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Qualitative Learning Analytics in teacher education: A protocol for interpreting digital traces

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Abstract: In university-based initial teacher education and qualification programmes governed by the Prime Ministerial Decree of 4 August 2023, coordinating tutors work in digital environments where communications, shared materials and activity records document different aspects of participation. This theoretical and methodological paper presents a Qualitative Learning Analytics (QLA) protocol for interpreting these traces without conflating observable behaviour, cognitive engagement and Cognitive Presence. The proposal defines inclusion criteria, units of analysis and distinct denominators for email, Classroom and Drive, integrated through rules for contextual triangulation. Three ideal-type configurations guide the interpretation of professional constraints, entry into the teaching profession and digital difficulties, while considering alternative explanations and hybrid cases. Procedures are also outlined for independent coding, disagreement resolution and analysis of communicative sequences between Teaching Presence and Cognitive Presence. The protocol provides for prior data-protection safeguards and separation of tutoring and research roles. Examples are synthetic and no individual participant results are presented. Future empirical application will need to test category reliability, procedural feasibility and the transferability of interpretations.

Keywords: Qualitative Learning Analytics; Initial teacher education; Community of Inquiry.

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1. Introduction

In university-based initial teacher education and qualification programmes established under the Prime Ministerial Decree of 4 August 2023 (Presidenza del Consiglio dei Ministri, 2023), the coordinating tutor helps connect academic preparation, teaching placements and reflection on professional experience (D'Anna et al., 2026). Digital environments serve different yet complementary functions: individual communication, sharing materials developed in indirect-placement workshops, and managing submission of the documentation required for direct and indirect teaching placements. Traces produced in these settings make some forms of participation observable but do not, in themselves, reveal the educational meaning of the activities.

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The availability of digital data does not, therefore, amount to unambiguous evidence of learning. A trainee might seek clarification by email, contribute to a Classroom discussion or edit a document in Drive: activities belonging to the same educational experience but requiring distinct interpretative criteria. The absence of traces from a particular channel must likewise be considered in relation to opportunities for participation, the organisation of activities and the actual coverage of the sources. The methodological challenge is thus to establish what each trace makes observable and under which conditions different sources can contribute to a contextually grounded interpretation.

Measurement choices in Learning Analytics presuppose a theory of learning and of the relationship between indicators and constructs (Knight et al., 2014; Wise & Shaffer, 2015). From this perspective, this paper proposes a Qualitative Learning Analytics (QLA) protocol that distinguishes units and denominators across sources, separates cognitive engagement from Cognitive Presence, and tests interpretations against converging and contrary evidence. The distinctive contribution lies in the operational articulation of these principles in the tutoring of teacher qualification programmes, without claiming absolute novelty.

The aim is to make explicit the process leading from trace observation to coding and contextual interpretation. The proposal also seeks to provide tools for examining professional, organisational and digital conditions that may shape visible forms of participation. Its possible contribution to inclusion remains a prospect to be tested, not an established effect.

This paper does not report participant findings. The codebook was developed during an internal exploratory phase rather than from the literature alone, and requires independent validation. The rationale for the proposed rules is set out here; examples are constructed from definitions and are not paraphrases of trainee communications.

2. Theoretical Foundations

2.1. Engagement and the Limitations of Digital Indicators

Engagement is a multidimensional construct encompassing behavioural, emotional and cognitive components (Fredricks et al., 2004), observable through different indicators (Henrie et al., 2015). Transferring these dimensions to digital-trace analysis requires caution (Bergdahl et al., 2024): accessing a resource or submitting work establishes that an action occurred but does not, by itself, demonstrate reflective processing; equally, a technical difficulty is insufficient evidence of an emotional state.

This issue becomes particularly important when digital tools offer different opportunities for action. The frequency of communications captures one aspect of participation, while their content can clarify its functions and conditions. A request

submitted close to a deadline, for instance, cannot be read as a sign of limited engagement without considering the task, the channel and possible professional constraints. Indicators must therefore be tied to explicit theoretical definitions and to the actual opportunities to produce a given trace (Knight et al., 2014; Wise & Shaffer, 2015).

2.2. Community of Inquiry and Thresholds for Cognitive Presence

The Community of Inquiry framework connects Teaching Presence, Social Presence and Cognitive Presence (Garrison et al., 2000). The latter describes meaning-making through the triggering of a problem, exploration, integration and resolution (Garrison et al., 2001). Planning work may express cognitive engagement without documenting conceptual integration. Rourke and Kanuka (2009) critically examine measures of learning in CoI research; Kanuka et al. (2007) highlight the importance of activities for discourse quality. These sources support explicit thresholds and observational conditions, not a universally expected frequency of CP.

Cognitive engagement and Cognitive Presence thus address related but different analytical questions. A trainee who plans a revision or monitors progress demonstrates a form of cognitive investment, whereas Integration or Resolution requires textual evidence of conceptual connections or reasoned application. The more restrictive threshold prevents every completed requirement or request for clarification from being interpreted as evidence of advanced inquiry. Conversely, the absence of a CP code in brief exchanges does not imply the absence of cognitive processing, which may occur in products or interactions not captured.

Within the Community of Inquiry framework, Teaching Presence encompasses design and organisation, facilitation of discourse and direct instruction (Anderson et al., 2001). The protocol distinguishes these general functions from two operational forms of support: scaffolding, which supports further thinking while preserving trainee initiative, and explicit emotional support, which responds to needs expressed in communication. Social Presence, by contrast, concerns expressions of relationship and belonging within exchanges: a polite expression alone does not demonstrate the establishment of a relationship or a sense of belonging. QLA is understood here as a qualitative, contextual approach compatible with transparent counts; Loperfido et al. (2018) provide a relevant precedent, although they address a different analytical problem.

Different forms of tutorial support do not necessarily lead to the same outcome: a reflective prompt, a direct explanation and reassurance fulfil distinct functions (Scipilliti et al., 2026). Whether subsequent manifestations of Cognitive Presence arise must be examined through analysis of communicative sequences, without assuming a causal relationship. Similarly, analysis of Social Presence must distinguish conventional exchanges from substantive expressions of relationship and belonging.

2.3. Contextual QLA and Interpretative Typologies

The three engagement configurations are formulated as ideal types: interpretative tools for identifying recurring combinations of conditions without assuming that each participant belongs permanently to a class. Stapley et al. (2022) show how ideal-type analysis calls for explicit cross-case comparison and scrutiny of the credibility of assignments. In this paper, these configurations are initial hypotheses to be tested, not outcomes of an already validated classification. Studies of career-changing prospective teachers also point to the coexistence of financial, family and training commitments (Varadharajan et al., 2021); employment status therefore cannot serve as a direct measure of time availability. In interpreting digital barriers, Selwyn (2004) and van Deursen and van Dijk (2019) similarly encourage attention to social and material conditions of access. An ideal-type approach thus makes it possible to analyse partially overlapping trajectories and compare alternative interpretations. A difficulty that appears individual may, for example, arise from permissions, the organisation of submissions or a platform malfunction. The proposed procedure therefore retains hybrid cases, discordant evidence and indeterminate situations rather than forcing every trajectory into a predetermined configuration.

3. Protocol Architecture

3.1. Design and Questions for Application

The protocol is intended for exploratory, longitudinal, multiple-case applications in which cohorts are observational contexts rather than experimental conditions to be ranked. The questions will concern empirical support for the ideal-type configurations and observable manifestations of Cognitive Presence in relation to different forms of tutorial intervention. Before data collection, a dated, prospectively specified planning document will set out the observation period, admissible materials, eligibility criteria and analytical procedures. Figure 1 summarises the proposed procedure.

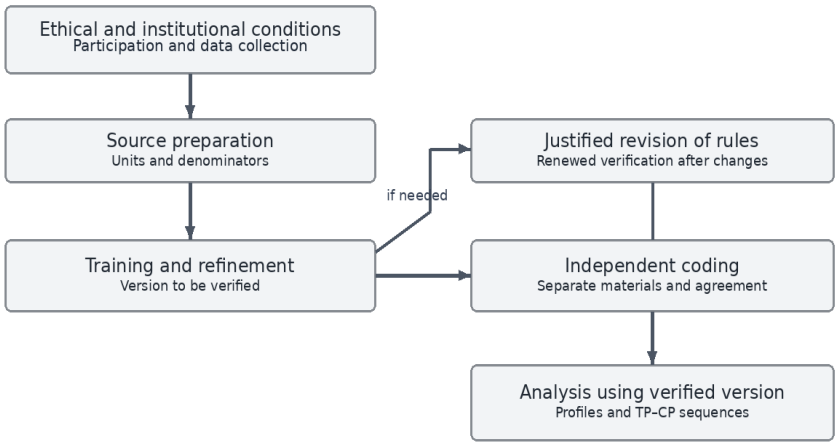


Figure 1. Proposed procedure. Any change to the rules requires renewed independent verification before analysis.

3.2. Participation and Recruitment

Participation in a future application will be voluntary and preceded by appropriate information. Recruitment will be handled by personnel not involved in the tutoring or assessment of those invited, to reduce possible undue influence. The implications of withdrawal, the sources and periods of data processing, and the handling of exchanges involving non-participants will be explained. The protocol will distinguish the number of people eligible, the number who participate and the number of individuals represented in the available traces. Self-selection will be considered in interpretation and assessments of transferability; an absence of textual communication will not justify assigning a profile. Sample size will be justified with reference to the questions and validation requirements.

3.3. Sources, Units, Context and Denominators

Table 1 distinguishes digital sources, their respective units of analysis and the limits of what each makes observable. Email, Classroom and Drive are regarded from the outset as distinct and complementary sources, with none accorded priority. For email, the original content of each message will be considered, avoiding recounting earlier messages quoted within a conversation thread; for Classroom, each individual comment will be considered in its communicative context; and for Drive, the action recorded in platform logs, such as uploading or modifying a file. These records describe operations and their timing but do not replace analysis of the content of a submitted product. Each category will have a specified channel, observation period and attributable role: ENG (engagement) and CP (Cognitive Presence) codes will apply to trainee texts, TP (Teaching Presence) codes to tutor interventions, while SP (Social Presence) and communicative functions will be examined with the interlocutors' roles distinguished.

Table 1. Sources, units and inferential limitations.

Source and unit of analysis	Observable elements	Interpretative limitations
Email — original message	Textual requests and responses; earlier exchanges as context.	Quoted messages in a thread are not new units; coverage is limited to exchanges obtained.
Classroom — individual comment	Textual interactions and their context, distinguishing public and individual messages.	Consider authorship and coverage: accounts, comment authors and enrolled participants are not necessarily identical.
Drive — action recorded in logs	File operations and their timing, when attributable to a user.	A log records an action, not the content of the work or cognitive or emotional processes.

Reporting will distinguish individuals, textual units and individual code assignments. If a unit receives several codes within the same broad category, it will be counted only once among units positive for that category, while the separate assignments remain documented. Cross-channel links will be made only where reliable correspondences exist and will be recorded in a protected register. Coverage will remain source-specific: disengagement will not be inferred merely from a missing trace.

Interpretation will first proceed within each source; only subsequently, where linkage is reliable, will trajectories spanning channels be examined. Conflicting information will not be removed to create a uniform reconstruction but will be analysed as a possible consequence of differing modes of access, visibility and participation. Triangulation will therefore not reduce sources to a single measure; instead, it will allow comparison of what each documents and what each leaves indeterminate.

3.4. Preparation of Materials

Documented rules will exclude automated messages, notifications and duplicates. Unnecessary identifiers and details will be removed or generalised, and the pseudonymisation key kept separately and securely. Dates will be ordered with time zones taken into account. Each unit will retain its provenance and identifier; the availability and version of artefacts will be recorded.

4. Codebook and Decision Rules

Table 2 presents codebook categories, their inclusion and exclusion criteria, and synthetic examples. Several code families may be assigned to the same unit where it provides evidence relevant to different dimensions; each assignment must nevertheless be justified by an identifiable textual passage. Ambiguous decisions will be recorded and discussed in the decision log. For Cognitive Presence, Integration and Resolution identify higher-order manifestations: merely submitting a product, for example, does not establish Resolution, which requires reasoned and verified application. Emotional categories presuppose explicit expressions; SP_OPEN, concerning substantive manifestations of open and reciprocal communication, will be used only for qualitative contextual interpretation. Any quantitative use would require specific revision of assignment criteria.

Table 2. Proposed codebook and synthetic illustrations.

Code	Proposed criterion and boundary	Synthetic example
ENG_BEH_RESP	Reported action; not understanding.	"I have submitted the form."

Code	Proposed criterion and boundary	Synthetic example
ENG_COG_INFO	Substantive clarification; excludes formats and deadlines.	"How do I distinguish a criterion from an indicator?"
ENG_COG_SELFREG	Planning or monitoring.	"I will check the objectives before the exercises."
ENG_COG_REFLECT	Reflection on practice.	"I listen to their answers but overlook how they arrive at them."
ENG_EMO_UNCERT	Explicit emotional uncertainty.	"Not knowing whether I am doing this correctly worries me."
ENG_EMO_POS	Positive affect; not mere politeness.	"I am enthusiastic about the activity."
ENG_EMO_FRUST	Expressed frustration.	"Repeating the task without understanding the error discourages me."
ENG_EMO_SUPPORTSEEK	Request for support; not generic feedback.	"I feel stuck: can you help me get started again?"
CP_TRIGGER	Conceptual problem initiating inquiry.	"Why do two plausible criteria lead to opposing judgements?"
CP_EXPLORATION	Examination of alternatives or sources.	"I compare assessment of the product and the process."
CP_INTEGRATION	Connecting elements into an articulated understanding.	"The product and explanation reveal different aspects: I would distinguish the outcome from its justification."
CP_RESOLUTION	Reasoned application and verification of a solution; not mere submission.	"I applied both criteria to the exercise solutions: they distinguish the result from the reasoning. This comparison justifies the new rubric."
SP_AFFECT	Affect expressed in a relationship.	"I am pleased to share this with you all."
SP_OPEN	Substantive reciprocal uptake; qualitative use.	"Your example helps resolve my uncertainty."
SP_COHESION	Group belonging.	"Let us build a collection that will be useful to all of us."
TP_DESIGN_ORG	Organisation, not conceptual explanation.	"Prepare a draft for discussion."
TP_DIRECT	Substantive explanation or feedback.	"An indicator describes what you observe; a criterion expresses what you evaluate."
TP_FACILITATE	Support for shared discourse.	"Compare the proposals: where do you agree?"
TP_SCAFFOLD	Guidance preserving trainee initiative.	"What do you want to observe? Try defining an indicator."
TP_EMO_SUPPORT	Explicit emotional support.	"I understand your discouragement; let us start again gradually."

Code	Proposed criterion and boundary	Synthetic example
FUNC_PROC	Organisational or procedural function.	"Where do I enter the submission date?"
FUNC_FEEDBACK	Feedback, including formal feedback.	"Could you check this wording?"
FUNC_REFLECT	Reflective professional content.	"What changes in how I listen to my pupils?"
FUNC_RELATIONAL	Substantive relationship; not a greeting.	"With you I feel part of this programme."
FUNC_TECH	Technical function; not a personal deficit.	"The link returns an error."
FUNC_ACK	Brief acknowledgement, distinct from relational content.	"Received, confirmed."
FUNC_OTHER	Residual function, for eligible units only.	"It is overcast today."

Note. The examples are entirely constructed, not research data. They illustrate the target criterion without ruling out concurrent codes; assignments must be checked in context. FUNC_OTHER applies only to units already deemed eligible.

The codebook is intended to support interpretative decisions that can be documented, not to provide a catalogue of expressions to be automatically matched to psychological conditions. Multiple coding will be permitted when a communication contains elements relevant to more than one category; reporting will distinguish code assignments from the units containing them. Synthetic examples serve to illustrate decision thresholds, which must be tested through independent verification, particularly where the boundary between self-regulation, reflection and inquiry is not immediately clear.

5. Ideal-Type Configurations

Profiles A, B and C represent three proposed ideal-type configurations intended to guide the reading of digital trajectories. Profile A considers the documented coexistence of teaching duties and constraints that compress available time; Profile B concerns entry into the profession and initiative in peer interactions, without assuming that novice status entails greater availability; Profile C examines digital and organisational difficulties in relation to actual conditions of system access and use. These are potentially overlapping hypotheses and correspond neither to cohorts observed in other studies nor to stable categories or prevalence estimates.

Trajectories will be selected through documented screening based on information about employment status, time constraints, experience, community participation and access conditions. Reporting will identify the population screened, candidate trajectories, cases selected for contrast and reasons for any exclusion. Activities recorded across channels will be linked only when identity and chronology can be verified. Temporal proximity between two actions will not, in itself, be

treated as evidence of a pedagogical relationship between them. The proposed support criteria are summarised in Table 3.

Table 3. Heuristic configurations and proposed support criteria.

Interpretative check	Proposed criterion	Configuration or outcome
Evening activity alone is insufficient. Teaching duties alone do not establish time constraints.	Teaching duties and competing constraints documented in the same trajectory.	A — Teaching duties and time constraints
Social interaction without status evidence provides only partial support. Do not infer availability from not being in service.	Teaching inexperience and peer initiative; available time assessed separately.	B — Entry into teaching and community orientation
A collective issue weighs against attributing an individual deficit.	Recurring difficulties, effects on participation and access conditions.	C — Digital and organisational barriers
Case-specific judgement, not general validation.	Central components converge; alternatives examined.	Strong support
Do not merge evidence from different people.	Only some components documented.	Partial support
Specify which attribution is contradicted.	Information conflicting with a central component.	Contrary evidence
Does not mean the phenomenon is absent.	Coverage or content prevents judgement.	Insufficient evidence

Note. The outcomes are not scores; configurations may overlap.

Any attribution of support for a profile will concern the individual trajectory and will not measure its prevalence. Hybrid cases, information gaps and alternative explanations relating to available time, permissions or platform characteristics will be retained. A configuration may therefore be supported, contradicted or impossible to assess on the available materials.

A judgement of strong support will require convergence of central components within the same trajectory and consideration of alternative interpretations; partial support will instead apply where only some essential elements are documented. Contrary cases will help clarify the limits of the configuration, while hybrid cases may reveal coexisting conditions. Where the available evidence does not support a

sufficiently justified interpretation, the profile will remain indeterminate rather than being assigned.

6. Application and Validation Plan

6.1. Independent Coding and Disagreement Resolution

Following shared training in the codebook rules, two coders will independently examine selected materials without access to each other's coding decisions. Neither will code their own trainees or tutorial communications. Cross-coding among colleagues will be distinguished from any assessment entrusted to external reviewers. The main sample will be defined with reference to sources, roles and observation periods; a targeted set of potentially positive and negative Cognitive Presence cases may be added to test category boundaries. The results of that supplementary examination will be reported separately, without treating preliminary labels as certain reference standards.

For each code, reporting will specify the number of eligible units and the numbers of agreements and disagreements between coders. Agreement will be described using observed percentage agreement, Cohen's κ, Gwet's AC1 and positive- and negative-case agreement measures, with estimation uncertainty also reported where possible (Gwet, 2008). Interpretation will account for repeated observations: high overall agreement driven mainly by numerous negative cases does not necessarily show that coders consistently recognise positive cases. Decision thresholds will be justified before verification. Disagreements will be discussed and resolved with the reasons documented, without deleting original codes; changes to the rules will require renewed verification on separate materials.

Studies of automated Cognitive Presence classification (Dornauer et al., 2024; Kovanović et al., 2016) provide methodological precedents but do not, in themselves, establish the reliability of a generative language model potentially employed in this protocol. If a Large Language Model (LLM) is used, the model and version, date, instructions, available parameters, assigned system functions and forms of human supervision will be documented. During independent verification, coders will not have access to automatically suggested assignments. Human–human agreement will be reported separately from agreement between a human coder and the system; reporting will also make the protocol version, analysed materials, indicators and decisions traceable.

6.2. Sequential Analysis of the TP–CP Relationship

The primary analysis will examine the first eligible response following each tutor intervention within the same conversation. Adjacency will therefore mean succession between intervention and response in the communicative exchange, rather than a predetermined number of hours. Rules will be specified for handling intervening messages, replies addressed to multiple participants and duplicates so that each response is counted only once in the primary comparison. Tutor

interventions receiving no response will be described separately: the absence of a message will not be interpreted as an absence of Cognitive Presence.

To assess responses following scaffolding, the comparison will use responses to tutor interventions that were not coded as TP_SCAFFOLD, selected under the same rules and with comparable opportunities for communication. The comparison set will therefore not automatically include all other textual units. Previous scaffolding interventions, other Teaching Presence categories, the task, channel and context will be documented. Wider observation windows may also be specified, provided they are defined and justified in advance, with explicit treatment of multiple exposures. The observed outcome will be the presence of Integration and/or Resolution in the response or predefined window.

Reporting will distinguish the number of intervention–response pairings, responses actually analysed, participants and conversations. Interpretation of any differences will account for repeated observations from the same individuals and the distribution of events. If materials are insufficient or incomparable, analysis will remain descriptive. Even a difference between responses cannot establish the causal effectiveness of scaffolding: a tutor may choose this intervention precisely because particular learning needs have arisen.

The comparison must be specified at the planning stage and not constructed retrospectively in light of the results. Responses produced under different communicative conditions cannot be pooled without checking whether their opportunities for participation are comparable. Interpretation will also consider why the tutor selected a particular intervention, the nature of the tasks, possible dependence between observations and the possibility that conceptual reworking may emerge beyond the observation window.

7. Ethics, Reflexivity and Data Management

7.1. Roles and Interpretative Responsibilities

The presence of tutors among the authors requires clarification of the distinction between educational support responsibilities and research responsibilities. First-hand contextual knowledge may aid understanding of activities but may also shape interpretative expectations. The application plan will therefore separate recruitment, coding and disagreement resolution as far as possible, ensuring that tutors do not code their own communications or those of trainees they support.

Verification procedures and recording of decisions will make the contribution of contextual knowledge open to scrutiny and distinguish it from evidence actually present in the traces. Reflexivity will thus concern not only final interpretations but also the decisions through which materials, units and decision criteria are delimited.

7.2. Preconditions and Data Protection

The management plan will specify access, retention, deletion and checks on extracts. Before any AI services are used, institutional officers will assess contractual conditions, reuse, retention and transfers: pseudonymisation does not automatically prevent re-identification. Where the necessary conditions are not met, that processing will not be undertaken.

Future application of the protocol will be preceded by checks with the relevant institutional bodies concerning the ethical and legal conditions governing collection and analysis of communications. The plan will specify purposes, information provision, lawful basis, minimisation, security safeguards and retention periods in accordance with Regulation (EU) 2016/679 (Parlamento europeo e Consiglio dell'Unione europea, 2016). The present proposal does not use individual data to generate new findings, and the examples are synthetic; specifying prior conditions does not attest to authorisations already granted or make them necessary merely to present this theoretical and methodological proposal.

8. Discussion and Conclusions

8.1. Theoretical and Methodological Contribution

The methodological contribution lies in documenting how a trace is selected, coded and interpreted throughout the analytical process. Using separate denominators respects the nature of the different sources, while sequential analysis and scrutiny of contrary evidence help test interpretations. This architecture is a proposal requiring verification; at present it does not demonstrate superiority over other methods.

The paper's proposed contribution is to combine admissibility criteria, operational definitions, source-specific denominators and explicit rules for triangulation and scrutiny of alternative explanations in the tutoring of teacher qualification programmes. This is not to suggest that QLA lacks precedents: Loperfido et al. (2018), for example, document a qualitative application in a different educational setting. The question addressed here is how individual communications, platform interactions and behavioural records can be interpreted together without turning them into interchangeable indicators of engagement or learning.

The distinction between cognitive engagement and Cognitive Presence is another theoretical choice with operational consequences. Requiring explicit textual evidence of integration and reasoned application reduces the risk of attributing advanced inquiry processes to purely procedural exchanges. However, this criterion may miss forms of processing expressed in products not collected or activities not verbalised. The protocol therefore aims not to represent learning exhaustively, but to make inferences from the available traces transparent and verifiable.

8.2. Implications, Limitations and Transferability

A person–system perspective encourages interpretation of digital difficulties in relation to participant characteristics, platform accessibility and the organisation of activities together. In a related area, Verbicaro and Oliva (2026) discuss tensions between support and assessment in the role of the teaching-placement tutor, which is distinct from that of the coordinating tutor. This comparison underlines the importance of clarifying roles and responsibilities, without providing evidence of the protocol's inclusive effects.

The ideal-type configurations may support reflection on forms of guidance suited to different conditions, provided they are used as revisable hypotheses. Profile A will require professional constraints to be documented, rather than inferred from evening activity; for Profile B, community orientation will not suffice to establish greater availability; for Profile C, the interpretation of difficulties must also begin by examining technical and organisational factors. The potential relevance to inclusion lies in this attention to the conditions of participation and must be tested empirically.

Anticipated limitations include the brevity of many communications, differences in coverage between channels, the fact that some activities cannot be observed and the unavailability of certain submitted products. The ideal-type configurations may also be applied too rigidly, while constructed examples cannot capture the full complexity of real language. Transferability will require testing in settings differing in language, tasks and tutoring organisation. The effort involved in double coding and cross-source linkage must also be considered, with any automation approached cautiously.

8.3. Conclusions and Future Developments

This article contributes a formalised protocol for interpreting heterogeneous digital traces in teacher qualification programmes. The proposal distinguishes observable behaviour from engagement and Cognitive Presence and defines procedures for analysing ideal-type configurations and communicative sequences without anticipating their outcomes. Its robustness will need to be examined through future empirical application conducted in compliance with relevant institutional and ethical conditions.

Subsequent research may test the reliability of assignments, the feasibility of independent coding, the conditions under which triangulation yields more contextually grounded interpretations, and cases requiring revision of the codebook. The central questions will remain support for engagement configurations and the observable relationship between Teaching Presence and Cognitive Presence. The value of the protocol will depend on the possibility of subjecting these interpretations to scrutiny, including cases requiring initial hypotheses to be amended or abandoned.

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