Reassembling AI-embraced Networked Learning through Actor-Network Theory

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Abstract
The rapid diffusion of generative artificial intelligence (GenAI; AI) is reshaping how learning and knowledge production take place in higher education. As AI generates text, proposes logical structures, and applies academic conventions, learning can no longer be explained as interaction among human actors alone. Judgments about what constitutes a legitimate research decision increasingly emerge through entanglements among humans and nonhuman elements such as documents, institutional regulations, interfaces, deadlines, and algorithms. This shift raises foundational questions central to Networked Learning (NL) theory concerning agency, relationality, and knowledge production. While NL has conceptualized learning as a relational practice grounded in connections among learners, its core concepts have largely positioned technology as a mediating condition, leaving learning agency predominantly human-centered. AI challenges this assumption by actively intervening in meaning-making and judgment. This study aims to reconfigure key NL concepts by introducing Actor–Network Theory (ANT) as a sociomaterial analytical lens. ANT conceptualizes learning not as the outcome of human interaction alone, but as a networked effect produced through ongoing translations among heterogeneous human and nonhuman actors. Drawing on ANT concepts such as generalized symmetry, relational agency, translation, and mediation, the study reinterprets relationality, distributed knowledge creation, self-directed learning, and technological mediation within NL. Empirically, the study examines doctoral research proposal writing as a critical learning context where supervision, institutional requirements, and AI intersect. The analysis draws on phenomenological posthuman interviews with doctoral students, supervisors, and early-career researchers, supplemented by the first author's research journal. Paired anecdotal analyses reconstruct the same research design scene through NL and ANT perspectives, enabling comparison of how different theoretical lenses foreground actors, relations, and agency. The findings show that research design decisions are not the result of individual intention or collaboration alone, but are provisionally stabilized through chains of translation involving supervisor, supervisee, documents, procedural forms, deadlines, digital systems, and AI. The study highlights how ANT makes visible the complexity of research design, repositions AI as an active translation device, and redistributes agency and power across sociomaterial assemblages. It suggests that NL research may benefit from engaging more explicitly with technology as an active participant in learning rather than as a background condition.

Keywords
Networked Learning (NL), Actor–Network Theory (ANT), Doctoral Supervision, Generative Artificial Intelligence (GenAI), Sociomaterialism

Introduction

The rapid diffusion of generative AI is reshaping the conditions under which learning takes place in higher education. AI generates text, proposes logical structures, and offers feedback aligned with academic conventions. As a result, learning can no longer be adequately explained as interaction among human actors alone. What counts as a "good" explanation and which choices remain as "legitimate" judgments are formed not only through human intention but through entanglements with nonhuman elements such as documents, regulations, interfaces, and algorithms. This shift reopens foundational questions: Who produces knowledge? Where is the agency of learning located? These concerns resonate with Networked Learning (NL) theory. NL conceptualizes learning as a relational practice and has emphasized knowledge construction through connections and interactions among learners (Goodyear et al., 1998; McConnell, 2006). However, its core concepts tend to position technology primarily as a medium or condition. Technology is often described as a background that facilitates human

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relationships, while the agency of learning remains largely attributed to human judgment and choice. Generative AI puts pressure on this assumption. Rather than merely transmitting information or supporting connections, AI intervenes in learning by reshaping forms of meaning, proposing criteria for judgment, and reconfiguring relational hierarchies.

This situation also aligns with recent theoretical shifts that understand learning as a sociomaterial practice (Adams & Thompson, 2016; Fenwick & Landri, 2021; Fawns, 2022). Under postdigital conditions, learning is less a matter of "using" technology than of being co-constituted with it. Humans and nonhumans, materiality and meaning, are continuously entangled and mutually constitutive, and learning emerges as a process of provisional stabilization within these entanglements. Accordingly, while retaining NL's concern with relations and connections, there is a need to reconfigure its theoretical framework so that it can also account for how nonhuman actors actively organize learning practices (Fox, 2009; Gourlay & Martin, 2018; Jones, 2015). To this end, this study introduces Actor–Network Theory (ANT; Latour, 2005) as an analytical lens to reinterpret key NL concepts from a sociomaterial ontological perspective. ANT treats human and nonhuman actors symmetrically and understands the social not as a fixed structure but as a network continuously assembled and reassembled through connections and translations among heterogeneous actors. From this perspective, learning cannot be reduced to the outcome of human interaction alone. It is configured through relations in which elements such as documents, regulations, schedules, digital systems, and AI enable certain actions while excluding others. Drawing on ANT's conceptual resources, this study redescribes core NL concepts—such as relationality, distributed knowledge creation, self-directedness, and technological mediation—and discusses their analytical implications.

To ground this discussion empirically, the study presents doctoral research proposal writing as a case. Doctoral supervision provides a concentrated context in which the relational learning emphasized by NL is organized through documents and institutional requirements, timelines and deadlines, digital tools, and the intervention of AI (Shulman, 2004; Kwiram, 2006). Research proposal writing constitutes a site where research purposes and methodologies intersect with institutional demands, supervisory judgment, and technical arrangements. This makes visible both the limits of NL's human-centered assumptions and what ANT enables us to see differently. The focus of the study is therefore not on explaining the doctoral supervision triad itself, but on theoretically rethinking NL in the era of AI. The case functions as an analytical device to show how this theoretical reconfiguration produces meaningful differences in practice.

Background and Problem

The formation of NL theory began in the late 1990s, coinciding with growing interest in the educational potential of information and communication technologies (ICT). Goodyear and colleagues (1998) defined NL as learning that uses ICT to promote connections among learners, between learners and tutors, and between learning communities and learning resources, positioning collaborative interaction in online environments as the core mechanism of learning. Early NL discourse focused on the capacity of digital technologies to overcome spatial and temporal constraints and largely understood technology as a mediating means that enabled interaction among learners. McConnell (2006) further developed these ideas into a practical pedagogical framework, proposing six principles—openness, self-determination, shared purpose, supportive environments, collaborative assessment, and continuous reflection. This work contributed to establishing NL as a pedagogical model for community-based collaborative learning. At this stage, however, NL retained an instrumental view of "learning through connection." Technology functioned as a condition that facilitated human interaction, and agency in learning was clearly attributed to human actors.

From the late 2010s onward, NL discourse shifted its focus from the quantitative extent of connections to the qualitative character of relations. The Networked Learning Editorial Collective (2021a) criticized earlier definitions for overemphasizing network structures and connectivity while insufficiently accounting for the purposes and meanings of learning. In response, they foregrounded concepts such as trust, shared challenges, and skilled practice, redefining NL not as information exchange but as a process through which social and ethical relations are formed. This marks a clear theoretical move from connection to relation, and from structure to meaning. Despite this shift, however, NL's relational ontology remains largely human-centered. An examination of the key concepts proposed by the Networked Learning Editorial Collective (2021a, 2021b)—relations and connections, distributed knowledge creation, self-directedness, and technological mediation—shows that technology continues to be positioned as a background condition enabling human interaction, rather than as an actor that participates in constituting relations. "Relations and connections" focus on interactions among learners and between learners and tutors, without including technology as a co-constitutive element of these relations.

Distributed knowledge creation centers on collaboration among multiple human actors, with nonhuman elements confined to instrumental support rather than treated as participants in knowledge production. The concept of self-directedness presupposes agency as an internal capacity of individual learners, thereby sustaining a modern image of the autonomous human subject. Technological mediation likewise frames technology as a means of transmitting human intention, fixing it in an intermediary role.

This human-centered orientation can be understood in relation to the technological context of the late 1990s, when NL first emerged. Digital tools such as email, discussion boards, and video conferencing systems primarily served functions of communication and information transfer, faithfully conveying human intentions without independent generative or inferential capacities. Viewing technology as a tool aligned with these material conditions. Within this context, NL's human-centered conceptual framework provided a persuasive account of learning experiences for a considerable period. As digital environments grew more complex, however, learning increasingly appeared irreducible to human interaction or the transmission of intention alone. When technologies began to intervene actively in learning processes and shape outcomes, concepts such as "tool," "mediation," and "support" revealed their limits by retrospectively simplifying the role of technology. This explanatory gap raised the need for theoretical resources capable of symmetrically tracing relations among human and nonhuman elements constituting learning. It is at this juncture that NL researchers turned their attention to Actor–Network Theory (ANT).

ANT offered a way to rethink the NL concerns with "connection" and "relation" by detaching them from human-centered assumptions. Whereas early NL discussions tended to understand learning as an extension of interaction among human actors, ANT analyzes learning as a network effect emerging from the entanglement of human and nonhuman elements. An early articulation of this perspective can be found in the work of Fox (2002, 2009). Critically examining social constructivist and situated learning approaches (Fox, 2002), he conceptualized learners and learning processes as networked products formed through interactions among heterogeneous elements such as technologies, texts, spaces, rules, and language (Fox, 2009, p. 31). This challenged approaches that reduced learning to cognitive change within the human subject and underscored the need to treat technology and materiality as central analytical elements in NL. Subsequently, Jones (2004, 2015) systematically examined the concept of "network" as used in NL, arguing that despite its emphasis on relationality and connectivity, NL research continued to rely on human-centered premises. He criticized the tendency to reduce networks to social connections among human actors and proposed, drawing on ANT, that networks be reconceptualized as heterogeneous assemblages co-constituted by human and nonhuman elements (Jones, 2015). For Jones, however, ANT was not positioned as a replacement for NL but as a critical theoretical resource that exposes and extends NL's conceptual limits. This reflects the fact that NL has selectively drawn on ANT within boundaries that preserve its educational orientation, rather than fully embracing ANT's radical symmetry.

These theoretical shifts are also evident in changes within the NL research community. Analyzing NL conference papers from 1998 to 2016, de Laat and Ryberg (2018, pp. 14–15) show that early work was dominated by human-centered theoretical perspectives such as cognitivism, constructivism, and communities of practice, while sociomaterial approaches, including ANT, gradually gained prominence over time. Although they do not suggest that ANT has become a single dominant framework in NL research, they argue that this trend indicates an expansion of interest beyond human connections toward more complex relational networks that constitute learning (de Laat & Ryberg, 2018, p. 30). Building on this trajectory, Gourlay and Martin (2018) advance a more radical critique, arguing that NL's core concepts fail to adequately account for actual learning practices in digital environments. They contend that human-centered notions such as participation, autonomy, and connection obscure the material and technological conditions of learning, and call for a reconceptualization of learning as a sociomaterial practice in which humans and technologies, discourse and materiality, are entangled (Gourlay & Martin, 2018). In this context, ANT functions as a key theoretical reference point that enables technology to be analyzed not as a mere medium or tool, but as an agentive element in the constitution of learning experience.

In sum, attention to ANT within NL should not be understood as the adoption of an external theory or a response to technological fashion. Rather, it has provided a way to sustain NL's longstanding concern with "connection" while extending it to include human–nonhuman entanglements and redescribing learning as a networked effect. At the same time, this engagement reveals the limits of existing NL–ANT discussions. While prior studies have succeeded in making technology and materiality visible as conditions of learning, they have been relatively hesitant to trace, at a micro level, how research designs and academic judgments are actually formed in practice. Moreover, even when technology is discussed as a nonhuman actor, the distinctive mode of intervention associated with AI—its capacity not merely to transmit intention but to generate meaning and propose criteria for judgment—has not been sufficiently examined. This study addresses this gap by examining an everyday practice:

graduate-level research design meetings. By redescribing the same scene through the lenses of NL and ANT, it analyzes how research learning and decision-making are not outcomes of any single actor's intention, but effects of an assemblage in which supervisor, supervisee, documents, institutional requirements, digital systems, and AI are entangled. In doing so, the study inherits NL's concern with relational learning while extending the NL–ANT discussion by showing how AI reconfigures the conditions of research learning and the criteria of academic judgment.

Towards an Actor-Network Perspective

ANT, developed primarily by Bruno Latour (2005), is a social theory that resists reducing the social to fixed structures or human actions. Instead, it conceives of society as an assemblage, a continuously reconfigured constellation of heterogeneous human and nonhuman elements that mutually constitute one another. In this study, ANT provides the primary conceptual resources for rethinking learning and supervision beyond human-centered accounts. In particular, the analysis draws on four key ANT concepts: generalized symmetry, which treats human and nonhuman entities as analytically equivalent; agency as a distributed and relational capacity rather than an individual attribute; translation, through which heterogeneous actors are aligned and networks are reconfigured; and the distinction between mediators and intermediaries, which foregrounds how technologies actively transform meaning rather than merely transmitting it (Latour, 2005; Callon, 1986). ANT also conceptualizes networks not as fixed structures but as provisional assemblages continuously produced and stabilized through ongoing associations. Building on these conceptual resources, this study reinterprets the core principles of NL within a sociomaterial ontology. Table 1 summarizes how key NL concepts are reconfigured through an ANT lens and outlines the analytical implications of this shift.

Table 1: Reinterpreting Key Concepts of NL through ANT

Key Concept of NL	Traditional NL Perspective	Reinterpretation through ANT	Analytical Implications
Relationality and Connection	Learning occurs through interactions and connections among learners; technology serves as a medium that facilitates such connections.	Relations are not predefined linkages among nodes but *assemblages* in which human and nonhuman actors entangle to generate new beings and meanings.	Shifts analytical attention from "connection" to the *performativity* of relating; learning is understood as the very enactment of relational formation.
Distributed Knowledge Production	Knowledge is collaboratively and interactively constructed through the participation of multiple actors within the network.	Knowledge is a *socio-material product* continuously reconfigured through processes of *translation* and *mediation* among actors.	Enables analysis of "knowledge production" not as an outcome of human interaction but as a chain of translational actions among heterogeneous actors.
Self-directed Learning	Learners autonomously construct and participate in networks as independent agents.	Agency is not an inherent attribute of individuals but is *distributed* across relations; self-directed learning is reinterpreted as *relational agency*.	Moves beyond the notion of an autonomous learner to highlight how agency is redistributed through the entanglement of AI, tools, and institutional structures.
Technological Mediation	Technology functions as a mediating tool that enables information exchange and interaction.	Technology participates as a *nonhuman actor* in processes of meaning-making and judgment.	Repositions technology not as a passive instrument but as an active participant that reshapes relations and hierarchies of authority through AI mediation.

In Networked Learning (NL), relationships have traditionally been understood as interactions among already existing subjects. From this view, learning occurs through exchanges between individuals whose identities pre-exist the relationship itself. However, from an ANT perspective, relations are ontologically prior: actors come into being only through relations. In Barad's (2007) terminology, this is not interaction but intra-action, which implies that relations constitute actors from within (intra) rather than occurring between (inter) them. Applied to the relationship among supervisor, supervisee, and AI, this means that the supervisor may shift from a "traditional authority" to a "collaborative advisor," the supervisee from a "passive learner" to a "critical editor," and the AI from a "tool" to a "proposer." These identities are not predetermined but reconfigured in every encounter.

Accordingly, NL research may benefit from moving beyond structural questions such as "who is connected to whom" toward processual questions of how relations are formed, when they stabilize, and how they become unsettled.

The NL concept of distributed knowledge creation assumes that knowledge is co-constructed through the collaboration of multiple human agents. This represents an epistemological shift from individual cognition to collective knowing within the network, yet it still limits the agency of knowledge production to human actors. From an ANT perspective, knowledge emerges through chains of translation. Translation here is not the transfer of information but the process through which each actor reconstructs the practices of others, thereby transforming their meanings and forms. Moreover, ANT conceptualizes epistemic authority not as something distributed but as circulating. At one moment, the professor's judgment dominates; at another, the AI's proposal takes precedence; at yet another, the student's interpretation becomes decisive. Learning can thus be understood as an ongoing negotiation of these circulations of authority.

The NL concept of self-directed learning has been crucial in positioning learners as active participants rather than passive recipients. However, it retains a modern conception of the subject that treats agency as an individual, internal capacity. From an ANT perspective, agency is not an inherent property of individuals but a relational capacity distributed across networks (Latour, 2005). A student's ability to write, for example, is not solely an outcome of personal skill but the emergent effect of an assemblage comprising word processors, reference materials, AI tools, supervisors' feedback, and academic norms. As Edwards (2010) suggests with the notion of relational agency, the analytical focus shifts from who can act to how action becomes possible through the alignment of heterogeneous elements. Self-directedness, then, is not a stable attribute of the learner but a temporarily enacted capacity emerging within relational entanglements.

In NL, technology has generally been conceptualized as a transparent intermediary that enables communication and interaction among learners. Generative AI, however, functions as a mediator. It does not simply transmit input but reconstructs it, generates alternatives, and applies academic norms in context-specific ways. When a student asks, "Please improve this section," AI interprets what "improvement" means, transforms the text accordingly, and generates new meanings. As Latour (2005) notes, a mediator "redefines both input and output rather than simply transporting cause or meaning." Through this mediating process, AI becomes an active participant that reconfigures the learning assemblage. Consequently, NL research may benefit from attending more closely to what technology transforms and generates through mediation, rather than treating technology solely as a channel of transmission.

Methodology

This study positions the doctoral supervisor–supervisee relationship as a key context for examining NL and explores the analytical potential of ANT through the scene of research proposal writing. Doctoral supervision vividly demonstrates that learning is not confined to individual cognitive activity, but unfolds as a relational practice in which interactions between supervisor and supervisee are entangled with institutional documents and schedules, as well as technological elements such as AI. Drawing on phenomenological posthuman interviews, this study analyzes anecdotal materials to examine how human and nonhuman actors are entangled in constituting research learning within doctoral supervision, from an ANT perspective.

Case and Participants

The empirical materials consist of in-depth interviews with three groups and the first author's research journal. Interview participants include (1) ten doctoral students, (2) ten doctoral supervisors, and (3) ten early-career researchers who obtained their PhD within the past five years, for a total of thirty participants. These groups occupy distinct positions from which doctoral research learning and supervisory relations are experienced and interpreted, enabling a multi-layered examination of how research design and academic judgment are formed and reconfigured. In particular, the early-career researcher group provides temporally reflective accounts that allow changes in learning and judgment to be examined retrospectively.

Data Collection

Interviews were conducted in a semi-structured format, focusing on experiences of research proposal writing, interactions with supervisors, institutional requirements (e.g., funding applications, IRB procedures), and the use of digital tools and AI. In addition, the first author—herself a doctoral researcher conducting her studies in an environment where AI is actively involved—has direct experience of the entanglement among supervisor,

supervisee, and AI. Accordingly, the research journal was included as part of the empirical material. This journal supplements interviews by capturing micro-level judgments, hesitations, and shifts in sensibility that are difficult to access through interviews alone. Data collection was guided by the heuristics proposed by Adams and Thompson (2016, pp. 24–49), including *gathering anecdotes*, *following the actors*, and *listening for the invitational quality of things*. Rather than reducing experience to generalized statements, this approach aims to make sociomaterial practices visible through close attention to anecdotes anchored in specific scenes and events. Anecdotes drawn from interviews and the research journal were partially reworked to preserve key relations and actor configurations while removing all personally identifiable information.

Data Analysis

For analysis, the study applied the ANT heuristic of *unraveling translations* proposed by Adams and Thompson (2016, p. 74). This heuristic traces how human and nonhuman elements translate one another, become connected, and are provisionally stabilized within situations, rather than reducing experience to individual subjective perception. Translation is understood here not as the simple transmission of meaning, but as a practice that reconfigures possibilities and constraints through relations. Accordingly, judgments and senses of responsibility emerging in research design and supervision are not interpreted as internal states of individuals, but analyzed as chains of translation through which documents, institutions, technologies, schedules, and AI become entangled, enabling a particular design to emerge as the "most plausible choice." The analytical focus is placed not on who made a decision, but on which translations made that decision possible.

Reassembling Research Design

This chapter analyzes what different theoretical lenses foreground and background by presenting the same research design scene side by side through two frameworks. To this end, a single case of research design is first described from the perspective of NL (Anecdote 1), and the same scene is then reconfigured from an ANT perspective (Anecdote 2). This comparison is intended to show how theory shifts the focus of analysis and how research design can be understood differently as a result.

[Anecdote 1] The research design meeting with my supervisor took place in her office. During the meeting, we discussed how to run a new project alongside an existing study that had already been approved as a foundation-funded project. Possibilities were raised for either linking the two studies or positioning them side by side. Based on advice from Professor B, expanding the participant group was also considered. By the end of the meeting, it became clear that the scope and structure of the research needed to be reorganized. After the meeting, I reviewed the discussion notes and revisited the research proposal and IRB application. In order to clarify the research aims, participant composition, and procedures, I entered the key issues discussed in the meeting into ChatGPT and asked for a summary. Drawing on this output, I concluded that juxtaposing the two studies, rather than integrating them into a single project, would be more appropriate. Based on this decision, I revised the interview questions and research procedures and proceeded to update the IRB application accordingly.

- Reconstructed from the first author's research journal (Oct 1, 2025) and interview transcript (Nov 14, 2025)

[Anecdote 2] The meeting ended in the supervisor's office. On the table, next to the laptop and the foundation project proposal, were notes reading "connection," "juxtaposition," "partial overlap of participants," and "IRB revision," none of which had yet been settled into a single conclusion. As I left the building, a message arrived on my phone fixing the deadline first: "organize it within this week." What exactly needed to be organized remained undecided, but the point of completion was already set. Back at home, as I opened the meeting notes, the foundation documents, and the IRB application in sequence, the approved sentences and form-based categories quietly narrowed the range of acceptable expressions. The paragraph summarizing the meeting was moved into a ChatGPT window, where a single explanatory narrative was rearranged into a list of procedural items. When I returned to the IRB form, these newly ordered items appeared to align with its structure. Once positioned within the research procedure, "juxtaposition" remained as the most plausible option. At the moment I saved the file and added the date, returning to the earlier state of discussion became difficult. Deadlines, documents, ChatGPT's reordering, and the formatting of the forms passed through one another, temporarily stabilizing a particular research design.

- Reconstructed from the first author's research journal (Oct 1, 2025) and interview transcript (Nov 14, 2025)

To make this contrast visible at a glance, Figure 1 visualizes how the same research design scene is configured differently through the lenses of NL and ANT. The diagram on the left represents an NL-based configuration, while the diagram on the right is constructed from an ANT perspective. In what follows, this figure is used as a reference point to analyze how the NL concepts reinterpreted through ANT can be read within the anecdotes presented above.

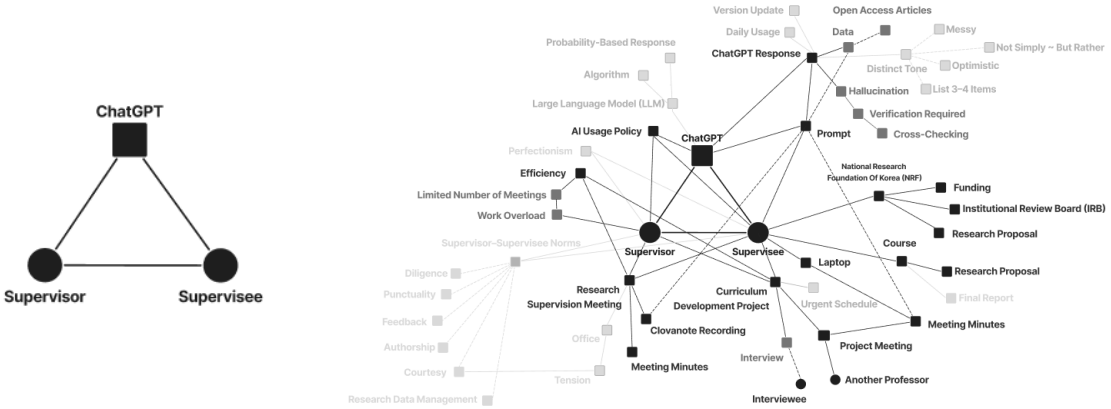

Figure 1: Supervisor–Supervisee–AI Relationship (Left: NL-based, Right: ANT-based)

First, from a traditional NL perspective, the central relationship in this anecdote is the interaction between supervisor and doctoral student. The options proposed during the research design meeting—"connection," "juxtaposition," and the expansion of the participant group—are examined and adjusted through discussion between the supervisor and the supervisee, with the outcomes subsequently reflected in revisions to the research proposal and IRB application. Here, relations are understood as channels of interaction between two already constituted subjects, and research design appears as the cumulative result of these interactions. ChatGPT, funding-agency documents, and IRB forms are positioned as contextual conditions surrounding this relationship. When the same anecdote is reread from an ANT perspective, however, relations are not pre-given connections but are performatively constituted through practice. The message received after the meeting—"organize it within this week"—does not simply extend the supervisor–supervisee relationship; it invokes a nonhuman actor in the form of a deadline, reconfiguring the nature of the relation itself. Funding-agency documents and IRB forms quietly delimit the range of acceptable expressions, redefining within the relation what can remain as "connection" and what can stabilize as "juxtaposition." In this view, relations do not emerge as outcomes of human interaction but appear as ongoing accomplishments enacted through the entanglement of documents, deadlines, and ChatGPT's reordering. ANT thus foregrounds not who is connected to whom, but how relations are provisionally produced and stabilized through specific practices.

Second, from an NL perspective, judgment about research design is formed through collaborative discussion between supervisor and supervisee. Decisions about how to relate the existing study to the new project are deliberated within the supervisory relationship, culminating in the conclusion that "juxtaposition" is the most appropriate approach. Knowledge, in this account, is understood as a shared outcome jointly constructed through human deliberation. From an ANT perspective, by contrast, this judgment appears not as the product of collaboration but as the effect of a chain of translations. What is discussed in the meeting is first translated into meeting notes, then rearranged into a list of procedural items through ChatGPT input. This reordered list overlaps with the structure of the IRB form, rendering "juxtaposition" the most explicable option. Knowledge here is not a judgment agreed upon in anyone's mind, but something gradually formed through sequential translations—from spoken discussion, to document, to ChatGPT's reordering, to form-based categories. ANT reveals knowledge production as a networked effect generated by heterogeneous actors passing through one another, rather than the outcome of human collaboration alone.

Third, applying NL's concept of self-directedness, the doctoral student in this anecdote can be read as an active subject who evaluates options and implements decisions. Reviewing the proposal and IRB materials after the meeting, organizing issues through ChatGPT, and arriving at the conclusion that "juxtaposition" is appropriate can all be interpreted as a paradigmatic instance of self-directed learning. ANT, however, refuses to reduce this judgment to an individual's internal capacity. The choice of "juxtaposition" becomes possible only through the prior entanglement of deadlines, approved sentences, form-based item structures, and ChatGPT's reordering

function. The supervisee's agency is provisionally accomplished through alignment with these elements. Self-directedness thus appears not as a personal attribute, but as a relational form of agency produced through the joint operation of documents, technologies, and institutional demands. ANT shifts the analytical question from "who made the decision" to "which relations made the decision possible."

Fourth, from an NL perspective, ChatGPT functions as a supplementary tool that helps organize meeting content and support judgment. Technology is understood as a medium that efficiently structures and transmits human intention, while decisional authority remains with the human actor. From an ANT perspective, however, ChatGPT appears not as a neutral intermediary but as a mediator that reconfigures meaning. A single explanatory paragraph is rearranged into a list of procedural items through ChatGPT, and this reordering intersects with the requirements of the IRB form, altering the trajectory of thought. Although ChatGPT's algorithm does not make visible the criteria by which this arrangement is produced, it is precisely this opacity that operates as a form of agency, steering the direction of research design. Technology here does not merely convey judgment; it participates in shaping the very form in which judgment becomes possible. ANT captures this mode of technological intervention in meaning-making within learning and research design.

In sum, a traditional NL perspective organizes research design as the outcome of interaction among human actors, positioning nonhuman elements as contextual background. Applying ANT, the same scene is redescribed as a process in which human and nonhuman actors, on a single analytical plane, translate one another and provisionally stabilize a research design. This analysis preserves NL's concern with relations and connections while revealing, at a micro level, how those relations are actually constituted and stabilized in practice. At the same time, it renders visible the concrete ways in which technologies such as AI intervene in learning and judgment, redescribing research design as a sociomaterial practice that includes processes prior to their black-boxing.

Discussion

The preceding anecdote analysis and Figure 1 demonstrated how the same research design scene is constituted as an entirely different practice when viewed through different theoretical lenses. In particular, the ANT perspective moves beyond explanations that reduce research design to the outcome of human interaction, making visible how judgment and decision-making become possible through entanglements among human and nonhuman actors. Building on this analysis, this Discussion examines the implications of the case for higher education learning and NL scholarship, focusing on (1) the visualization of complexity in research design processes, (2) the redefinition of AI's position, and (3) the expansion of analytical perspective and the redistribution of power.

First, this analysis foregrounds complexity and reconceptualizes decision-making. From an ANT perspective, research design is revealed as an inherently complex practice. This analytical value of ANT resonates with Gourlay and Oliver's (2018) argument that learning consists of assemblages of micro-practices such as searching, reading, note-taking, collecting, writing, and speaking. Further empirical support can be found in Lee et al.'s (2025) analysis of EdTech policy as an assemblage in the context of AIDT implementation in Korea, which demonstrates ANT's capacity to surface the complexity of policy phenomena that otherwise appear flat or linear. Within an NL framework, changes in research design are typically summarized as outcomes of relational interaction, with complexity receding into the background. By contrast, when the case is reconfigured through ANT, research design is not explained as interaction among elements operating at different levels—individuals, institutions, or technologies. Human and nonhuman actors appear simultaneously on the same analytical plane, and the direction of design emerges gradually through their entanglement. In this case, "juxtaposition" was not a premeditated choice. The continuity of a funded project, the formal requirements of the IRB, temporal constraints, and technological reordering became connected while carrying different interests, resulting in the provisional stabilization of a particular design. The decision thus appears not as an act taken at a single moment, but as the outcome of intra-actions through which multiple demands collided and were adjusted. ANT does not simplify this complexity; instead, it places it at the center of analysis, repositioning research design as a living practice.

Second, the case prompts a redefinition of AI's position. Much of the existing literature frames AI either as an object of ethical concern (Holmes & Porayska-Pomsta, 2023; Jobin et al., 2019) or as a technology assessed in terms of whether it can replace human judgment (Chan & Tsi, 2024; Lepri et al., 2023). From an ANT perspective, however, AI functions as a translation device that decomposes utterances into procedural elements and reorders sequences of thought to align with documentary and formal requirements. As shown in Figure 1, ChatGPT is not merely a mediating tool within a triangular relationship between supervisor and doctoral student, but one actor among others—alongside documents, regulations, and schedules—that actively organizes the flow of thinking. This aligns with Iatrellis et al.'s (2025) discussion of a tripartite mentoring model in which AI functions as an

actor structuring cognition and research processes. The present study extends this argument by positioning AI not simply as an advisory or feedback-support tool, but as a translation device that organizes academic practice itself through the formalization of utterances and the arrangement of thought. From this perspective, AI use shifts from a question of permission or prohibition to one of how AI operates within the assemblage that constitutes graduate learning and research practice. AI should thus be understood not as an exceptional external intervention, but as one of the legitimate actors already organizing academic practice.

Third, ANT enables an expansion of analytical perspective and a redistribution of power. Rather than reducing power relations in learning and supervision to interpersonal conflict or hierarchy, ANT conceptualizes power as an effect of the operation of the assemblage as a whole. While NL accounts tend to describe research design as a sequence of discussion and agreement between supervisor and supervisee, ANT shows that research design does not resolve into the judgment of a single human subject. Nonhuman actors—such as funding documents, the categorical structure of IRB forms, and scheduling systems—mediate human deliberation and preconfigure what becomes possible and what is excluded. This aligns with the notion of collateral realities that emerge through everyday practice (Law, 2011) and with the politics of stabilization and exclusion emphasized by Adams and Thompson (2016). Power is thus distributed across human and nonhuman actors rather than concentrated in individual decision-makers. The supervisor is positioned not as the central authority, but as one actor within an assemblage where constraints and possibilities intersect. This does not signal a weakening of the supervisory relationship, but a reorganization of the levels and pathways through which power operates. Such a shift provides a multi-layered critical perspective that renders the politics of learning and supervision visible at the assemblage level.

This article uses ANT as a complementary lens that retains NL's concern with relations and connections while foregrounding the operations of nonhuman actors that have often been relegated to the background. Learning is thereby reconceptualized not as an activity coordinated within stable structures or systems, but as a practice provisionally stabilized through entanglements among human and nonhuman actors. This perspective moves beyond explanations that reduce graduate learning to individual self-directed activity or the outcome of supervisory relations, offering a more fine-grained analysis of the conditions and devices through which learning takes place. In particular, in the context of the rapid diffusion of AI, NL research must move beyond positioning technology as a mere medium or environment and engage more rigorously with technology as an actor that actively constitutes learning.

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