they can enjoy the privacy of the back of the ambulance as their own space. But, the back of the ambulance does not provide the same amenities as a study room would.

When they need privacy, paramedic students withdraw to the back of the ambulance. Rooms inside paramedic bases tend to be occupied by paramedics. Even in bases where multiple rooms exist, professional norms dictate that students yield the use of these rooms to working paramedics. In these situations, students find that the back of a parked ambulance offers them much needed privacy. There they can engage in studying – which most report doing – or take a break away from prying eyes. As an example, this duality of function, is visible in Haskell's explanation regarding the manner in which they use the back of the ambulance during idle times in their preceptorship:

> "I use my laptop or like pocketbook and just read through directives and stuff like that […] [redacted] […] [redacted]

[redacted] […] And then in the ambulance I can just be like yeah. I can do … [redacted] breaks".

The back of the ambulance does not provide the same amenities as a study room would. Figure 5.14 shows the back of the ambulance as drawn by students. This patient care space, is turned by students into their own place as an alternative to the paramedic base. In it, the decor is quite austere; students sit on a chair, their legs resting on the stretcher or another side chair and the laptop in their lap.

5.6.5 Summary

Redundancy is visible in some areas of the learning-technology-spaces intersection. While some redundancy is mediated by the school, most is generated by students. Figure 5.20 shows redundancy related connections visible in data.

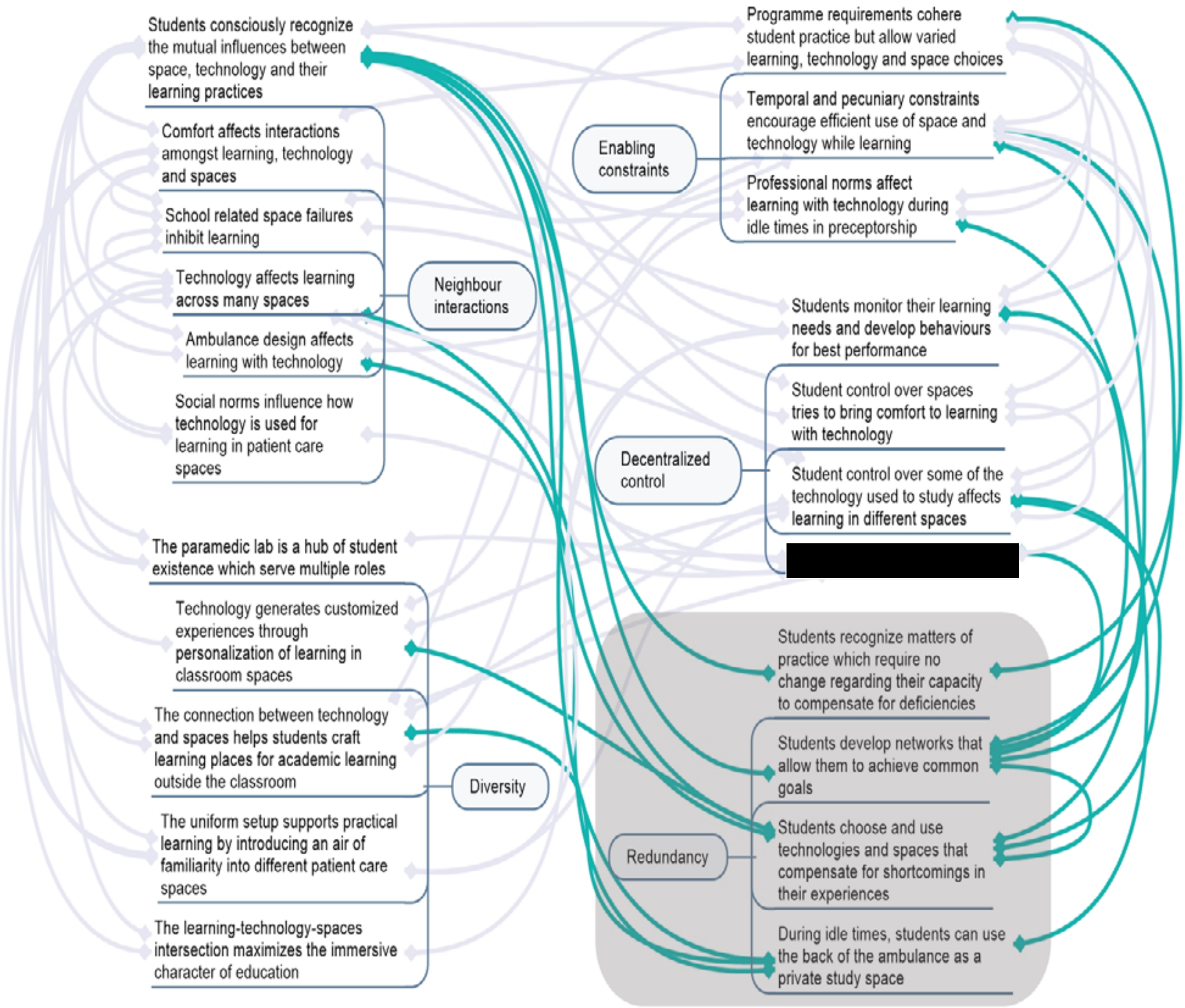

Figure 5.20: Redundancy and highlighted connections.

5.7 Summary

In this chapter I described my research findings, in the form of interconnected themes centred around the five complexity thinking principles which guided my data gathering and initial analysis: enabling constraints, neighbour interactions, decentralized control, diversity and redundancy. In the next chapter I will built upon these themes and use the notion of emergence to guide my subsequent analytical work which will lead to higher-level themes used in answering my research question.

Chapter 6: Discussion

6.1 Introduction

This chapter addresses my research question and outlines how my account contributes to knowledge in the areas of literature reviewed in chapter two. My research question was: “How do paramedic students experience the relationships amongst their learning practices, the technologies they use and the physical spaces they traverse?”. The brief answer is: students experience these relationships as wide ranging rules, interactions, matters of control, functions and compensatory mechanisms which I argue constitute a shadow learning landscape. I use this metaphor to represent the intricate workings paramedic students undertake to make their educational experiences successful while engaging with technology and spaces in a manner that accounts for, compensates and completes institutional offerings, yet is not directly or specifically institutionally driven or approved.

This shadow learning landscape is modelled in Figure 6.1 as having complex adaptive system traits, being student co-created and functioning as an institutional intervention threshold. The message I am trying to send through this model is that student experiences highlight the learning-technology-spaces intersection as an entity where different components and interactions mediate for failures in others, which is under the direct influence of students and where the balance between student (in)actions and comfort could indicate whether institutional intervention in student experiences is needed.

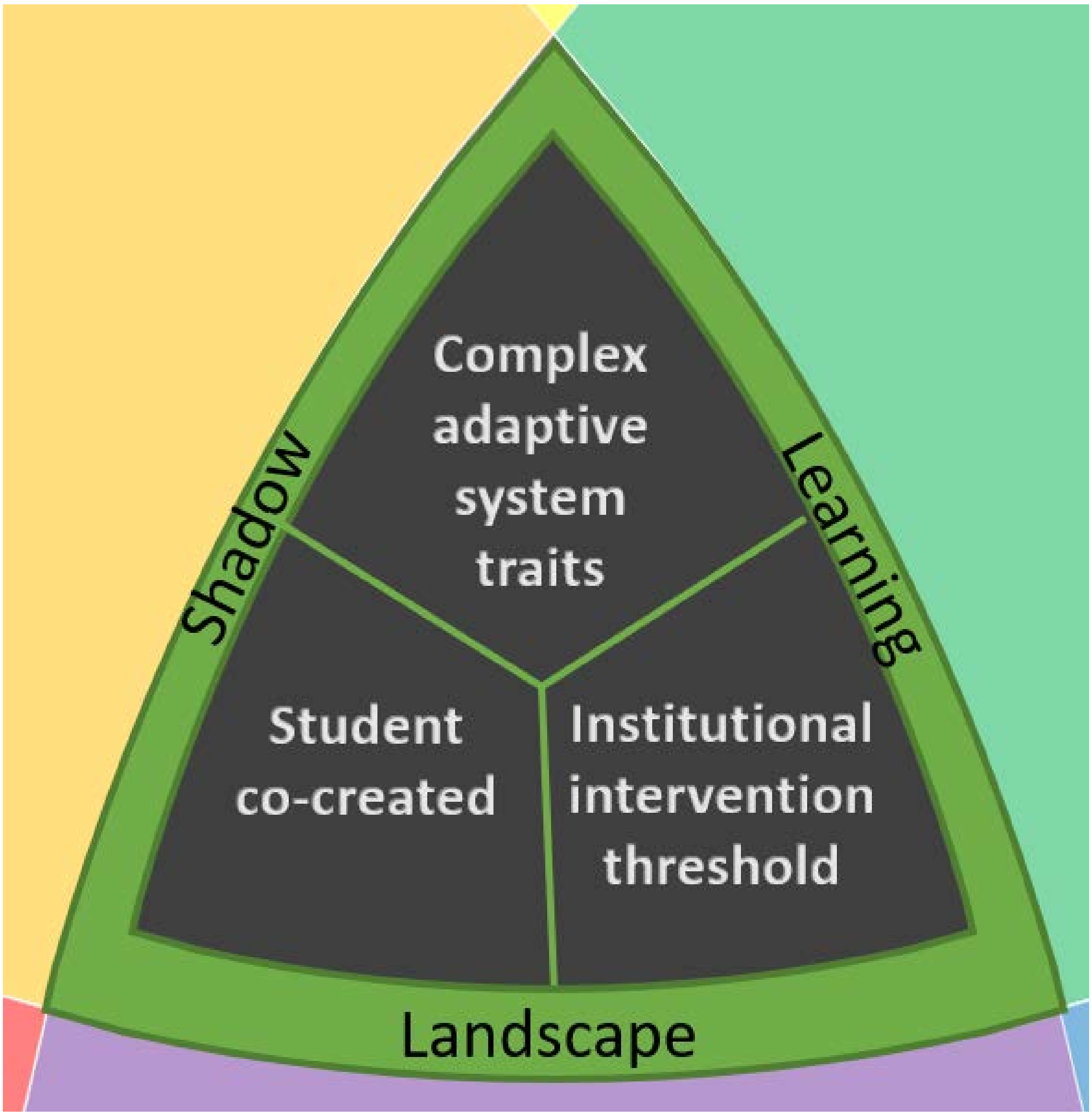

Figure 6.1:The shadow learning landscape and the main themes associated with it. The shadow learning landscape has complex adaptive system traits, is student co-create and serves as an institutional intervention threshold.

In answering my research question, I build upon chapters two and five. I synthesize empirical findings presented in chapter five and position this synthesis within the literature reviewed in chapter two. This highlights my threefold contribution to knowledge: I introduce the shadow learning landscape model, I present new facets of student experiences – e.g., using uniforms to co-create calm in chaotic patient care spaces – and I supplement knowledge already described in literature with richer detail regarding how students shape their own experiences in spaces.

Together, chapters five and six form a continuum. Chapter five mapped how students see the learning-technology-spaces intersection. Chapter six consolidates this intersection into a shadow learning landscape model. Chapter five uncovered intricacies of the learning-technology-spaces intersection as seen by students and explored by me through a theoretical framework influenced by complexity thinking. Chapter six now zooms out and presents trends that appear by bringing together matters of complexity thinking previously highlighted in chapter five – enabling constraints, neighbour interactions, decentralized control, diversity and redundancy.

In developing this chapter I use the concept of emergence to sensitize the "additional data exploration and analysis" (Schreier, 2012, p. 220) that leads to answering my research question. While my response to the main question builds on my earlier analysis, it required some additional analytical work of exploration to draw together the themes that I am about to present. Emergence provides those conceptual "directions along which to look" (Albert J. Mills, 2012) while exploring together matters individually presented in chapter five. Two portrayals of emergence influence me most:

> "*Emergence* […] refers to the arising of novel and coherent structures, patterns, and properties during the process of self-organization in complex systems" (Goldstein, 1999)

and

> “agents residing on one scale start producing behavior that lies one scale above them: ants create colonies; urbanites create neighborhoods; simple pattern-recognition software learns how to recommend new books. The movement from low-level rules to higher-level sophistication is what we call emergence” (Johnson, 2012).

I especially keep the words of the former and the imagery of the latter in mind when searching for the high-level answers to my research question that chapter six presents. After seeing data separated into the distinct parts of chapter five, I avoid using chapter six to simply restate themes already presented. For example, one of the themes that I identified early in my chapter six work was “Students devise their own learning management system which is easily deployable across a multitude of spaces and learning activities”. I eliminated this from my writing as it did not have the intricacy needed for this chapter; this was merely a restatement of findings from the previous chapter. Instead, I looked at the core of chapter five findings and realized that they speak about matters of adaptiveness, systemic interactions and complexity in action which students put together – thus co-creating – their own educational experiences. I used these as the building blocks of the shadow learning landscape model.

In the rest of this chapter, I will first present the shadow learning landscape and detail the main themes visible in chapter five data as being connected to it. I will then present my contribution to knowledge by considering how the shadow learning landscape model and the examples that support it address the literature reviewed in chapter two.

6.2 The shadow learning landscape as an emergence from student experiences

Much like ants build colonies inside anthills made from separate dust particles (Johnson, 2012), paramedic students develop their own shadow learning landscape which coagulates learning, technology and spaces into a stand-alone gestalt. The learning-technology-spaces intersection appears in student accounts – chapter five – as a collection of entities, connected with each other and with the surrounding world. Students learn while engaging with technology and spaces in a manner that accounts for, compensates and completes institutional offerings, yet is not directly or specifically institutionally driven or approved. This intersection is then a shadow learning landscape. This metaphor offers a name to that which students are doing and serves as a focusing point for my thesis.

6.2.1 The shadow learning landscape metaphor

The shadow learning landscape is a metaphor offering a figurative presentation of findings related to the way students experience the interplay of learning, technology and spaces. This metaphor shows the learning-technology-spaces intersection as a gestalt and recognizes the student driven, unified way learning, technology and spaces appear in data.

I use this metaphor as a name, an admission and a display of findings. *Shadow* denotes that what is seen in chapter five is student made, exists parallel to, builds upon, mimics, responds to, but does not represent institutional impositions (*Shadow*, 2022; W. Zhang & Bray, 2020). *Learning landscape* embodies the "conceptually holistic, loosely coupled inter-connections of all formal and informal, on- and off-campus, virtual and physical facilities, sites and services" (Thody, 2011, p. 131) presented in the previous chapter.

The model presented in Figure 6.1 rounds off my thesis. This is symbolized in Figure 6.2 where I replace the question mark from Figure 1.1 with the shadow learning landscape model. This model provides a visual answer and offers a standalone graphical representation showing how students experience relationships amongst their learning practices, the technologies they use and the physical spaces they traverse. Students navigate all these matters in ways unintended by institutions but purposefully crafted by learners.

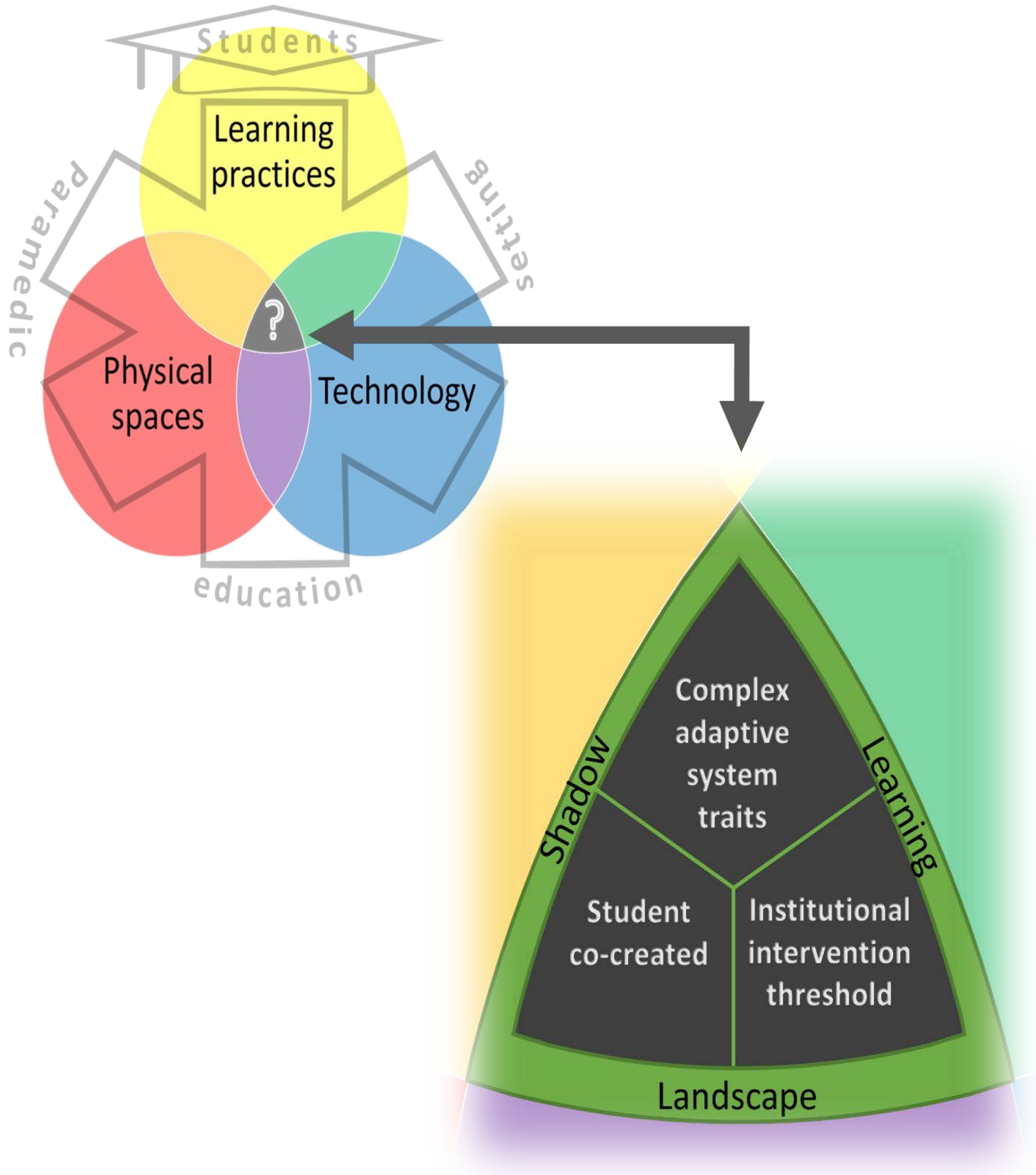

Figure 6.2: The shadow learning landscape model rounds off my thesis. This is symbolized by having the model – seen here in the lower right corner – replace the question mark from the first figure of my thesis – represented in the upper left corner.

6.2.2 The shadow learning landscape emerges as having complex adaptive system traits

Much like “urbanites create neighborhoods” (Johnson, 2012) students create a learning landscape that has complex adaptive system traits. This means that the learning-technology-spaces intersection is seen as a standalone entity which needs to be analysed together, whose relationships are not linear and which can adapt itself to different situations. The complex adaptive system traits legitimize discussions already found in literature and add a focused lens through which future works can be approached.

The shadow learning landscape has a systemic nature. This means that learning, technology and spaces are interconnected and studying them separately would decrease the value of the findings. Student accounts presented in chapter five show the system-like characteristics of the learning-technology-spaces intersection. This system-like nature is both explicitly and implicitly present. Explicitly – in subsection 5.3.1 – students recognize mutual influences between space, technology and learning practices. For example, a student states “to be able to learn something, you need the technology that you like and you use in the spaces that you learn” (P15). Implicitly, chapter five presents students, instructors, smartphones, patients, ambulances and other entities inextricably held together by the act of learning; sections 5.2 to 5.6 attest to this. For example, students use technology to generate customized experiences through personalization of learning in classroom spaces – subsection 5.5.2. Practically, the need to view learning, technology and spaces as interconnected entities is not only visible in student accounts; it is also supported by student generated artefacts. Interviews show animated stories with intricate detail regarding the learning-technology-space intersection. Drawings support spoken words; there, spaces are never empty, technology is omnipresent, and both relate to elements of learning.

The five elements of complexity thinking that were used to analyse the learning-technology-spaces intersection showed a predominant lack of linear cause-effect relationships amongst each other. This is important as it underlines the complex nature of the learning-technology-spaces system. Yes, some accounts point to cause-and-effect relationships: if students are cold they will don a sweater – subsection 5.3.2. Nonetheless, most data point away from these mechanistic reflexes and detail circumstances with multiple levels of intricate influences. This is what gives the system its complexity. Overall, explaining the learning-technology-spaces intersection cannot be done by separating it “into its parts and studying the linkages among them” (Fenwick et al., 2011, p. 22); this would only offer a truncated version of what my thesis investigates. To obtain a detailed, less fragmented story, the multifaceted connections between learning, technology and spaces cannot be ignored. To exemplify, students’ decision to use a room is not only affected by ambient temperature; it is also affected by the number of pre-existing occupants, their characteristics, neighbouring spaces, availability of personal and institutional technology, experiences potentially housed within its boundaries, time of day, time already spent studying, schedules, etc. – subsections 5.2.1, 5.2.2, 5.3.1 to 5.3.4, 5.4.1, 5.4.2, 5.5.1, 5.5.3 and 5.5.5. Realms of possibilities rather than specific probabilities are what make learning-technology-space decisions complex.

Through adaptiveness, the learning-technology-spaces intersection serves different purposes. Examples of adaptiveness abound. The way students engage with learning, using technology and interacting with physical spaces responds to a multitude of inputs and develops multiple embodiments. School and programme realities, temporal and pecuniary constraints, professional norms, social norms and the need for comfort are main declared influences of adaptiveness visible in data – subsections 5.2.1, 5.2.2, 5.2.3 and 5.3.2. Under their umbrella, a great deal of possibilities – both regarding the manner in which influence is exercised and the fashion in which students respond – resides. [redacted] studying in the back of an ambulance to avoid the noise inside a base, are all obvious examples of adaptiveness – subsections 5.4.1, 5.4.2, 5.4.3 and 5.4.4. Other, more inconspicuous examples of adaptiveness also exist in data; not overtly challenging professional norms to not commit career suicide – subsection 5.3.6 – is such an example. All these examples not only substantiate the existence of adaptiveness, but also show that its causes and its results are multifaceted. Understanding that student experiences abound with intricate examples of adaptiveness completed my realization that the shadow learning landscape has traits of a complex adaptive system.

6.2.3 The shadow learning landscape emerges from ad-hoc student co-creation

"[A]nts create colonies; urbanites create neighborhoods" (Johnson, 2012) and students co-create their own shadow learning landscape. Elements of co-creation are visible in evaluated literature. Yet, they have not been previously recognized as such.

Students co-create own experiences in an ad-hoc manner. A distinct pattern emerges from chapter five data: students forge, without being mandated to do so by educational institutions, most of their learning-technology-space experiences. I define this pattern as ad-hoc co-creation. Essential to my definition is the explanation of co-creation provided by Bovill et al.: "Co-creation of learning and teaching occurs when staff and students work collaboratively with one another to create components of curricula and/or pedagogical approaches" (2016). Student behaviours are akin to co-creation, yet, do not involve purposeful, institutional supported collaborations. Therefore, I present co-creation as an ad-hoc process.

Paramedic "students work collaboratively with one another to create components of curricula and/or pedagogical approaches" (Bovill et al., 2016). In this sense, they co-create their own learning landscape. Students' active involvement in learning means that they do not passively use ready-made resources; they diagnose challenges – subsection 5.4.1 – then tinker and modify matters of learning, technology and spaces to create a combination that suits their needs – subsections 5.4.2 to 5.4.4. To exemplify, students set-up their uniform to dimmish overall distractions in chaotic patient care spaces – subsection 5.5.4 – or use the back of the ambulance as a private study space during idle times – subsection 5.6.4. Student co-creation thus seems driven by a desire to achieve physical and psychological comfort – subsection 5.3.2.

Students build their own learning landscape without being recruited by educational institutions to do so. This ad-hoc co-creation upholds the shadow character of the learning landscape students develop. While learning, technology and spaces could be used as offered by educational institutions, students do not appear to use what is given to them without discernment. Much of chapter five shows students trying to achieve comfort – subsection 5.3.2 – by combining, modifying and generally adapting different elements of learning, technology and spaces to suit their needs. This adaptation builds upon institutional offerings, yet it is not an institutionally supported act. It is rather a student driven action making learning possible amidst institutional and social provisions. At no time it became apparent in the previous chapter that students admit to being recruited by educational institutions to develop their own experiences. At times, co-creation appears implicitly expected. For example, students seem to face no impositions and appear expected to use whatever technology they desire in their classroom note-taking process – subsection 5.5.2. At other times, co-creation is not expected; in enacting it, students [redacted]

Much of students' co-creative energy is used to fix institutional failures. Many student accounts – presented in chapter five and reviewed above – portray learners involved in activities aimed at fixing institutional failures. Buying and using whiteboards – subsection 5.3.4 – [redacted] – are examples of situations where students fix institutional failures. This brings forth two matters. First, this facet of student co-creation invites discussions regarding institutional interventions. I develop this in the next subsection when I discuss the institutional intervention threshold component of the shadow learning landscape. Second, since students seem to expend much of their co-creative energy on fixing institutional failures, I wonder how the shadow learning landscape would look when institutions fix the failures that nowadays students are trying to mend. Only future research can provide this answer; I detail this in my contribution to knowledge.

6.2.4 The shadow learning landscape emerges as an institutional intervention threshold connecting student co-creation and comfort

Much like "simple pattern recognition software learns how to recommend new books" (Johnson, 2012), the combination between student (in)actions and their discomfort serves as a means of suggesting when institutional intervention in student experiences is needed. At a minimum, student (in)actions that could lead to increased discomfort, invite institutional intervention to take place. In this sense, the comfort of student experiences acts as an institutional intervention threshold.

The institutional intervention threshold is a function of student co-creation and comfort. Three broad categories of connections between student co-creation and comfort emerge from chapter five. Two of these categories point towards the need for institutional intervention. In situations where students co-create experiences in an expected manner and no additional discomfort is imparted on them, institutional intervention is unlikely needed. When students co-create experiences in a manner that potentially exposes them to discomfort or when they cannot change an uncomfortable situation, institutional intervention is likely needed to improve student experiences.

Comfort combines physical and psychological factors. Students perceive physical and psychological comfort as affecting interactions amongst learning, technology and spaces – subsection 5.3.2. Yet, student accounts cannot verify whether physical or psychological comfort are more likely to affect student actions at a specific time.

The need for institutional intervention is unlikely needed when student co-creation does not lead to uncomfortable experiences. As chapter five presents, this is usually seen when students engage in somewhat expected behaviours. I group in this category student actions that appear implicitly expected. For example: using preferred technology to take notes, engaging in learning within available spaces or setting up the uniform to decrease the stress of a chaotic scene – subsections 5.3.4, 5.4.3 and 5.5.5.

Students could experience discomfort when mediating institutional failures. Institutional change is usually needed in these cases to assure comfortable student experiences. Four examples will clarify these statements. [redacted]

[redacted] These behaviours allow students to mediate failing facilities but could be sources of additional psychological stress [redacted]. All these examples could cause additional student stress. In all cases, institutions, rather than students are better equipped to mediate these challenges.

When students are unable to enact change and thus partake in uncomfortable experiences, institutions also need to intervene. Two specific examples stand out in this case. First, students acknowledge that ambulance design affects learning with technology. More specifically, it seems that centre-mount ambulances are more conducive to learning than side-mount ones – subsection 5.3.5. Designing and purchasing ambulances is outside the purview of students. Educational institutions and host paramedic agencies should then intervene to mediate a positive student experience. Second, professional and social norms are also outside the control of students, yet these norms directly affect student experiences – subsections 5.2.3 and 5.3.6. In both cases, students engage in learning without trying to extensively change these norms. Discomfort caused by these norms is outside the control of students; it should be mediated by educational institutions and not by learners.

My thesis highlights the need for institutional interventions, yet it does not prioritize these interventions. The threshold for institutional intervention is a function of student co-creativity and comfort. Institutional interventions seem needed when students enact unexpected behaviours or when they act in uncomfortable situations. However, as many influences can generate uncomfortable student experiences, my thesis does not determine which challenges should be mediated first. I can posit that situations where students [redacted]. More research would be needed to verify this hypothesis.

6.3 Contribution to knowledge

In this section I first identify how the shadow learning landscape model adds new perspectives to existing knowledge. I then highlight how my research enhances and enriches the literature on student experiences regarding educational spaces and the use of technology within these spaces. For clarification, enhancement is achieved by presenting new facets of student experiences and enrichment is attained by introducing richer detail regarding how students shape their own experiences.

6.3.1 The shadow learning landscape model adds a new perspective to existing knowledge

The shadow learning landscape model adds an original perspective to existing knowledge. This originality partly stems from the nomenclative and modelling potential associated with the shadow learning landscape; these can serve as unmistakable focusing points for future policy, practice and research discourses. Concomitantly, the original contribution to knowledge of the shadow learning landscape also stems from its unique theoretical implications amongst existing research on the topic. Three ideas help explain this latter contribution to knowledge.

First, the shadow learning landscape stems from a theoretical framework heavily sensitized by sociomaterialism and complexity thinking. This differentiates my research from the bulk of existing work. This is important because this allows my scholarship to highlight the role that elements of sociomaterialism and complexity thinking could have for future research interested in the intricate connections between humans and non-humans that dominate the learning-technology-spaces intersection. Second, the shadow learning landscape's contribution to knowledge stems from its unique, focused analysis of a specific combination of elements – the intersection of learning, technology and spaces in paramedic student experiences – which has rarely been considered as the dedicated scope of research in the past. That is important, because this combination is an important part of today's learning experiences where "[t]he proliferation of digitalized education has […] renewed an interest in physical learning spaces" (Bligh, 2019a). Third, the shadow learning landscape's original contribution to knowledge also stems from its metaphorically evocative power; this means that its metaphorical usage can introduce a mental shift, potentially solving fundamental challenges identified in reviewed literature. This is useful because it allows readers interested in student experiences to imagine learning, technology and spaces as a cohesively united shadow learning landscape, which is novel compared with most literature on the topic, which typically fails to highlight the complex intertwining of humans and non-humans in practice.

The shadow learning landscape has nomenclative and modelling potential. This is important because, by introducing a new nomenclature and an associated model, the shadow learning landscape aims to serve as an unmistakable focusing point for future policy, practice and research discourses. To detail, the shadow learning landscape is a representation of the learning-technology-spaces intersection as experienced by students existing amidst institutional impositions but acting beyond the limits of institutional offerings. Students learn while engaging with technology and spaces in a manner that accounts for, compensates and completes institutional offerings, yet is not directly or specifically institutionally driven or approved. The shadow learning landscape uncovered through my interaction with students then focused my thesis by allowing an evocative summary and a model of my research findings. Likewise, this landscape could potentially serve as the logistical focusing point for future discourses, conceptually coagulating the object of upcoming inquiry into an unequivocal term. This has policy, practice and future research implications which I will detail in sections 7.5 and 7.6.

The shadow learning landscape stems from a theoretical framework heavily sensitized by sociomaterialism and complexity thinking. This differentiates my research from the bulk of existing work. This is the first unique theoretical implication of my thesis amongst existing research. This is important because it allows future research to be sensitized not only by the shadow learning landscape model but also by the elements that went into the making of my theoretical framework – I will detail this in section 7.6. To explain, against the backdrop of a literature that largely lacks sociomaterial and complexity sensitization, my research specifically anchors itself in these two theories. In doing so, my research leads to a model that provides adequate theorization of student actions outside institutional impositions. The shadow learning landscape thus highlights the complex interplay of learning, technology and spaces in student experiences, students' capacity to co-create their learning and also introduces a possible threshold for institutional intervention. Existing literature is mostly marred by a lack of attention to theories which highlight materials. In my research I specifically chose to highlight materials along with humans and their interactions by employing sociomaterialism and complexity thinking principles which provide the depth and breadth of sensitization needed to analyse how paramedic students' experiences are influenced by interplays of physical spaces, technologies and learning practices. I argued in chapter two that the marked failure of most existing research to foreground materials leads to reviewed literature only presenting student experiences regarding spaces and the use of technology within spaces in a fragmentary manner. As I discussed in section 2.7 and highlighted in different parts of sections 2.5 and 2.6, most reviewed research only notices space (in)adequacies in passing, rarely addresses within discussions challenges identified in findings and presents little information about the way students shape their own experiences. In my research however, I eliminate these challenges. In doing so, I allow my research to uncover details of the complex interplay of learning, technology and spaces in a manner that is rarely encountered before. My work adds new perspectives which legitimize situations poorly articulated in reviewed literature. Researchers interested in student experiences, could allow their future work to be sensitized by these perspectives. In doing so, they can benefit from my model, while also legitimizing, by further investigating, the shadow learning landscape of paramedic students.

The shadow learning landscape's contribution to knowledge stems from its unique, focused analysis of a specific combination of elements – the intersection of learning, technology and spaces in paramedic student experiences – which has rarely been considered as the dedicated scope of research in the past. This is the second unique theoretical implication of my thesis amongst existing research. That is important, because this combination is an important part of today's learning experiences where "[t]he proliferation of digitalized education has […] renewed an interest in physical learning spaces" (Bligh, 2019a) yet these are still part of *"an under-researched topic"* (Temple, 2008). My thesis then makes a significant contribution to knowledge because it provides evidence of how research into these areas can develop and offers insights into areas of investigation which need to be further analysed in the future. To detail, as I presented in section 2.3, while scoping the literature, I discovered that literature focused on concomitantly understanding the learning-technology-spaces intersection is scarce and that paramedic literature regarding student experiences vis-à-vis the learning-technology-spaces intersection is limited. Given the ubiquity of technology and spaces in student learning and the visibility or paramedics in today's society, this lack of research needs to be decreased. The shadow learning landscape that I uncovered in my thesis offers a unique analysis geared towards a poorly studied profession and focuses on the learning-technology-spaces intersection which should form the scope of analysis for future research.

The shadow learning landscape's original contribution to knowledge also stems from its metaphorically evocative power; this means that its metaphorical usage can introduce a mental shift, potentially solving fundamental challenges identified in reviewed literature. This is the third unique theoretical implication of my thesis amongst existing research. I chose to present this contribution to knowledge now, after already presenting the previous ones, to highlight its summative power for my thesis; the contribution to knowledge presented in this paragraph is extremely important as it coagulates in it all the other contributions to knowledge previously presented in this section. The shadow learning landscape's metaphorically evocative power is then useful because it allows readers interested in student experiences to imagine and approach matters of learning, technology and spaces not as separate entities but rather as a cohesively united shadow learning landscape which is built upon complex interactions of humans and non-humans in practice. This is also novel compared with most literature on the topic, which typically fails to highlight such complex interactions. The shadow learning landscape is thus not only a conclusion to my research but also as a springboard for future research. To explain, I identified in section 2.7 that research failing to foreground materials largely generates fragmentary findings, whereas richer findings tend to be associated with material-focused research underpinnings. I supported this latter claim with examples from three articles (Donetto et al., 2017; Hawick et al., 2018, 2021). Using the shadow learning landscape metaphor creates a mindset that could solve many of these challenges. Spaces, along with learning and technology, are recognized and analysed as omnipresent within student experiences. The gestalt nature of the model, helps conceptualize learning, technology and spaces as interconnected, highlighting the concomitant role of humans and non-humans in shaping student experiences. This supports student co-creation and allows students and institutions to conceptualize when institutional interventions are needed. This also helps the narrative of student experiences to cohesively unfold, connecting findings and discussions.

In this section I presented how the shadow learning landscape presented in my thesis, adds to existing knowledge. In the next two sections – 6.3.2 and 6.3.3 – I will present how my research enhances and enriches existing literature focused on student experiences connected to spaces and on student experiences regarding the use of technology in educational spaces.

6.3.2 My research enhances and enriches existing knowledge about educational spaces in the experiences of healthcare students

The next paragraphs describe how my thesis enhances and enriches existing literature focused on student experiences connected to spaces – section 2.5. Below, themes to which I contribute are bolded to reflect subtitles from section 2.5.

My thesis contributes to knowledge regarding how **space adequacy affects healthcare student experiences across the campus-clinical continuum** – subsection 2.5.1. Examples of literature that I reviewed in that subsection showed that “adequate facilities are crucially needed to assist students to meet academic demands” (Tharani et al., 2017) and that small, noisy rooms, with inappropriate light and ventilation are inadequate to studying (Anarado et al., 2016; Fajardo et al., 2021; Mthimunye & Daniels, 2019; Oguro et al., 2022; Takase et al., 2019). Chapter five cites similar requirements. It also adds details not yet encountered in reviewed literature. First, my findings add details of how students create, by themselves, adequate space experiences. For example, despite pecuniary constraints, students co-create adequate study spaces by purchasing and using whiteboards which are missing in school provided study-rooms. Second, my findings add the patient care compartment of ambulances as spaces whose adequacy healthcare students struggle with; this perspective was not found in reviewed literature. To clarify, students in my research identify that centre-mount – and not side-mount – ambulances provide more access to patients during high-acuity calls. However, institutions, rather than students, control ambulance design. These represent important contributions to existing literature because they offer evidence of situations not previously described which, through their comfort and space-related implications, could affect student learning across many generations. Students attempt to actively shape their experiences; in doing so they enact complex leaning, technology and space combinations but are challenged by circumstances beyond their control. My research shows the intricacies of the shadow learning landscape but, more importantly, establishes student co-creation and ambulance design as two areas which research focused on space adequacy within healthcare student experiences needs to further investigate.

My thesis adds a new facet of **welfare facilities encountered in student clinical learning experiences** – subsection 2.5.2. My work does not sufficiently explore students' hospital based clinical training, but introduces ambulance focused discussions regarding welfare facilities. My study participants, similar to students from reviewed literature, need spaces to engage in academic learning while in practicum (Al-Dweik et al., 2021; Kapucu & Bulut, 2011; Moonaghi et al., 2015); this, in my thesis, is ambulance related. My thesis contributes to existing knowledge by showing students actively creating welfare spaces when needed. Paramedic students use the complex interplay of learning, technology and spaces to transform the back of an idle ambulance into an academic study room. This is important because it introduces an example of student-improvised welfare facilities and thus legitimizes students' co-creative behaviours which currently remain in the shadows. Yet, while ad-hoc co-creation offers students much needed welfare facilities, the implications of these improvisations on student learning and comfort remain a mystery which only future research can elucidate.

My thesis re-enforces the need to investigate **unintended consequences spaces can have on student experiences** – subsection 2.5.3. In examples from reviewed literature unintended consequences of spaces were seen when a medical school, despite built to unite students, unintendedly lead to medical student separation from other university students (Hawick et al., 2018, 2021). [redacted] Ambulances, despite mainly intended for patient care, become study-rooms during idle-times. My research does not necessarily uncover unintended consequences as direct results of built-space failures as the reviewed literature seems to do. My thesis instead uncovers unintended consequences as symptoms of deep-rooted institutional disturbances within the learning-technology-spaces intersection which students try to mediate themselves. Carefully researching these unintended consequences is important because they affect students' physiological comfort, could signpost limitations of student co-creation and might identify institutional intervention thresholds. [redacted]

[redacted]

My thesis identifies new spaces whose **potential for impacting learners' professional identity** – subsection 2.5.4 – needs further investigation. Currently, examples from medicine and nursing show that spaces where students act as professionals and interact with patients while separated from their preceptors can positively impact learners' sense of professional self (van der Zwet et al., 2011; Vuckovic et al., 2021). Neither examples from reviewed literature, nor my research, show the existence of these spaces in paramedic student experiences. This is a notable absence. Future research cannot ignore investigating the possibility of enacting such spaces in paramedic education because their existence could positively influence paramedic students' sense of professional self by allowing them to balance between "being 'allowed' to be a learner and […] the freedom 'to really be a'" professional (van der Zwet et al., 2011).

My thesis enriches existing knowledge regarding **spaces' potentially negative impact on student experiences**. Examples of literature reviewed in subsection 2.5.5 showed that spatial separation of a maternity unit from the rest of the hospital seemingly associated with staff’s tormenting behaviours towards students (Capper et al., 2020). Literature reviewed in subsection 2.6.5 showed that negative behaviours and incivility exist in ambulance stations (Axelsson et al., 2016; Boyle et al., 2008): “some students were not made welcome at the ambulance station, were ignored, made to feel like a burden on the crew” (Boyle et al., 2008). While my work does not present such severe student tormenting, it does show that professional norms mandate certain student behaviours. Concomitantly, my work highlights that the crew room – a small, isolated space – is where such professional norms are evident. My work also shows that paramedic students remove themselves from the crew room and use ambulances as student-focused spaces during idle times. My findings thus contribute to literature the insight that students enact a place, away from professional paramedics, where technology is used to learn or take a break. Nonetheless, challenges that potentially affect students in crew rooms, cannot be mediated by students and thus invite institutional intervention. These are important findings, as they can potentially affect the comfort – mental and otherwise – of paramedic students and thus warrant further investigations.

6.3.3 My research enhances and enriches existing knowledge about using technology in educational spaces in the experiences of healthcare students

The next paragraphs describe how my thesis enhances and enriches existing literature focused on student experiences regarding the use of technology in educational spaces – section 2.6. Below, themes to which I contribute are bolded to reflect subtitles from section 2.6.

My thesis adds to knowledge regarding **technology's roles in customizing student experiences across different spaces** – subsection 2.6.1. Examples of literature reviewed in that section present students as "more or less continuously connected" (Clarke et al., 2019), taking notes and accessing information through podcasts, e-textbooks and internet – the latter being used both in classroom and during patient care (Altmann & Brady, 2005; Clarke et al., 2019; Emory et al., 2021; Lee et al., 2019; Mcnally et al., 2017; Meade et al., 2011; O'Connor & Andrews, 2018; Shanahan, 2012; Willemse & Bozalek, 2015). My students mimic same behaviours. Concomitantly, my thesis also contributes to existing literature. First, it adds descriptions of student actions aimed at immersing learners in their education – subsection 5.5.5; these enrich the detail of existing literature. For example, my thesis highlights students involving family members to practice skills at home or using voice-recorded notes to learn while driving. These are important additions to existing knowledge as they exemplify the potential of technology to expand the boundaries of learning. Nonetheless, future research also needs to consider the potential negative implications of blurring the boundary between personal life and learning. Second, my thesis adds descriptions of what students [redacted] these are shadow learning landscape descriptions generally invisible in reviewed literature. For example, I present students controlling temperature by layering, using headphones to minimize distractions [redacted]. This is an important addition to literature because it highlights situations where students' co-creative energy is wasted on mediating institutional failures. The inference can be made that, if institutions were to fix these failures, students would be able to focus more energy on matters with more direct patient care impact. Only further research can verify this inference.

My thesis further legitimizes that **customization of student experiences trough technology is restricted by factors outside student control** – subsection 2.6.2. For example, students' usage of electronic devices while involved in patient care is shown in my thesis to have potential lifesaving benefits for patients yet is affected by social norms – subsection 5.3.6. [redacted] This agrees with examples from reviewed literature – subsection 2.6.2. My findings are nonetheless important because they provide richer than previously encountered examples of the gut-wrenching challenges associated with restrictions outside forces impose on students' capacity to customize experiences through technology. For example, students' decision to use a smartphone to verify patient care information has the potential to bring unwelcomed psychological stress: [redacted]

[redacted]. Only further research can elucidate the impact of these challenges and the institutional interventions needed to decrease student discomfort.

My work enriches and enhances literature discussing the **role of realistic simulation in shaping student experiences** – subsection 2.6.3. Examples of reviewed literature revealed matters which also appear in my work: realistic experiences involve equipment and physical spaces which mimic the real world, students crave realistic experiences, students engage with simulation as a means of individual practice and sometimes simulation meets users in their spaces. This is important because it adds additional support to existing literature and strengthens the presence of prehospital related findings connecting student experiences and realistic simulation. The use of simulation at paramedic bases seems especially important as it appears to enhance the learning that takes place during idles times in preceptorship – subsection 5.3.4. Additional research would be needed to further elucidate the implications of deploying and using simulation equipment in paramedic bases. My findings also reveal efforts students make to access simulation equipment after hours – e.g., [redacted]. [redacted]. My findings are important because they exemplify students' co-creative potential and, same as above, identify areas where co-creative energies are diverted into fixing institutional failures. Future investigations are needed to elucidate the effects of eliminating these diversions from student experiences. The potential of the shadow learning landscape model to focus such investigations leads me to advocate for its use in future research.

My thesis presents a new facet of how students mediate **chaotic ambulance related patient care spaces** – subsection 2.6.4. Examples of literature reviewed in that subsection show that ambulance related patient care spaces can be chaotic, “unpredictable, violent” (Melby, 2001) and “students […] never know what kind of scene and patient illness they will encounter during their shift” (Nilsson & Lindström, 2017). This chaos is mediated in reviewed literature through student flexibility and structured approaches to calls (Nilsson & Lindström, 2017). To this, my thesis adds a finding prevalent amongst interviewees which has not yet been reported in reviewed literature: the student uniform setup supports practical learning by introducing an air of familiarity into different patient care spaces – subsection 5.5.4. This is important, because it provides new insight into elements used to create the structure needed to decrease the chaos of ambulance related care spaces. Future research should build upon this finding.

My thesis contributes to knowledge showing the way **ambulance related spaces affect student experiences during idle times** – subsection 2.6.5. My findings agree with examples from existing research: paramedics and students have moments of rest; idle times have the potential to be used for practice but can be affected by negative experiences. In my work, I however emphasize the shadow learning landscape of these idle times which is not evidenced in reviewed literature. My work presents these idle times as being affected by ambient noise and professional norms which force students to move to the quiet areas of ambulance bases or, usually, the back of ambulances – subsections 5.2.3 and 5.6.4 – where they use technology to study – subsection 5.5.3. This is important because it not only depicts specific challenges students encounter during idle times, but also shows the way learners mediate these challenges by themselves. My thesis thus adds a layer of sophistication not currently visible in existing works, which future research can build upon.

6.4 Summary

Chapter six identified high-level themes emerging from chapter five which mapped how students experience the learning-technology-spaces intersection. Chapter six consolidates this intersection into a shadow learning landscape model, which adds a new perspective to existing knowledge and could help future research avoid fundamental challenges identified in reviewed literature. Findings presented in chapter five justify the shadow learning landscape model. My thesis adds new facets of student experiences that were not clearly present in reviewed literature – e.g., using uniforms to co-create calm in chaotic patient care spaces. My research also supplements knowledge already described in literature with richer detail regarding how students shape their own experiences. Concomitantly, my thesis raises questions about the possibility of researching spaces of private paramedic student-patient interaction in future projects. Future areas of investigation can help students focus their co-creative energy on learning about patient care rather than on fixing institutional failures.

Chapter 7: Conclusions and Future Work

7.1 Introduction

In my thesis I set out to explore how paramedic students' experiences are influenced by the interplay of physical spaces, technologies and learning practices and I uncovered characteristics of a metaphorical shadow learning landscape. Based on student experiences, the learning-technology-space intersection has complex adaptive system traits, is co-created by students in an ad-hoc manner and functions as an institutional intervention threshold.

The impetus for my research connects to personal, academic and political circumstances. Personal observation and academic literature pointed to the intricate connections amongst learning, technology and spaces in student experiences. Yet, literature focused on student experiences only presented fragmentary mentions of spaces, usually visible within works focused on other matters. However, despite this penury of information, educational institutions evaluate and constantly reach decisions regarding spaces and technology. The dichotomy between how little is known and how many decisions seem to be affected by the learning-technology-spaces intersection, made me especially interested in understanding student experiences regarding this intersection.

My findings present a systematic description of student experiences across the learning-technology-spaces intersection continuum from classrooms to preceptorship. In doing so I initially presented themes connected to matters of enabling constraints, neighbour interactions, decentralized control, diversity and redundancy as visible in student interviews and artefacts. I then look at the higher-level ideas visible when analysing all these themes together. In this way I describe the shadow learning landscape's properties and highlight my contribution to knowledge.

Carrying out my study addressed many of my original intentions, particularly with regards to uncovering the hidden connections between humans and non-humans that shape the learning-technology-spaces intersection in paramedic student experiences. In doing so, my thesis describes a model of the shadow learning landscape, adds facets of student experiences not encountered before, and enriches the detail of some experiences already reported upon in current literature. Nonetheless, as I discuss below in the overall project limitations, I was less successful in having my accounts verified by stakeholders and I was not able to capture details about all facets of student experiences.

7.2 Reviewing my findings

My thesis conceptualizes the shadow learning landscape as an emergence appearing out of student experiences vis-à-vis the learning-technology-spaces intersection. This landscape is rendered visible as having complex adaptive system traits, being student co-created and serving as an institutional intervention threshold. These three high-level themes resulted from the emergence sensitized analytical work of my initial findings. In their turn, these findings were the result of gathering and analysing data regarding student experiences through five complexity inspired principles: enabling constraints, neighbour interactions, decentralized control, diversity and redundancy. I will review my findings below, starting with these five principles and then outlining the high-level themes described in chapter six. I will then reconnect to personal motivations as well as academic and political discourses presented in chapter one.

Enabling constraints point to rules which students act within. Programme requirements, temporal and pecuniary constraints as well as professional norms, all represent rules which students cannot break. Yet, these rules mediate a myriad of learning-technology-space possibilities for learners.

A look at *neighbour interactions* in student experiences, identifies student opinions about elements of learning, technology and spaces which are closely related. Overall, the mutual connections between learning, technology and spaces are recognized by students. Concomitantly, comfort affects the manner in which learning, technology and spaces interact, school related space failures inhibit learning, ambulance design affects learning with technology and social norms influence how technology is used for learning in patient care spaces. At this point, accounts start showing the complexity and adaptiveness of learning-technology-space groupings and the areas where institutional, rather than student, input is needed to maximize their utilization – such as the case of ambulance design challenges.

Looking for *decentralized contro*l helped me pinpoint those areas of the learning-technology-spaces intersection which allow for bottom-up decisions to take place. As such, I became aware that, as part of their experiences, students monitor their learning needs and develop behaviours for best performance, try to bring comfort to learning with technology and control some of the technology used to study thus affecting learning in different spaces. [redacted] At this point, it became visible that, whenever possible, students make decisions aimed at using the learning-technology-space intersection to mediate their needs and achieve comfort; those areas which cannot benefit from student control, would need institutional help to improve.

The concept of *diversity* sensitized me to look for the specific functions the different embodiments of the learning-technology-spaces intersection appear to have. I thus discovered that the paramedic lab is a hub of student existence, technology generates customized experience through personalization of learning in classroom spaces, the connection between technology and spaces helps students craft learning places for academic learning outside the classroom, the uniform setup supports practical learning by introducing an air of familiarity into different patient care spaces and the learning-technology-spaces intersection maximizes the immersive character of education.

Redundancy helped identify those similitudes or commonalities that directly mediate interaction (cf. Davis & Sumara, 2008, p. 39), while also allowing interacting elements to “compensate for one another’s failings” (Davis et al., 2010). When investigating matters of redundancy, I discovered that students recognize that some areas require no change regarding their capacity to compensate for deficiencies, develop networks that allow them to achieve common goals, choose and use technologies and spaces that compensate for shortcomings in their experiences and can, during idle times, use the back of an ambulance as a private study space. While some redundancy is mediated by the school, most is generated by students.

Uncovering the above repeated ideas, helped me identify the fact that students develop a shadow learning landscape. I was sensitized to uncover this by the idea of *emergence*. To uncover it, I underwent additional data analysis, looking for high-level themes which emerge out of the previously presented empirical findings – the previous five paragraphs. The shadow learning landscape is a metaphor for those things that students do to assure that their experiences match their needs.

The shadow learning landscape is characterized by having complex adaptive system traits, being student co-created and serving as an institutional intervention threshold. This means that the learning-technology-spaces intersection is essential in shaping student experiences. The interconnectedness of these three elements also means that one needs to consider them together when analysing or deciding matters of student experience. Saying that students co-create their shadow learning landscape means that they are actively involved in shaping their own experiences. Albeit ongoing, co-creation seems to be an ad-hoc process which would need to be consciously legitimized to assure educational institutions learn from that which students are doing. In the end, the shadow learning landscape functions as an institutional intervention threshold which is a function of student (in)actions and their comfort. Future research can be driven by these concepts.

My thesis and its findings reconnect to my personal motivations as well as the academic and political discourses that led to this project. In my thesis work I listened to denizens, added to descriptions of spaces, especially as they indissolubly connect to learning and technology, and gave new meaning to the learning-landscapes metaphor. In doing so, I not only satisfied my personally motivated broad interests in educational spaces. I also offered prima-facie examples of the kind of detailed information about the learning-technology-spaces intersection students have access to and can share with us if we are willing to listen. By listening to students' voices, I was able to identify facets of their experiences which, until now, remained hidden. This helped me model the shadow learning landscape I present in this thesis. Through its findings, my thesis offers student formulated answers to political discourses. Overall, by making students' voices heard, my thesis feeds back into and supports the same academic discourses that focused my research interests. To continue uncovering students' hidden knowledge, subsequent research needs to further listen to the voices of these educational denizens and understand learning, technology and spaces as cohesively interconnected.

7.3 Reviewing my contribution to knowledge

My contribution to knowledge is threefold: introducing the shadow learning landscape model, presenting new facets of student experiences and enriching the detail of knowledge already available in literature. These could be of interest to scholars focused on at least three areas of research.

My findings are presented in a manner that aims to make them interesting to scholars in three areas: healthcare student experiences, healthcare education and healthcare-focused technology enhanced learning. The indissoluble connection between learning, technology and spaces highlighted in my thesis, points to fluid interconnections within these three areas of scholarly interest. Researchers from these three areas can find in my thesis examples with which they can relate. Further, all can use the shadow learning landscape metaphor to guide an understanding of student experiences across varied learning practices, while using multiple technologies and traversing different physical spaces.

My thesis introduces the shadow learning landscape which is important because, by its nomenclative power and the model associated with it, can serve as an unmistakable focusing point for future policy, practice and research discourses. To clarify, the shadow learning landscape represents student experiences regarding the learning-technology-spaces intersection which are positioned amidst but outside institutional impositions. This means that students learn while engaging with technology and spaces in a manner that accounts for, compensates and completes institutional offerings, yet is not directly or specifically institutionally driven or approved. Logistically, this landscape focused my thesis by allowing an evocative three-word summary of my research. Similarly, the shadow learning landscape can serve as the logistical focusing point for future discourses, conceptually coagulating the object of inquiry into an unequivocal term. This has policy, practice and future research implications which I will detail in upcoming sections.

The original contribution to knowledge of the shadow learning landscape also stems from its unique theoretical implications amongst existing research. These implications are visible in the manner in which my thesis connects to the previous literature and its potential for future research. First, the shadow learning landscape's originality stems from a unique approach to research I adopted in my thesis. To explain, my thesis uses a theoretical framework heavily sensitized by sociomaterialism and complexity thinking. This differentiates my thesis from the bulk of existing work which is dominated by research which fails to foreground the role of materials and thus leads to truncated findings – I specifically argued this in section 2.7 after starting to introduce it throughout sections 2.5 and 2.6. Second, the originality of the shadow learning landscape's contribution to knowledge stems from its unique, focused analysis of a specific combination of elements – the intersection of learning, technology and spaces in paramedic student experiences – which has rarely been considered as the dedicated scope of research in the past. Third, the shadow learning landscape's original contribution to knowledge also stems from its metaphorically evocative power. Through the shadow learning landscape, student experiences are seen as complex adaptive learning-technology-space interconnections, student co-created, which could indicate when possible institutional intervention in these experiences is needed. This introduces a mental shift, potentially solving fundamental challenges identified in reviewed literature. Future research can benefit from using this model as it coagulates a kind of sensitization not previously encountered.

Facets of student experiences regarding the learning-technology-spaces intersection which have not been found in reviewed literature are visible in my research. My research shows that students are capable to maximize the complex interactions between learning, technology and spaces to co-create their own learning by enhancing and personalizing educational experiences offered by institutions. As an example, the students' tremendous co-creative energy is exemplified by the manner in which students wear their uniforms to decrease chaos during patient care. Concomitantly, my research also shows that students' co-creative energy is wasted when they are trying to fix institutional failures or are forced to learn in uncomfortable situations. Using ambulances as academic study spaces even though they were not designed for such purposes or learning in ambulances which are not conducive to proper patient interactions are such examples. In these cases, my thesis, draws attention to the need for institutional interventions aimed at alleviating these challenges. My hope is that through future work, students' co-creative energy could be diverted back into learning about patient care.

Richer detail regarding how students shape their own experiences supplements knowledge already described in literature. For example, adding detail to events students are already known as partaking in during preceptorship idle times and showing richer descriptions than in the reviewed literature of the ways students customize their learning by using technology and modifying spaces to fit their needs – e.g., [redacted], buying whiteboards or [redacted]. All of these can be further researched in the future. Nonetheless, my thesis adds a prehospital perspective to previously existing literature and thus widens the spectrum of learning-technology-space related investigations in healthcare education.

Even though my thesis presents many new facets of student experiences, it lacks findings regarding paramedic practice spaces where students can privately interact with patients without constant preceptor supervision. These spaces can have positive influences on students' professional identity. Hence, future research should closely investigate the possibility of enacting such spaces in paramedic student experiences.

7.4 Overall project limitations

While I accounted for some limitations when I setup my project – section 4.8 – additional limitations became visible after gaining an overall picture of my thesis. In this section I focus on the latter.

My accounts are not verified by stakeholders. While I maintained an audit trail and continuously consulted with my supervisor, I was not able to involve students in confirming the authenticity of my findings. This was due to time constraints and the intricacies of researching students while involved in patient care. This is an expected limitation, which I accounted for when designing my research project. Nonetheless, future research should seek participant involvement at multiple times throughout the project and not only at its initial stage.

My research had an intentionally wide scope which led to a great amount of data being gathered but did not capture details about all spaces of student experiences. I intentionally set up my research to investigate student experiences without specifically focusing on one of the four areas of education, paramedic students are known to undergo: academic, simulation, clinical and preceptorship (Paramedic Association of Canada, 2011). This allowed me to uncover as much information as possible, in a situation where little previous knowledge was available. However, this led to long interviews, which were possibly taxing on students and took an unexpected amount of time to transcribe. Surprisingly, not all spaces of student experiences were detailed in the collected data. For example, while paramedic students undergo hospital-based training, my research did not capture in-hospital student experiences connected to the learning-technology-spaces intersection. As such my thesis cannot enhance knowledge related to hospital experiences of healthcare students. In future research, the scope of the project should be more clearly defined to match specific areas of education encountered by healthcare students.

The information presented in my thesis is mostly applicable to the realities of pre-COVID face-to-face learning. While current within the last four years, my data collection took place before COVID, so the information presented in my thesis reflects that reality. I suspect that COVID realities have induced students to create a new shadow learning landscape that I am interested in, but presently unaware of. Future research can investigate post-COVID student experiences regarding the learning-technology-spaces intersection and compare them to my findings.

My thesis does not claim to contribute to the development of sociomaterialism or complexity thinking. While I produced the shadow learning landscape model, I have not yet connected it back to the literature on sociomaterialism or complexity thinking. Also, the use of diversity in my thesis is narrower than what the concept of diversity might investigate – subsection 3.2.4 – so there is scope for more diversity investigation in the future. My model thus introduces new concepts which could sensitize future research, but additional exploration is needed before it can make ontological or epistemological contributions to theoretical knowledge on sociomaterialism. Future research can investigate other facets of complexity thinking, diversity in particular, as they apply to the shadow learning landscape. Future studies could also re-engage with this model from a critical standpoint and highlight its role within sociomaterialistic or complexity thinking.

My model is highly contextualized. In my project I investigated and drew conclusions about a specific research site. The shadow learning landscape model I developed is thus highly specific to that site and I do not currently know its implications for other sites. Future research could investigate the peculiarities of the shadow learning landscape for other healthcare student learning contexts.

7.5 Future policy and practice implications

My research has future policy and practice implications. These could have possible institutional and personal ramifications.

Institutionally, concepts from the shadow learning landscape can be used to generate future policy and practice guidelines. My work has produced knowledge about student experiences that are hidden from policy makers and practitioners. The shadow learning landscape uncovered in my thesis could form the basis of guidelines aimed to bring future policy and practice closer to student needs. Such guidelines could cover issues such as mechanisms for students to signal when institutional interventions are needed or to partake in the development of future policies, especially regarding educational spaces. These guidelines could be developed to purposefully account for the complex adaptive learning-technology-space interconnections, student co-creation and institutional intervention thresholds. In this sense, student experiences should be concomitantly considered as involving learning, technology and space related matters. The co-creative power of students should be harnessed by institutions through collaboration and open dialogues aimed at fixing institutional failures [redacted]. Institutions should also carefully analyse the balance between student (in)actions and their comfort and should urgently act when such (in)actions could lead to further discomfort. Policy and practice guidelines based on these principles would thus allow institutions and students to collaboratively develop meaningful experiences.

Personally, I will use findings from my thesis when considering my teaching practice. When devising courses or classroom activities, I am more likely to consider the learning-technology-spaces intersection as an important influence on my pedagogy. I will also carefully consider assignments and after-hours work that I require from my students. Now that I understand the struggles they face and [redacted] I will try to act in such a manner as to decrease their stress inducing discomfort.

7.6 Future research implications

Future research could build upon the contribution to knowledge and the associated questions for future research I present in section 6.3. Especially interesting to me are future explorations of the shadow learning landscape and the new facets of healthcare student experiences my research highlights. For example, the shadow learning landscape model developed in my thesis can be further tested either through quantitative works, perhaps exploring its wider applicability, or through research especially looking at clarifying each of its components. Similarly, matters not currently covered in existing literature such as the connection between side-mount and centre-mount ambulances and student experiences or the use of ambulances as impromptu academic learning spaces can be further explored in future research.

Future studies might address some of the limitations visible in my project – section 7.4. Efforts should be made to have participants confirm research findings and focus the scope of research projects to only specific areas of healthcare student education. Concomitantly, the shadow learning landscape model could be analysed across a wide range of research sites and its connection to sociomaterialism and complexity thinking should further be investigated.

Future studies focused on student experiences should further investigate the use of sociomaterial and complexity thinking sensitized approaches to research. These underpinnings could unlock facets of student experiences that would otherwise remain hidden. Tools and methodologies used in my thesis were influenced by these theoretical underpinnings and could also inspire other researchers. Sociomaterialism helped me focus on the connections between humans and non-humans in student experiences related to the learning-technology-spaces intersection. Complexity thinking provided the five areas of interest – enabling constraints, neighbour interactions, decentralized control, diversity and redundancy – which focused my initial investigation of these experiences. Complexity thinking also uncovered the concept and the illustrations of emergence, which inspired me to engage in additional data analysis through which I discovered the shadow learning landscape and its previously described characteristics. In this sense, sociomaterialism and complexity thinking inspired my theoretical framework and provided ontological, epistemological and methodological influences to my research. Similar sensitizations can be used in future research.

Future research can benefit from using interviews to the double, either alone of combined with participant drawn pictures (Fenwick & Nimmo, 2015). As I was hoping and expecting (Dieumegard & Cunningham, 2019; Fenwick & Nimmo, 2015; Nicolini, 2009; Scoles, 2017), during my research, the interviews to the double allowed me to build trustful, meaningful, connections with the students and provided intricate details of student experiences. The participant drawn pictures did not only support the spoken word, but also incited conversations and insights into student practices. Specifically important to me was then the synergistic connection between the interview to the double and the drawings students were producing while talking. This is for example visible, in section 5.3.5 where I present a segment from a student interview which takes place while the student is drawing the inside of the ambulance as visible at the bottom right side of Figure 5.4. These two methods – the interview to the double and participant drawn pictures – while concomitantly used, supported each other, synergistically enhancing student engagement and allowing for triangulation of information during the data analysis phase of my thesis. The power of these techniques and their benefit for my thesis, make me hopeful that others choose to use the interview to the double, hopefully combined with participant drawn pictures, in their work.

7.7 Conclusions

My thesis offers a first look at the shadow learning landscape of paramedic student experiences through a sociomaterialistic and complexity sensitized exploration of the learning-technology-spaces intersection. My findings connect to the experiences of healthcare students in general, while also uncovering spaces of specific interest to ambulance related practice. Matters uncovered in my thesis offer a contribution to relevant existing scholarship, can form the basis of future research, and have the potential for influencing future policy and practice. It is my hope that works connected to my thesis will drive knowledge further.

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