Characterizing Teacher Agency in Processes of Evaluation, Co-Design, and Orchestration of Intelligent Technologies: A Multicase Study

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Abstract

Teacher agency refers to the capacity of educators to enact educational transformations that align with their personal stances, beliefs, values, and goals. To exercise agency effectively, teachers must navigate the complexities of their working environments. In Technology-Enhanced Learning (TEL) contexts, the increasing use of intelligent technologies—such as Learning Analytics systems that provide adaptive recommendations or AI-driven feedback—has led to the automation of tasks traditionally performed by teachers. This automation, which occurs during the enactment of learning activities, can either empower or challenge the teacher's role. Nevertheless, the potential to influence teaching practices can be better understood by considering a broad range of factors, including the evaluation of technological systems, the co-design of learning activities and intelligent components, as well as aspects related to orchestration. Particularly through the lens of agency, whose implications for this context remain to be fully explored and understood. In this thesis, we are conducting a multicase study that spans three cases, each involving different technologies that support unique learning scenarios. Learning Analytics are central to the three cases because they support or hinder teachers' agentic behavior as a result of the capacity to automate orchestration activities. Thus, we aim to provide an understanding of how teachers' agency is shaped by intelligent technologies and by practitioners' involvement in evaluation, co-design, and orchestration activities. So far, one case study involving a Smart Learning Environment has been conducted and fully analyzed. While two others, involving the co-design of a multi-agent generative AI architecture for a Computer Supported Collaborative Learning social platform and the evaluation of a Multimodal Learning Analytics system with AI-driven feedback, are in the final data collection phases.

Keywords

Teacher Agency, Orchestration, Co-design, Intelligent Technologies, Learning Analytics, Multiple case study

1. Introduction

The current societal and educational landscape in which technologies with intelligent features are more pervasive is raising concerns about the question of teacher control and decision-making in relation to these technologies [1]. At the same time, artificial Intelligence (AI) has the potential to optimize educational processes, resulting in augmenting or complementing teachers' practices [2, 3]. Meanwhile, teacher agency refers to educators' capacity to make intentional decisions that influence their teaching contexts and classroom environments to achieve their educational objectives [4, 5]. However, the conceptual foundations of agency may differ depending on the discipline [1],

particularly in relation to the activities performed by teachers in educational settings [6, 7]. Beyond these issues, in the field of Technology-Enhanced Learning (TEL), there is a growing interest in teacher agency, particularly concerning the extent to which educators can actively engage in transformations and integrate new technologies into their instructional contexts [8, 9]. In this dissertation, teacher agency is being approached from the ecological perspective [6] and the social cognitive theory defined by Bandura [10]. For the ecological perspective, agency emerges as a result of temporal and relational processes through which it is enacted [4]. The ecological approach considers structural and contextual determinants specific to the TEL domain that either empower or constrain agency (e.g., technological affordances, support from researchers through co-design processes). Besides this perspective, we are also considering the psychologically driven approach of Bandura's Socio Cognitive Theory (SCT) [10, 11]. According to SCT, agency is framed as the capacity of individuals to intentionally determine the course of action [10]. Agentic behavior is manifested through three core properties (i.e., forethought, self-reactiveness, and self-reflectiveness) that guide humans in creating action plans, in their execution, and in the reflection on their actions [11]. Figure 1 depicts a graphic representation of these two models.
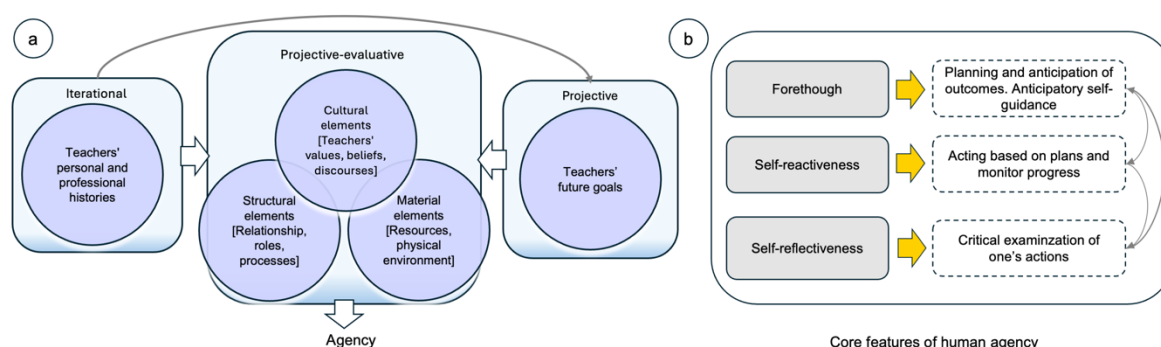

Figure 1: a. Ecological model of teacher agency (adapted from [6]); b. Core features of human agency with descriptions (self-elaborated).

A key distinction needs to be made regarding autonomy and agency. We understand these two concepts as different. Teacher autonomy is understood as the degree to which educators perceive themselves as having control over their professional actions and the conditions of their working environment [12]. According to the understanding of agency that guides this research [6, 10], having autonomy does not imply that agency is going to be achieved. Agency involves purposefully planning and acting towards meaningful educational transformations. In the context of professional practices, Goller and Harteis [13] advocate for combining different perspectives of agency, such as the ecological one (that understands agency as a non-static feature and something achievable) and the psychologically driven one (that sees agency as the capacity to make choices, initiate action, and exercise control over the environment). This underscores the value of adopting a multi-theoretical approach to studying agency. In the realm of TEL, teacher agency is key to achieving critical engagement with AI systems in ways that align with pedagogical stances and contextual requirements [14]. However, Sun et al. [15] argued that collecting more in-depth evidence helps to understand teachers' motives for desired collaboration. In this regard, investigating teachers' imaginaries regarding technological integration helps identify key values and how these relate to the motives, tensions, and trade-offs involved in bringing intelligent technologies into education [16].
Within this research context, we have identified two key gaps. First, there is a need for further investigation into how intelligent systems can effectively support aspects of teacher agency, such as decision-making, particularly through orchestration processes [2, 3]. Second, framing the analytical approach through the lens of agency is especially valuable, as the concept remains under-theorized within the field of education [7, 16]. In this regard, comprehensive reports based on empirical data are to help advance the understanding of implications for teacher agency. Furthermore, more research is needed on co-design approaches in Learning Analytics (LA) and AI-enriched educational

contexts to study how teacher agency can be fostered to promote critical engagement with data-driven dynamics (i.e., how data collection, analysis, and algorithmic decision-making influence teaching and learning) and to ensure ethical shaping of educational practices [17, 18, 19].

Thus, this research focuses on studying the phenomenon of teacher agency across different professional practices in TEL, particularly in contexts where educators participate in co-design and orchestrate learning activities supported by intelligent technologies. For this research, both practices and the technologies serve as contextual elements through which teacher agency is examined, rather than as the primary target for designing interventions.

Hence, this dissertation is driven by this general research question (**RQ**): *How do evaluating, co-designing technological innovations, and orchestrating learning activities supported by technologies with intelligent features shape teacher agency?* This RQ has been decomposed into three sub-research questions. **SRQ1**: How do the alignment or misalignment between teachers' pedagogical stances and the affordances of intelligent technologies shape their agency? **SQR2**: How do the involvement and perception of researchers responsible for the development of intelligent technologies shape teacher agency? **SQR3**: How do teachers perceive that specific functionalities of intelligent technologies impact their practice?

2. Research context: teacher agency in TEL-scenarios involving intelligent technologies

Understanding the phenomena of teacher agency in TEL scenarios requires relating facets of agency models to the concrete practices that teachers perform within TEL contexts supported by intelligent technologies. For instance, the core features of human agency [10, 11] explain how individuals engage in agentic behavior when planning, acting, evaluating, and adapting their behavior. These features are relevant to characterizing the sequence of activities that teachers typically engage in when orchestrating learning in TEL contexts. Orchestration refers to the process in which teachers design and enact (including management, awareness, and adaptation) of learning activities [20]. When orchestrating, teachers (i) monitor the learning activities, (ii) decide on the need to perform adaptations, and (iii) perform adaptations [20]. During the enactment, intelligent technologies can support teachers in managing learning activities (e.g., assuming control of learning activities, assisting in assessment, or suggesting recommendations for adaptations) [3]. Specifically, technologies that (i) follow an operational model based on *Sense, Analyze, React*, and (ii) have the capacity to adapt to contexts and act autonomously are regarded as *Smart* [2, 21]. While integrating smart technologies has the potential to support teaching practices [6], it also raises questions about how teachers' ability to make choices would be affected [1]. Thus, the deployment of LA-enriched ecosystems afforded by intelligent technologies should strive to empower teachers' roles [22]. Figure 2 illustrates the conceptual connections among the operational model of intelligent technologies, orchestration activities, and teacher agency, which serves as the core concept of this research.

However, there is still a need to provide more guidance for research on how to conceptualize teacher-AI teaming [3]. Beyond orchestration, there are additional activities through which the phenomenon of teacher agency can be studied [23]. Combining the study of implications of LA and AI, considering both the classroom orchestration level and aspects related to teachers' professional development, may allow for a more holistic evidence-based understanding of teachers' agentic disposition toward intelligent technologies [24]. For instance, the co-design of innovations (learning activities and technologies themselves) or the reflective evaluation of tools aimed at their continuous informed-refined accounting for teachers' needs offer opportunities for looking at the phenomena. Co-design in TEL is understood as the process in which researchers, educators, and other stakeholders (e.g., teachers or students) engage in partnerships aimed at deploying meaningful innovations [25]. In such a process, teachers typically have a voice, and they are likely to develop a stronger sense of ownership towards innovation, which reinforces agency [26]. Engaging teachers in the full co-design cycle (i.e., involving the co-design of a new technology or features of an already existent one) increases the likelihood that intelligent technologies with LA solutions will maximize

opportunities for teachers' agentic practices [17]. Beyond the outcomes of the co-design, there is significant value in studying the process of teacher agency. Providing opportunities for teachers to express their perspectives and engage in activities aimed at generating tangible solutions creates an ideal setting for observing the inherent tensions within teacher agency. Additionally, collective endeavors lay the ground for professional agency to emerge [16].
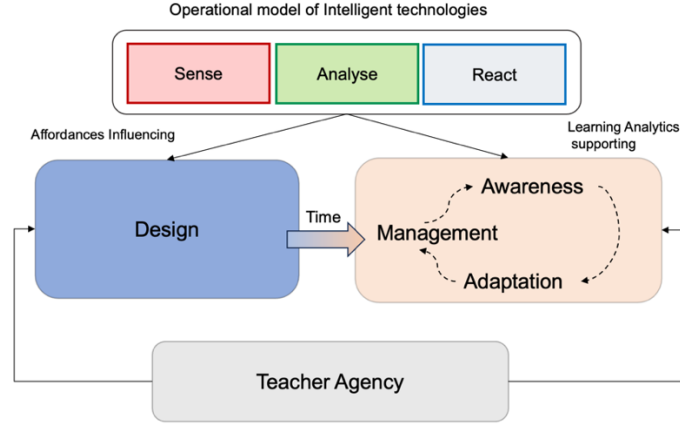

Figure 2: Relationships between the Sense-Analyse-React model, orchestration activities, and teacher agency.

As a complementary "arena" for the study of teacher agency, examining parts of the full cycle of technological deployment (i.e., co-designing technologies, learning activities, and enactment) is also relevant, as it might allow for unveiling other tensions. Studying the co-design of learning activities (e.g., in which the technology that would support these activities already exists) also lays the groundwork for looking at how facets that are related to the phenomenon of agency (e.g., teachers' knowledge and researcher support) emerge and unfold [27]. While allowing for the identification of tensions intrinsic to the function of intelligent technologies and highlighting the need to align pedagogy with LA solutions [17]. Additionally, involving teachers in formative evaluation of existing intelligent technologies, in particular Multimodal Learning Analytics (MMLA) ones, that seek to refine stands as another different "arena" in which implications for teacher agency may arise, while also educators elicit practical recommendations for refining these tools in a way that the gap between MMLA advances and classroom needs can be harmonized. Moreover, MMLA tools must align with the practical needs of educators [28]. By involving teachers in the evaluation and refinement of these tools, their expertise and contextual knowledge can bridge the gap between theoretical advancements in MMLA and practical, accessible applications in the classroom [29, 30].

3. Methodology

This dissertation follows a multiple case study research design in which teacher agency in relation to intelligent technologies (e.g., SLEs) is being examined across a collection of single case studies [31]. The RQ is formulated as: *How do evaluating, co-designing technological innovations, and orchestrating learning activities supported by technologies with intelligent features shape teacher agency?* The multicase study is inscribed in the qualitative research paradigm, aiming to get a deep comprehension of how the problems developed in situated settings [31]. The collection of cases involves studying particular problems (named *issues*, see Figure 4) across contexts, involving different activities, technologies, and participants. Each of the three sub-research questions previously introduced is represented in all cases: This RQ has been decomposed into three sub-research questions. **SRQ1**: How do the alignment or misalignment between teachers' pedagogical stances and the affordances of intelligent technologies shape their agency? **SQR2**: How do the involvement and perception of researchers responsible for the development of intelligent technologies shape teacher agency? **SQR3**: How do teachers perceive that specific functionalities of

intelligent technologies impact their practice? These SRQS are transversal to each case of study, which means that evidence found in all cases is to contribute to the final cross-case report. To facilitate the cross-case analysis, conceptual and analytical dimensions of agency have been identified from the literature. Mainly from the ecological framework of teacher agency [6] (see Figure 1.a) and the core features of human agency of the Social Cognitive Theory [10, 11, 32] (see Figure 1.b). Figure 3 represents the methodological schema of the multiple case study, depicting relations between SRQs, professional practices teachers engage in TEL, and the analytical dimensions (i.e., facets of agency).

The ecological dimensions of agency based on temporal extensions: iterational (past), projective (future), and practical-evaluative (present) allow analysis of whether affordances of intelligent technologies align with teachers' pasts and future practices (see Figure 3, SQR1). Stakeholder collaboration and motivation are among the contextual elements explicitly addressed by the ecological framework. These interactions help highlight the mediating capacity of researchers responsible for tool development, as they navigate between practitioners' needs and the design and functioning of technologies (e.g., adjustments to tools or learning activities), thereby influencing teacher agency (see Figure 3, SRQ2). Facets of agency of the ecological model are used interchangeably to adapt to analytical requirements of SRQ1 and SQ2 (e.g., exploring the pedagogical alignment requires considering teachers' professional knowledge and technological affordances, which are grounded, arguably, as "material elements"). Within this approach, agency is looked at more in a longitudinal perspective, constrained or supported by present-time contextual elements (see Figure 2.a). While the concrete orchestration process in which teachers design or co-design learning activities, enact, and regulate them is approached from the core features of human agency (i.e., forethought, self-reactiveness, and self-reflectiveness) as the internal psychological processes that teachers follow are related, arguably, to the archetypical orchestration flow in TEL (See Figure 3, SRQ3). This model may be more suitable for studying dynamic decision-making (see Figure 1.b).
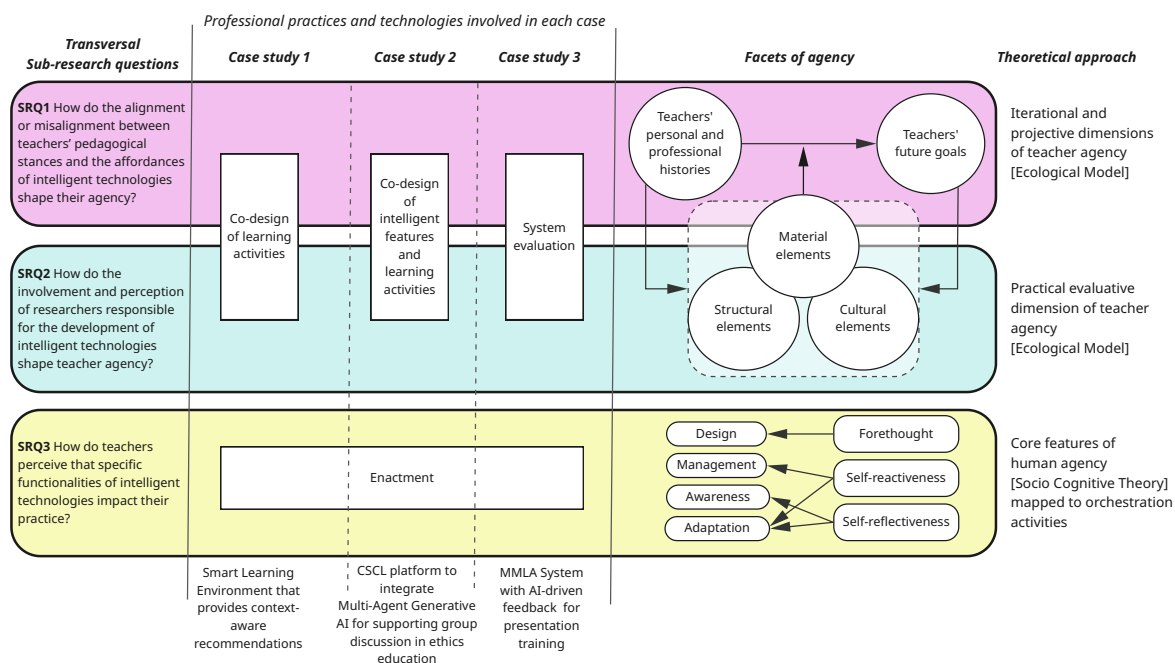

Figure 3: Overview of the multi-case study methodological plan. From left to right: sub-research questions, professional practices studied per case, and facets of agency taken as analytical components for guiding the inquiries.

Additionally, we aim to enrich and better ground teacher agency facets within the TEL field through two complementary approaches: an ongoing non-systematic literature review and a systematic literature review focused on the specific context of involvement of intelligent

technologies. Although an anticipatory data condensation approach [33] is being followed, we expect to integrate emergent codes into the a priori chosen models, aiming to advance in the comprehension of the phenomena in the studied contexts. Subsequently, a summary of activities and technologies involved in each case is provided. Case Study 1 has been conducted already and involved the study of the co-design and enactment of a learning activity supported by a Smart Learning Environment (SLE). The SLE enabled the connection of different learning spaces [34]. Case Study 2 is ongoing and involves the study of the co-design of a multi-agent architecture based on Generative AI to support ethics education when using a Computer Supported Collaborative Learning platform for ethics education [35]. The study of a prior iteration without intelligent support [36] is intended to guide the comparison of results when the multi-agent architecture is deployed. Case Study 3 is ongoing and involves the evaluation of an MMLA system for training presentations that includes AI-driven feedback [37].

The decisive role of LA is implicit in the sub-research questions. LA is intended to support the reconceptualization of educational practices (studied in SRQ1) and the extension to what reflective process and informed adaptations are possible due to LA (studied in SRQ3). This has been identified as a critical aspect to study to advance the field of LA [38]. Researchers' motivations and understanding of the impact of their solutions are critical for teachers' ecology, for example, in determining what LA would be needed by teachers and what their role would be (this is studied in SRQ2).

Multiple data collection techniques and data sources are deployed per case (e.g., semi-structured interviews with teachers and researchers, audio and video recordings of co-design meetings, in-class observations of enactments, questionnaires, and analysis of generated artefacts such as the learning activities or teachers' diaries), seeking to ensure a detailed observation of the phenomena [39]. Case reports include thick descriptions of contexts and excerpts for enhancing the transferability of results to other similar contexts [40].

4. Contributions and projected work

The expected contributions of this dissertation are manifold. First, an overview of how the concept of teacher agency is used/understood in research on intelligent technologies will be delivered after concluding an ongoing Systematic Literature Review (See Figure 4, Contribution 1). Second, through a cross-case analysis of empirical evidence, in light of our ad hoc created analytical frameworks, we expect to advance the understanding of the phenomenon of teacher agency when teachers evaluate, co-design intelligent features, and/or orchestrate technologies with intelligent features (See Figure 4, Contribution 2). Third, complementing the theoretical contribution, this work expects to provide transferable recommendations to similar contexts, supporting practitioners and other stakeholders to empower teacher agency (See Figure 4, Contribution 3). Finally, an analytical framework for identifying manifestations of teacher agency within orchestration activities will be empirically evaluated.

Currently, we have conducted the analysis and identification of findings from Case Study 1 (submitted for publication). Regarding Case Study 2, a mini-case (particular inquiry embedded in a case aiming to gain insights) in which the platform did not include the intelligent support was conducted and partially reported [36]. This aims to enable comparison with findings from the deployment of the intelligent support (a multi-agent Generative AI architecture to foster the quality of argumentations in group discussions), which will result from the co-design. A complete co-design cycle was planned and enacted from autumn 2024 to the present. The final data collection stage involved a detailed protocol focused on human, teaching, and technology-related values. Regarding Case Study 3, the formative evaluation stage is about to conclude, preliminary reports have been generated, and an enactment is to be studied. Additionally, there is a projected Case Study 4, which will focus on studying real-time support for teacher awareness and assistance for teachers' decision-making, a tool that tracks learners' progress and struggles. Figure 4 shows the overview of the thesis, including the research context, objectives, contribution, and evaluation. Significant progress in

narrowing down the objectives and identifying and designing cases has been made since a previous report of this dissertation was published [41].
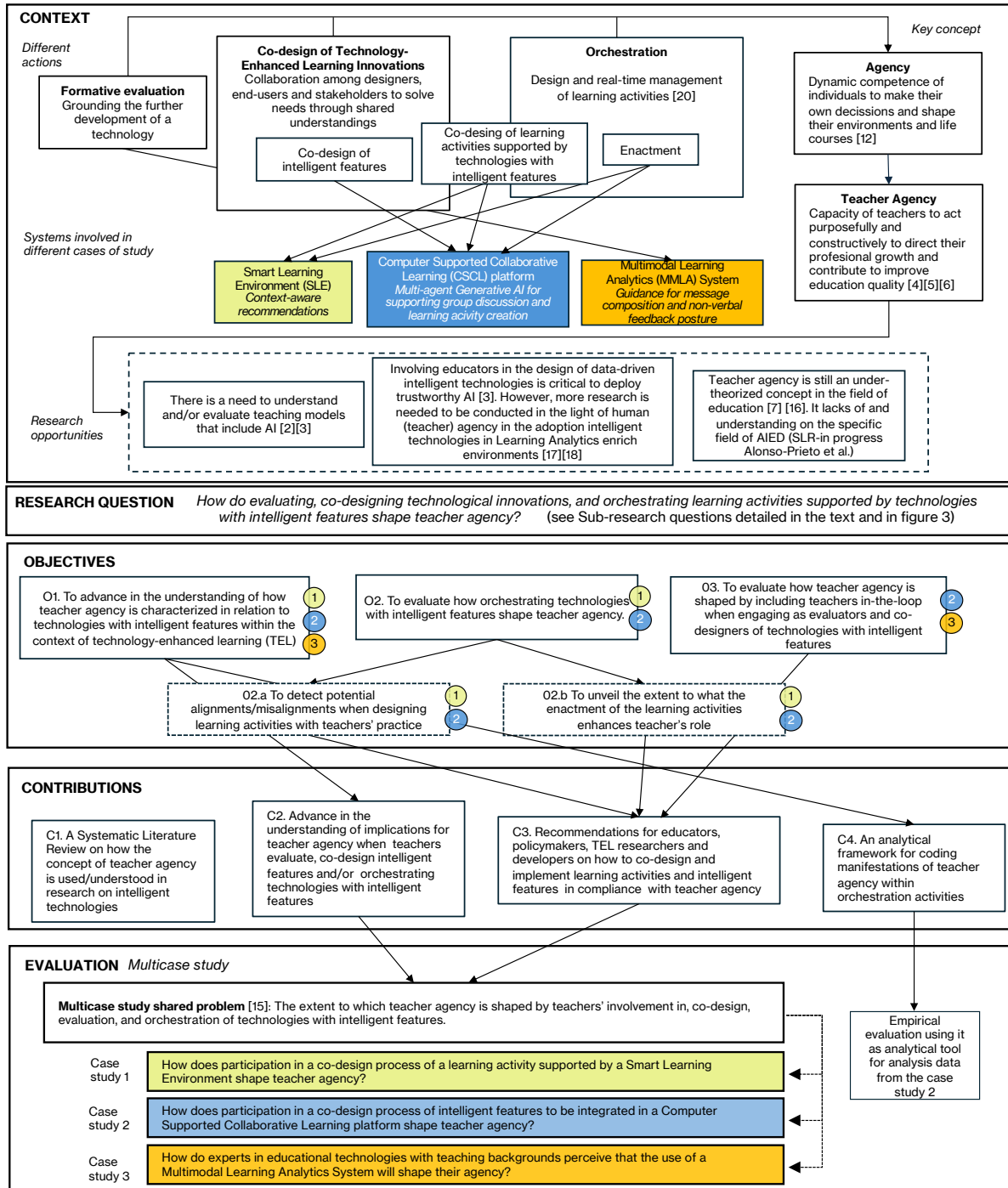

Figure 4: Dissertation schema depicting the main elements of the thesis.

Acknowledgements

Declaration on Generative AI

The authors have not employed any Generative AI tools.

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