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AN ACCESSIBLE SOFTWARE-AND-DIDACTIC MODEL FOR DEVELOPING ACTIVE CITIZENSHIP COMPETENCE IN PRE-SERVICE SPECIAL EDUCATORS

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Abstract

Digital participation, inclusive education, and human-rights-based professional practice increasingly converge in the work of special educators. Yet active citizenship in teacher education is often treated as general civic knowledge, while digital competence is reduced to technical tool use and accessibility is considered an optional design feature. This article develops an accessible software-and-didactic model for fostering active citizenship competence in pre-service special educators. The study is theoretical and design-oriented. It combines conceptual analysis, competence mapping, pedagogical modelling, and synthesis of primary frameworks on global citizenship education, democratic culture, digital competence, inclusive pedagogy, universal design for learning, web accessibility, adaptive learning, formative feedback, e-portfolios, and learning analytics. Five competence components are operationalised: civic-legal, motivational-value, activity-participatory, digital-communicative, and reflective-professional. The proposed model comprises seven interdependent blocks: target, conceptual, content, adaptive-didactic, communicative-activity, digital-technological, and diagnostic-result. Its central mechanism is a transparent cycle of initial diagnosis, individual goal setting, accessible microlearning, professional-inclusive cases, digital debate, service-learning projects, multi-source feedback, electronic portfolio reflection, and corrective reassignment. Six pedagogical conditions are specified, including authentic rights-based tasks, accessibility by design, explainable adaptation, structured collaboration, multi-evidence assessment, and human oversight of data-informed decisions. The article argues that platform activity should not be equated with competence; reliable interpretation requires triangulation of situational judgement, project products, accessibility evidence, individual contribution, reflection, and process data. The model offers a traceable

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foundation for a discipline-specific digital platform and future quasi-experimental validation without claiming completed empirical effects.

Keywords: Active citizenship competence; pre-service special educators; inclusive education; digital citizenship; accessible learning; software-and-didactic support; universal design for learning; authentic assessment.

Introduction

Active citizenship is increasingly enacted through digital environments. Citizens search for and verify information, communicate with institutions, participate in public discussion, create multimedia messages, organise initiatives, and evaluate the social consequences of online action. Accordingly, citizenship education can no longer be confined to knowledge of institutions or occasional participation in civic events. UNESCO frames global citizenship education across cognitive, socio-emotional, and behavioural domains, while the Council of Europe links democratic participation to values, attitudes, skills, knowledge, and critical understanding [6, 7]. Digital citizenship research further emphasises critical literacy, ethical participation, respectful interaction, and civic engagement rather than technical access alone [11–14].

This transformation has specific implications for special education. A special educator works at the intersection of learning, rights, family participation, institutional coordination, accessibility, and social inclusion. The United Nations Convention on the Rights of Persons with Disabilities establishes dignity, non-discrimination, accessibility, participation, and inclusive education as interconnected obligations [4, 5]. In Uzbekistan, the Constitution and national education and disability-rights legislation likewise establish equality, access to education, and public responsibilities for protecting rights [1–3]. From this perspective, the educator is not merely a provider of individual remediation. The educator must identify environmental barriers, support learner voice and choice, coordinate stakeholders, justify reasonable accommodation, and challenge practices that restrict equal participation. Research on inclusive pedagogy describes teachers as agents of inclusion and social justice and stresses that inclusive practice should expand participation for everybody rather than produce separate solutions for selected learners [8–10]. However, pre-service preparation

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does not automatically connect this professional agency with active citizenship or digital participation. Civic education may remain detached from professional cases; digital competence may be assessed through tool operation; and accessibility may appear as a technical checklist after content has already been designed. These separations weaken the transfer of values and knowledge into responsible professional action. A second problem concerns the design of digital learning systems. Learning management systems can deliver content, tests, forums, and analytics, but the presence of these functions does not itself produce active citizenship. Platforms frequently optimise what is easy to count–logins, time, completion, or quiz accuracy–although competence is demonstrated through integrated performance in complex situations. A student may score well on a legal knowledge test and still fail to recognise discrimination, include a learner's perspective, collaborate with stakeholders, or create an accessible digital product. Therefore, software functions must be embedded in a coherent didactic model that connects intended competence, authentic activity, evidence, feedback, and correction.

The purpose of this article is to develop an accessible software-and-didactic model for fostering active citizenship competence in pre-service special educators. The study addresses four questions: (1) which components define the competence in a professional-inclusive context; (2) how should methodological approaches and principles be translated into model blocks; (3) which pedagogical conditions connect a digital platform with meaningful civic action; and (4) what evidence is required to evaluate competence without confusing digital activity with professional readiness? The article presents a theoretical and design-oriented result and does not report a completed pedagogical experiment.

Literature Review

Active and digital citizenship as competence

Competence-oriented education defines learning outcomes through the mobilisation of knowledge, skills, values, and judgment in a particular context. Constructive alignment requires expected outcomes, learning activities, and assessment to demand the same form of performance [19]. This principle is especially important for citizenship education because declarative knowledge and actual participation may diverge. Westheimer and Kahne distinguish personally responsible, participatory, and justice-oriented citizens, showing that different

Educator Insights: A Journal of Teaching Theory and Practice
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educational designs produce different forms of civic action [11]. Digital citizenship broadens the context of action. Choi conceptualises it through ethics, media and information literacy, critical resistance, and political activism [12]. The Digital Citizenship Scale developed by Choi, Glassman, and Cristol includes internet political activism, technical skills, local/global awareness, critical perspective, and networking agency [13]. Jones and Mitchell focus on online respect and civic engagement [14]. DigComp 2.2 organises citizen digital competence around information and data literacy, communication and collaboration, digital content creation, safety, and problem solving [15], while DigCompEdu connects digital resources, teaching, assessment, learner empowerment, and the facilitation of learners' digital competence [16]. These frameworks imply that active citizenship competence in special education should not be defined as an additional list of generic virtues. It must show how civic-legal reasoning, values, participation, digital communication, and reflection are mobilised to support the dignity, voice, and equal participation of learners with special educational needs.

Inclusive professional agency and accessibility

Pantić and Florian conceptualise teachers as agents of inclusion and social justice whose agency is relational and situated in institutional and collaborative contexts [9]. Florian and Spratt propose inclusive pedagogical thinking that extends what is ordinarily available to everybody, thereby avoiding deterministic assumptions about learner ability [10]. The Profile of Inclusive Teachers similarly emphasises valuing learner diversity, supporting all learners, working with others, and continuing professional development [8]. These ideas provide a professional basis for active citizenship: the educator recognises exclusion, facilitates participation, collaborates across roles, and assumes responsibility for change. Accessibility is both a technical and civic principle. The Universal Design for Learning Guidelines encourage multiple means of engagement, representation, and action and expression [17]. WCAG 2.2 provides testable requirements for perceivable, operable, understandable, and robust web content [18]. For a special educator, producing accessible digital content is therefore not merely compliance with interface standards; it is an observable expression of equal participation. Captions, alternative text, keyboard navigation, readable structure, sufficient

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contrast, flexible formats, and clear language become competence evidence when they are connected to audience analysis and user feedback.

Adaptive learning, formative feedback, and evidence

Adaptive educational systems typically combine a domain model, learner model, and adaptation model to modify sequence, difficulty, representation, scaffolding, or feedback [22]. In competence development, adaptation should not create permanent low-expectation tracks. Its purpose is to vary support and challenge while preserving shared professional outcomes. The learner model should be explainable and based on multiple sources rather than on a single test or opaque behavioural prediction. Formative feedback is effective when it is timely, specific, usable, and oriented toward the next action [23]. Feedback should also develop students' capacity to judge quality and act on information rather than encourage passive correction [24, 25]. Electronic portfolios can connect artefacts, criteria, reflection, feedback, and revised products over time [26]. Learning analytics can reveal patterns and support intervention, but they should be interpreted as process evidence, not as direct proof of competence [27, 28]. The literature thus provides strong components–citizenship frameworks, inclusive professional agency, accessible design, adaptive support, feedback, portfolios, and analytics–but rarely integrates them into a traceable model for pre-service special educators. The proposed model addresses this design gap.

Methodology and Research Design

Research design. The article is a theoretical and design-oriented study. Its output is a pedagogical model that can guide the development of a digital learning platform and a subsequent empirical intervention. No participant scores, effect sizes, or implementation outcomes are fabricated or reported. Source base. The model was developed through analysis and synthesis of primary legal and conceptual documents on disability rights, inclusive education, global citizenship, democratic culture, digital competence, universal design for learning, and web accessibility, together with peer-reviewed research on active citizenship, inclusive teacher agency, adaptive learning, formative feedback, electronic portfolios, and learning analytics [4–32]. Analytical procedure. The design process consisted of six stages. First, active citizenship content units were extracted from citizenship and digital competence frameworks. Second, the

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professional functions of special educators–educational, consultative, coordinative, protective, and community-oriented–were mapped against rights-based inclusive practice. Third, overlapping units were consolidated into competence components. Fourth, each component was operationalised through content, function, observable indicators, and evidence. Fifth, the components were connected to methodological approaches, principles, model blocks, platform mechanisms, and pedagogical conditions. Sixth, a traceability check required every block to have a learning activity, platform function, assessment evidence, and feedback route.

Design criteria. The model was judged conceptually adequate when it met seven criteria: internal coherence; professional relevance; rights-based and inclusive orientation; accessibility by design; transparency of adaptation; multi-evidence assessment; and explicit human oversight. Future validation should include expert content review, accessibility and usability testing, pilot task analysis, inter-rater reliability, and a quasi-experimental study.

Research Results

Result 1: an operational structure of active citizenship competence

The first design result is a five-component competence construct. The components are analytically distinguishable but function together in a professional-inclusive situation. Civic-legal reasoning establishes the rights and duties at stake; motivational-value orientation determines the ethical direction; activity-participatory competence converts judgment into collaborative action; digital-communicative competence supports credible and accessible interaction; and reflective-professional competence enables correction, transfer, and continued development.

Educator Insights: A Journal of Teaching Theory and Practice
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Table 1 Operational structure of active citizenship competence for pre-service special educators

Component	Core content	Observable indicators	Recommended evidence
Civic-legal	Rights, duties, equality, non-discrimination, institutional procedures.	Identifies a rights issue; selects relevant norms; justifies a decision by balancing rights and responsibilities.	Knowledge test; situational judgement; legal evidence card; case rationale.
Motivational-value	Dignity, justice, empathy, responsibility, opposition to stereotyping.	Places the person before the diagnosis; evaluates consequences for different stakeholders; assumes responsibility for action.	Value dilemma; observation rubric; reflective justification; self-assessment.
Activity-participatory	Initiative, advocacy, collaboration, collective decision, project impact.	Maps stakeholders; distributes roles; negotiates a solution; produces and documents a socially relevant outcome.	Case, digital debate, service-learning project, contribution log, stakeholder response.
Digital-communicative	Source verification, online ethics, privacy, e-participation, accessible content.	Verifies information; communicates respectfully; creates content with captions, alternative text, readable structure, and appropriate privacy safeguards.	Fact-checking record; forum contribution; accessible multimedia product; WCAG/UDL checklist.
Reflective-professional	Evidence-based self-evaluation, feedback use, correction, transfer.	Distinguishes strong and weak evidence; revises a product after feedback; plans the next action; transfers learning to a new context.	Electronic portfolio, revision history, reflective commentary, individual development plan.

Result 2: a seven-block software-and-didactic model

The second result is a cyclical model that connects pedagogical purpose with platform functionality. The target block defines the integral competence and the expected component outcomes. The conceptual block integrates systemic, competency-based, activity-oriented, axiological, learner-centred, inclusive, UDL, and digital-didactic approaches. The content block organises learning around rights, dignity, participation, digital citizenship, inclusive communication, community collaboration, and professional reflection. The adaptive-didactic block transforms initial and ongoing evidence into transparent decisions about task complexity, representation, scaffolding, practice density, and corrective

Educator Insights: A Journal of Teaching Theory and Practice
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routes. The communicative-activity block contains professional-inclusive cases, digital debates, collaborative problem solving, and service-learning projects. The digital-technological block provides accessible content, user roles, portfolio functions, analytics, event logs, privacy controls, and interoperability. The diagnostic-result block combines criteria, analytic rubrics, multi-source evidence, competence profiles, and corrective recommendations. The model is cyclical rather than linear. Diagnostic evidence updates the learner profile; the profile informs a provisional pathway; authentic activity generates new evidence; teacher, peer, and system feedback supports revision; and portfolio reflection leads to recalibration. A teacher may accept, modify, or reject an automated recommendation, and a student should be able to understand why a route was proposed.

TARGET	Integral and component outcomes
↓	
CONCEPTUAL	Approaches, principles, conditions
↓	
CONTENT	Rights, participation, digital and inclusive practice
↓	
ADAPTIVE-DIDACTIC	Diagnosis, pathway, scaffolding, correction
↓	
COMMUNICATIVE-ACTIVITY	Cases, debate, projects, collaboration
↓	
DIGITAL-TECHNOLOGICAL	Accessible platform, portfolio, analytics
↓	
DIAGNOSTIC-RESULT	Rubrics, evidence, profile, feedback
FEEDBACK LOOP: evidence and reflection recalibrate the learner profile, pathway, and next target.	

Figure 1. Cyclical software-and-didactic model for developing active citizenship competence

Educator Insights: A Journal of Teaching Theory and Practice
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Table 2 Functions and digital expressions of the model blocks

Model block	Function	Pedagogical output	Platform expression
Target	Defines the integral result and five component outcomes.	Competence profile; shared success criteria; individual goals.	Goal dashboard; component map; learner goal sheet.
Conceptual	Coordinates approaches, principles, and pedagogical conditions.	Coherent rights-based and inclusive design.	Design matrix; teacher guide; expert review record.
Content	Sequences eight thematic modules from rights and values to participation and reflection.	Integrated civic, digital, and professional-inclusive knowledge.	Accessible microcontent; source packs; scenario library.
Adaptive-didactic	Uses multi-source diagnosis to vary support, complexity, representation, and retry opportunities.	Individual support without lowering common outcomes.	Diagnostic profile; transparent recommendation; corrective task.
Communicative-activity	Organises cases, digital debate, collaboration, and service-learning.	Responsible participation, negotiation, and social impact.	Decision record; debate evidence; project product; contribution log.
Digital-technological	Provides accessible interface, roles, portfolio, analytics, privacy, and audit functions.	Reliable and inclusive digital learning environment.	WCAG/UDL audit; event log; version history; consent record.
Diagnostic-result	Combines rubrics and multiple evidence sources; produces feedback and recalibration.	Valid interpretation of progress and next steps.	Component scores, critical indicators, narrative feedback, revised pathway.

Result 3: principles and pedagogical conditions

The model is governed by ten principles: human dignity and rights; non-discrimination; accessibility by design; learner agency; personalisation without segregation; active participation; collaboration and dialogue; evidence-based decision making; transparency and data ethics; and continuous feedback and reflection. A principle states a normative design requirement, whereas a pedagogical condition specifies what must be organised for the requirement to operate in practice.

Six interdependent pedagogical conditions were derived. They do not duplicate platform functions. For example, an accessible interface is a technical feature, whereas accessibility by design as a pedagogical condition requires learning

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goals, content, tasks, communication, and assessment to include multiple means of access and expression and to be evaluated with users.

Table 3 **Pedagogical conditions for implementing the software-and-didactic model**

Pedagogical condition	**Mechanism**	**Observable implementation**	**Evidence**
1. Explicit competence indicators and authentic rights-based tasks	Each module links outcomes to observable professional-inclusive actions and quality criteria.	Students solve cases involving voice, choice, equality, barriers, and stakeholder responsibility.	Relevant decisions and products rather than content completion alone.
2. Accessibility and UDL by design	Content and activity are created in multiple accessible formats from the beginning.	Alternative text, captions, keyboard access, clear structure, flexible expression, user testing.	Accessibility checklist, user feedback, revised artefact.
3. Multi-source diagnosis and explainable adaptation	Recommendations use criterion-referenced tasks, self-assessment, teacher observation, portfolio, and selected process data.	The reason for a recommendation is visible; teacher and learner can challenge it.	Evidence map, adaptation rationale, accepted or modified pathway.
4. Structured participation and collaboration	Cases, debate, and projects require roles, listening, evidence, negotiation, and individual accountability.	Learner voice and stakeholder perspectives are built into decision making.	Contribution log, peer evidence, joint decision, project impact.
5. Multi-evidence formative assessment and portfolio reflection	Assessment triangulates knowledge, judgment, performance, product, reflection, and revision.	Feedback identifies a strong evidence point, a specific gap, a next action, and an exit criterion.	Analytic rubric, revised product, reflective commentary, competence profile.
6. Human orchestration, privacy, and ethical governance	Teachers validate high-stakes judgments; data are minimised, role-protected, auditable, and used for declared educational purposes.	No automated label or recommendation is treated as final; consent and alternative routes are available.	Audit log, data notice, teacher override, bias/accessibility review.

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Result 4: a transparent learning and correction cycle

The operational cycle begins with an entry task that includes legal reasoning, value judgement, participation planning, digital communication, and reflection. The result is not a single label but a five-component profile. The learner selects an individual goal, while the system and teacher recommend accessible microcontent and a task route. A student who lacks a prerequisite receives a worked example and guided practice; a student who demonstrates routine accuracy but weak transfer receives a changed context and reduced scaffolding; a student with stable productive performance receives an open project with additional stakeholders and ethical constraints.

After microlearning, the student solves a professional-inclusive case. A complete response identifies the rights and interests at stake, represents learner voice, compares alternatives, anticipates consequences, and specifies evidence. Digital debate then requires the student to present a position, acknowledge a counterargument, use credible sources, and respond respectfully [31]. The service-learning project transfers learning into a real or carefully simulated community problem and produces an accessible digital or organisational product [32].

Feedback is multi-source. Automated support may detect missing prerequisites, recurrent procedural errors, incomplete accessibility metadata, or unsubmitted evidence. Peer feedback can address clarity, perspective taking, and collaboration. Teacher feedback is essential for contextual, ethical, and professional judgment. Students must interpret the feedback, explain which recommendation they used or rejected, revise the product, and document the reason in an electronic portfolio. A corrective task is closed only when the relevant indicator is demonstrated in a new or revised situation.

The model rejects the direct equation of platform activity with competence. Time-on-task, clicks, attempts, or logins can signal a need for investigation, but they are not civic performance. A defensible interpretation triangulates situational judgment, the quality and accessibility of products, individual contribution, reflection, revision, and selected process traces. Critical indicators–dignity, non-discrimination, privacy, safety, and truthful representation–require minimum thresholds even when the total score is high.

Educator Insights: A Journal of Teaching Theory and Practice
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Discussion

The proposed model differs from a content-centred citizenship course in that it begins with professional-inclusive performance. Rights and democratic values are not treated as separate topics to be memorised; they become criteria for analysing barriers, representing learner voice, selecting digital tools, negotiating with stakeholders, and evaluating consequences. This interpretation is consistent with global citizenship and democratic culture frameworks [6, 7] and with scholarship that distinguishes forms of civic participation [11].

The model also extends digital citizenship beyond online behaviour. Source verification, privacy, respectful interaction, accessibility, multimedia authorship, and electronic participation are placed inside authentic professional activity. This reflects the broader conceptualisation of digital citizenship found in Choi and related work [12–14] and aligns with DigComp and DigCompEdu [15, 16]. For special educators, accessibility is especially important because it transforms equality from an abstract value into a design decision that can be observed and evaluated.

A further contribution is the distinction between platform function and pedagogical mechanism. A forum does not guarantee dialogue, analytics do not guarantee valid diagnosis, and a portfolio does not guarantee reflection. Each technology needs structured tasks, criteria, teacher orchestration, and opportunities for revision. The model therefore connects every function with an intended action, evidence, and feedback route. This traceability reduces the risk that a digital platform becomes a repository of files or a catalogue of screenshots.

The adaptive block is deliberately transparent and bounded. Adaptation varies support and challenge while preserving common outcomes and learner agency. This is important in special education, where personalisation can inadvertently reproduce low expectations or segregation. The teacher retains responsibility for consequential decisions, and students can inspect and question recommendations. Such hybrid regulation is consistent with data-informed teaching that treats analytics as support for judgment rather than a substitute for it [27, 28].

The multi-evidence approach strengthens construct representation. Tests are useful for legal and conceptual knowledge, but they cannot adequately capture collaboration, accessible product design, advocacy, or reflection. Cases, debates, projects, portfolios, and process data broaden the evidence base. At the same time, the model requires validation: experts should review content relevance; tasks

Educator Insights: A Journal of Teaching Theory and Practice
Volume 1, Issue 12, December 2025
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should be piloted; scoring rubrics should be tested for inter-rater agreement; and interpretations should be examined for fairness across learner groups [29, 30].

Practical Implications

Universities can begin implementation without building a complete platform. A pilot module may define two or three competence indicators, prepare an accessible source pack, use one professional-inclusive case and one digital debate, collect a portfolio artefact, and apply an analytic rubric. The team can then examine the clarity of indicators, workload, accessibility, feedback quality, and evidence sufficiency before scaling.

A full platform should include role-based accounts; entry diagnosis; an explainable competence profile; accessible microlearning; case, debate, and project engines; peer and teacher feedback; electronic portfolios; component-level analytics; corrective routes; consent and privacy controls; and export of anonymised research data. Accessibility should be included in acceptance criteria rather than postponed until the end of development.

Teacher preparation is indispensable. Educators need competence in rights-based case design, UDL, accessibility testing, facilitation of controversial discussion, formative feedback, rubric use, data interpretation, privacy, and critical evaluation of AI-assisted content. Students likewise need orientation in source verification, respectful communication, disclosure of AI assistance, intellectual property, consent, and the limits of automated recommendations.

Limitations and Future Research

The study is conceptual and design-oriented. It does not establish causal effectiveness, optimal component weights, or threshold scores. The proposed blocks and conditions must be contextualised for specific special education programmes, languages, institutional infrastructure, and learner populations.

Future research should proceed in stages: expert validation of the construct and model; participatory review with pre-service special educators and users with disabilities; accessibility and usability testing; pilot analysis of tasks and rubrics; and a quasi-experimental study comparing the model with a non-adaptive but otherwise equivalent course. Evaluation should include pre- and post-performance tasks, effect sizes and confidence intervals, rubric reliability, transfer

Educator Insights: A Journal of Teaching Theory and Practice
Volume 1, Issue 12, December 2025
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to a new case, portfolio revision quality, process analytics, and qualitative evidence about agency, fairness, accessibility, and workload.

Particular attention is needed to prevent novelty effects, excessive data collection, automation bias, and the use of engagement metrics as competence proxies. Research should also examine which components benefit from automated support and which require expert or stakeholder judgment.

Conclusion

Active citizenship competence of pre-service special educators is an integrated professional-personal capacity to mobilise civic-legal knowledge, inclusive values, responsible participation, digital communication, and reflection in support of dignity, learner voice, equal participation, and social inclusion.

The proposed software-and-didactic model connects seven blocks–target, conceptual, content, adaptive-didactic, communicative-activity, digital-technological, and diagnostic-result–within a transparent cycle of diagnosis, accessible learning, authentic action, feedback, portfolio reflection, and correction. Its value lies not in the number of digital functions but in the traceable relationship among competence outcomes, activity, evidence, and pedagogical decision making.

Implementation requires authentic rights-based tasks, accessibility and UDL by design, explainable adaptation, structured collaboration, multi-evidence formative assessment, and human oversight of data use. Subsequent empirical validation should test whether these conditions improve professional performance and transfer while preserving learner agency, fairness, privacy, and accessibility.

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