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Learning Sciences in Action: A Reflective Case on the Pedagogy of a Learning Sciences Course for Postgraduates

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Abstract: Learning Sciences (LS) is an emerging field shaping education research and addressing key divisions in knowledge societies. While its global presence is expanding, teaching LS remains challenging due to the need to question assumptions about learning and to engage with abstract, complex theories. This paper reports on a postgraduate LS course in an Indian institute, demonstrating how such theories can be made accessible. The course employed a conceptual scaffold—the concrete–abstract spectrum—to position learning theories ranging from behaviourism and constructivism (including social constructivism and constructionism) to the emerging 4E paradigm of cognition, which emphasises embodied and situated learning. The design incorporated (a) starting from student motivations, (b) introducing theories through an Action–Reflection–Discussion–Reflection (ARDR) cycle to ground engagement, (c) fostering peer discussion and collective reflection, and (d) assessment milestones culminating in a field observation project that initiated students into LS research practice. Drawing on observations and student feedback, we discuss the efficacy of these elements in addressing key pedagogical challenges and offer insights into advancing LS scholarship and course design.

Keywords: Teaching learning sciences, learning sciences, pedagogy

1. Introduction

Learning Sciences (LS), an emerging and highly interdisciplinary field, draws from education, didactics, cognitive science, psychology, computer science, social sciences, philosophy, engineering, and educational technology. Positioned at the intersection of research and practice, LS addresses key divides in contemporary knowledge society — such as formal vs informal learning, authentic vs inauthentic contexts, and laboratory science vs design research (Packer & Maddox, 2016). With technology transforming how we learn and interact, LS offers critical insights for advancing knowledge societies. It also reflects broader paradigm shifts in science — from positivist behaviourism and cognitivism to post-cognitivist, situated, and interpretative approaches (Rourke & Friesen, 2006) — and the rise of design-based research. Learning sciences programmes, largely at master's and PhD levels, are growing worldwide. A review of 75 programmes (Sommerhoff et al., 2018) found common topics such as how people learn, supporting learning, disciplinary learning, technology-enhanced learning, computer-supported collaboration, and research methodologies. While concentrated in North America and Europe, LS programmes are expanding globally, including in India. Expanding scholarship in underrepresented regions is vital, especially for countries like India with a young population and significant education sector needs.

We conducted a semester-long LS course for postgraduate and PhD students in educational technology, who came from diverse academic backgrounds and varying exposure to education. Since they also take a separate research methodology course, our goal was to help them: (a) understand major learning theories and shifts in how the mind and science are conceptualised, and (b) apply these theories to real-world learning situations. Key challenges included: (1) Students' preconceptions of learning shaped by personal and popular narratives,

which they must critically examine (Tillema, 1994; Joram & Gabriele, 1998); (2) The abstract nature of learning theories, requiring careful contextualisation and nuanced understanding. (3) Navigating institutional constraints that shape course design and delivery. This paper examines how the course addressed key learning challenges while familiarising students with major learning theories, their applications, and underlying philosophical shifts. We report insights on the scope of LS, pedagogical approaches, student responses, and critical reflections from teaching a semester-long course to postgraduate and PhD students. After describing the course design, we: (i) outline the coverage of learning theories; (ii) present the concrete–abstract (CA) spectrum as a scaffold for connecting theories with applications; and (iii) detail the Action–Reflection–Discussion–Reflection (ARDR) cycle and field observation project. We evaluate the ARDR approach through student feedback, reflections, and instructor observations, yielding frameworks and strategies that can guide future LS courses.

2. Description of the Course

The course was organised in three phases:

- Phase 1 (8–10 weeks): Core learning sciences, covering foundational theories, their empirical basis, limitations, and relevance.
- Phase 2 (2 weeks): Widening learning to include motivation, emotion, and identity.
- Phase 3 (2–3 weeks): Application, where students observed real-world learning and applied theories to interpret it.

Methodological aspects were excluded, as students took a parallel research methodology course. After introducing LS and expanding the “what of learning” beyond formal contexts, Phase 1 explored the “how” of learning through three clusters of theories: (i) early theories—Skinner’s behaviourism and Tolman’s cognitivism; (ii) constructivism and related approaches—Piaget, Vygotsky, Papert, and Engeström; and (iii) field models of cognition—Gibson’s ecological psychology and 4E approaches, including situated and socio-cultural learning. This trajectory mirrors shifts in models of the human mind.

Discussions deliberately broadened the “who” of learning, from animals and infants to adults, collectives, systems, and even machines (given AI’s role). Where relevant, underlying philosophical and methodological shifts in science were integrated, though at times challenging for some master’s students. These philosophical strands connected with distinctions noted by Packer and Maddox (2016) and were scaffolded using the concrete–abstract (CA) spectrum, discussed in the following section.

2.1 Concrete–Abstract Spectrum: A Conceptual Scaffold

Figure 1. Concrete-abstract spectrum: A conceptual scaffold.

The concrete–abstract (CA) spectrum, illustrated with a real apple on one end and an abstract representation on the other (Fig. 1), was used as a recurring lens to interpret each learning theory and situate students’ own experiences. This scaffold highlighted how theories make assumptions about what counts as “knowledge” and how it is accessed. This anchored reflections across weeks, covering multiple paradigms of learning theories. For instance, this spectrum can be traced to Piaget’s developmental stages, moving from concrete to formal stages. Further, it helps while discussing Papert’s constructionism and Vygotsky’s social constructivism, where the capacity to interact and manipulate with tools is extended even to

the symbolic world, and also how speech and written language make abstractions accessible, citing Ong & Hartley (2013) and Kirsh (1995). The framework reached its richest interpretation during discussions on the 4E paradigm, from Gibson's affordances to non-dualist, anti-representational stances. Beyond theories, it also supported reflections on formal/informal and authentic/inauthentic contexts of learning, and across domains such as sports, music, and STEM, offering an accessible way into philosophical discussions on learning, knowledge, and mind.

2.2 ARDR Cycles: A Pedagogical Framework

Weekly sessions followed an Action–Reflection–Discussion–Reflection (ARDR) cycle, with students organised into mixed teams of three.

- *Action*: Each week, teams explored a topic using readings, multimedia resources, and their prior experiences. This stage involved an active encounter between existing knowledge and new ideas, often supported by digital and AI tools, with the expectation that prior conceptions would be affirmed, refined, or challenged.
- *Reflection (pre-class):* Individually, students submitted structured reflections addressing prompts such as the theory's central claim, links to their own experiences, connections to other paradigms, persuasiveness, and open questions. This process encouraged critical engagement and progressive refinement of thinking.
- *Discussion*: Weekly three-hour sessions combined (i) peer discussions between action teams, where students debated agreements and concerns, and (ii) whole-class discussions led by the instructor, which clarified contradictions, highlighted philosophical and application-related issues, and situated ideas within the broader LS discourse. These dialogues, built on their reflections, ensured a shared baseline of understanding.
- *Reflection* (*post-class):* Students then wrote post-class reflections, drawing on whole-class discussions and asynchronous exchanges on Moodle and WhatsApp. These provided opportunities for consolidation, peer interaction, and instructor feedback.

2.3 Field Observation Project

In the final phase, teams of 3–4 conducted field studies applying LS theories to real-world learning. Each project involved: (i) a pre-observation plan defining the learning setting, theoretical lens, and logistics; (ii) field observation; and (iii) analysis and presentation to faculty. Chosen contexts included a football coaching session, an entrepreneurship workshop, classrooms in experimental and public schools, and a higher education makerspace. This staged progression—from theory to structured reflection to applied observation—helped students move from abstract reasoning to concrete practice. Weekly ARDR cycles encouraged engagement with learning theories, while reflections and discussions helped connect them to students' reasoning. The field observation project extended this work by allowing students to apply theories in real contexts and practice core LS research skills.

3. Methodology, Observations and Findings

We analysed data from weekly assignments, reflections, and participant feedback to examine perceptions of course content, pedagogy, and the ARDR cycles. Ethical protocols, including consent for anonymised use of data, were followed. The course enrolled 19 students (plus one auditor and two PhD observers) from diverse fields such as entrepreneurship, educational technology, and computer science; 52% were master's students and 48% doctoral. About one-third had no prior exposure to learning sciences. All 19 completed the post-course survey. Seventeen students submitted motivation statements, which clustered into four themes: (i) Understanding learning processes, driven by intellectual curiosity—for instance, "deeper insights into how learning theories, cognition, and social interactions influence the learning process"; (ii) Designing learning environments, particularly among educational technology

students who aimed “to create impactful learning environments” or “design a new tool that fosters curiosity and engagement”; (iii) Enhancing pedagogical strategies, especially among those with teaching experience, such as a physics instructor who saw the course as “an opportunity … to address such challenges through evidence-based approaches”; and (iv) Engaging in learning sciences research, with doctoral students aspiring “to contribute to the field of learning science and entrepreneurial capacity building by coming up with a fresh approach… based on sound principles of learning sciences.”

3.1 Overall Course Experience, Relevance and Effectiveness

Participant feedback on the overall course experience was highly positive, with an average rating of 4.32/5 (Fig. 2). The course content was perceived as relevant, clear, and aligned with personal goals (M = 4.21). Pedagogical effectiveness and the ARDR cycle received slightly lower but still favourable ratings (3.58 and 3.84), with 50–60% rating them above 4. Some Master’s-level students, however, reported challenges in adapting to the design, pointing to a need for additional scaffolding for beginners.

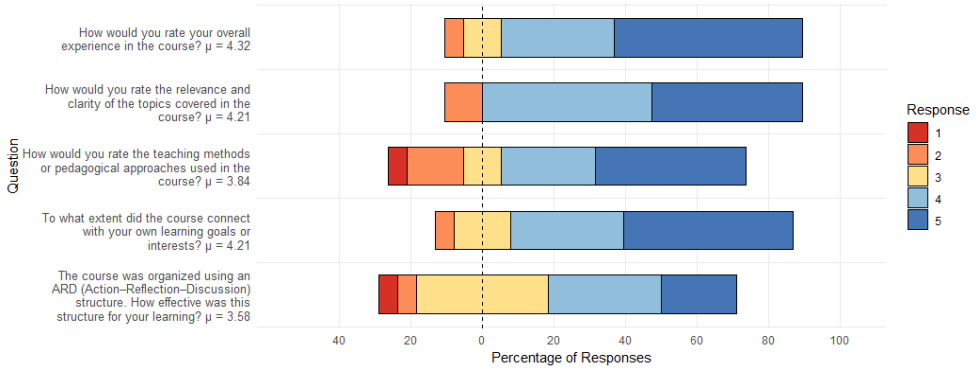

Figure 2. Distribution of responses on overall course experience, relevance & effectiveness.

3.2 Action-Reflection-Discussion-Reflection Cycles

3.2.1 Action: The Role of Prior Readings & Exploration Tasks

The Action phase was rated central by 58% of participants, who valued engaging with readings beforehand for connecting theory with personal experience and field observations. One student explained, “I applied [the theory] to a personal level and saw how my personal experiences included what was there in the learning theory.” Others noted that the flipped design “allowed a longer period to engage with the topic” and was “time-saving since I was not tabula rasa while entering the class.” At the same time, some—particularly master’s students with less experience reading research—struggled with the volume and complexity of texts. A common concern was that “30+ documents over the semester” felt overwhelming. As one participant noted, “I felt confused at multiple points… the readings were overwhelming and did not fit well with my learning style.” Students recommended lighter or summarised readings and introductory guidance before tackling dense theoretical texts. While action teams were intended to provide scaffolding, logistical challenges sometimes hampered their functioning. Yet, when teams worked well, they strengthened peer learning and supported less experienced participants. Overall, the Action phase was foundational, enabling deeper classroom discussions and conceptual grounding, though additional scaffolding could improve accessibility.

3.2.2 Reflection: The Role of Pre & Post-Session Reflections

The Reflection phases (pre- and post-class) were rated least influential by participants, though analysis suggests they played a critical role in fostering readiness. Weekly reflections provided insights into students’ confusions and connections, serving both as feedback to instructors

and a structured space for students to articulate responses. The quality of questions students posed illustrates their critical engagement. For instance, they asked: “Does behaviourism undermine intrinsic motivation? Can it adequately address higher-order thinking?”, After Gibson’s ecological psychology: “How does prior knowledge or culture influence what we perceive as affordances?”; after 4E cognition: “How do we design external representations that enhance rather than hinder cognition?” Though not always recognised by students as impactful, these reflections helped consolidate understanding and seed deeper discussions in class and online forums.

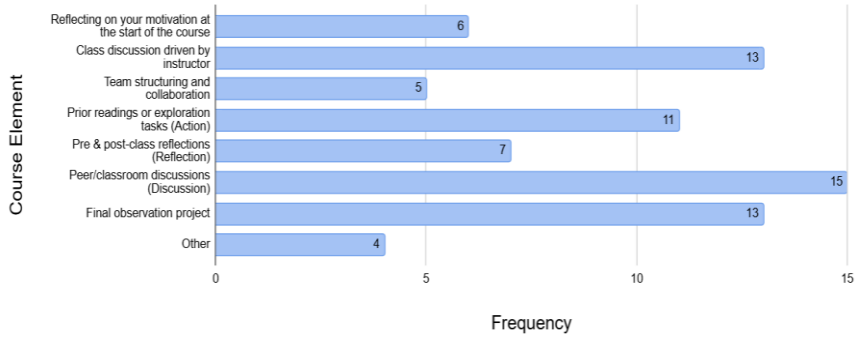

Figure 3. Course elements that were found to be the most influential to students’ learning.

3.2.3 Discussion: The Role of Peer-Led and Instructor-Driven Discussions

Among the course elements, peer group discussions during the first hour of each session emerged as the most influential for learning (Fig. 3). They fostered collaborative meaning-making, active engagement, and a sense of community by giving everyone space to participate. Students noted that peer exchanges helped them uncover nuances and clarify doubts: “Peer interactions helped me get a different perspective on the readings” and “helped to check on if any points were left out.” While widely appreciated, discussions sometimes digressed or caused confusion. As one student observed, “Sometimes I felt that our discussion was going in another direction. We need to narrow down, but yes, narrowing down may not help us to explore everybody's thinking. In the beginning I felt some discussion was meaningless.” Another added, “Sometimes I used to get confused because of multiple interpretations but when the professor explained what exactly it wanted to say.” These limitations were mitigated by instructor-led discussions, which clarified misconceptions and refined interpretations. Students noted, “The class discussion, solidified, my perspective, and sometimes clarified if I had any issues into understanding some parts of the discussion,” and “Sometimes I would take the reading in a different perspective than what was discussed in the class. The class discussion would give me a scaffold and support to understand the nuances of it.” Thus, the discussion phase of the ARDR cycle synthesised ideas at two levels: exploratory peer dialogue with multiple perspectives, and collective convergence led by the instructor. This dual process not only clarified philosophical issues but also strengthened the class as an authentic community of practice.

3.3 Assessment of Learning Through the Field Observation Project

Learning was assessed in two stages. The mid-semester (2–3 hours) required participants to consolidate their understanding of learning and critically analyse any learning tool, seeding theoretical application midway through the course. The final assessment, a field observation project, was identified as a key element, with 68% reporting it significantly deepened their understanding (Fig. 3). Students applied theories to real-world encounters, noting it “helped me connect everything to the real world” and was “the best way to understand the theory learnt in class.” One called it “a major takeaway of the course,” while others valued the structure—from framing to reports—for integrating theoretical and empirical analysis. A suggestion was to start the project earlier to allow more time for engagement. The project served as a good

anchor, allowing the students to ground the abstract theories and philosophical clarifications into concrete real-world observations in varied contexts: football sessions, maker sessions, regular class sessions. Learning sciences researchers recognised the final presentations for combining contextual breadth with theoretical depth, noting this was achieved within a semester despite students' limited prior exposure.

4. Discussion

This course demonstrated both strengths and areas for improvement in teaching learning sciences. The ARDR cycle supported students in questioning pre-existing notions: readings in the Action phase encouraged sense-making and enquiry, while reflection assignments—though seen as less influential—still showed critical engagement. Peer and instructor-led discussions enabled collective churning of ideas. Conceptual scaffolds, such as the concrete–abstract (CA) spectrum, and the field observation project made abstract theories accessible by linking them to real-world contexts (e.g., football, maker sessions). Presentations reflected this accessibility through the depth of student analysis. The course also balanced institutional constraints with workload and motivation, addressing key pedagogical challenges with varying success. Students' appreciation of discussions and projects, alongside difficulties with readings, echoes findings from a modified flipped classroom study (Chiang & Chen, 2017). Our study extends this by examining pedagogical elements in greater depth.

At the same time, areas needing attention remain. The course began challenging assumptions but did not fully assess conceptual change in students' notions of learning. Some continued to struggle with abstraction in the Action phase—suggesting that more structured action-teams could provide additional scaffolding. Future work should explore these possibilities. We hope that this reflective case on the Learning Sciences course can trigger more conversations in the Learning Sciences community.

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