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Patterns in Clinical Leadership Learning: Understanding the Quality of Learning about Leadership to Support Sustainable Transformation in Healthcare Education

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Abstract: Frontline doctors' clinical leadership (CL) is key to addressing healthcare sustainability challenges. Research shows CL requires professional learning. Significant investments into CL development notwithstanding, little evidence exists of how frontline clinicians learn leadership, highlighting an educational sustainability challenge. We propose a fundamental constitutive step towards understanding CL professional development (PD) through theorising and analysing CL-learning mechanisms and their association with clinicians' leadership competences required for sustainable healthcare development. This mixed-methods study developed a concept of leadership learning patterns to assess doctors' learning processes associated with sustained innovation. It analysed a post-course dataset of past participants of a CL-PD course ($N = 150$) and a pre-post dataset of an online CL-PD ($N = 34$). EFA demonstrated a reasonable factor model for the Leadership Learning Inventory, measuring two dimensions of doctors' leadership learning patterns: Meaning-oriented and Problematic learning. Qualitative and quantitative analyses showed that Meaning-oriented learning increased significantly during CL-PD and is linked with sustainable leadership competences. This study suggests that the concept of leadership learning patterns is useful for evaluating the quality of clinical leadership learning processes during PD. It offers a conceptually and empirically sound way to assess clinical leadership learning involved in sustainable healthcare improvement, and the sustainability of educational interventions to support it.

Keywords: sustainable development in healthcare; clinical leadership; organisational learning; professional development; professional learning theory



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1. Introduction

1.1. Sustainable Healthcare: A Financial, Environmental and Social Sustainability Challenge

As Štrukelj et al. [1] point out in this Special Issue, “[t]he issue of sustainable development has been at the centre of the attention of economically developed countries for several decades.” More specifically, the authors highlighted the need for sustained innovation to address the current challenges faced by societies. Both sustainable development and sustained innovation are particularly pertinent in discussions about public healthcare, even more heightened since the COVID-19 pandemic [2]. Questions of sustainability in healthcare concern the environmental impact of healthcare [3] but also more generally societies' and systems' capability to offer healthcare to populations with increasingly complex health needs without ever-expanding resource use [4,5]. Sustainability in healthcare hence entails both effective and efficient use of resources, and the equity of healthcare access, practices and outcomes [2,6,7].

How do we achieve more sustainable resource use, practices and outcomes in healthcare? There is widespread agreement that a transition to a more sustainable model of

healthcare that successfully reduces health gaps, care and quality gaps and efficiency gaps requires continuous improvement in healthcare systems and practices [7–9]. This in turn cannot be achieved solely at the level of top managers. Scholars reviewing evidence on sustainable healthcare highlight that continuous improvement requires practitioners at all system levels to engage in sustained service improvement and lead change in organisational practices and cultures [7–10]. Consequently, Stanford and colleagues [11] in the Lancet Planetary Health argued that a “health system that is socially, environmentally, and financially sustainable requires clinical leadership”—the leadership of frontline doctors, cf. [12]. The leadership of frontline doctors is also highlighted in Mostepaniuk et al.’s [2] systematic review as one of the key issues for sustainable healthcare. This is echoed in our earlier research on UK policy documents, which showed that clinical leadership (CL) is raised as a central factor in achieving sustainable healthcare [12].

CL is associated with improved quality of care and healthcare efficiency [13–15] and decreased staff burnout [16]. The literature is also highly positive on CL’s capacity to improve patient outcomes [17–20], although much of the evidence remains discursive. The COVID-19 pandemic further highlighted the importance of leadership competences among frontline practitioners for healthcare effectiveness, efficiency and improvement [21–28].

What is this clinical leadership that can contribute to the sustainability of healthcare? While a plethora of sustainable leadership ‘theories’ have been identified in the literature [8,29], we have argued that a more effective approach to understanding how CL may contribute to sustainability may be to consider the mechanisms by which it may do so [12]. Pursuing this question, our earlier research identified that besides financial savings, cascading and speeding up good practice on the frontline, enhancing interprofessional collaboration and supporting transformation in frontline practice are considered key mechanisms to address sustainability challenges in healthcare, expected to be realised through doctors’ CL. The research further identified that what this requires of practitioners is a shift to a leadership mindset instead of solely one of clinical expertise; capacity to engage stakeholders; boundary-crossing expertise and change agency [12]. These resonate strongly with capabilities identified as necessary for leadership for sustainability in recent evidence reviews, cf. [7,9]. Our research additionally identified risk-taking and willingness to learn from failures as a key clinical leadership competence [12,30].

Research suggests that structural institutional challenges notwithstanding, frontline practitioners can lead change in their practice [31,32]. However, this is far from given, cf. [7]. Our earlier research found that when trainee doctors first become consultants, they often feel that they do not want to try to effect change, but rather want to ‘lay low’ and ‘tread carefully’ [30]. Stanford et al. [11] argue that while clinical leadership is identified as a key issue for sustainable healthcare, few clinicians have the conceptual or practical skills for continuous improvement of care, suggesting that clinical leadership requires education/training [33]. While many authors have recognised clinical leadership competences as ‘learnable’ [8,29], Eustachio et al.’s [34] recent review points out that few evidence reviews on sustainability leadership have examined the role of leadership education and training for sustainability. Our paper addresses this gap and makes a novel contribution to understanding sustainable healthcare development by generating insights about clinical leadership learning.

1.2. Developing Clinical Leaders: An Educational Sustainability Challenge

Given its identified key role in developing sustainable healthcare, it is no surprise that CL has been identified as a key focus for the education and professional development of doctors in the UK [35–38], US and Canada [17,19,39,40], China [41], Australia and New Zealand [42–44], as well as across Europe [18,45–47], Africa [48,49] and Latin America [50,51]. To enable sustained development, a significant amount of education is needed to create a critical mass of clinical leaders for a healthcare system [52]. Many countries have integrated CL into their medical training programmes and a burgeoning in-

dustry of clinical leadership professional development (PD) programmes has emerged [53]. However, we know little about its impact on healthcare sustainability.

Sustainable development of CL requires ways of assessing the impact of CL-PD interventions and their transferability to other settings [51]. Chatpinyakoo et al. [54] highlight that once systems and educators accept the responsibility for educating future practitioners with not only the ‘technical’ knowledge/skill of their profession (such as clinical knowledge/skill) but also the knowledge, skills and mindsets to lead the transformation towards sustainability, “the question becomes, ‘What learning methods and experiences will yield graduates who demonstrate the motivation, knowledge, and skills needed to support the change towards sustainability in their organizations?’” They point out that there is no consensus on the answer to this question, cf. [55]. There is limited rigorous evidence in healthcare education research of the effectiveness and beneficial features of CL-PD for sustainable development of healthcare [9,56]. Recent methodological reviews on evaluating leadership-PD emphasise that given the popularity of leadership training and its potential to achieve positive outcomes or waste significant amounts of resources, it is imperative to evaluate whether, how and why such PD leads to change in outcomes, in order to advance the theory of leadership learning for sustainability and inform education and training [9,57,58].

Despite numerous publications, research on outcomes and impact of CL-PD (the ‘whether’) is in its infancy, and few indicators of change towards sustainability exist [7,9]. While the ultimate goal of CL-PD is improving the sustainability of healthcare processes and outcomes [12], there is, in existing research, a paucity of methodologically robust models and tools to analyse such causal pathways [59–61]. A recent methodological review highlights fundamental unresolved challenges involved in establishing causal relationships between leadership-PD and organisational outcomes [57]. Some research has aimed to capture organisation-level impact on sustainability but often through qualitative data or non-validated survey instruments (cf. Lyons et al., 2020 review) [61]. We are some way off from rigorously assessing the organisational benefits of CL-PD on the sustainable development of healthcare [7,9]; we suggest that we need new ways of thinking about this challenge.

We take a step back and propose a pragmatic but robust approach as a fundamental constitutive step towards the goal of understanding CL development and its impact on healthcare sustainability. Our approach is in line with several recent reviews which suggest that to be able to address the ‘wicked problem’ of studying the impact of leadership-PD, we need to first develop a theory of the learning mechanisms by which the PD affects its desired wider outcomes. Wallace et al. [62] argue that professionals’ learning serves as the critical mediating mechanism between leadership training and its more distal outcomes. This turns the focus on the ‘how’ and ‘why’ of doctors’ learning during CL-PD as a constitutive step in enhancing the field’s capacity to robustly study the ‘whether’ CL development improves healthcare sustainability.

Martin and colleagues [57] highlight that leadership-PD interventions have two active components that can affect outcomes, PD content and process. A recent systematic review [61] showed that no CL-PD content area was particularly associated with organisational outcomes; its results suggested that the educational methods involved are more important, calling for attention to the process. A similar observation arises from research on learning sustainability competences in HE more generally: participants’ learning processes need to be considered when designing instructional events [63]. We hence argue that the first step of the ‘how’ is examining doctors’ learning processes during CL-PD that may enable them further down the line to engage in new sustainable leadership behaviours. Research on medical students’ learning supports this, highlighting that educational processes impacting learning include not only external contextual factors but crucially the learners’ internal learning factors [64,65]. As phenomena of the ‘mind’, learning processes need to be conceptualised theoretically in order to be made visible for study.

The study at hand focuses on developing conceptual and methodological tools for investigating how clinicians learn leadership during CL-PD. This contributes to the gap in the literature on understanding how clinicians learn how to lead so that sustainability outcomes can ultimately be achieved, cf. [8]. It contributes to the development of sound constructs of leadership learning which can provide a tool for communication about progress and thereby contribute to a constitutive step of developing future tools to evaluate whether institutions are making progress towards education for sustainable healthcare [9].

The recent review evidence [57,58,61] highlights that examining the process factors associated with CL-PD requires theory, something that has been identified as a gap in the design and evaluation of CL-PD [66–68]. As our focus is on leadership learning, we build on theory from the Learning Sciences, widely agreed as the sound theoretical base for understanding medical education and training and education for sustainability [69–75]. Budwig [71] highlights that drawing on the Learning Sciences “can contribute to a more nuanced understanding of transformative learning and in particular ways to deepen sustainability science goals of building ecosystems that build the transformative social learning necessary for sustainable futures”.

1.3. The Processes of Clinical Leadership Learning: A Professional Development Sustainability Challenge

Research in the Learning Sciences highlights that a key omission in the literature studying the ‘how’ of professional learning and development is that research typically focuses on PD programme characteristics while ignoring, or conflating these with, the qualities/characteristics of professional learning processes [76]. Focusing on programme features while failing to explicate the underlying theoretical learning processes and mechanisms limits generalisation beyond an individual study and PD-context [77,78]. Conceptualising and operationalising such CL-learning processes in a way that can contribute transferable insights into sustainable—and sustainability—professional development of healthcare practitioners is the focus and contribution of this study.

What forms of professional learning may support development towards sustainability? Learning scientists argue that such research needs to start from the motivational and self-regulatory aspects of learning that enable participants’ learning about leadership [62,74,79,80]. While a relatively new emphasis in professional learning research of doctors (ibid.), in the research literature on student learning in higher and medical education, there is a long tradition of research on the processes of student learning that has addressed these aspects of learning. This research highlighted two key concepts. Firstly, Marton and Säljö [81] found a deep and surface approach to university students’ learning of their studies. Deep learning strategies (characterised by relating ideas and understanding) have been shown to be relevant in medical education generally [82–84], and for learning for sustainability specifically [71,85]. Secondly, Vermunt [86] and Pintrich [87] discovered differences in the way higher education students self-regulate their learning processes. Swing and colleagues [74] and Schaubert and colleagues [64] have shown that learners’ self-regulation has an impact on how doctors engage in the learning process, particularly in relation to complex expertise (such as required by CL). Regulation of one’s learning is specifically important since sustainability requires that we prepare professionals to engage with uncertainty, and effective utilisation of available resources [55,71,88]. We therefore suggest that these concepts form an important theoretical framework for considering leadership learning for sustainability in healthcare contexts.

We introduce a novel way of utilising this conceptual framework to the learning of leadership for sustainable healthcare. We draw on Vermunt and Vermetten [89] who combined the study of students’ processing of subject matter with that of students’ regulation of their learning processes and extended these perspectives with the study of students’ conceptions of learning and their learning orientation or motivation. They introduced the concept of ‘learning patterns’ as a dynamic term to refer to the interrelated whole of students’ processing and regulation strategies, their views on learning and their motives

for learning. Research on students' learning patterns has identified four such patterns: meaning-directed learning, application-directed learning, reproduction-directed learning, and undirected learning [90]. These learning patterns have also been identified among medical students (Gulpinar, 2014, cited in [90]): meaning-directed learning has been found to be consistently and positively related to preclinical and clinical study achievement among medical students [91]. Moreover, rather than a stable learner characteristic, student doctors' learning patterns have been shown to vary according to educational methods in medical curricula [92]. Most importantly, Schrempft et al. [84] demonstrated that deep learning processing is a mechanism through which learning environments and interventions impact medical students' learning, highlighting the importance of attending to internal learning processes, cf. [93] as key learning mechanisms (the 'how'). We suggest this makes them a potentially relevant mechanism that may help explain why (some) educational methods of CL-PD appear to be linked with wider CL-PD outcomes and that may hence enable us to rise above the specifics of individual PD programmes and contexts and enable us to compare them and their outcomes in future research.

The research on learning patterns in medical education resonates with a call to attend more to the motivational and self-regulatory aspects of professional learning of graduate doctors [65,74,79,80]. Our study is the first we know of in applying the concept of learning patterns to graduate doctors' leadership learning for sustainability. However, research on teachers leading continuous improvements in their practice has indicated the learning patterns concept has applicability beyond HE in professional contexts. We are not suggesting that the professional work of teaching and medicine are the same; different professional cultures are distinct and create different contexts for such learning [77,94]. However, the mechanisms through which novice practitioners learn are shown to be consistent across professional fields [69,95,96].

Research on professional learning of in-service teachers [76] found three dimensions that resembled the learning patterns that emerged among university students: meaning-oriented learning, application-oriented learning and problematic learning. Teachers who adopted an application-oriented way of learning were primarily focused on learning about what works. They wanted to know which teaching methods worked, used tips and ideas from colleagues in one's work practice, learned most from their own practical experiences, and learned best when trying out new ideas in practice. Other teachers were (also) meaning-oriented in their learning and wanted to know why and how things worked in the classroom, looked for arguments behind new practices, and tried to extend their understanding of existing practices and new ideas. It is this kind of professional learning pattern, engaging with analysis and development of ideas and approaching new ideas openly, that the above literature review suggested is important for sustainability, cf. [8,29]. Lastly, teachers who showed signs of problematic learning struggled with new practices, did not know how to solve problems in another way than they were used to, were increasingly dissatisfied with their work, and only wanted to learn things that could be used immediately in practice. Vermunt et al. [76] developed and validated a diagnostic tool to assess these learning patterns in in-service teachers, the Inventory of Teacher Learning (ITL).

1.4. Concluding Summary and Research Questions

Summarising this discussion, in the current paper, we explore medical doctors' processes of leadership learning, identified as a key competence for the continuous improvement required for the sustainable development of healthcare. We explore whether the concept of learning patterns, identified in medical education, and in practising professionals in other fields engaging in sustained improvement of practice, can describe and capture professional leadership learning processes of doctors during CL-PD and whether it can predict the learning of the kinds of clinical leadership competences involved in sustainable healthcare development. We will develop and use adapted versions of the conceptual framework and diagnostic tool of professional learning patterns described above. We are

especially interested in the relevance of the framework for understanding the leadership learning of medics, and whether this framework may help capture what changes in doctors' leadership learning during CL-PD that could help future research identify whether and when (through what mechanisms) CL-PD achieves sustainable impact in organisations. Given the widespread agreement on the importance of frontline doctors' clinical leadership for sustainable healthcare development, the observation that few clinicians currently have the required leadership competences for the continuous improvement required by sustainable development, and the lack of understanding in the literature of how those competences are learned, we ask:

- RQ1 Can we conceptualise and measure the quality of doctors' leadership learning through the construct of learning patterns?
- RQ2 Can a leadership learning measure adapted from the ITL (Inventory of Teacher Learning) capture change in doctors' leadership learning patterns during CL-PD, to demonstrate progress in leadership learning?
- RQ3 Are the as-identified leadership learning patterns associated with those clinical leadership competences that are considered central for sustainable healthcare development?

We understand this as a first step in equipping future research on CL-PD's impact on organisational sustainability outcomes in healthcare, with concepts and tools to "capture the multidimensional and temporal nature of learning which serves as a critical mediating mechanism between training and more distal outcomes" [62].

2. Materials and Methods

2.1. Participants and Setting

Given the challenge for statistical analyses that many leadership-PD programmes are small [57], we developed a dataset over several cohorts of CL-PD participants. The data for this study comes from two different versions of a clinical leadership PD-course in the East of England, the Chief Residents Management and Leadership programme. The first (CL-PDv1), 10-month professional development course was initiated at Cambridge University Hospitals UK National Health Service (NHS) Foundation Trust in 2010 and ran until 2021. It targeted early career doctors who aim to develop into future clinical leaders of sustainable healthcare delivery and would be prepared and willing to initiate and lead improvement initiatives in their clinical settings and address leadership challenges involved in sustainable healthcare development. The programme recruited 40–50 participants each year from the East of England and was sponsored by the NHS's local education and training board, Health Education East of England (HEEoE). The programme had three main components: taught modules (1/month), a service improvement project in the participant's department and a Chief Resident role, intended to facilitate communication between consultants and trainees. The course ran in-person 2010–2021. The second version (CL-PDv2), a remote learning version of the course, was designed and offered in 2020–21. This study utilises previously unanalysed data from both courses.

2.2. Design, Instruments and Data

This study uses a theory-informed partially mixed parallel/concurrent (independent) mixed methods design to address its questions [97,98]. The qualitative and quantitative data were analysed separately to answer the same overall research questions, and the findings were considered together to explore insights. Specifically, quantitative analysis was used to uncover patterns and change. From the wider qualitative analysis, extracts are introduced in this paper to exemplify patterns and change by bringing in participant voices as to how the how, why and whether were experienced and interpreted by participants. (For reasons of length, in addition to a smaller number of lone-standing data extracts, we have integrated further quotations in the narrative text body, designated by quotation marks and data source.) Both analyses were guided by the same theoretical framework and concepts discussed above. RQ3 is answered through quantitative data.

Acknowledging the methodological challenge that asking participants to respond to a theory-informed instrument at the start of their CL-PD programme can form part of the learning on that programme, and in line with recommendations from recent methodological reviews on leadership development research [57], this study utilised two different designs in the two PD-contexts. A Post-Only study was conducted in CL-PDv1, and a pre-post study in CL-PDv2, both utilising validated instruments and, as recommended by Joseph-Ricard and McCray review [58], each study drawing additionally on qualitative data. The first dataset comes from CL-PDv1. All participants who had completed the course in the years from 2010–11 until 2016–17 were asked in the summer of 2017 to complete two instruments (Dataset 1), including the sub-set of participants who had just completed the course (Dataset 1ImmPost). The second (pre-post) dataset comes from CL-PDv2, whose 2020–21 cohort were invited to fill in the same instruments at the start of their course (Dataset 2Pre) and immediately upon completing their course (Dataset 2ImmPost). The research design and datasets are detailed in Figure 1 below. Return rates for the survey instruments were high, at 59% (173 out of 293), 85% (53 out of 62), 82% (61 out of 74) and 72% (53 out of 74) for Datasets 1, 1ImmPost, 2Pre and 2ImmPost, respectively.

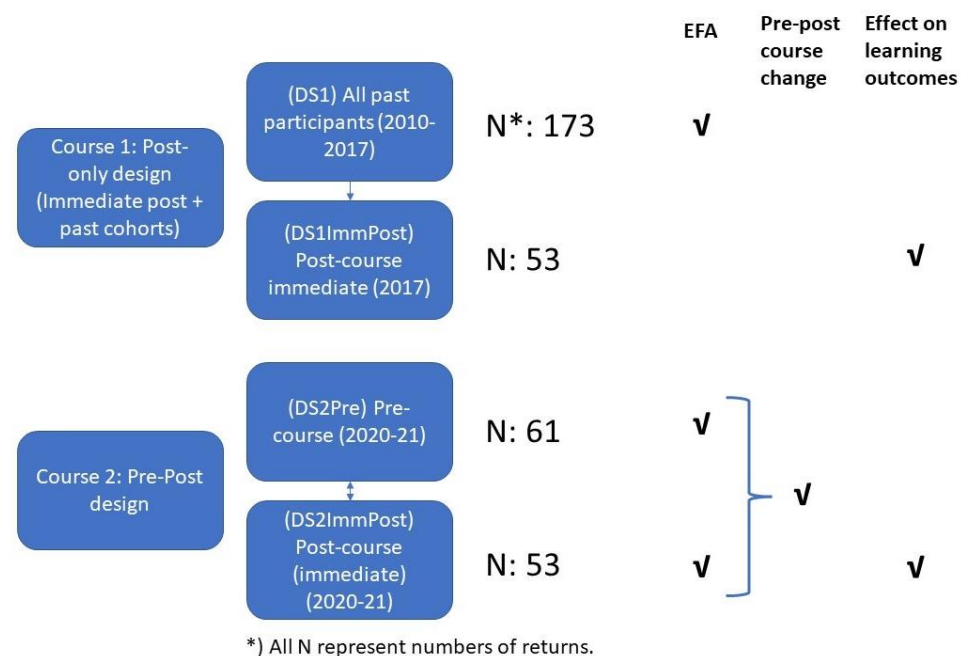


Figure 1. Study design and data.

Aware that learning processes are not always behaviourally observable, this study used two quantitative instruments.

- (1) A conceptually-sound and empirically robust individual clinical leadership learning instrument was developed and validated in earlier research [12] to assess participants' self-assessed individual clinical leadership competences as a context for understanding their leadership learning processes. These competences (leadership self-efficacy involving knowledge and mindset for clinical leadership; engaging stakeholders, boundary-crossing expertise, change agency and willingness to take risks and learn from failures, [12]) are widely identified in the literature on sustainability as key leadership competences for leading organisational change towards sustainability. This instrument served as the basis for answering RQ3.
- (2) A novel self-assessment instrument on leadership learning patterns, adapted from a validated longer instrument on professional learning, the Inventory of Teacher Learning [76], specifically revised for medics for the first time as part of the study at hand, to assess medical doctors' learning processes in the context of clinical leadership PD. The original instrument consisted of 32 Likert-type items in three scales (meaning-

oriented, application-oriented and problematic learning), two containing 9 items and one scale consisting of 14 items. For reasons of usability, we shortened the instrument to 18 items with 6 items in each of the three scales. We selected those items with the highest r -it's within a scale in the original study [76] and at the same time secured maximum variability in indicators within each scale.

We conducted 30 qualitative, in-depth interviews with participants from across six cohorts of CL-PDv1 ($N = 231$, 13%) who had completed the programme. The interviewees were selected from the whole participant population through a stratified sampling procedure to ensure a range of views and experiences were represented. The stratification criteria entailed that at least 10% (or 4, whichever was more) of interviewees were from each participating region/health trust type, and different programme cohorts, and included participants from different specialties, hospitals and genders. In the sampling process, the total participant list was split according to these criteria. Each sub-group ran through a random order generator and participants were invited to interviews in the resulting order, subject to the principle of different genders and specialties being included in each group. If an interviewee was unavailable, they were replaced by the next listed person in their category. For further details, see [30]. Due to the smaller total number of participants in the second dataset (CL-PDv2) and the ongoing COVID-19 pressures at the time, nine interviews (12% of the whole cohort so the same proportion as for PD1) were conducted with participants from CL-PDv2 (2020–21). A stratified random sampling approach was not appropriate due to the much smaller size of the whole participant group ($N = 74$), so interviewees were selected randomly, however, we checked that the interviewee group included participants across the whole participant cohort along the same criteria as for PD1 (multiple trusts/regions, multiple different hospitals, multiple different specialties, and more than one gender).

The interviews were audio recorded and transcribed verbatim. In efforts to minimise social desirability bias and enhance validity, interviewees were explicitly asked for negative as well as positive reflections on the programme experience, and to give examples of points raised. We also highlight that unlike much leadership development research [57], the research team was not involved in PD programme design or delivery.

2.3. Data Analysis

Three types of data analysis were conducted.

- (1) Exploratory Factor Analysis (EFA) on the novel instrument (detailed description of EFA in a previous paper, [12]). Both varimax and oblimin rotations were used. The varimax rotation is an orthogonal approach that, when used in factor analysis, creates uncorrelated factors; whilst the oblimin rotation is an oblique approach that takes into consideration the possibility of factors being correlated. Costello and Osborne [99] suggested that although varimax rotation is more commonly used, oblique rotation should produce more accurate results, especially in our field where factors are likely to be correlated based on the intertwined nature of behaviours. Regardless, both methods should produce highly similar results should the factors be indeed uncorrelated. Taking into account Costello and Osborne's suggestions and the consideration that exploratory factor analysis was run on a novel instrument, both varimax and oblimin rotations were used for theoretical and methodological rigidity purposes;
- (2) Multiple linear regressions were run to examine the relationships across the five individual learning outcomes and learning patterns. Little's MCAR test [100] indicated that the data was missing completely at random, so listwise deletion could be used in handling missing data without creating any biases in the results [101]. All statistical analyses were conducted in R4.2.2.;
- (3) Thematic analysis of the qualitative participant interviews: and open responses in the survey: All qualitative data was cross-sectionally coded and systematically compared across the whole dataset [102] by members of the research team experts in qualitative

data analysis. The first dataset's data was coded by Author1, scrutinised by a research assistant with experience in qualitative data analysis, and re-coded by Author1 based on this feedback. In this second round of coding, the themes were probed by repeatedly discussing them and the supporting data with Author4. The coding of the second dataset was conducted by the research associate, who was experienced in qualitative coding (Author3), and Author1. Alongside inductive coding, the data were deductively coded for a talk on meaning-oriented learning and problematic learning, as defined above, using NVivo12 software. It is this latter deductive coding we particularly draw on in this paper. Code content was compared systematically [103] to identify manifestations of learning patterns and their links to clinical leadership. Additional strategies to support validity involved (a) word and coding queries in NVivo12 checking for any missed insights and (b) comparison of the interview findings with findings from the quantitative analyses. Discussing the findings with the programme team and its then-current cohort provided participant validation.

3. Results

3.1. RQ1: Can We Conceptualise and Measure the Quality of Doctors' Leadership Learning through the Construct of Learning Patterns?

The factorial structure of the doctors' leadership learning self-assessment instrument was originally evaluated on the basis of 3 factors of 6 items each, reflecting the original longer instrument's factors of application-oriented, meaning-oriented and problematic learning. The Kaiser-Meyer-Olkin MSA (Measure of Sampling Adequacy) showed that partial correlations among variables were acceptable (Course1-PostOnly_Dataset1[AllCohorts dataset] = 0.78; Course2-Dataset2Pre = 0.62; Course2-Dataset2ImmPost = 0.67), and Bartlett's test of sphericity was significant ($p < 0.001$) on all three datasets, indicating strong relationships among the variables. Therefore, it was appropriate to conduct a factor analysis on the items. Both varimax and oblimin rotations were used with the maximum likelihood extraction method. After listwise deletion of the missing values, the analyses were conducted on the data of 150 (Dataset 1), 42 (Dataset 2Pre), and 37 (Dataset 2ImmPost) participants who had answered all the questions.

Regardless of the rotation method used, a three-factor model resulted in double loadings of many items. This was especially the case for items from the original application-oriented learning scale loading on the meaning-oriented factor. After reviewing the models, a two-factor solution was preferred, where items of the application-oriented learning scale were excluded as in this sample meaning-oriented and application-oriented learning were highly correlated, and it was considered that application-oriented learning did not offer additional insights into these doctors' learning, likely because as participants of a selective and intensive PD programme, the participants were already interested in learning new things in principle (illustrated by the fact that the items in this construct had a higher mean and lower SD already at the Pre-test than Meaning-oriented learning (4.07 and 0.33 respectively). Besides, a meaning-oriented learning pattern was considered in the literature review to be most important for leadership for sustainability.

Using varimax rotation, the two-factor model explained 39.2%, 38.5%, and 45.9% of the variance in participants' leadership learning self-assessment in Datasets 1, 2Pre and 2ImmPost, respectively. The results with the Dataset 1 showed two distinct factors, while several items had cross-loadings of 0.3 in Dataset 2Pre and Dataset 2ImmPost. In line with the original instrument, we call this the Leadership Learning Inventory (Table 1).

The results demonstrate a reasonable underlying factor model for a two-dimension instrument: meaning-oriented and problematic learning, with clearer evidence from the larger dataset (Dataset 1)/post-measurement datasets (1 and 2ImmPst).

Table 1. Factor loadings of leadership learning items of the Leadership Learning Inventory in a two-factor varimax solution (loadings < 0.30 omitted).

Item	Meaning	Problematic
Dataset1: Course1-PostOnly_AllCohorts		
Q49_1. I try to understand why certain leadership methods work.	0.762	
Q49_3. I exchange ideas about new ways of leadership with colleagues.	0.593	
Q49_8. I try to understand new ideas about leadership.	0.684	
Q49_11. I often reflect on my leadership practices.	0.646	
Q49_12. I like to experiment with new ways of leadership.	0.639	
Q49_17. I analyse why my team members/colleagues don't understand my proposals.	0.667	
Q49_2. I feel disappointed because most of my team members don't want change.		0.379
Q49_4. I don't know how I can improve my leadership.		0.703
Q49_5. I only want to learn things that I can use immediately in my practice.		0.673
Q49_10. Knowledge that I cannot apply quickly is useless to me.		0.674
Q49_14. I have a growing feeling of discontent with my work.		0.439
Q49_18. New ideas about leadership are naïve most of the time.		0.446
Dataset2pre: Course2-Pre		
Q49_1. I try to understand why certain leadership methods work.	0.447	
Q49_3. I exchange ideas about new ways of leadership with colleagues.		0.373
Q49_8. I try to understand new ideas about leadership.	0.580	
Q49_11. I often reflect on my leadership practices.	0.585	
Q49_12. I like to experiment with new ways of leadership.	0.667	0.460
Q49_17. I analyse why my team members/colleagues don't understand my proposals.		
Q49_2. I feel disappointed because most of my team members don't want change.		0.442
Q49_4. I don't know how I can improve my leadership.	−0.569	
Q49_5. I only want to learn things that I can use immediately in my practice.		0.768
Q49_10. Knowledge that I cannot apply quickly is useless to me.		0.842
Q49_14. I have a growing feeling of discontent with my work.	−0.366	0.344
Q49_18. New ideas about leadership are naïve most of the time.	−0.637	0.501
Dataset2ImmPost: Course2-ImmediatePost		
Q49_1. I try to understand why certain leadership methods work.	0.365	−0.336
Q49_3. I exchange ideas about new ways of leadership with colleagues.	0.705	
Q49_8. I try to understand new ideas about leadership.	0.427	−0.367
Q49_11. I often reflect on my leadership practices.	0.585	
Q49_12. I like to experiment with new ways of leadership.	0.434	
Q49_17. I analyse why my team members/colleagues don't understand my proposals.	0.637	
Q49_2. I feel disappointed because most of my team members don't want change.	0.410	0.773
Q49_4. I don't know how I can improve my leadership.		0.689
Q49_5. I only want to learn things that I can use immediately in my practice.		0.655
Q49_10. Knowledge that I cannot apply quickly is useless to me.		0.567
Q49_14. I have a growing feeling of discontent with my work.		0.906
Q49_18. New ideas about leadership are naïve most of the time.		0.774

In the qualitative data participants discuss their orientation prior to taking part in CL-PD, showing signs of Problematic learning, discussing dealing with leadership challenges as a “burden” (CL-PDv1_Int16), or describing clinical and leadership work in negative terms as an “Us and them scenario” (CL-PDv1_Int14), with leadership work talked about as “the dark side—a bad place to go” (CL-PDv1_Int24). Participants describe doctors who have not had the opportunity to take part in leadership-PD as “struggling” and being “reluctant” (CL-PDv1_Int24) with regard to clinical leadership, suggesting this is “natural” (CL-PDv1_Int15) since before participating in the course “we were never encouraged to look at things like that, [as] a registrar we never looked at the financial documents that the trust produced”, and: “I wouldn't even have thought of things like that—Why would I care? As long as I got my pay at the end of the month” (CL-PDv1_Int19), reflecting a sense of disaffection with their work consistent with a Problematic learning

pattern. Participants also explicitly reflected on different learning patterns resonant with problematic and meaning-oriented learning.

If you'd have asked me six months into the [leadership] project, I'd have probably thought well

what's the point, but actually at the end of it I realise what the point was." (CL-PDv1_Int02)

*"When you talk to doctors sometimes they feel very **disillusioned about management processes** because often they feel excluded from those and **disempowered**, and probably partly because of the course I feel completely the opposite.—I feel quite empowered in changing things that I'm unhappy with and I think that's from a longevity in your job point of view quite important, if you feel like you have agency."* (CL-PDv1_Int15)

Meaning-orientation does not mean that things are easy but that instead of feeling disillusioned, disempowered and avoiding attempting to implement new practices that do not immediately work ("my feeling immediately after the year was that I had been a failure and it hasn't been worthwhile (CL-PDv1_OpenResponse_Participant114), participants want to understand why things work or not, and keep trying:

"Unable to implement project [as Chief Resident] as clinical lead did not [support the project]. I have taken this project to another organisation and it is now being implemented there. The skill I learnt on the [PD] course have helped me be more successful the second time round." (CL-PDv1_OpenResponse_Participant82)

Both the qualitative and quantitative data characterise leadership-related learning patterns consistent with the theoretical notions of meaning-oriented and problematic learning. The qualitative analysis further suggests a shift in participants' learning towards a greater meaning-orientation, leading to our second question.

3.2. RQ2: Can the Leadership Learning Inventory Capture Change in Doctors' Leadership Learning Patterns during CL-PD?

The participants reported that their 'mindset on leadership had changed dramatically' (CL-PDv2_Int1), they were now 'actively' and 'consciously' thinking about leadership ideas and practices (CL-PDv2_Int8), rather than being prescriptive as before (CL-PDv2_Int6), and developing tools (CL-PDv2_Int4) to have begun querying 'reasons behind current leadership practice' (CL-PDv2_Int3). In the interviews, participants demonstrated a reduction in problematic learning and developing meaning-oriented learning, expressing an increased focus on understanding why/how things work in leadership, looking for arguments behind practices and trying to extend their understanding of existing practices and new ideas:

"Being a Chief resident almost changed my way of thinking slightly to understand a lot more, this is the problem and these are the possible answers rather than this is the problem and I'm really mad and angry about it." (CL-PDv1_Int4)

*"Mindset towards leadership and change—I have definitely thought more about that in the last year as a result of the course than I ever have before, consciously. I have been aware vaguely of people around me who are good leaders, or maybe not so good leaders but in leadership roles, but I had not really actively thought as much about **why they were good** or perhaps not so good, and how that affected their ability to effect change. [Later in interview:] I think I probably try and have a broader perspective on things before I jump in or try and initiate a change in some way."* (CL-PDv2_Int8)

*"As a junior doctor you think that 95% of your work is clinical and the more senior you get the more you realise that whilst the clinical side of your job is intrinsic to what your role is as a doctor, that actually the management side is just as important and I think the shame is that a lot of doctors **see it as a burden whereas I see it as exciting** and I think the [PD] course has helped me to put me in that **positive frame of mind so I want to do it as opposed to feeling I have to do it.**"* (CL-PDv1_Int16)

To probe this and analyse whether the construct and instrument could capture change in participants' leadership learning, the pre-post course data from Course2 (Datasets 2pre and 2post) were utilised in this analysis. The analysis showed that meaning-oriented learning increased significantly from the beginning to the end of the course (see Table 2), while problematic learning decreased, as would be expected, but did not do so statistically significantly.

Table 2. Welch two-sample *t*-test results of the changes in the learning orientation.

	<i>n</i>	Mean (Pre)	SD (Pre)	Mean (Post)	SD (Post)	Df	<i>t</i>
Meaning	34	3.52	0.47	3.90	0.48	66.00	3.27 **
Problematic	34	2.75	0.53	2.55	0.85	55.35	−1.17

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

3.3. RQ3: Are Leadership Learning Patterns Associated with Those Clinical Leadership Competences That Are Considered Central for Sustainable Healthcare Development?

To consider whether the concept of leadership learning patterns might be a relevant conceptual tool for understanding the mechanisms by which learning processes during CL-PD may be linked with the learning of the leadership competences considered central for continuous improvement and thereby sustainable development of healthcare, we used the five dimensions of individual leadership competences identified in our earlier research [12]. Due to the small size of the individual datasets, this analysis used the immediate post-course data from Course2 (Dataset 2ImmPost) and the immediate post-course data from the equivalent sub-set of Course1 (Dataset 1ImmPost), i.e., the participants who had in both cases just finished the course. We asked whether the two leadership learning patterns predict the five individual clinical leadership learning outcomes in this data. We do not present this as evidence of effectiveness, the 'whether' (which will need to be the focus of future research) but as evidence of conceptual relevance in the context of developing clinical leadership competences considered relevant for healthcare sustainability.

Acknowledging that *p*-value could be impacted by sample size, effect sizes were also evaluated using the following criteria: small ($R^2 = 0.04$), medium ($R^2 = 0.25$), and large ($R^2 = 0.64$) [104]. The immediate post-course scores on the five individual learning outcomes [Course2-ImmediatePost and Course1-Immediate post] were regressed on the two post-course learning pattern scores in five respective models. All models were significant with small to medium effect sizes (Knowledge: $R^2 = 0.24$, $p < 0.01$; Engage Stakeholders: $R^2 = 0.23$, $p < 0.01$; Boundary Crossing: $R^2 = 0.39$, $p < 0.001$; Effecting Change: $R^2 = 0.18$, $p < 0.05$; Risk Taking: $R^2 = 0.29$, $p < 0.001$). The construct of meaning-oriented learning predicted all five individual learning outcomes positively, while problematic learning (as a reverse dimension) predicted Boundary crossing expertise negatively. The other predictors were non-significant (see Table 3).

Table 3. Regression results of the five individual learning outcomes on the learning orientations ($n = 93$).

Predictors	Unstandardised Coefficients	Standard Error	Standardised Coefficients	95% Confidence Interval		<i>p</i> -Value	Variance Inflation Factor (VIF)
				Lower Limit	Upper Limit		
Outcome Variable: Self-Efficacy							
(Intercept)	2.62	0.40	-	1.82	3.41	<0.001	-
Meaning	0.45	0.09	0.46	0.26	0.63	<0.001	1.00
Problematic	−0.12	0.07	−0.17	−0.26	0.01	0.074	1.00
Outcome Variable: Capacity to Engage Stakeholders							
(Intercept)	2.14	0.45	-	1.25	3.03	<0.001	-
Meaning	0.52	0.10	0.48	0.31	0.73	<0.001	1.00
Problematic	−0.07	0.08	−0.09	−0.22	0.08	0.358	1.00

Table 3. Cont.

Predictors	Unstandardised Coefficients	Standard Error	Standardised Coefficients	95% Confidence Interval		<i>p</i> -Value	Variance Inflation Factor (VIF)
				Lower Limit	Upper Limit		
Outcome Variable: Boundary Crossing Expertise							
(Intercept)	1.82	0.36	-	1.10	2.53	<0.001	-
Meaning	0.59	0.08	0.61	0.43	0.76	<0.001	1.00
Problematic	−0.13	0.06	−0.18	−0.25	−0.01	0.040	1.00
Outcome Variable: Change Agency							
(Intercept)	1.93	0.58	-	0.77	3.09	0.001	-
Meaning	0.54	0.14	0.39	0.27	0.81	<0.001	1.00
Problematic	−0.17	0.10	−0.17	−0.37	0.03	0.088	1.00
Outcome Variable: Willingness to Take Risks and to Learn from Risks and Failures							
(Intercept)	0.77	0.52	-	−0.25	1.80	0.137	-
Meaning	0.66	0.12	0.50	0.42	0.90	<0.001	1.00
Problematic	0.16	0.09	0.17	−0.01	0.34	0.066	1.00

4. Discussion

Sustainability and healthcare are intricately linked. Sustainable development of healthcare concerns not only the environmental impact of healthcare; it concerns the capacity to provide publicly funded healthcare to changing populations without the use of ever-increasing resources [5]. This paper argued that this is not only a political and financial sustainability challenge, but an *educational* one. The literature review showed that socially, environmentally and financially sustainable healthcare requires the clinical leadership of frontline doctors to lead continuous improvement in their practice [2,8,11,12]. Shown to be associated with a range of positive outcomes related to healthcare sustainability, CL has become of key policy interest globally for the sustainable development of healthcare. However, the literature review also showed that while CL is learnable, few clinicians have the conceptual or practical skills for continuous improvement of services [11]. Vast amounts of CL-PD are offered to address this need, but in the literature, there is a paucity of high-quality evidence of CL-PD's effectiveness on healthcare sustainability [56,59–61], which is in itself not educationally or financially sustainable [53,57]. A deeper gap was found to underlie this challenge: despite CL being widely identified as a central factor for sustainable healthcare, there is no consensus understanding of how CL is learned [54] and a discussion of CL-education/training has only recently emerged in the sustainability literature [34], with a call for more research.

This study addresses this gap in the literature through a novel approach, informed by theoretical literature on professional learning of sustained innovation and continuous improvement. Acknowledging the challenges in identifying causal pathways from PD-courses to organisational effects on sustainability, and a lack of extant conceptual and methodological tools of evaluation [7,57,59,60], we proposed that a constitutive step of theorising and empirically analysing how leadership is learned during CL-PD is needed first. While many evaluations focus on and compare the content and features of CL-PD interventions, evidence has suggested that learning *processes* during CL-PD are more important [61,63–65,76–78]. We argued that identifying a way of conceptualising and capturing the quality of leadership learning processes would generate transferable tools to enable a comparison between CL-PD interventions in future evaluations of CL-PD's impact on sustainable healthcare development. Our study contributes to this goal.

This paper outlined and developed a conceptual framework and an empirical approach to studying clinical leadership learning processes during CL-PD. We drew on 'learning patterns' [89,90] as a key construct in describing the quality of professional learning, known to be associated with learning of complex competences by medical students [91,92] and sustained innovation in teacher development [76], applied here for the first time to clinical leadership development of doctors. Our research drew on three types of quantitative data (pre-post, post-only and delayed post) on two different year-long CL-PD courses in the

UK, all the datasets utilising the same instruments, as well as qualitative data within a concurrent mixed methods design.

To study whether we can conceptualise and measure the quality of doctors' leadership learning through the construct of learning patterns, this study adapted the original 32-item Inventory of Teacher Learning [76] to the medical context, thereby revising the original inventory into a shorter instrument, for usability. Moreover, the context in the 12 selected items was reworded to suit the context of CL professional development. An Exploratory Factor Analysis of this novel *Leadership Learning Inventory* showed that a theoretically sound construct of leadership learning patterns could be identified and measured through the novel instrument, consisting of two dimensions consistent with the theory: meaning-oriented learning and problematic learning, further supported by qualitative data.

We also wanted to know whether we can identify *changes* in learning patterns during CL-learning interventions. This is important because we were seeking a construct that can characterise, and enable the comparison across PD-courses of, the quality of professional development *processes*, rather than a stable learner characteristic. In line with findings from pre-graduate medical education, and non-clinical professional contexts, the qualitative data suggested a positive change in participants' meaning-oriented learning during the PD-course. The quantitative data analysis for the pre-post course study (Course 2) showed that participants' meaning-oriented learning increased statistically significantly from the start to the end of the year-long course. This is an important conceptual strength of this construct, as a meaning-oriented learning pattern characterises the kind of professional learning quality identified as important for sustained innovation in this study's literature review [8,29]. Problematic learning was suggested to have been reduced by the qualitative data, and decreased in the quantitative pre-post measurement, as would be hoped, but not statistically significantly within this sample size. This suggests that the construct and associated novel measure are able to detect a change in participants' leadership learning patterns during a clinical leadership PD course, particularly meaning-oriented learning, and hence is able to characterise the *quality of the learning processes* during leadership-PD. Problematic learning warrants further research, as its lesser role in this study may at least in part reflect the selective nature of the participant cohort of the PD programme. It may play a more significant role in clinical leadership learning of new cohorts of doctors on a whole.

Finally, we wanted to explore whether doctors' leadership learning patterns might reasonably be expected to play a role in doctors' individual clinical leadership competences, identified as key to continuous improvement towards sustainable healthcare, and therefore be a relevant factor to characterise the quality of CL-PD learning in future research on CL-PD's impact on behavioural and organisational sustainability outcomes. We examined the relationship between participants' leadership learning patterns and their self-assessed individual clinical leadership competences. This study showed that participants' meaning-oriented learning predicted their self-assessed clinical leadership competences, as measured by the validated individual Clinical Leadership Learning Outcomes instrument [12], suggesting it may be a worthwhile construct to use in future research on the impact of CL-PD on enhancing sustainable practices.

This study offers evidence that the construct of learning patterns, and the Leadership Learning Inventory, can meaningfully capture and characterise effective features of *the quality of the learning processes* during clinical leadership PD and highlight the kinds of learning patterns such provision should facilitate to foster the learning of leadership competences required for sustainable development of healthcare. It hereby contributes a constitutive element to our understanding of the 'how' of clinical leadership professional development, which is essential for rigorously evaluating future CL-PD provision and its impact on sustainability.

4.1. Implications

Implications for research. This study advances our theoretical understanding of *how* doctors learn about leadership. We have theoretically outlined and empirically demonstrated a novel construct of Clinical Leadership Learning Patterns to characterise the *quality of doctors' learning processes* during CL-PD. The literature suggests this may be a relevant mechanism by which CL-PD impacts its wider sustainability outcomes; tentatively, and consistent with the theory, this study suggests the importance of doctors' learning patterns to their individual clinical leadership competences seen as key to sustainable healthcare development. In particular, the study showed the relevance of meaning-oriented learning: a leadership learning pattern aimed at understanding *why and how* leadership ideas and practices work in clinical settings. Far from this being a fixed characteristic of some professionals/doctors and not of others, our study suggests that doctors' leadership learning patterns can change during PD interventions. Hence this concept can be utilised in future research on clinical leadership learning to more rigorously study and evaluate the quality of learning processes enabled by professional development interventions, thereby also enabling a theoretically coherent comparison across different CL-PD programmes. Such tools are crucial for the sustainable development of educational interventions for clinical leadership development.

Our research also offers a concrete tool for such future research. We developed and empirically-validated an efficient 2×6 -item Leadership Learning Inventory, an instrument that measures clinicians' leadership learning patterns. Its concise nature makes it a highly efficient tool for future PD evaluations and research. This is not restricted to healthcare. Our discussion identified that the leadership of frontline practitioners is considered central to sustainable development in organisations across sectors. Moreover, the conceptual and empirical research foundation of this concept and instrument draws on cross-sector professional learning theory and on research from across HE and teacher professional learning. Relatedly, other studies in this Special Issue suggest that similar dimensions of graduate competences that formed the basis of our research (such as self-efficacy and collaborative working) are important for sustainability across a range of professional fields [1,105]. We therefore suggest that this research contributes to understanding and evaluating leadership learning, and hence to sustainability across sectors. The shorter version of the instrument developed in this study has already been extensively and successfully adapted to and extensively trialled in an international study of teacher professional learning across four countries, [106].

Implications for policy and practice. As the authors in this Special Issue discuss, it is important for sustainability that educational organisations of different types conduct their own research on their practice and local learning objectives [107]. This requires practically feasible yet robust tools for local evidence-generation [108,109]. As the Leadership Learning Inventory proposed is very short (12 items in total) and its outputs easy to analyse, it also lends itself well to practical use in local evaluation and continual enhancement of leadership PD provision by a range of stakeholders in policy and practice contexts without requiring academic researchers' input. It is already being adapted for use by the UK Government across the public sector in professional development for sustainability leadership. It is therefore likely that it can also be effectively utilised in research on leadership development for sustainability in other fields.

Future developments. In outlining and articulating a conceptual model of clinical leadership learning, this study also contributes to the development of a common language to discuss and further develop sustainable clinical leadership-PD, and leadership-PD more generally, called for by the AMEE consensus statement on planetary health and education for sustainable healthcare [9]. A shared language has been seen as particularly important for novel educational approaches where such a shared language does not yet exist, such as simulation-based learning [110]. Simulation-based learning is considered one of the future directions of travel for learning for sustainability. It has been seen to offer significant promise to the learning of 'non-technical' skills, such as leadership, in medicine and [110],

as well as for developing capacities to lead change for sustainability more generally [54]. Despite its popularity, more evidence is needed of the effectiveness of simulation-based learning to support the learning of both technical and non-technical competences required for sustainability [111–113]. Our research also offers conceptual and operational tools for such knowledge-generation.

4.2. Strengths and Limitations

There are some caveats to these findings. While the sample sizes are decent for a study of professional development over a significant period (10 months for the pre-post study; while for the post-only study, past course participants from the preceding 7 years were surveyed), they may have rendered some of the statistical analyses non-significant. The focus of this study was on participants' learning patterns, which is an internal, non-observable phenomenon. Like most studies focused on non-observable learning phenomena [19,56,114], this study utilises self-report instruments. Compared to other research methods on learning processes, self-reports have their advantages and disadvantages, as have other methods trying to capture what goes on in people's minds [115]. Unlike most studies cited in the above reviews, our instruments are validated (previously or here) through robust statistical methods and are based on solid professional learning theory and not simply participants' self-perceived course satisfaction. We highlight that due to the focus of this study and its strong rooting in the theory of learning patterns, the measures utilised are *not* measures of participants' perceptions or opinions. Instead, the instruments in this study measure theoretically robust constructs by asking participants to characterise their thinking and learning along the dimensions of those constructs. Self-report instruments are common and will continue to play a significant role in the field of assessing participants' learning patterns which are not directly observable in practice. Future research should seek to study the direct links between these learning processes, through the constructs and measures developed by this study, and observable behavioural and organisational sustainability outcomes of CL-PD.

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