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COMPARATIVE ANALYSIS OF PLATFORMS FOR ACADEMIC COLLABORATION IN GRADUATE DISTANCE RESEARCH

Abstract. This study aims to comparatively analyze three collaborative platforms widely used in distance graduate programs: Moodle, Blackboard, and Google Classroom. The research employs descriptive qualitative methodology with bibliographic research, examining academic sources from the past five years. The analysis was based on the conceptual framework of the four structuring axes of Virtual Learning Environments. Results identified shared meaning construction as the central concept of collaborative practices, aligning with Computer-Supported Collaborative Learning theoretical foundations. Work coupling establishes different degrees of interdependence, from loosely coupled to tightly coupled work. The comparison demonstrated that Moodle features balanced functionality across the four structuring axes, suiting environments requiring versatility between different collaboration degrees; Blackboard excels in sophisticated hierarchical management, better suited for loosely coupled work; while Google Classroom offers superior adaptability through an integrated system, suited for project-based collaborations requiring intensive temporal coordination for tightly coupled work. These findings reveal that different technological configurations favor specific collaborative models, contributing to addressing gaps in understanding platform suitability for diverse research contexts. Remote academic collaboration in distance graduate programs presents multiple dimensions transcending purely technological aspects, facing methodological and theoretical limitations. The investigation confirms effective application of the four structuring axes framework for analyzing collaborative platforms. Future research could conduct empirical analyses of comparative platform effectiveness, conceptual framework refinement, and analytical scope expansion.

Keywords: academic collaboration; distance graduate programs; collaborative platforms; computer-supported collaborative learning.

1. INTRODUCTION

The problem statement. Scientific knowledge production is undergoing structural changes that redefine contemporary academic practices. The transition from traditional disciplinary models toward collaborative, transdisciplinary, and socially distributed paradigms reconfigures relationships among researchers, institutions, and society [1]. In this paradigm transformation scenario, universities have begun to compose broader networks of scientific creation and dissemination, driven by the expansion of digital technologies that enable new forms of interaction among geographically dispersed researchers.

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Scientific collaboration[1], defined as social interaction among researchers for sharing meanings and achieving common goals [2], acquires specific characteristics when mediated by digital technologies. In virtual environments, these interactions fundamentally depend on the technological platforms that support them, establishing a close relationship between collaboration possibilities and platform characteristics.

As part of this movement of change in higher education, distance education has expanded into graduate programs in various countries [3]. The consolidation of remote modality in master's and doctoral programs raises central issues about collaborative knowledge construction mechanisms in these technologically mediated environments.

Remote collaboration mechanisms, given their inherent complexity, depend on specialized technological platforms for effective implementation in online programs [4]. Institutional models of technology-mediated collaboration range from one-time collaborations to mutual service alliances, each demanding specific technological configurations [4]. Weak ties theory [5] offers a theoretical framework for understanding how apparently peripheral connections between different researcher groups contribute to information diffusion and innovation, configuring a particular characteristic of virtual environments that requires adequate technological support.

Research gap. The literature on online education presents gaps regarding the understanding of technological components that structure collaborative processes at different organizational levels. This gap becomes particularly evident in the context of the digital transformation of the last decade, where new technological possibilities emerge continuously [6].

Regarding technological platforms, gaps persist about which configurations favor different models of academic collaboration in scientific production in distance graduate programs. The literature presents limitations in structured comparative analysis of collaborative platforms applied to this specific context. While multiple studies examine educational platforms in isolation [7], [8], [9], there exists an absence of analytical structures that enable objective comparison of their capabilities to address different degrees of scientific interdependence necessary in this domain.

Furthermore, a gap exists between consolidated theories of academic collaboration and their operationalization in technological platforms. Specifically, theoretical contributions from Computer-Supported Collaborative Learning (CSCL) [10], [11], and the Community of Inquiry Model (CoI) [12], [13], lack practical operationalization in selection criteria and evaluation of technological platforms.

The need for conceptual structures for comparative platform analysis becomes even more evident considering that different technological architectures present specific correspondences with certain collaborative models, establishing particular affinities between platform and academic practices. The absence of these analytical structures hinders systematic understanding of functional characteristics of available platforms for distance graduate programs.

The **research objective** is to comparatively analyze three collaborative platforms widely used in distance graduate programs: Moodle, Blackboard, and Google Classroom. This analysis will be grounded in theoretical principles and functional characteristics that support different models of academic collaboration in scientific production.

For this purpose, the following research **tasks** were defined:

1. Identify theoretical perspectives on academic collaboration processes in virtual learning environments, analyzing the technological platforms that enable them;

[1] This study adopts the term ‘academic collaboration in scientific production’ to specify scientific production within the academic context of distance graduate programs, while part of the literature uses the term ‘scientific collaboration’ without this particular contextual delimitation.

2. Examine articulations between technological platforms and scientific production processes in distance graduate programs, analyzing how different architectures of platforms mediate these collaborative relationships;

3. Characterize the guiding principles that underpin collaborative practices for knowledge construction, highlighting the role of technological solutions in operationalizing these principles.

The main **scientific contribution** of this research consists of applying the framework of the four structuring axes of Virtual Learning Environments (VLE) as described in A. I. S. Meyer [14] to comparative analysis of collaborative platforms in distance graduate programs. This application will seek to examine how different technological platforms relate to various degrees of scientific work coupling [15], from loosely coupled to tightly coupled work, organizing information present in the literature that can guide comparative analyses of collaborative platforms.

Complementing this contribution, the research intends to investigate connections between CSCL theoretical foundations and functional characteristics of selected platforms, compiling articulations between theory and technological implementation present in specialized literature. The comparative analysis seeks to demonstrate whether different technological architectures present specific affinities with certain types of collaborative practices, organizing knowledge present in the literature that may support researchers and professionals in the field in understanding technological platforms.

From a methodological standpoint, this study aims to demonstrate the application of bibliographic research for comparative analyses of collaborative platforms, organizing the review through technological, pedagogical, and organizational perspectives to examine platform characteristics. The investigation will compile elements present in the literature about correspondences between technological configurations and institutional collaboration typologies, organizing information that can contribute to understanding grounded in academic evidence.

2. THE THEORETICAL BACKGROUNDS

The conceptual principles of CSCL, developed by researchers in the field, underpin the understanding of how digital technologies can effectively mediate collaborative knowledge construction mechanisms [10]. In distance graduate program environments, this model offers a theoretical framework for analyzing how technological platforms support academic collaboration practices in scientific production.

The central concept of CSCL is grounded in shared meaning construction, a process through which participants build shared understandings through technologically mediated interactions [10]. Unlike methodologies that treat collaboration as mere division of labor, G. Stahl et al. conceptualize collaboration in this field as a mechanism of shared understanding construction where “meaning making is not assumed to be an expression of mental representations of the individual participants, but is an interactional achievement” [10, p. 8].

Analysis of the historical evolution of CSCL arrangements enables identification of changes in conceptions about collective knowledge construction. The trajectory extends from computer-assisted instruction and intelligent tutorial arrangements to arrive at this field proper [10]. Each stage of this evolution indicates different perspectives on technology's role in learning, culminating in the current conception of CSCL as foundation for collaborative knowledge construction practices that transcend mere enablement of remote collaboration.

A central distinction in the field refers to the differentiation between cooperation and collaboration. In cooperation, partners divide the work, solve subtasks individually, and subsequently gather partial results into the final product. In collaboration, partners perform the

work ‘together,’ characterized by joint and simultaneous construction [10]. This distinction is particularly relevant for graduate programs, where the nature of research activities frequently demands effectively collaborative methodologies.

CSCL environments transcend simply enabling remote collaboration, having as their main purpose creating conducive conditions for successful group interactions among participants [11]. The importance of technological platforms resides not only in connecting geographically dispersed researchers, but in structuring interactions that effectively enable academic collaboration in scientific production. This perspective emphasizes that CSCL environments have as their central concern meaning-making mechanisms during joint activities and the ways technological artifacts mediate these practices.

The CoI Model proposed by D. R. Garrison [12] offers a central theoretical structure for understanding intellectual production mechanisms in technology-mediated educational environments. This model brings together three interdependent components that articulate to support meaningful learning experiences: social presence, cognitive presence, and teaching presence.

Cognitive presence, central to scientific training in graduate programs, is defined by D. R. Garrison et al. [16, p. 11] as “the extent to which learners are able to construct and confirm meaning through sustained reflection and discourse in a critical community of inquiry.” This presence operationalizes through four sequential and cyclical phases: triggering event, exploration, integration, and resolution. The process demands both personal reflection and shared discourse, configuring a shared metacognition model that integrates individual self-regulation and collaborative co-regulation of knowledge.

Social presence is related, according to the CoI Model, to participants' identification with the community and their ability to project themselves as real people in mediated interactions [12]. In distance graduate programs, this dimension becomes indispensable for creating the trust relationships necessary for effective academic collaboration in scientific production. Teaching presence forms the organizing core of the educational process, encompassing educational design, discourse facilitation, and direct learning guidance [12].

A relevant and recent contribution to the CoI Model is the addition of emotional presence [13], which addresses the affective dimension of learning. This dimension recognizes that emotionally present teaching stimulates learners' understanding, acceptance, and transparency regarding their emotions, expanding comprehension of dynamics in educational environments. For distance graduate programs, emotional presence becomes particularly relevant considering the challenges of academic isolation and maintaining motivation in long-duration research activities [13], [17], [18].

The CoI model is grounded in explicit learning mechanisms with high engagement levels, where students explore diverse materials, surpassing mere teacher-centered content transmission [13]. This methodology aligns with the specific needs of research training, where students must acquire intellectual autonomy and independent investigation capacity – competencies that develop through active participation in scientific practice communities [19], [12].

Remote collaboration dynamics in academic environments are fundamentally influenced by interpersonal bond characteristics and technological conditions that sustain interactions. Weak ties theory [5] offers important perspectives for understanding how lower-intensity connections between researchers from different groups provide access to novel and diversified information, creating favorable conditions for innovation processes in academic collaboration.

Weak ties, characterized by lower contact frequency, intimacy, and reciprocity, play a central role in information diffusion between different social groups. Unlike strong ties, which tend to form closed networks, weak ties act as connections or ‘bridges’ between groups that would not have direct contact with each other [5]. In the academic field, this theory suggests

that interdisciplinary collaborations tend to generate greater scientific innovation, a principle that becomes particularly relevant in virtual environments where geographical barriers are reduced.

G. M. Olson and J. S. Olson [15] systematized conditions for successful remote collaboration through four essential components: high degree of common ground (shared knowledge), loosely coupled work, collaboration readiness, and collaboration technology readiness. These concepts constitute the foundation for understanding how technological platforms must be configured to accommodate different types of collaborative activities.

Work coupling, as systematized by G. M. Olson and J. S. Olson [15], characterizes different degrees of interdependence in scientific activities. Tightly coupled work is characterized by its non-routine nature and open-ended definitions, demanding constant coordination among participants for solving complex problems. Conversely, loosely coupled work presents more predictable processes and greater execution autonomy [15]. In academic collaboration for scientific production, stages such as complex data analysis, research problem formulation, and methodological design tend to be tightly coupled, requiring environments that provide intense interactions and immediate clarifications.

In the particular context of distance graduate programs, academic collaboration in scientific production presents distinct characteristics that distinguish it from other forms of joint work. The development of common ground and work organization according to different coupling degrees form determining characteristics for the success of remote collaborative practices [15]. These dynamics are mediated by technologies that must be capable of enabling both frequent synchronous interactions and asynchronous mechanisms for reflection and knowledge construction.

VLEs form the practical implementation of CSCL and CoI Model theoretical principles in specialized technological platforms. The organization of technological components described in A. I. S. Meyer [14] identifies four structuring axes that constitute a basic infrastructure for academic collaboration: pedagogical/administrative management, communication, documentation/information, and production.

The pedagogical/administrative management axis [14] enables monitoring participant performance, virtual academic office consultations, and access to assessments. In distance graduate programs, this axis supports administrative dimensions of collaboration, including research timeline monitoring, management of mandatory academic stages, and activity coordination between supervisors and graduate students [20], [9].

The communication axis is structured to facilitate synchronous and asynchronous interactions among participants. These communicational modalities address different aspects of academic collaboration, considering that the three presences of the CoI Model – social, cognitive, and teaching – demand different types of interaction [12], [13]. Synchronous tools favor activities demanding intensive coordination – characteristic of tightly coupled work [15], while asynchronous tools provide time for reflection and elaboration – aspects that constitute important elements for collaborative knowledge construction in CSCL environments [10], [11].

The documentation/information axis is responsible for content exposition, didactic materials, and file storage. This component facilitates resource sharing and construction of collective knowledge repositories [21]. The evolution of this axis is reflected in the growth of institutional repositories that evolved from simple digital archives to arrangements that actively mediate academic collaboration [21].

The production axis is designed to enable activity development and collaborative problem solving, forming the dimension most directly related to knowledge construction mechanisms. This axis supports collaborative writing practices [22], joint data analysis, and development of scientific products that characterize research activities at the graduate level.

The analysis of organization into four axes enables demonstrating the multifunctional nature of technological resources necessary to support complex collaborative mechanisms at the distance graduate level, offering an integrated model for comparative analysis of individual platforms [23], [19]. This framework, as described in A. I. S. Meyer [14], was developed in direct connection with CSCL principles by recognizing the need for technological platforms to support multiple collaboration characteristics, from basic communication to joint knowledge production [24], [25], creating the conceptual foundation for comparative analysis of collaborative platforms developed in the Results and Discussion section.

3. RESEARCH METHODS

This study adopts a descriptive qualitative approach based on bibliographic research, which enables analysis of concepts and theories about academic collaboration in technological environments, recognizing different theoretical perspectives and application contexts present in specialized literature.

M. M. Silva et al. define bibliographic research as a qualitative technique that transcends conventional literature review, characterizing it as an investigative modality that seeks to "problematize, question and articulate previous knowledge with new knowledge" [26, p. 96] (translated from Portuguese).

The bibliographic survey constitutes the main process by offering the necessary theoretical foundation for understanding concepts related to technological infrastructures for academic collaboration [26]. This method enables analysis of specialized literature, allowing identification of convergences, divergences, and gaps in knowledge about academic collaboration in distance graduate programs. The comparative examination is justified by the need to understand functional characteristics of collaborative platforms.

Regarding selection criteria, the bibliographic survey was organized into two complementary strands, encompassing seminal documents that established essential conceptual frameworks and recent publications covering current discussions in the field. Searches were conducted in the CAPES Periodicals Portal (Brazilian federal database), ERIC, Google Scholar, Scopus, Web of Science, and ResearchGate databases, using descriptors such as 'academic collaboration,' 'technological infrastructures,' 'distance graduate programs,' 'CSCL,' 'virtual learning environments' and their English variations. Inclusion parameters encompassed academic publications between 2020-2025, peer-reviewed articles, book chapters from recognized publishers, and relevant conference papers. For seminal works, widely recognized theoretical contributions in the field's literature were prioritized.

Treatment of selected material followed a structured method [26], comprising exploratory reading to verify relevance of works, selection of material of direct interest, detailed analysis to organize information, and interpretation to create relationships between contents and identify theoretical convergences and gaps. This process enabled construction of a theoretical foundation the object of study.

However, it is recognized that the study presents restrictions related to the adopted analytical scope, concentrating on three selected platforms. This delimitation, although justified by the representativeness of these platforms in specialized literature, does not encompass the totality of technological solutions available for academic collaboration in scientific production.

4. THE RESULTS AND DISCUSSION

4.1. Data sharing resources

Examination of data sharing functionalities reveals distinct technological configurations that favor different models of academic collaboration in scientific production.

Moodle provides repositories and file sharing modules structured into two main categories: course components (web pages, texts, notes, and links) and interactive components (glossaries, wikis, forums, and databases) [7]. This dual configuration was designed to enable both direct material storage and dynamic interactions among participants, an important characteristic for collaborative mechanisms involving different degrees of work coupling [15].

Google Classroom integrates with Google Drive, creating an integrated documentation and sharing system that centralizes research materials, operationalizing the documentation/information axis [14] through continuous synchronization. This integration enables flexible sharing with different access levels (editing and viewing), facilitating collaborations that demand constant material synchronization [9]. Real-time sharing functionality aligns with CSCL principles [10], enabling shared meaning construction through common informational materials.

Blackboard presents content management capabilities through hierarchical organization that facilitates stratified arrangement of materials, assignments, and research data [8]. This technological configuration was developed according to a particular institutional typology that favors certain collaborative models, creating affinities between hierarchical platform and academic practices demanding greater structuring [8]. The organizational structure better suits loosely coupled work [15], where participants need access to specific materials in a controlled manner without intensive synchronization dependency.

This comparative examination demonstrates that each platform expresses different conceptions about knowledge management in collaborative environments. While Moodle balances flexibility and organizational structure, Google Classroom prioritizes fluidity and synchronization, and Blackboard emphasizes control and hierarchical organization. This configuration diversity reflects collaborative typologies proposed by D. Porter and K. Perris [4], indicating how technological platforms favor certain types of institutional arrangements.

4.2. Collaborative writing tools

Collaborative writing constitutes an important aspect of academic collaboration in scientific production that demands specialized resources for simultaneous editing and version control.

Analysis of Moodle functionalities reveals capabilities for this practice through wikis and integration with Etherpad Lite [22]. This configuration is supported by M. Burchart and J. M. Haake [22], who identified this solution for its capacity to operationalize CSCL principles, enabling simultaneous and continuous real-time editing with flexibility for both synchronous and asynchronous work. This temporal versatility aligns with different coupling degrees necessary in research activities [15].

Google Classroom integrates with Google Docs, providing real-time editing and reliable version control [9]. This tool enables collaboration during all research phases, including thesis and article writing, through targeted comments and responses integrated into the text. Simultaneous editing functionality addresses tightly coupled work, where participants demand continuous coordination among their activities for solving complex problems [15].

Blackboard presents limited capabilities for real-time collaborative writing, relying primarily on forum tools for discussions about texts under development [8], [20]. This limitation reflects a configuration oriented toward loosely coupled work, where individual contributions are subsequently integrated into final products.

Studies by M. Burchart [27] demonstrate that collaborative writing practices produce positive effects on textual quality, resulting in more cohesive productions superior in adequacy, grammatical accuracy, and structural complexity. This finding empirically validates CSCL theoretical foundations [10] about shared meaning construction, proving that technologically mediated academic collaboration can enhance scientific products. From this analysis, a dilemma emerges between technological sophistication and accessibility: while specialized tools like Etherpad Lite offer advanced functionalities, integrated solutions like Google Docs provide greater ease of use.

4.3. Communication tools

Communication tools operationalize the three presences of the CoI Model [12], supporting synchronous and asynchronous interactions important for academic collaboration.

Moodle provides diversified tools: chat for immediate synchronous communication, forums for reflective asynchronous discussions, and videoconferencing for complex interactions [7]. This configuration variety facilitates different types of collaborative work, from one-time clarifications to in-depth theoretical discussions.

Blackboard provides Collaborate Ultra, an integrated solution that delivers interactive web conferences with immersive experiences across diverse devices [8]. This specialized tool privileges complex synchronous interactions, suiting activities that demand real-time coordination, such as joint data examination or methodological discussions [15].

Google Classroom integrates with Google Meet for videoconferencing but restricts textual communications to comments on activities and topics initiated by professors [28]. This communicational limitation reflects a configuration that privileges centralized control over communication, contrasting with CSCL principles of shared knowledge construction [10].

This analysis enables identification that different communicational configurations support distinct pedagogical models. Synchronous tools facilitate tightly coupled work through immediate feedback and instant clarifications, while asynchronous tools provide reflection and conceptual elaboration characteristic of loosely coupled work [15]. This functional differentiation enables operationalization of remote collaboration theoretical principles [5], where weak ties (asynchronous communication) and strong ties (synchronous communication) play complementary roles in knowledge diffusion and innovation in academic collaboration.

4.4. Project management tools

Project management for collaborative work constitutes the pedagogical/administrative axis of the VLE framework [14], supporting temporal and organizational coordination necessary for research activities.

Moodle provides sophisticated instruments including timelines, temporal milestones, and Trello integration [9]. This integration was developed to enable creation of boards with different purposes, allowing task arrangement with individualized timelines for each activity, representing important flexibility for simultaneous supervision of multiple graduate students.

Blackboard provides integrated coordination resources through sophisticated task assignments and progress tracking [8], [20]. This integrated configuration was designed to eliminate dependence on external tools, providing institutional control over management mechanisms. The hierarchical methodology facilitates structured academic supervision [8], suiting environments that prioritize formalization of collaborative mechanisms.

Google Classroom, although not created specifically for project management, uses integration with Google Sheets and Google Slides for basic task coordination [9]. This functional limitation can be contrasted with advanced resources necessary for complex coordination in distance graduate programs [9].

Results reveal that management tools express different conceptions about autonomy and control in collaborative mechanisms. While flexible integrations (Moodle-Trello) privilege adaptability and personalization, integrated arrangements (Blackboard) emphasize consistency and institutional control. This differentiation can be aligned with weak ties theory [5], where flexible tools facilitate connections between distinct groups, while hierarchical arrangements strengthen internal ties within established groups.

4.5. Comparative synthesis of selected platforms

The systematization of functionalities examined through the four structuring axes framework [14] reveals distinct configuration patterns that favor different collaborative models. Table 1 presents this comparative synthesis:

Table 1

Comparative analysis of technological platforms

Platform	Documentation Axis	Communication Axis	Production Axis	Management Axis	Most Suitable Model*
Moodle	Dual repositories (static/ interactive)	Diversified tools (synchronous/ asynchronous)	Wikis + integrated Etherpad Lite	Timelines + Trello integration	Balanced collaborations
Blackboard	Structured hierarchy	Specialized Collaborate Ultra	Structured forums	Sophisticated integrated system	Formalized institutional alliances
Google Classroom	Integrated documentation with synchronization	Meet + limited comments	Real-time Google Docs	Basic Sheets/Slides	Agile project-based collaborations

*Most suitable models based on institutional collaboration typology [4].

Results from this analysis demonstrate that each configuration expresses a particular pedagogical philosophy, reflecting different institutional collaboration typologies [4]. Moodle operationalizes CSCL principles [10] through balance between structuring and flexibility, supporting shared meaning construction in diverse environments. Blackboard reflects traditional institutional methodologies through hierarchical control and formalization, suiting environments that value structured supervision. Google Classroom reflects enterprise collaboration paradigms through integration and synchronization, privileging agility over pedagogical structuring.

Application of work coupling concepts [15] enables identification of particular suitabilities: tightly coupled work (complex data examination, problem formulation) benefits from Google Classroom's synchronous tools and Blackboard's Collaborate Ultra, while loosely coupled work (literature review, individual writing) suits Moodle's asynchronous capabilities and Blackboard's hierarchical organizations.

From the analysis, correspondence emerges between technological configurations and institutional collaboration typologies established by D. Porter and K. Perris [4]. Project-specific collaborations align with Google Classroom's agility and integration, which facilitates rapid material mobilization for one-time initiatives, benefiting from its superior adaptability and universal compatibility [28]. Cooperative collaborations (long-term partnerships) benefit from Moodle's functional balance, which sustains long-term collaborations through diversified tools. Mutual service alliances (bidirectional exchanges) suit Blackboard's administrative sophistication, which provides control and formalization necessary for established institutional alliances.

Identifying this correspondence demonstrates that technological platforms are not neutral [19], but favor certain assumptions about academic collaboration that influence institutional practices. Thus, platform choice implies decisions about underlying pedagogical models, formalization degrees, and priority collaborative modalities. Institutions privileging innovation and adaptability may opt for flexible configurations (Google Classroom), while those valuing tradition and control may prefer hierarchical arrangements (Blackboard).

Weak ties theory [5] materializes distinctly in each configuration, where Moodle facilitates weak ties through open forums and collaborative wikis, Blackboard limits them through hierarchical organizations, while Google Classroom potentializes them through dynamic sharing, a differentiation that has implications for innovation in academic collaboration by creating distinct channels for idea diffusion among diverse groups.

4.6. Limitations and challenges identified

The investigation identifies multiple restrictions that transcend purely technological characteristics, configuring structural limitations for remote academic collaboration. Digital literacy constitutes an obstacle, with T. Khan and C. S. Hazari [23] identifying that collaborative tools frequently demand programming knowledge, limiting accessibility for researchers without computational training. This limitation relates directly to collaboration technology readiness systematized by G. M. Olson and J. S. Olson [15], demonstrating that this condition is more complex than the authors suggested, compromising CSCL shared meaning construction [10] and creating hierarchies based on technical competencies that may exclude relevant academic contributions.

The comparative analysis revealed specific limitations of established theoretical frameworks. The four essential conditions for remote collaboration proposed by G. M. Olson and J. S. Olson [15] proved insufficient to explain observed differences between platforms. Particularly, the concept of ‘collaboration technology readiness’ [15] proved more complex than initially proposed, encompassing not only basic technical competencies, but also navigation capabilities between different technological configurations.

The CoI Model demonstrated limitations in practical operationalization of the three presences. The analysis proved that different platforms facilitate some presences unequally – Google Classroom privileges cognitive presence through real-time editing, but limits social presence through restricted communication. This asymmetry was not adequately addressed in D. R. Garrison's original model [12].

The four structuring axes of VLEs, as described in A. I. S. Meyer [14], while useful as an analytical tool, showed limitations in capturing the dynamic interdependence between axes. The analysis revealed that the production axis, for example, fundamentally depends on the sophistication of the other three axes in a non-linear manner, an aspect not contemplated in the original formulation.

Weak ties theory [5], applied to the digital context, revealed limitations in explaining how specific platform functionalities (such as automatic sharing or connection suggestions) alter the dynamics of tie formation, transcending the original conceptualization centered on face-to-face interactions.

This investigation presents methodological restrictions inherent to the adopted scope. The analytical focus on three selected platforms, although justified by their representativeness in specialized literature, does not encompass the totality of available technological solutions. The absence of primary empirical data constitutes a limitation that privileges theoretical analysis over practical validation of identified functionalities.

Limitations also include the predominance of international literature, which may not reflect specificities of regional educational environments and particular academic cultures.

These restrictions limit direct applicability of results, although they offer foundations for future investigations.

5. CONCLUSIONS AND PROSPECTS FOR FURTHER RESEARCH

The study confirmed fundamental structural differences among the three platforms for academic collaboration in distance graduate programs, demonstrating that different technological configurations favor specific collaborative models.

The analysis revealed that Moodle possesses balanced functionality across the four structuring axes, combining dual repositories, diversified communication tools, and flexible integration with specialized solutions. This configuration enables addressing both loosely and tightly coupled work, suiting environments that demand versatility between different collaboration degrees. Blackboard excels in sophisticated content management through specialized hierarchical organization, aligning with environments that prioritize control and formalization of collaborative processes, better suiting loosely coupled work. Google Classroom provides superior adaptability through systemic integration, enabling flexible sharing, real-time collaborative editing, and constant synchronization – a configuration suited for agile project-based collaborations requiring intensive temporal coordination for tightly coupled work.

Application of the four structuring axes framework proved effective as an analytical tool for comparing collaborative platform capabilities, integrating CSCL and CoI Model principles in structuring the analysis. Literature examination revealed that different technological configurations not only enable remote collaboration, but also reflect distinct conceptions of autonomy, structure, and control that shape academic practices, demonstrating that platform choice involves decisions about underlying pedagogical models.

This research contributes methodologically by demonstrating an application of bibliographic research for comparative analyses of collaborative platforms, organizing elements disseminated in the literature about correspondences between technological configurations and academic collaboration modalities. The work compiles connections between consolidated theoretical foundations and practical functionalities of the platforms, organizing existing knowledge about the relationship between academic collaboration theories and technological implementations in distance graduate programs.

The investigation presents methodological restrictions related to the adopted analytical scope and absence of primary empirical data, in addition to limitations identified in the theoretical frameworks themselves.

These limitations demonstrate specific needs for future investigations such as the development of empirical analyses of examined platforms to verify whether patterns identified in the literature are confirmed in practice, as well as refinement of conceptual frameworks for greater understanding of studied phenomena, and expansion of analytical scope to include other existing collaborative platforms.

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ПОРІВНЯЛЬНИЙ АНАЛІЗ ПЛАТФОРМ ДЛЯ АКАДЕМІЧНОЇ СПІВПРАЦІ В ДИСТАНЦІЙНИХ ДОСЛІДЖЕННЯХ АСПІРАНТІВ

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Анотація. Мета цього дослідження – порівняльний аналіз трьох платформ для співпраці, які широко використовуються в дистанційних програмах для випускників: Moodle, Blackboard та Google Classroom. У дослідженні використовується описова якісна методологія з бібліографічним дослідженням, у ході якого аналізуються академічні джерела за останні п'ять років. Аналіз базувався на концептуальній моделі чотирьох структурних осей віртуальних навчальних середовищ. Результати визначили спільне конструювання значення як центральну концепцію практик співпраці, що відповідає теоретичним основам комп'ютерно підтримуваного спільного навчання. Співпраця у роботі встановлює різні ступені взаємозалежності, від слабко пов'язаної до тісно пов'язаної роботи. Порівняння показало, що Moodle має збалансовану функціональність по чотирьох структуруючих осях, що підходить для середовищ, які вимагають універсальності між різними ступенями співпраці; Blackboard виділяється витонченим ієрархічним управлінням, що краще підходить для слабко пов'язаної роботи; тоді як Google Classroom пропонує чудову адаптивність завдяки інтегрованій системі, що підходить для проєктної співпраці, яка вимагає інтенсивної тимчасової координації для тісно пов'язаної роботи. Ці висновки показують, що різні технологічні конфігурації сприяють конкретним моделям співпраці, що допомагає усунути прогалини в розумінні придатності платформи для різних дослідницьких контекстів. Дистанційна академічна співпраця в межах дистанційних програм для випускників має багато вимірів, що виходять за межі суто технологічних аспектів, і стикається з методологічними та теоретичними обмеженнями. Дослідження підтверджує ефективність застосування чотирьох структурних осей для аналізу платформ співпраці. Майбутні дослідження можуть містити

емпіричний аналіз порівняльної ефективності платформ, удосконалення концептуальної структури та розширення аналітичного охоплення.

Ключові слова: академічна співпраця; дистанційні програми для випускників; платформи співпраці; комп'ютерно підтримуване спільне навчання.

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