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Chapter

Extending Brookfield's Framework: A Fifth Lens for Critical Reflection in Digital Pedagogy and Learning Environments

Ellie Koseda

Abstract

As Higher Educational Institutions (HEIs) adapt to the demands of contemporary learners, rapid technological changes prompt a re-evaluation of traditional pedagogical methodologies and sustainability directives. This chapter investigates the impact of digital environments in teaching, learning and assessment (TLA) practices. Findings indicate that student autonomy in assessments is influenced by the method of critical reflection adopted by instructors and learners. Our connection with Brookfield's work becomes more apparent in an applied philosophical analysis of reflective teaching, and the intersection of new teaching paradigms under Noopshere and speculative epistemological frameworks. To this day, Brookfield's core thesis remains largely unchanged: the critically reflective teacher identifies and scrutinises assumptions that shape practice by using the four lenses of critical reflection: (1) students' eyes, (2) colleagues' perspectives, (3) theory, and (4) personal experience. We argue that critical adjustments in HEIs support reflective practices in examining these changes through an additional autobiographical lens, alongside students' eyes, colleagues' perceptions, and theoretical literature associated with reflection. Our study builds on a recent proposal for incorporating a fifth lens—the "Learning Environment" to effectively account for the learners' interactions with the physical classroom, digital interfaces, simulations, or virtual learning environments (VLEs).

Keywords: Brookfield's lenses, critical reflection, online pedagogy, virtual learning environments, digital literacy

1. Introduction

Reflection is found to be an important learning tool in professional education, and that the skills required for reflection need to be developed in professional courses. McIntosh et al. [1] assert that critical reflection, accompanied by action-oriented

reflection, facilitates gradual adjustments to instructor practice in (HE) Higher Education context [2, 3]. Their review of the literature was carried out to identify reflection directly related to education in practice [1]. A total of 100 papers were reviewed to re-evaluate the importance of educators engaging in actionable processes informed by reflective insights, which contribute to the consistent enhancement of approaches in teaching, learning and assessment (TLA) – [1, 4, 5].

Reflective engagement and reflective action involve a thoughtful and intentional approach to learning and decision making, distinguished primarily by the temporal dimension of reflection [1]. Reflective engagement denotes the continuous process of analysing and interpreting experiences, information, or situations as they unfold [1, 6]. Furthermore, it encourages cyclic self-awareness, character building, and critical thinking during real-time learning or decision-making contexts [1, 7–9]. Conversely, reflective action is inherently retrospective, acting as a mechanism for extracting information from prior experiences and re-evaluating outcomes to inform future practice [1, 7]. To a greater extent, reflection as a practice continues to evolve in contemporary education against digital learning protocols, work environments, and technological advancement. Koseda et al. [10], extend this perspective by positioning reflection as an essential component of learning and digitally induced knowledge transfer under Education 4.0/5.0 paradigms [11, 12].

Educational literature on post-Covid teaching practices unequivocally prioritises reflective engagement over common approaches to practitioner reflective practice [13, 14]. Brookfield's Four Lenses of Critical Reflection – (1) students' eyes, (2) colleagues' perspectives, (3) theory and (4) personal experience overlaps a structured framework that augments this reflective process [5, 15]. Traditionally, these lenses are used by educators to critically examine their practices from multiple viewpoints [5, 15].

2. Critical reflective practices and digital alignment

In contemporary education, each lens combines reflective engagement with reflective action, contributing to higher education institutions' adaptation to the diverse learning needs of students [1, 3, 5, 10]. Biggs and Tang [4] adds to reflective engagement and reflective action through the concept of "Constructive Alignment," (CA) where pedagogical architecture synchronises intended learning outcomes (ILOs), didactic approaches, and alternative learning strategies. This model effectively develops the learner's cognitive engagement, capacity, and adaptability through dual lenses of reflective engagement and reflective action [1, 4]. Moreover, Biggs [16] makes it abundantly clear that the teacher's job is to create a learning environment that supports the learning activities appropriate to achieving the desired outcomes.

If the key is to make all components in the teaching system aligned to each other, then practitioners must recognise the acute impact of VLEs and digital pedagogies have on knowledge acquisition [4, 10, 17]. The lack of alignment creates gaps in learners' digital competencies, hindering their ability to achieve the (ILOs). These gaps, once manageable, now pose substantial barriers, demanding the urgent integration of digital skills into educational frameworks [12, 16]. John Biggs maintains that CA starts with the notion that the learner constructs his or her own learning through relevant learning activities [16, 18]. A critical discourse compels us to consider a seemingly paradoxical omission: why should VLEs, or indeed digital environments more broadly, be exempt from rigorous scrutiny? Ignoring their significance would overlook another dimension of the learning process and thus undermine any holistic

alignment with ILOs [4, 18]. In the interest of efficiency, some institutions implement safeguards for interface usability and user experience. Consequently, evaluations may be deliberately limited to standardised VLE template assessments, a decision driven by resource efficiency and the desire to avoid superfluous design elements [19]. The same applies to Artificial Intelligence (AI), as the inappropriate application of these tools further exacerbates serious lapses in higher education [20, 21]. This results in students relying on surface-level learning techniques instead of engaging in deep-learning and reflections, without analysing the influence of the new postmodern paradigms in education [22]. HEIs have distinct purposes and requirements compared to other forms of education, to which students and instructors must adapt [22].

2.1 Future driven pedagogical transformation in (HEIs)

Dumitru [23] outlines several caveats against criteria: learner involvement (formal/academic, personal), efficiency (efficient, inefficient), organisation (institutional, neo-institutional), independence (dependent, self-directed), participant number (individual, group, societal), intentionality (implicit, explicit), awareness (mechanical, logical), assimilation method (perception, discovery), and purpose (maintenance, innovation). An inability for instructors to meet this classification reveals a lack of proper application and structure. In such cases, students may struggle to achieve the ILOs due to misalignment between teaching methods and assessment tasks. On an institutional level, poor adherence to the criteria for broader structural change and inefficiencies has a knock-on effect for learning outcomes. However, studies on the pathway to institutional transformation suggest that structural changes should occur through, "futuristic, pre-conceived scenarios and pre-planning by foreseeing digital competition for target year 2030" [24–26]. This entails using effective change agents and engaging key stakeholders to sustain HEI objectives [27, 28]. Hence, our discussions stress the importance of future planning and promoting change at both the micro and macro levels within institutions for extending Brookfield's lenses.

2.2 Brookfield's extended reflective lens

As a precautionary measure, extending Brookfield's model to intertwine reflective and the adaptive theoretical frameworks analysed in literature create new directions [1, 29, 30]. Beyond these theoretical considerations, VLEs have also received attention in relation to safeguarding and the critical necessity for individuals to cultivate digital proficiencies [30].

This imperative is intrinsically tied to employability, requiring capacity to navigate digital tasks manifested in the form of strategic misalignment [31, 32]. Brookfield's "Reflective Lens" model, in its current iteration, falls short in digital areas [29]. We therefore introduce a fifth lens, the "Learning Environment," focusing on the profound influence of technologies on digital pedagogical paradigms shaping recent HE transformation (**Figure 1**) [33, 34].

The extended model stimulates instructor awareness of emerging digital experiences conducive to effective knowledge transfer within both physical (classroom) and digital/virtual learning environments [4, 35]. A shift in pedagogical approach, from transactional to transformational engagement, catalyses the development of international digital learning experiences [36]. This fifth lens evolves into a regulatory mechanism, designed to mitigate potential misalignments arising during the

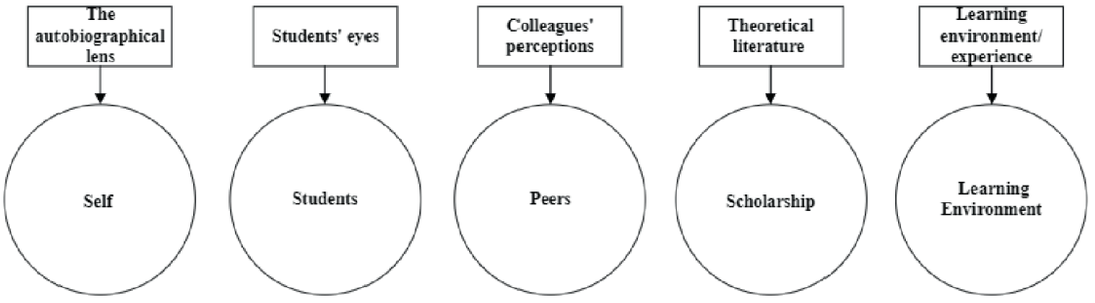

Figure 1.
Brookfield's lenses extended. Source: Koseda et al. [10].

digital transformation of HEIs overtime, even with the unpredictable trajectory of technological innovation [34, 37]. An applied method for future adaptation takes precedence over the perpetuation of traditional approaches in HE pedagogic spheres [37, 38]. This is not to suggest that a classical approach is obsolete. On the contrary, it remains of paramount importance though modified to suit the expectations of today's learners, particularly in the aspect of transmissive pedagogic archetypes [4]. Instructors are, therefore, encouraged to make deliberate adjustments to their instructional methods and delivery modalities that increase student engagement and learning outcomes [39].

2.3 The impact of VLEs on student learning

The unrestrained use of digital technologies in automotive processes is one of the prime advantages of the third industrial revolution. As a result, both developed and developing nations have started to digitise mundane tasks [40]. The abundance of accessible educational data, supported by technology-enhanced-learning platforms helps educators to mine and collate data on student learning behaviour [40]. HEIs have shown a tremendous increase in online educational data to yield ample educational repositories and optimise users' engagement with technological platforms [40].

Educational data, a by-product of the interaction between learners and instructors, has been substantiated as a multidisciplinary field of study. Studies report that students feel enthusiastic and motivated toward the use of VLEs, and they suggest that all educators should integrate VLE activities in the design of curricula [41]. The progression of accumulated educational data has stimulated the emergence of research subcategories, such as learning analytics to predict learners' behaviour and educational data science, which cohesively inform HEI policy formulation [42]. Models have been explored in the learning analytics paradigm, however, identifying the significance of deep learning in the learning analytics domain is still in its infancy, with studies on the adoption of this technique arising in the last few years [40].

Critical discussions on digital environments lean more toward deep learning pertaining to student learning and tutor-to-student knowledge transfer practices being affected by the students' learning environment rather than the Artificial Neural Networks (ANNs) deep learning used in Educational Data Mining (EDM) – [40]. Previous studies have explored how the blended use of VLEs can impact student

learning and create a greater sense of community, combined with enhanced higher learning skills [40–42]. These findings highlight the importance of viewing VLEs as an environment comparable to a knowledge focused medium, as the physical classroom, accessibility of content, discussions, and content uploaded on these platforms matter as much as the transmission of deliverables [40]. Student engagement with VLE activities will inevitably have an impact on student learning if the activities are aligned constructively with formative assessments and the ILOs [4, 42].

2.4 VLEs and the physical learning environment

Blended learning encompasses face-to-face and online learning approaches [43, 44]. The VLE expands the reach for courses under blended learning structures through collaborating with instructors remotely and interacting with multimedia resources: videos, podcasts, and virtual simulations bespoke to various learning styles [4, 42, 43]. Research indicates that VLEs facilitate a more personalised learning journey where students can progress at their own pace, revisiting materials as needed, and access support through online forums [40–43]. Assessment tools integrated into VLEs are effective for distant cycles, accommodating quizzes, micro assignments, and peer-reviewed tasks that redirect immediate feedback [4, 39, 45]. Several studies conducted during pre-to-post Covid Pandemic allude to the importance of the learning environment, regardless of whether activities occur online or offline [12, 34, 46]. A well-designed physical space that is comfortable, well-lit, and resource wise plays the same role as how well a VLE interface is designed [47]. Equally important, is the psychological aspect of learning environments, where safety and inclusivity are critical factors in academic success. Effective integration of digital tools into VLEs extend educational opportunities beyond traditional pedagogical and philosophical boundaries [30, 48].

Within blended learning structures, a VLE does not replace the physical learning environment, but it enhances the students' learning experience and combines the element of flexibility beyond the confines of the classroom [39]. Careful attention to the user interface (UI) design and user experience (UX) is required for learners to reap the full benefits from VLE integrated technologies [19]. Interactive simulations mutually bind with a UX that guides students' attention to critical equilibrium points or reaction forces with visual feedback methods.

Effective UX design adapts interfaces to change visualisations, manipulate models in real time, or consult specific hints to match their individual preferences [19]. UI/UX principles elevate the student experience to increase the level of deep learning and clearer conceptualisation for more efficient problem solving [4, 19].

2.5 AI and VR simulation

Artificial Intelligence (AI) and Virtual Reality (VR) based simulations add another dimension to immersive, interactive and adaptive learning experiences. These experiential approaches can improve spatial reasoning skills and increase creative ability in learners [49]. Historically, the application of VR was prominent in healthcare, although there has been a recent expansion across various course disciplines [50]. VR simulations train learners for real world scenarios by incorporating activities that translate theory into practice [49, 51]. Niu et al. [50] describe a spectrum of virtual reality – e.g., MR, and AR that contain digital elements as opposed to real, tangible elements.

The content and structure of curricular consider the following:

- Virtual Reality (VR) known for being fully immersive;
- Mixed Reality (MR) combines real world and virtual elements;
- Augmented Reality (AR), also known as Mixed Reality, overlays virtual elements onto the real world—e.g., in social media and gaming platforms such as Pokémon Go;
- Extended Reality (XR) mainly lies at the intersection of three technologies: virtual reality (VR), augmented reality (AR) and mixed reality (MR).

Educators should not underestimate the impact of new digital technologies on student learning outcomes, as AR and VR applications are more than a portal for entertainment. From 2019 to 2024, there was a 78.3% growth rate for spending on AR and VR in the UK. Growth is predicted to reach £62.5 billion by 2030, and the UK offers significant opportunities for investors [52, 53].

AR and VR technologies are being used across industries (including academic) - smart cities, engineering, film and TV, gaming and health tech. With over 1250 immersive technology companies operating across various sectors, the UK's immersive industry provides a large pool of talent with a broad range of transferable skills [52, 53]. Additionally, the UK Research and Innovation, through the Audience of the Future challenge, invested £39.3 million in the development of new immersive technologies [5, 8, 54]. Interconnected frameworks and models established the foundation for conceptualisation beyond the surface of learning [16, 37, 39].

This, in turn, prepares the student to transition from one phase of learning to deeper, higher cognitive functioning [17, 38]. HEI onus over testing, trials and ethical measures are a necessity to manage any enhanced learning regimes, achievement benchmarks or suitability for course embedment in alignment with safeguarding expectations [30].

2.6 AI powered systems to overtake "chalk and talk" delivery

AI powered systems used as intelligent tutoring platforms have the edge of providing personalised feedback, identify common misconceptions, and adapt content at the learner's pace [54, 55]. HEI digital transformation is slowly phasing out "chalk-and-talk" methods for more highly engaging, learner centred environments that support a nuanced grasp of concepts being taught [55]. Currently, the sector is compounded by the lack of appropriate implementation strategies in adherence to a defined ethical framework for impactful use and deeper learning [20, 21]. Poor implementation leads to the student learning environment being impacted negatively and deep learning processes for knowledge transfer to stagnate [56, 57]. E-learning is at an exciting point in its development, although there is little control over AI-misuse or inappropriate integration [55].

HEIs are in the position to consider the macro dimensions of E-learning and refine access and inclusivity within the digital domain [58]. A key to this endeavour is the sophisticated use of technological tools for the adoption of progressive learning grounded in modern theories. Design and management of educational resources must be adeptly handled, alongside nurturing professional and learner identities [59, 60].

Critical discussions segway into the advancement of e-assessment techniques, coupled with enhanced collaboration and motivational strategies for educational evaluation and success of e-learning frameworks [58, 59, 61]. Without effectively accounting for the learning environment, HEIs run the risk of inadvertently hindering learner progress and graduate outcomes [20]. We make an urgent call for the extension of Brookfields lenses to safeguard the students' experience in both physical and virtual learning environments.

3. Methodology

This study employs a multifaceted research approach to examine the application of speculative epistemology and noosphere pedagogy within higher education. These theoretical frameworks critique the development of a knowledge economy and analyse learning environments through various philosophical perspectives to challenge the conventional status quo [62]. As student profiles and engagement preferences generationally change, HEIs must reimagine their approaches to be capable of delivering transformative educational experiences. Student perspectives in parallel with HEI vision are needed to compete in the sector. These philosophical stances help investigate the nuances of TLA practices and uncover hidden complexities of systemic barriers. Crucially, they all unanimously promote personalisation of TLA, flexible learning and partnerships between all stakeholders: educators, institutions, students and employers [27, 32, 63, 64].

3.1 Hybrid philosophical analyses

To complement the speculative epistemological and noospheric theoretical approaches, a hybrid philosophical and logic analysis were applied to assess and arrange complex systems of thought into simpler elements that are brought into focus [48, 65].

3.2 Logical analysis

The initial phase of logical analysis involves constructing the premises of an argument i.e., those statements that justify the conclusion. These premises can be either clear or implied and presented in forms such as empirical data, personal anecdotes, or philosophical principles [66]. A second phase involves verifying the accuracy of these premises [66]. Crucially, the method of verification varies depending on the nature of the argument. Our approach relies on philosophical discussions that incorporate logical reasoning and intuition. Traditionally, once the premises have been evaluated, the focus shifts to examining the argument's overall logical consistency to ensure it holds up under scrutiny [66].

Logical coherence measures how well the premise of an argument supports its conclusion and checks for any inconsistencies or contradictions within the argument itself [66]. This type of analysis includes assessing the argument's logical structure, determining whether it employs deductive or deductive reasoning, and confirms its international consistency and logical validity [66]. To determine the soundness of an argument, it must be both valid and logically coherent, that is, built on true premises and maintaining logical integrity [66]. Conversely, arguments that are invalid or logically incoherent are considered unsound and are discarded [66].

3.3 Philosophical analysis

The method of philosophical analysis has a long history but became especially prominent at the start of the twentieth century [48]. The subsequent integration into Russell's development of logical theory acquired a greater degree of sophistication than before [48]. Logical positivism developed the method further during the 1930s, in the context of their anti-metaphysical programme, held that analysis was the only legitimate philosophical inquiry [48]. Post-1945, philosophers seeking to broaden the scope of philosophical inquiry and phenomena beyond positivism constraints refined the concept of analysis to encompass broader linguistic and cognitive structures [48]. Consequently, a re-defined analytical philosophy to emphasise on the critical examination of language and meaning was developed [48]. This period also prompted a re-evaluation of Frege's contributions to analytical philosophy [48]. Meanwhile, Quine questioned the efficacy of analytical methods, arguing against the existence of a fixed structure in thought or language for analysis. Debates sparked inquiry into the relevance of analytical philosophy with some suggesting its era has ended, while others, finding Quine's critique unconvincing, argue for its continued significance as a key philosophical methodology [48]. Given the depth of this method for argumentation and analysis, this study integrates Speculative Epistemology (S) and Noosphere Pedagogy (N) frameworks into philosophical analysis to produce sustainable and actioned outcomes for Learning Environments (L) and Critical reflection (C) [67–70].

Given the depth of this method for argumentation and analysis, this study integrates Speculative Epistemology (S) and Noosphere Pedagogy (N) into a philosophical framework to produce sustainable, action-oriented outcomes for Learning Environments (L) and foster Critical Reflection (C) [68–70]. Speculative Epistemology (S) and Noosphere Pedagogy (N) can be integrated by employing philosophical and logical analysis that directly guides the chosen methodologies. This approach enables sustainable, action-oriented outcomes for Learning Environments (L), while encouraging Critical Reflection (C) [67–70]. Grounding strategies in philosophical frameworks establishes a cohesive foundation for both theoretical development and reflective educational practices.

Conceptual clarification, logical argumentation, and theoretical synthesis are constructed. We begin by defining and explicating concepts within speculative epistemology and noosphere pedagogy to develop a conceptual foundation. Formal logic structures are used to construct and evaluate our arguments, demonstrating how these theories interact with learning environments and critical reflection [1, 10, 71]. Logical arguments could potentially model empirical evidence and counterfactual theorems, validating the practical implications of the proposed theoretical integration to justify the extension of Brookfield's lenses [10, 71].

4. Theoretical frameworks

4.1 Speculative epistemology and noosphere pedagogy

Speculative Epistemology and Noosphere Pedagogy are relatively undeveloped in mainstream education theory [67–70]. Each theoretical framework is predominantly oriented toward niche philosophical criterion instead of direct application in the higher education sector. Furthermore, speculative philosophy (also termed

speculative epistemology) is a branch of epistemology that centres on the understanding of knowledge systems [72, 73]. What differentiates this domain from traditional epistemological classifications is "how knowledge could be known," or "how knowledge might evolve in unpredictable or nascent contexts" [70–73].

Noosphere pedagogy is inspired by Pierre Teilhard de Chardin's concept of the Noosphere applied to the sphere of human thought and collective consciousness. Crucially, the applicability of this framework is appropriate for establishing an interconnectedness between all learners and educators within a global intellectual ecosystem, strengthening collective responsibility and the notion of shared knowledge creation [67–69]. On the other hand, speculative philosophy interrogates the contingent and motile nature of knowledge. Philosophically, its contention is with the epistemic tendencies that are moulded by unpredictable future developments [69, 74]. Since speculative philosophy prioritises future-thinking paradigms, it enables researchers to engage with epistemic scenarios not fully realised [70]. An inquiry into knowledge systems through philosophical creativity is invaluable to our study as well as future-thinking strategies espoused by Koseda et al. [75] see also – Solovyova [67] for related perspectives on the competencies of qualificatory rates of technical development. In essence, our approach emphasises on future-oriented paradigms to overcome deterministic and rigid epistemological constructs capable of accommodating indeterminacy [69, 70, 76].

4.2 Speculative epistemology in virtual learning and critical reflection

As speculative epistemology explores the nature of knowledge through a futuristic lens, our study envisions future scenarios of virtual education and critically reflects on epistemological shifts [1, 10, 72]. We attribute speculative thinking to effective preparatory measures for unforeseen technological advancements and pedagogical transformations [58]. More importantly, our methods exclusively question what is feasible, real, and normal, using empirical evidence, literature and sound theory in the higher education sector to reintroduce context into the application of speculative epistemology [73, 77].

Controlling for speculative fiction and fabulation, challenges assumptions in contemporary educational paradigms, ideally through speculative epistemology [70]. Speculative fiction is not an inadequate method for analysing philosophical ideas, in certain scenarios, it can be a far more effective philosophical thought experiment due to its ability to evoke emotional responses [72]. Generally, speculative knowledge is a fresh concept that enables people to reason about the unknown [72]. For the direction of this study, it requires some controlled measures to ensure this framework aligns more effectively with scientific practice than just producing eccentric narratives [70].

4.3 Noosphere pedagogy for evolutionary learning and global consciousness

Instructor views on education as an evolving process contribute to the advancement of collective human consciousness. As previously highlighted, noosphere pedagogy is principled on the collective knowledge and cognitive resources of the learning community, aiming to broaden awareness of global issues [68]. The interconnectedness of human endeavours and their application to virtual education in the design of collaborative projects empower students from diverse backgrounds. Under these conditions, HEIs should strive to facilitate the sharing and co-creation of knowledge.

The role of education within the knowledge economy has significantly expanded, and its importance continues to grow [62]. However, modern education faces numerous existential problems related to changes in the methodologies of cognition and management processes [62].

We discover that V. Vernadsky's teaching on the noospheric approach to the development of education in the knowledge economy is imperative [69]. The features of the noospheric approach to education development and the relationship with models of paradigmatic innovation development and vertical integration of knowledge are maintained. The noosphere is a logical continuation of a variety consisting of the sphere of physical and chemical (geosphere) and biological (biosphere) phenomena [69]. The phenomena of which the noosphere consists of are integrated through information phenomena (the infosphere) – [68, 69]. The noospheric approach to the development of education is based on noospheric thinking, as well as the conceptual model of paradigmatic innovation development and the vertical integration of knowledge methodology [68, 69]. Recent literature challenges existential thinking that currently dominates with noospheric thinking. We note that the parabola of knowledge becomes a model of learning based on the integration of knowledge from philosophy to practice [62].

Khanin [62] states that one of the most important conditions for implementing the noospheric approach to the cognition development and economy is a high-quality education. Therefore, the main ideas of its development in the part of submitting material, understanding the goal, additional education, bridging the gap between the natural and human sciences are put forward.

5. Limitations

Although this study draws on a range of prior empirical investigations across various digital pedagogical applications, critical reflective practices, and student learning outcomes, its own primary contribution is conceptual. Our analyses develop existing empirical findings from sources reviewed to propose extending Brookfield's framework [5], but the specific synthesis, and joint application of speculative epistemology with noosphere pedagogy, remain largely untested in (real-world) higher education contexts [62]. Secondly, our argument relies on the theoretical extrapolation from studies conducted in diverse settings rather than providing direct data to support the proposed component to Brookfield's model [5, 48, 66].

Another concern is that the transferability and generalisability of our earlier recommendations may be limited by variations in institutional culture, technological infrastructure, and learner demographics [25]. It may also invite ambiguity regarding immediate, concrete implementation strategies in HEIs due to gaps in capturing emerging technological developments beyond the scope of sources. The integration of digital pedagogies, AI and VR is constantly evolving which will require iterative adjustments that are not fully accounted for in our analysis [54, 55]. Future research involving iterative pilot studies and longitudinal data collection would substantiate the effectiveness of our extended reflective framework. HEIs should aim to support educators to apply these multi-lens reflections in professional development which go beyond the parameters of this study.

This study does, however, attribute these analyses to the implementation of logical and set logical constructs, weaving together the threads of speculative epistemology and noosphere pedagogy to fortify Brookfield's reflective model. Each strand

coalesces around the expanded lens of 'Learning Environments' (L), representing critical reflection in higher education through a future-oriented perspective and adaptable framework. This is the first phase of our analysis to logically construct an argument to follow up with empirical study of the extended framework's effectiveness, thus bridging innovation theory with practical exigencies [69]. Ultimately, this approach crystalises a dynamic of pedagogical reflection for technological agility in HE.

6. Analysis

6.1 Propositional variables

Speculative Epistemology (S), Noosphere Pedagogy (N), Learning Environments (L) and Critical Reflections (C).

Where:

$\rightarrow$ (Implication): If the premise on the left is true, the premise on the right must also be true.

$\wedge$ (Conjunction): Represents a logical "and," indicating that both connected propositions must be true.

$\vee$ (Disjunction): Represents a logical "or," indicating that at least one of the connection propositions must be true.

$\neg$ (Negation): Indicates the opposite of the proposition.

Defined propositions – P1.

E: Use of the extended Brookfield's framework incorporating a fifth lens (Learning Environment).

A: Enhanced engagement in digital learning environments.

P: Personalised learning adaptations in real time.

I: Increased accessibility of digital learning platforms.

6.2 Speculative outcomes

$E \rightarrow A$.

$E \rightarrow P$.

$E \rightarrow I$.

$E \rightarrow (A \wedge P \wedge I)$.

Integration of Speculative and Noosphere Pedagogy for Learning Environments – P2 (a).

$(S \wedge N) \rightarrow L$.

Integration of Speculative and Noosphere Pedagogy for CriticL Reflections –P2 (b).

$(S \wedge N) \rightarrow C$.

Combined effects expanded – P2 (c).

$((S \wedge N) \rightarrow L) \wedge ((S \wedge N) \rightarrow C)$

$(S \wedge N) \rightarrow (L \wedge C)$

Premise 1. If Speculative Epistemology (S) is applied, then Learning Environments (L) are enhanced – $S \rightarrow L$.

Premise 2. If Noosphere Pedagogy (N) is applied, then Critical Reflections (C) is enhanced – $N \rightarrow C$.

Premise 3. The application of either Speculative Epistemology or Noosphere Pedagogy leads to enhanced Learning Environments – $(S \wedge N) \rightarrow (L \wedge C)$.

A plethora of literature positions (S) and (N) within the framework of effective application, complementing our logical foundation for refocusing on learning environments and critical reflection [39, 62, 67, 69, 70, 72, 78]. Our proposition $\rightarrow L$ accounts for the impact of (S) and its future approach in conjunction with (N), in encompassing practices on global and collective dynamics to stimulate effective reflective practices [1, 5–7, 9–11]. The combined application of $(S \wedge N) \rightarrow (L \wedge C)$ defines a synergistic effect of these frameworks. When (S) visionary strategies are coupled with (N) collaborative ethos, the HE environment metamorphosises into a shared culture of knowledge [67, 68]. Moreover, $(S \wedge N) \rightarrow (L \wedge C)$, suggests that even the independent application of either framework can catalyse development for infrastructure of learning and the depth of critical reflection practices [5, 62, 69] Various studies identify a clear need for flexibility to navigate the complexities of modern educational channels under an education 4.0/5.0 paradigm [25, 28, 33].

6.3 Conceptual clarification

We consider an argument form valid if the truth of its premises guarantees the truth of the conclusion. Empirical data and educational literature analysed confirm the truth of these premises in real-world higher education (HE) settings. Our argument structure is logically valid as it properly uses disjunction and implication. However, to avoid the potential fallacy of a false dilemma—where outcomes are inadvertently oversimplified by assuming that only (S), (N), or both can enhance (L) and (C), thereby excluding other potential factors—measures are taken to control for this bias. This can be mitigated by integrating additional theories or practices that may also influence (L) and (C). In this instance, the risk of overgeneralisation is acknowledged, as the premises assume that any application of (S) or (N) will enhance (L) and (C), potentially overlooking variations in implementation or context. It is important to specify the conditions under which (S) and (N) are effective.

Furthermore, the proposed pedagogies (S) and (N) essentially fill gaps related to global perspectives [38, 67, 79, 80]. The anticipatory dimension of speculative epistemology helps higher education institutions HEIs respond to current educational demands while proactively preparing for rapid technological change [62]. Adaptations to the theory is supported by research indicating that HEIs incorporate future thinking into their deliverables to achieve increased learner adaptability [1, 10].

Similarly, Noosphere Pedagogy emphasises on the values of collective intelligence and collaborative knowledge creation across diverse learning communities [67]. Methodologically, implementing these theories within Brookfield's lenses develops structured steps for educators to follow. Obstacles to professional development may arise when assessing the outcomes of these approaches, even when guided by speculative inquiries [62]. Countering these challenges would require ongoing support and clear guidelines for methodological implementation, alongside measuring the impact of these TLA strategies.

7. Speculative and Noosphere pedagogy in Brookfields extended lenses

7.1 Integration of a fifth Lense (learning environments)

We use a theoretical basis, logical derivations and set theoretic concepts to propose extending Brookfield's framework. Our argument is outlined below for the

integration of a fifth lens into Brookfield's lenses and critical reflection framework to include the learning environment, and thereby strengthen the initial argument presented by Koseda et al. [10].

7.2 Brookfield's existing lenses defined

$\mathcal{L}$ = {S, C, T, P}, where:
S: represents the lens of "self reflection",
C: denotes colleagues' "self perceptions",
T: symbolises "theoretical literature",
P: stands for "students' perspectives".

This study supports Koseda et al. [10] proposal for adding a fifth lens, *L* for "Learning Environments" to Brookfield's framework [5].

The current framework L 'evolves into, L ∪{*L*}.

7.3 Proposition: P1

The integration of (*L*) into L enriches the critical reflections process through accommodating a space for dynamic interactions that reflect current educational modalities and technologies. $\forall x \in \mathcal{L}, (\exists y \in \varepsilon: y \rightarrow L) \wedge (L \rightarrow x)$, where ε represents the set of all elements in educational environments influencing learning dynamics [39, 40–43, 78].

We assume (*L*) brings in elements ε = { *e1, e2,..., en*}, with each *e1* being factors related to the digital transformation, United Nations' sustainable development 2030 agenda for quality education, spatial dynamics, and environmental psychology which directly affect ILOs [4, 18, 81].

7.4 Logical derivation

$\forall ei \in \varepsilon$, $ei \rightarrow L$ - every element in ε implies the importance of (Learning Environments) in Brookfield's framework [5].

$\forall ex \in \mathcal{L}$, $L \rightarrow x$ - Lens (*L*) implies enhancements into each of the other lenses due to the interdependencies of learning environment factors with self-reflection and theoretical background [1, 5].

7.5 Set derivation

$L \rightarrow \subseteq P(\mathcal{L}')$ where (*L*) is the subset of the power set $\mathcal{L}'$, showing that learning environments encompass aspects of all the other lenses in Brookfield's framework [5], either directly or indirectly.

$L \cup_{i=1}^{n} \cdot \in_i$ which is the union of all elements of ε that forms the basis of (*L*), substantiating its nature. Since (*L*) is influences by and influences all components $\mathcal{L}$, integrating (*L*) into Brookfield's framework inherently strengths and expands the framework's applicability.

The formal incorporation of "Learning Environments" (*L*) represents not merely a logical augmentation but an essential adaptation to shifting paradigms in TLA and educational theory [36]. The analysis reveals that (*L*) is intrinsically interwoven with all pre-existing lenses within the framework [5], thereby significantly enhancing its capacity to develop more effective and contextually relevant critical reflection. The proposed lens accommodates the contemporary challenges of new technologies

to ultimately improve instructor understanding and analysis of the ILOs [11]. Our argument prioritises ongoing development in educational theories but also measures to ensure that critical reflection remains robust in HE programmes.

8. Discussion

The logic propositions establish clear relationships among the components of (S), (N), (L) and (C). These propositions appear valid for enhanced engagement, personalisation and accessibility. Caution is advised against oversimplifying outcomes solely to (S) and (N), due to the potential for other confounding factors to influence (L) and (C). There are strong logical arguments and evidence in the literature to suggest integrating a fifth lens (L) would enhance critical reflective practice in current HE learning environments. In such environments, findings indicate that student autonomy in assessments is influenced by the method of critical reflection. One of the most compelling strengths in the analysis relies in its systematic approach to speculative epistemology and noosphere pedagogy whereby their complementary frameworks illuminate the centrality of learning environments and critical reflections. The analysis presented formal logic and set-theoretic principles to construct a coherent theoretical foundation that demonstrates how (S) and (N) synergistically enhance course curriculum and learning experiences. These arguments are not immune to impervious scrutiny – one could contend, for instance, that (S) and (N) may not be effectively realised in contexts where institutional constraints or cultural imperatives overshadow creative inclinations.

Likewise, the assumption that integrating (L) into Brookfield's framework invariably boosts the efficiency of (C) could be viewed overly optimistic without empirical and sensitive evidence. Logical structures are subject to question regarding instructor competence, learner heterogeneity and even subtle differences in digital environments [1, 5, 11]. The overall analysis, its premises, arguments and conclusions could face counterarguments on multiple fronts. Empirically, (S) and (N) have not consistently yielded the theorised benefits in diverse HE settings. This raises questions about whether a logic-based approach fully captures the complexity of human learning and reflective processes [48]. Further research is needed to justify practitioner application of (S) and (N), ensuring that other equally impactful frameworks capable of enhancing (L) and (C) are not overlooked.

9. Conclusion

We have argued that the learning environment comprises the psychological, social, cultural and physical settings in which learning occurs. Digital realms profoundly influence pedagogical strategies and learner outcomes. As higher education continues to adapt in concert with new technologies, instructors tend to underestimate the effect that digital and physical learning environments exert on educational processes, which risk poorer learner engagement. Numerous studies reviewed on learning environments have focused on student perspectives, although few have jointly incorporated the perspectives of students and faculty. Some exceptions extend to features of learning environments in elementary phases of schooling and virtual learning in further educational environments (FE). Other researchers have investigated perceptions of both groups, but in ways that are not centred on the impact

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of learning environments on learner outcomes. Our study takes a different angle with the concept of a global consciousness and collective human cognition under noosphere pedagogy to conceptualise a new collaborative model of education that transcends conventionalist ideals.

From our dissection of conventionalist notions of knowledge, its acquisition prowess proves inadequate for this generation of learners to independently absorb information effectively. Speculative epistemology equips instructors with forward thinking approaches to assess how knowledge changes along with societal expectations. It invites both educators and learners to move beyond traditional educational frameworks, encouraging an approach that considers how knowledge may evolve in response to emerging technologies and changes in society. Our arguments platform a paradigm where learning is not only about absorbing information but also about actively participating in the creation of new knowledge influenced by learning environments.

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