

Education, Technology and Human-Centred Learning

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ABSTRACT

Educational technology can expand access, feedback and personalization, but its value depends on pedagogy, teacher capacity, inclusion and learner agency. This article presents a simulated empirical study of human-centred learning readiness. A reproducible synthetic dataset representing 720 illustrative learners across low-, moderate- and high-support educational settings was generated using five-point scales. The model assessed technology access, teacher support, learner agency, quality feedback, digital literacy, learning belonging and digital strain. Simulated results produced an overall readiness mean of 3.47 (SD = 0.73). Readiness differed across support settings, $F = 130.44$, $p < .001$, $\eta^2 = 0.267$; High-support settings recorded higher readiness (3.93) than Low-support settings (3.01). The regression model explained 60.5% of the variance. The findings are illustrative rather than population estimates. They demonstrate that technology contributes most strongly when teachers remain central, learners exercise agency and digital systems are accessible, trustworthy and pedagogically purposeful.

Keywords: Education Technology, Human-Centred Learning, Digital Education, Learner Agency, Teacher Support, Artificial Intelligence in Education.

I. Introduction

Digital technology now influences curriculum, assessment, administration and everyday classroom activity. Learning-management systems, adaptive software, multimedia resources and generative artificial intelligence can reduce distance and provide new forms of support. Yet technology does not improve learning automatically. UNESCO's 2023 Global Education Monitoring Report cautions that technology should serve learners and teachers rather than define the aims of education (UNESCO, 2023a).

Human-centred learning begins with the needs, capabilities and dignity of learners. It values agency, dialogue, feedback, belonging and the role of teachers in interpreting context. This approach is especially important as AI systems enter education, because automated outputs can support explanation and practice while also creating risks related to accuracy, privacy, bias and over-reliance.

UNESCO's guidance on generative AI in education calls for a human-centred approach that protects privacy, supports age-appropriate use and maintains meaningful human agency (UNESCO, 2023b). The OECD Digital Education Outlook 2023 similarly distinguishes simple digitization from deeper digital transformation and emphasizes trustworthy, useful and equitable educational ecosystems (OECD, 2023).

This simulated study examines which factors most strongly predict human-centred learning readiness and whether digital strain reduces readiness after access, pedagogy and belonging are considered. All observations and results are synthetic.

II. Education, Technology and Human-Centred Learning

2.1 Technology as a Pedagogical Tool

Technology is most effective when it supports clear learning goals. Multimedia, simulation and adaptive practice can help learners visualize complex concepts and receive timely support, but poorly designed tools can add cognitive load or distract from conceptual understanding.

2.2 Teacher Capacity and Professional Judgment

Teachers remain essential for diagnosis, motivation, feedback and ethical judgment. Digital systems should augment rather than replace professional expertise. Professional learning must therefore include pedagogical design, data interpretation, AI literacy and strategies for inclusive participation.

2.3 Learner Agency and Personalization

Human-centred personalization gives learners meaningful choices over pace, pathway and representation while preserving curriculum coherence. Agency also includes the ability to question automated recommendations and reflect on how tools influence learning.

2.4 Feedback, Assessment and Academic Integrity

Technology can increase the frequency of feedback and support low-stakes assessment. However, automated assessment needs transparency and appropriate human review, particularly when results affect progression. Generative AI also requires updated approaches to authorship and authentic assessment.

2.5 Inclusion, Accessibility and Belonging

Access to devices is only one component of digital inclusion. Connectivity, assistive technologies, language support, accessible interfaces and teacher responsiveness shape who benefits. Belonging remains important because learning is social as well as cognitive.

Illustrative framework for human-centred technology-enabled learning

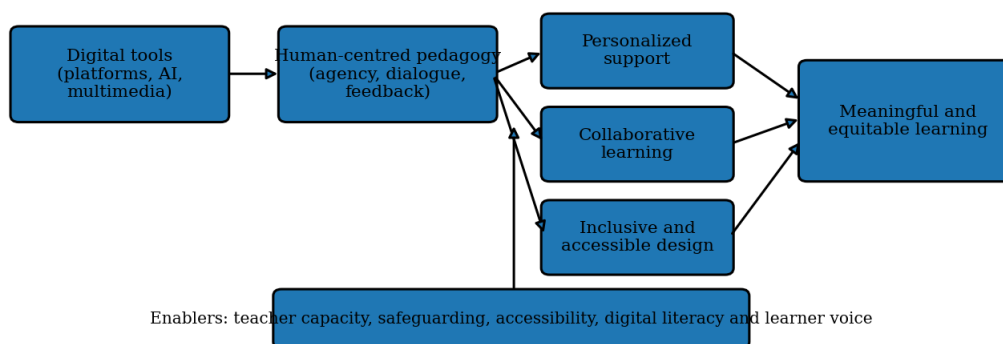


Figure 1. Illustrative conceptual framework linking educational technology with human-centred pedagogy and learner outcomes.

III. Literature Review

3.1 Human-Centred Educational Technology

Educational technology research increasingly evaluates how tools interact with pedagogy and context rather than treating devices as independent interventions. UNESCO (2023a) emphasizes that decisions should begin with learning problems, evidence and equity.

3.2 Digital Education Ecosystems

OECD (2023) describes digital education as an ecosystem involving infrastructure, governance, interoperability, teacher capacity and data. This broader perspective explains why the same tool can produce different outcomes across institutions.

3.3 Generative AI and Human Agency

UNESCO (2023b) recommends human agency, privacy protection and pedagogical validation in generative-AI use. These principles support the inclusion of teacher support and learner agency in the present model.

3.4 Social Learning and Belonging

Learning occurs through interaction with teachers and peers. Human-centred technology should therefore create opportunities for collaboration rather than isolating learners behind individualized interfaces.

3.5 Research Gap

The simulated model integrates access, pedagogy, agency, feedback, digital literacy, belonging and digital strain, allowing technology-enabled learning to be assessed as a human system rather than a hardware problem.

IV. Methodology

4.1 Research Design and Transparency

A simulated cross-sectional survey design was used. No real learners, institutions or courses were studied; all data are synthetic.

4.2 Illustrative Sample

The synthetic sample contained 720 observations across low-, moderate- and high-support educational settings. The categories are analytical constructs rather than real institutions.

4.3 Measures

Seven predictors and one outcome were represented by four simulated five-point items each. Digital strain reflects overload and fatigue, while the other predictors represent enabling learning conditions.

4.4 Data Generation

A correlated multivariate structure and fixed random seed 20260732 were used. Group shifts created a plausible gradient in access, teacher support and feedback. Readiness was generated as a weighted function of the predictors plus error.

4.5 Statistical Analysis

Descriptive statistics, reliability analysis, correlations, ANOVA and regression were used. Significance statistics are illustrative only.

V. Simulated Results and Analysis

5.1 Illustrative Sample Profile

Table 1. Simulated sample profile (N = 720).

Characteristic	Category	n (%)
Analytical group	Low-support	240 (33.3)
	Moderate-support	240 (33.3)
	High-support	240 (33.3)
Age	18-24	140 (19.4)
	25-34	215 (29.9)
	35-44	182 (25.3)
	45-54	122 (16.9)
	55-65	61 (8.5)
Gender	Female	331 (46.0)
	Male	380 (52.8)
	Other/Prefer not to say	9 (1.2)
Education	Secondary or below	160 (22.2)
	Diploma	177 (24.6)
	Bachelor	285 (39.6)
	Postgraduate	98 (13.6)
Employment	Student	132 (18.3)
	Salaried	368 (51.1)
	Self-employed	140 (19.4)
	Other/unemployed	80 (11.1)

5.2 Reliability and Descriptive Statistics

Table 2. Simulated scale reliability and descriptive statistics.

Construct	Items	Cronbach's alpha	Mean	SD
Technology access	4	0.850	3.35	0.73
Teacher support	4	0.841	3.42	0.69
Learner agency	4	0.807	3.38	0.64
Quality feedback	4	0.816	3.29	0.65
Digital literacy	4	0.826	3.46	0.66
Learning belonging	4	0.785	3.48	0.59
Digital strain	4	0.797	3.55	0.61
Human-centred learning readiness	4	0.839	3.47	0.73

Human-centred learning readiness averaged 3.47 (SD = 0.73). Descriptive results indicate that access is important but not sufficient; teacher support, feedback and belonging represent distinct dimensions of the learning environment.

5.3 Group Differences

Readiness differed significantly across support settings, $F = 130.44$, $p < .001$, eta-squared = 0.267. Means increased from Low-support (3.01) to Moderate-support (3.48) and High-support (3.93), consistent with cumulative benefits when technology and pedagogy improve together.

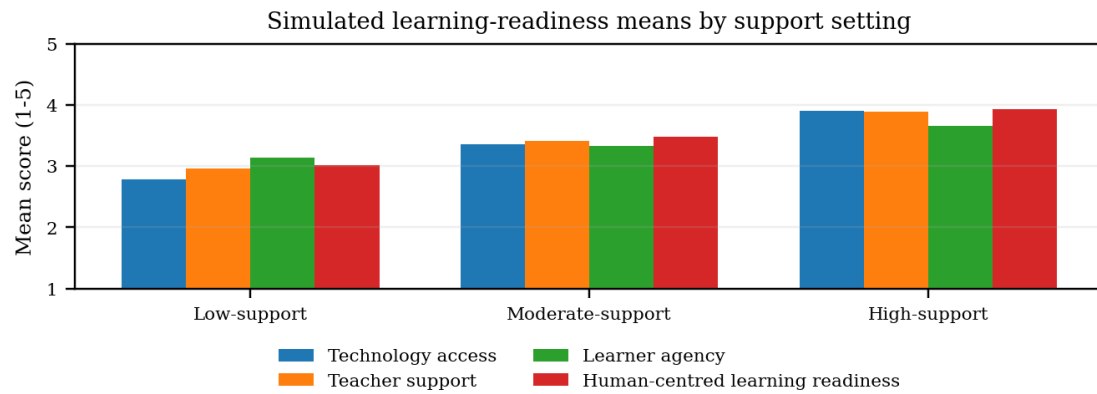


Figure 2. Simulated mean scores for selected learning constructs across support settings.

5.4 Correlation Structure

Readiness was positively associated with access, teacher support, learner agency, feedback, digital literacy and belonging. Digital strain was negatively associated with readiness, illustrating the importance of workload, attention and well-being in technology-rich environments.

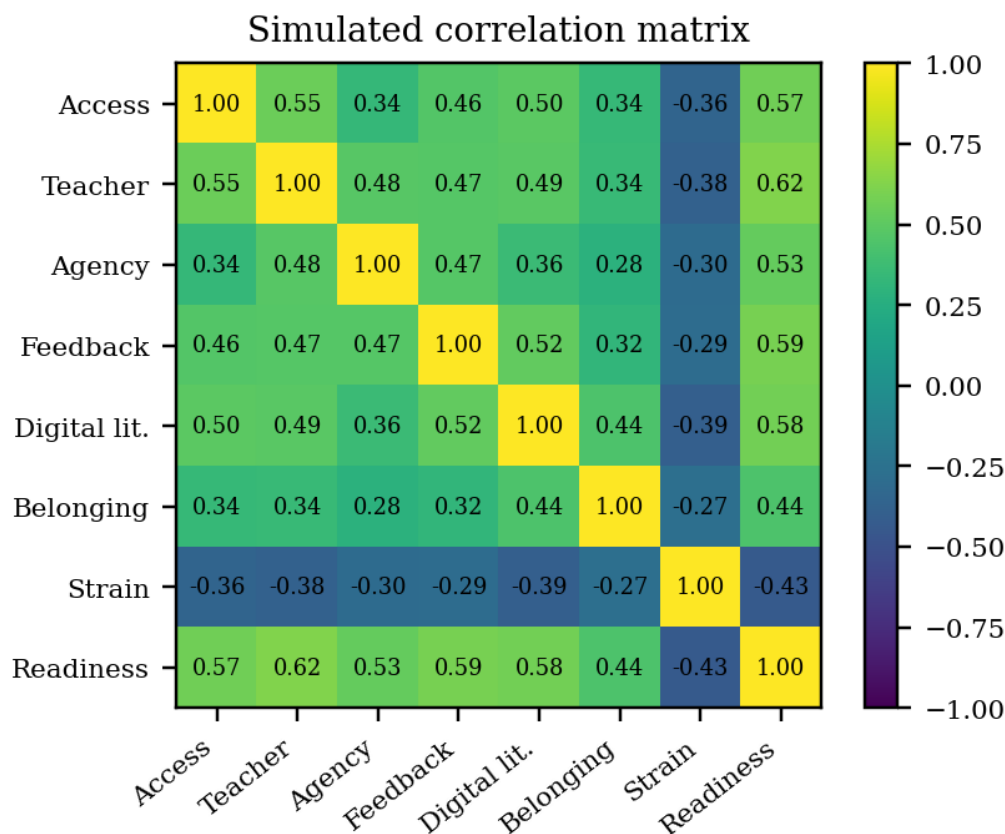


Figure 3. Simulated Pearson correlation matrix for the study constructs.

5.5 Predictors of Human-Centred Learning Readiness

Table 3. Simulated ordinary least-squares regression predicting human-centred learning readiness.

Predictor	B	SE	beta	t	p
Technology access	0.156	0.030	0.157	5.15	< .001
Teacher support	0.223	0.033	0.212	6.68	< .001
Learner agency	0.191	0.033	0.167	5.82	< .001

Predictor	B	SE	beta	t	p
Quality feedback	0.228	0.034	0.202	6.64	< .001
Digital literacy	0.154	0.034	0.141	4.47	< .001
Learning belonging	0.137	0.033	0.110	4.08	< .001
Digital strain	-0.124	0.032	-0.105	-3.92	< .001

The regression explained 60.5% of the simulated variance. The strongest standardized effects were Teacher support (beta = 0.212), Quality feedback (beta = 0.202), Learner agency (beta = 0.167) and Technology access (beta = 0.157). The pattern supports a human-centred interpretation in which pedagogical support matters at least as much as device access.

5.6 Illustrative Priorities and Barriers

Teacher professional learning and accessible digital resources received the strongest illustrative priority ratings, followed by formative feedback and learner agency. The largest barriers were the digital divide, weak teacher support and digital strain.

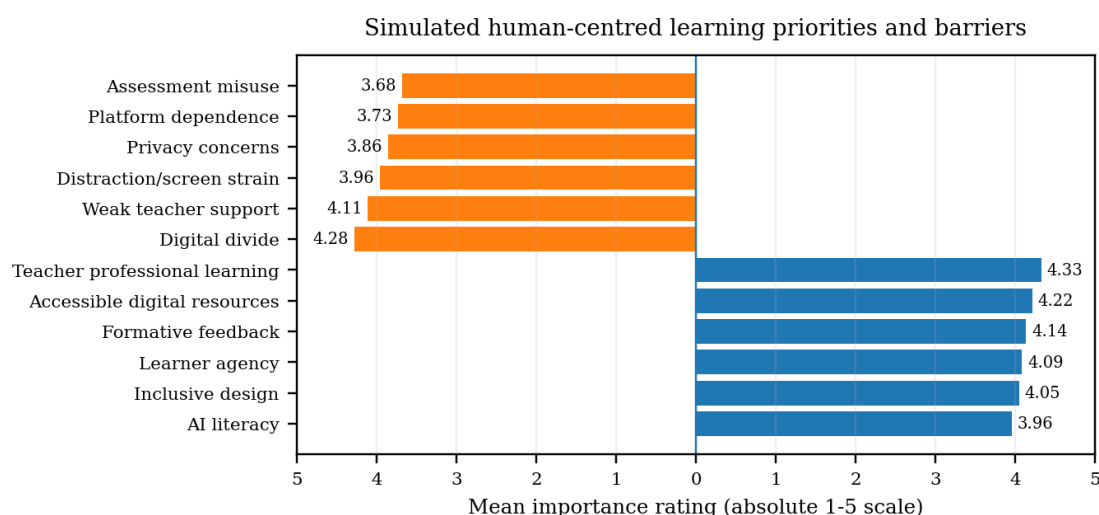


Figure 4. Simulated ratings of educational-technology priorities and implementation barriers.

VI. Discussion

6.1 Pedagogy Should Lead Technology

The simulated findings suggest that educational technology is most useful when embedded in deliberate teaching practice. Tool adoption without pedagogical redesign may digitize existing routines without improving learning.

6.2 Teacher Support Remains Central

Teacher support was among the strongest predictors. Professional judgment helps learners interpret feedback, detect errors and connect digital activities with broader learning goals.

6.3 Agency Supports Meaningful Learning

Learner agency contributed positively after access and teacher support were controlled. Personalization should therefore involve learner choice and reflection rather than opaque automation.

6.4 Digital Strain Is a Learning Risk

Higher digital strain reduced readiness. Institutions should manage screen time, notification burden, platform fragmentation and workload so that digital learning remains sustainable.

6.5 Equity Requires More Than Devices

Connectivity and devices are necessary but insufficient. Accessibility, language, family support and teacher capacity influence whether technology reduces or reproduces inequality.

VII. Challenges and Future Research Directions

7.1 AI Accuracy and Academic Integrity

Generative systems can produce fluent but incorrect content. Future research should test verification strategies and redesign assessment around authentic reasoning.

7.2 Privacy and Learner Data

Digital platforms collect sensitive educational data. Governance should define minimization, retention, access and appropriate secondary use.

7.3 Teacher Workload

New platforms can increase administrative and cognitive load. Research should evaluate whether technology genuinely reduces workload or merely redistributes it.

7.4 Accessibility and Inclusion

Assistive technologies and universal design should be tested across disability, language and connectivity contexts.

7.5 Empirical Validation

The current findings are simulated. Real studies should combine validated learner surveys, teacher data and objective learning outcomes using longitudinal designs.

VIII. Conclusion and Future Work

Human-centred learning requires technology to remain subordinate to educational purpose. The simulated analysis showed that teacher support, learner agency, feedback, digital literacy and belonging jointly support readiness, while digital strain constrains it.

Educational transformation should therefore invest in teachers, accessible infrastructure, responsible AI use and learner voice. Real empirical validation is required, but the framework demonstrates how technology can be evaluated through human learning rather than adoption alone.

Declarations

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Data Availability: All numerical results were generated from a reproducible synthetic procedure using fixed seed 20260732. No real participant dataset exists.

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