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Artificial Intelligence and the Future of Education in Croatia: Student Professor Co-Creation in a Structured Narrative Review

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ABSTRACT

This structured narrative review examines student–professor co-creation in AI-supported higher education in Croatia. It distinguishes routine AI use from shared educational decision-making and synthesizes Croatian higher-education evidence with international research, using K–12 evidence only as adjacent context. The review organizes the literature around five readiness domains: stakeholder participation, institutional capacity, AI and digital competencies, responsible technical conditions, and external relevance and sustainability. Across the evidence reviewed, AI use and preparation are more visible than sustained student-professor co-creation. The paper therefore proposes an unvalidated AI Co-Creation Readiness Framework and a mixed-method research agenda for future Croatian evaluation. As a selective narrative synthesis, it does not establish causal effects, national prevalence, comparative effectiveness, or financial return.

KEYWORDS artificial intelligence, student–professor co-creation, Croatia, higher education, responsible AI

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Introduction

Artificial intelligence (AI) now features across higher education teaching, individualized learning activities, and administrative processes [1]. Rapid growth in generative and conversational AI has intensified debate about pedagogy, assessment, and institutional practice [2]. Evidence from Romania and Serbia demonstrates both the opportunities and challenges associated with implementation [3]. These developments underscore the significance of educational relationships, ethical responsibilities, and institutional capacity, which are now as critical as technical access [4], [5]. This review examines the ways in which students and professors collaboratively influence AI-supported learning. In this context, AI adoption denotes the use of artificial intelligence in educational activities. Student–professor co creation is defined as the active involvement of both groups in designing, evaluating, or revising learning tasks, assessments, feedback, or guidelines for AI use. This distinction is significant, as frequent AI use alone does not indicate shared educational decision-making. The Croatian context is analyzed in conjunction with international evidence to identify design principles and outstanding questions.

Human-centered approaches maintain human judgment and responsibility, even when artificial intelligence is involved in collaborative activities [6]. Studies on AI assisted academic writing and teacher–AI collaboration emphasize the importance of coordination, shared control, transparency, and student agency [7]–[9].

These forms of human–AI interaction are relevant to educational design, but they should not be treated as evidence that students and professors co-create the rules, tasks, or assessments through which AI is used.

The review asks one central question: What conditions and evidence gaps shape student–professor co-creation in AI-supported higher education in Croatia? The analysis therefore treats AI use and AI co-creation as distinct constructs and examines the conditions under which students and professors can jointly design, evaluate, and revise AI-supported learning. Existing Croatian research primarily documents AI use, attitudes, literacy, and implementation, while evidence examining students and professors as joint decision-makers in the design of AI supported learning remains limited. This review addresses that gap by distinguishing AI adoption from educational co creation, synthesizing the Croatian studies identified in this review alongside relevant international research, and proposing a context-specific readiness framework for future empirical testing. The framework is intended not as a validated measurement model, but as a structured basis for future empirical examination of the conditions under which student–professor co-creation can occur in AI-supported higher education.

Conceptual Background and Evidence

AI Integration and Collaborative Learning

Existing reviews of artificial intelligence in education identify applications that include instructional support, adaptive learning, and administrative functions [10]. Comprehensive syntheses emphasize the need for enhanced educational foundations, increased ethical consideration, interdisciplinary collaboration, and greater methodological rigor [11], [12].

For the present review, the key implication is that access to an AI tool neither establishes educational value nor determines who participates in decisions about its use.

Co-creation research in higher education places relationships, participation, and shared design at the center of educational practice [13]. Research on AI and value co creation extends this perspective to interactions among students, educators, institutions, and technology [14]. Related work distinguishes using AI outputs as finished products from involving learners actively in creating, examining, and evaluating AI-supported content [15], [16]. Together, these perspectives provide a conceptual basis for separating AI use from shared educational design.

Teacher-focused studies examine learning design and collaboration with AI [17], [18], active learning with generative systems [19], and AI-supported feedback and collaborative work [20], [21]. These studies identify processes relevant to co-creation, but teacher–AI and student–AI interaction remain analytically distinct from student–professor co-creation.

Stakeholders and Institutional Conditions

Student-focused studies emphasize usefulness for learning, feedback, and efficiency while also reporting concerns about accuracy, dependence, and academic integrity [22]–[24]. Educators similarly identify potential benefits alongside needs for professional knowledge and institutional support [25], [26]. Research comparing teacher and student perspectives further highlights questions of support, replacement, and digital literacy [27]. These differences make shared expectations and role negotiation central to co-creation research.

Institutional integration also depends on ethical, social, and organizational conditions [28]. Studies of academics identify implementation opportunities and constraints [29], [30], while institutionally mediated AI initiatives illustrate how organizational structures can support engagement [31]. For co-creation, the relevant issues are whether students and professors have sufficient time, skills, guidance, authority, and accountability to make shared educational decisions.

School-level evidence is used only as adjacent context. Studies involving parents, teachers, or pupils can inform questions of trust, skills, and responsible use, but their findings cannot be transferred directly to university co creation because adult learner autonomy, assessment responsibilities, and governance arrangements differ [32].

Workforce Preparation and Sustainability

AI-supported entrepreneurship education and studies of student perceptions provide context for how learners connect AI with practical and professional development [33], [34]–[36]. These indicators assist in identifying expectations regarding future employment trends; however, direct evidence from employers is necessary before such expectations can be recognized as established labor-market requirements.

Economic sustainability is significant only to the extent that it influences the feasibility of co-created practices. Potential efficiency gains must be distinguished from demonstrated financial returns, which require evidence of attributable benefits and consideration of all implementation costs, including training, maintenance, staff time, and technical support. Educational value should be evaluated directly based on learning quality, learner agency, accessibility, and responsible participation [5], [29], [37].

Methods or analytical approach

Review Approach and Scope

This paper uses a structured narrative review to organize Croatian and international literature on student–professor co-creation in AI-supported higher education. Croatian higher-education studies are treated as direct local context, international higher-education studies as comparative evidence, and K–12 studies as adjacent evidence requiring adaptation. The objective is interpretive synthesis and framework development rather than exhaustive coverage, a protocol-based scoping review, or a pooled estimate of effects.

Sources were retained when they addressed stakeholder expectations, Croatian AI use and preparation, collaborative educational design, responsible technical conditions, employer or economic evaluation, or relevant conceptual and measurement boundaries. Literature was identified through targeted searches of Scopus, Web of Science, and IEEE Xplore, supplemented by searches of publisher platforms

including SpringerLink, ScienceDirect, MDPI, Taylor & Francis, Wiley, Frontiers, SAGE, and Nature Portfolio. Search terms combined concepts related to artificial intelligence, higher education, co-creation, student–staff partnership, AI literacy, responsible AI, and Croatia. Priority was given to peer-reviewed higher education research, Croatian empirical evidence, and recent international studies relevant to the conceptual boundaries of student–professor co-creation. K–12 studies were included only where they informed implementation, readiness, or responsible-use considerations not yet represented in the Croatian higher-education evidence identified. Because the review was designed as a structured narrative synthesis rather than a systematic review, no claim of exhaustive retrieval is made. Searches have been conducted during the last six months.

Synthesis and Interpretation

The synthesis distinguishes educational setting, stakeholder group, and form of collaboration. School-level studies are treated as adjacent evidence rather than direct tests of university co-creation. Student attitudes are separated from observed collaboration and learning outcomes, while perceived employability is separated from direct employer evidence. Proposed evaluation criteria are reported as future research recommendations rather than as findings from the reviewed studies.

Consequently, identified gaps refer to the literature synthesized in this review rather than demonstrating that no other relevant studies exist. The review therefore cannot establish causal effects, national prevalence, or comparative effectiveness.

For auditable interpretation, the synthesis distinguishes direct Croatian higher-education evidence, international higher-education evidence, K–12 evidence, and conceptual or review evidence. Each category supports a different level of inference: Croatian studies inform their reported settings, international studies support comparison and design principles, and school-level studies require adaptation to university autonomy, assessment, and governance.

Each substantive claim is interpreted in relation to the cited study's population, setting, design, and outcome. Table I makes these evidentiary roles explicit for sources central to Croatian contextualization and international comparison. It is a narrative evidence map rather than a quality-ranked inventory. Independent duplicate screening and formal risk of-bias assessment were not used, increasing the possibility of selection and interpretation bias.

Results and findings

The synthesis identifies five connected areas relevant to student–professor co-creation: stakeholder perspectives, Croatian AI use and preparation, evidence on collaborative design, employer and economic evaluation, and responsible technical conditions. Across these areas, the recurring distinction is between evidence of AI use or attitudes and evidence of shared educational decision-making. Proposed design and evaluation criteria are therefore reported separately from findings in the cited studies.

Stakeholder Perspectives on AI-Supported Education

Student-focused studies report interest in learning assistance and feedback together with requests for reliable information and guidance [22], [38]. Research across disciplines shows that attitudes and perceptions are important dimensions of AI integration [23], [39], and studies of education and careers indicate why student expectations should inform institutional discussion [33], [35]. However, favorable attitudes or frequent tool use do not establish participation in the design of AI-supported teaching or assessment.

Educator-focused research identifies potential teaching benefits alongside concerns about dependence, integrity, and professional preparation [25]–[27]. Student views about possible teacher replacement and AI–teacher collaboration further highlight questions of educator roles, control, and interpretation of learning activity [8], [40]. Taken together, the evidence suggests that co-creation requires explicit negotiation of roles and responsibilities rather than an assumption of shared expectations.

Multi-stakeholder research shows that AI acceptability depends on context and use case [32]. The implication for co-creation is methodological as well as practical: students' and professors' perspectives should be examined together, and enthusiasm from either group should not substitute for evidence about the fairness, educational quality, or acceptability of a specific collaborative practice.

Croatian Evidence on AI Use and Preparation

A Croatian institutional study by Vrana [41], conducted at FHSS Zagreb, provides an example of student AI use alongside limited formal preparation. Its importance lies in the potential gap between tool access and organized preparation; it does not estimate national prevalence or test student–professor co-creation. Rožman et al. [42] surveyed 471 business students in Slovenia, Croatia, and India and reported differences in AI knowledge and applications. These findings identify curricular questions, including ethical and legal understanding, but do not establish national educational effectiveness or the effect of co-design.

Spanish studies address a different construct. Research on disciplinary attitudes [39] and validation of the four-item Artificial Intelligence Attitude Scale (AIAS-4) in 650 university students [43] inform measurement of AI attitudes, not co-creation. The Croatian institutional study therefore informs local preparation needs, the Slovenia–Croatia–India study informs AI-literacy dimensions, and the Spanish studies inform instrument adaptation. Their different constructs and samples preclude a common country ranking; valid cross-context comparison would require aligned constructs, sampling frames, and measurement checks.

Croatian school-level research addresses teacher adoption, a three-year K–12 pilot, personalized learning and creative integration of AI in teaching [44], [45], [48], [49]. These studies identify issues of skills, task design, and implementation support, but do not establish how university students and professors jointly design curricula, assessment, or governance.

Table 1. Evidence Roles and Comparative Limits

Evidence and setting	Role in this review	Inference boundary
Vrana [41] FHSS Zagreb	Institutional AI use and preparation	One institutional context; no national prevalence estimate
Rožman et al. [42] Slovenia, Croatia, India	AI literacy among business students	Sample and construct differences preclude national effectiveness ranking
Almaraz-López et al. [39]; Luque-Reca et al. [43] Spain	Disciplinary attitudes and attitude measurement	Attitudes are distinct from co-creation and learning effects
Brodarič and Babić [44]; Lišnić et al. [45] Croatian schools	Teacher adoption and K–12 implementation	Requires adaptation to university autonomy and assessment
Martin et al. [46]; Williams and Ingle [47] International higher education	Participatory assessment and student–staff partnership	Examples for local design, not proof of Croatian effectiveness

Research on young entrepreneurs in Croatia provides context for the environment graduates may enter, but is not direct evidence about university teaching or employer requirements [50]. Across the Croatian sources reviewed, AI use, literacy, and implementation are more visible than sustained student–professor co-creation. The principal local evidence gap is therefore not whether AI is being used, but how shared educational design operates and with what outcomes.

Evidence on Co-Creation and Its Limits

International research provides examples of participatory assessment design, student-generated content, and student staff partnership [46], [47], [51]. Work on human–AI co creation and postdigital co-design broadens the conceptual discussion [52], [53]. These studies show that participation can be examined through shared tasks and design decisions rather than attitudes alone, but they do not establish a single model that can be assumed to transfer across Croatian universities.

Related studies examine AI-supported personal and collaborative learning environments [54], coordination in academic writing [7], comparisons of human and AI support in teacher education [55], and human–AI co-creation in programming education [56]. Because populations, interventions, and outcomes differ, these studies should inform design choices rather than be combined into a general causal claim about student–professor co-creation.

The literature is strongest in identifying design questions and examples; transfer across institutions remains uncertain. Reviews of co-creation and educational AI emphasize context, conceptual clarity, and rigorous evaluation [11] [13]. For Croatia, the unresolved question is how shared educational design operates over time, for which participants, and with what consequences for learning, agency, and responsibility.

Employer Perspectives and Economic Evaluation

Student perceptions of professional development and employment illuminate learner expectations [33], [35], but are not equivalent to direct employer assessments of graduate competence. Similarly, broader discussions of economic transformation and entrepreneurship education justify examining workforce relevance without establishing which AI competencies employers require in particular Croatian sectors [5], [34].

The reviewed literature also provides insufficient evidence to estimate the financial return of student professor co-creation in Croatian universities. A credible economic evaluation would require attributable benefits, full implementation costs, and an appropriate time horizon, while pedagogical outcomes should remain visible in their own terms rather than being converted automatically into monetary savings [5], [29], [37].

The evidence need is therefore specific: future research should connect observed shared educational design with learning outcomes, institutional conditions, direct employer input, and longitudinal cost data while keeping these evidence types analytically distinct.

Responsible Technical Conditions for Co-Creation

Educational AI systems can shape shared decisions through the data they use, the outputs they generate, and the mechanisms available for correction. Generative systems used for feedback raise questions about unsupported statements and prompt-sensitive responses, while predictive or adaptive systems raise questions about recommendations, differential error, and the data used to allocate support [10], [11]. These system classes require different evaluation approaches. The present review does not assess architectures or compare technical performance. Responsible-AI literature nevertheless supports attention to fairness, interpretability, privacy, and human oversight [4], [32], [57].

A future co-creation pilot could therefore include a task specific evaluation in which students and professors agree on criteria for acceptable AI feedback and document substantive errors, omissions, corrections, and appeals. Where justified and privacy-preserving, subgroup patterns and accessibility could also be examined. Data minimization, approved access, retention rules, and records of human review should accompany the task. These are proposed evaluation criteria, not technical findings of this review.

Discussion

Evaluating Shared Educational Design

Future Croatian research should directly examine how students and professors share decisions about AI-supported learning tasks, assessment criteria, feedback, and rules for responsible use. Project-based learning, reflective dialogue with AI, and participatory curriculum or assessment teams provide plausible settings for evaluation [46], [47], [58], but should be treated as designs to test rather than established solutions.

A feasible preliminary study would follow one semester across at least two comparable courses, preferably at more than one Croatian institution. Within a common assignment type, students and professors would jointly define assessment criteria, permissible AI assistance, disclosure, verification, and appeal procedures. A usual-practice comparator with the same learning objectives and access to the selected AI tool would help distinguish participatory design from tool access alone. Random allocation should be used only where sufficient independent course sections make it methodologically defensible; otherwise, the study should be framed as an exploratory matched-course pilot.

Baseline and post-task measures could be combined with interviews, design artefacts, observations, and workload logs. Primary pilot outcomes should emphasize feasibility, recruitment, retention, participation fidelity, and usable data; exploratory educational outcomes could include AI literacy, student agency, and task quality assessed with a common rubric. AIAS-4 may capture general attitudes [59], but should not substitute for measures of participation or learning. Any Croatian adaptation would require appropriate linguistic and measurement checks.

The study would also require institutional ethics approval, informed consent, voluntary research participation without grade penalties, and a suitable non-research learning option. With a small number of courses, analysis should emphasize feasibility, descriptive change, uncertainty, and qualitative explanation rather than a definitive causal estimate. The selected AI system, task conditions, errors, correction requests, and privacy incidents should be documented. These procedures describe future research and have not been implemented in this review.

A mixed-method design would connect reported attitudes with observed participation and assessment products. Prior research on shared control and student concerns provides dimensions such as transparency and responsibility [8], [9], while work on AI-assisted content creation illustrates the value of examining both process and product [51]. Agreement in self-reports alone would not establish the quality of a co-creation partnership.

Fig. 1 summarizes the AI Co-Creation Readiness Framework. AI access and use provide the context, but co creation requires readiness across stakeholder participation, institutional capacity, AI and digital competencies, responsible technical conditions, and external relevance and sustainability. These domains support shared educational decisions, which can then be evaluated through participation, learning, agency, responsibility, implementation burden, and costs. The framework is a conceptual synthesis for future testing rather than a validated causal model.



Fig. 1. Proposed AI Co-Creation Readiness Framework linking readiness domains, shared educational decisions, and evaluation outcomes.

Within the framework, readiness refers to conditions that permit responsible co-creation. Stakeholder participation concerns whose proposals shape tasks and assessment; institutional capacity concerns policy clarity, time, support, and accountability; digital and AI competencies concern critical appraisal of system capabilities and limitations; responsible technical conditions concern error handling, fairness, privacy, explanation, and human review; and external relevance and sustainability concern curriculum relevance, employer input, and implementation burden. Candidate indicators include decision logs, documented support arrangements, task-based literacy measures, error and-appeal records, and cost logs. These indicators are proposed operationalizations, not a composite readiness score, and would require content review and psychometric testing before any scale development.

Measuring Attitudes and Learning Processes

Validated instruments can support the measurement of clearly defined constructs. The four-item Artificial Intelligence Attitude Scale (AIAS-4) measures general attitudes toward AI [59], with validation studies in Norwegian and Spanish university populations providing methodological examples [43], [60]. Additional research has examined AI attitudes in other student samples [61]. An attitude scale, however, should not be treated as a direct measure of co-creation, institutional readiness, or learning effectiveness.

For Croatian research, translated instruments should be examined for linguistic suitability and measurement quality in the target population. Attitude measures should be combined with evidence of shared decision-making, task participation, and evaluation of AI outputs. Longitudinal follow-up could help distinguish initial novelty from sustained practice. Comparison groups or interventions may strengthen inference, but causal conclusions would still depend on design quality and its assumptions.

Institutional Capacity and Responsible Participation

Educator development should address educational design and responsible use as well as technical skills. Studies of co creation among innovation champions and open-schooling initiatives offer adjacent examples of participatory competence development [62], [63]. Their transfer to higher education requires adaptation to adult learner autonomy, disciplinary standards, assessed authorship, university grading, data access, accountability, and student representation. Principles may transfer; effectiveness requires separate university-level evaluation.

Institutions should also create structured opportunities for students and professors to discuss acceptable AI assistance, authorship, output verification, and sensitive information. Research on responsible-AI education informs these priorities [4], [57], while discipline-specific evidence, including medical education, reinforces the importance of context [64]. Croatian studies should therefore compare institutional types and resource conditions rather than generalize from a single faculty.

Employer Input and Economic Sustainability

Future research should collect direct employer perspectives through interviews, surveys, or participation in curriculum discussions. Comparing these data with student and professor expectations would identify areas of agreement and disagreement about graduate AI competencies while preventing assumed market needs from substituting for educational judgment.

Economic evaluation should compare co-designed practice with usual practice over a defined period and report implementation costs alongside educational outcomes. Costs may include software, training, maintenance, technical support, and staff time, with student time reported separately. A cost-consequence approach can preserve outcomes such as learning quality, agency, accessibility, workload, and responsible participation rather than forcing them into a single monetary measure. Financial ROI should be estimated only when benefits can be credibly attributed and monetized. The present review estimates neither pedagogical effects nor financial returns.

Limitations

This structured narrative review is selective and does not establish exhaustive coverage. Croatian higher-education evidence is geographically and institutionally limited and cannot establish national representativeness. International comparisons use heterogeneous populations, measures, designs, and policy settings; they support contextual interpretation rather than causal country ranking. K–12 and discipline-specific evidence is adjacent and requires adaptation before application to Croatian universities. No primary participant data, technical algorithm experiment, formal meta-analysis, evidence-certainty grading, or pedagogical or financial ROI estimate is reported. The proposed AI Co-Creation Readiness Framework is conceptual and unvalidated; effectiveness, generalizability, technical performance, and economic value remain questions for empirical testing.

Conclusion

This review distinguishes AI adoption from student professor co-creation in higher education. Across the Croatian evidence identified, research has focused primarily on AI use, literacy, attitudes, and implementation rather than sustained shared educational decision-making. The proposed AI Co-Creation Readiness Framework integrates five conditions for future empirical investigation: stakeholder participation and agency, institutional capacity and governance, digital and AI competencies, responsible technical conditions, and external relevance and sustainability.

Future Croatian research should test these domains through mixed-method co-design studies that directly observe how students and professors jointly shape AI supported learning. The central research challenge is therefore no longer simply whether AI is used in higher education, but how its use can be jointly designed, governed, and evaluated in an educationally meaningful and responsible manner.

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