The AI Factory Blueprint for Higher Education

A Standardized Framework for Unified AI Deployment Across Universities

A Doctoral Research Report
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> *"The institutions that will define the next century of scholarship are not those that bought the most GPUs. They are the ones that built a coherent, governed, and reusable AI factory; one that turns every dollar of compute into compounding intellectual capital."*
>
> **— Dr. Matt McKenna, Foreword, 2026**

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Foreword by Dr. Matt McKenna

This report is published as part of my ongoing research portfolio on vertical AI transformation, and specifically as my professional commitment to deliver a defensible, executable path forward for the Higher-Education vertical. The inspiration for this work arises from the upcoming conversations that I will inevitably have with Provosts, CIOs, Deans, and Department Heads, who all asked the same question in different forms. I imagine it will go something like this: *"We see the AI tidal wave coming, but how do we build something that simultaneously serves a 50,000-student undergraduate population, a 5,000-researcher portfolio, a hospital system, an athletics enterprise, and a research-park startup ecosystem — without buying the same infrastructure five times and without ceding our data sovereignty to a hyperscaler?"*

This report is my answer. It synthesizes 24 months of evidence (January 2024 through May 2026) from EDUCAUSE, Stanford HAI, McKinsey, Gartner, HolonIQ, Tyton Partners, UNESCO, OECD, the U.S. National Science Foundation, the European Union, and more than thirty leading universities. It then translates that evidence into a concrete, defensible blueprint anchored in the Dell AI Factory with NVIDIA framework — chosen not out of vendor preference, but because, as of Q1 2026, Dell and NVIDIA jointly publish the most comprehensive, validated, and modular reference architecture for on-premises and sovereign enterprise AI (Dell Technologies, 2026a).

The reader — whether a tenured PhD, a Dean weighing a nine-figure capital request, or a Department Head defending a research compute line item — should finish this report with two forms of confidence: intellectual confidence that the analysis withstands peer review, and operational confidence that the blueprint can be acted upon tomorrow. The 12–15 doctoral research opportunities in Section XII are explicitly offered to the next generation of scholar-practitioners who will inherit, refine, and ultimately surpass the framework presented here.

This work is published in the service of the Higher Education vertical and of the public good it sustains.

— Dr. Matt McKenna, May 2026

1.0 Executive Summary

Higher education stands at a structural inflection point. Between January 2024 and May 2026, institution-wide adoption of artificial intelligence in U.S. higher education surged from 49% to 66%, a 17-percentage-point increase in a single year, and 91% of higher-education administrators now report personal use of AI. Yet only 43% of institutions have formally incorporated AI into strategic plans, and the #1 institutional barrier remains data security and privacy at 56% (Ellucian, 2025). The gap between individual experimentation and institutional capability is now the central management problem of the sector.

In parallel, MIT's Project NANDA found that 95% of enterprise generative-AI pilots fail to produce measurable P&L impact (Fortune, 2025; MLQ.ai, 2025). The cause is rarely the model — it is the absence of a productionized, governed, multi-tenant AI factory capable of moving an idea from pilot to enterprise scale. Universities are not immune: the AAUP reports that faculty are systematically excluded from AI decisions at most institutions, and EDUCAUSE finds that "shadow AI" spending — fragmented departmental SaaS contracts — is the dominant pattern of capital allocation (Inside Higher Ed, 2025c; EDUCAUSE, 2025a).

A. Decisive Factory Economics

A centralized, standardized AI factory documents a 269% first-year ROI, a 1,225% four-year ROI, and inferencing economics that are 2.6× more cost-effective than IaaS and 4.1× more cost-effective than public API services (Dell Technologies, 2026b).

B. Validated Reference Architecture

The Dell AI Factory with NVIDIA is the most defensible, modular, and validated multi-tenant reference architecture for higher education data sovereignty and scalable deployment.

C. Unified & Federated Support

A single physical AI factory can support unified central services and federated departmental/lab installations via namespace multi-tenancy and Kubernetes-based MLOps.

D. Future-Proofed Investment

The blueprint readies institutions for agentic AI, physical AI/robotics, sovereign AI, and quantum-classical hybrid workloads without tearing down today's infrastructure investment.

- **Regulatory Failure:** Inability to comply with the EU AI Act's August 2026 full applicability (European Commission, 2024).

2.0 The State of AI in Higher Education (2024–2026)

Adoption: The 49% → 66% Inflection

The Ellucian 2025 AI in Higher Education Survey documents that 49% of institutions were using AI broadly in 2024; by 2025 that figure reached 66%. More than half of institutions are now using AI for curriculum design (54%) and administrative automation, though alignment of funding and policy heavily lags experimentation (Ellucian, 2025; UMass IDEAS, 2025; GovTech, 2025).

2.1 Faculty Sentiment: Productive Anxiety

Despite high usage, 68% of faculty say their institutions have not prepared them to use AI in teaching, mentorship, or scholarship. Furthermore, 48% of faculty believe student research has gotten worse because of GenAI (Inside Higher Ed, 2026; EDUCAUSE, 2026).

2.2 Student Sentiment and Equity

Tyton Partners' *Time for Class 2025* documents that faculty workload in course-content development, assessment design, and feedback has measurably decreased among AI-adopting instructors (Tyton Partners, 2025). Meanwhile, Inside Higher Ed's Student Voice survey confirms students desire AI literacy integration but lack uniform trust in professors to teach it effectively (Inside Higher Ed, 2025).

2.3 Market Size and Capital Flows

The global education market is projected to reach nearly US$10 trillion by 2030 (HolonIQ, 2025). Stanford HAI's AI Index 2025 and McKinsey's State of AI 2025 show rising global investment but a persistent failure to scale in many organizations—underscoring the critical need for an enterprise-grade, productionized AI factory (Stanford HAI, 2025; McKinsey, 2025).

2.4 Regulatory Landscape

Jurisdiction / Authority	Instrument	Key Date / Implication	Source
European Union	AI Act (Reg. 2024/1689)	Full applicability Aug 2026; High-risk classification for admissions/grading	EU Commission
United States	White House EO on AI Education	Signed April 2025; Funds K-20 AI literacy	White House
US Dept of Education	Guidance & FERPA Updates	AI ingested student data must comply with records/consent rules	US ED / AACRAO
NIH	Policy on AI in Grants	Effective Sept 2025; Requires strict disclosure in proposals	SRA Int.
UNESCO	Generative AI Guidance	Global ethical baseline frameworks	UNESCO
US NSF	NAIRR Pilot	Institutional AI infrastructure prerequisite for allocations	NSF

> *"AI is forcing higher education to re-examine the value it offers to students."*

3.0 Use Case Taxonomy: Four Pillars

The higher-education AI opportunity is not a single application category but an institutional portfolio. The evidence from 2024–2026 supports at least 28 concrete use cases distributed across student success, pedagogy, research acceleration, and administrative efficiency. The strategic implication is clear: one standardized AI factory can serve all 28 use cases with one capital outlay, one security boundary, and one governance regime.

3.1: Pillar 1 — Student Services & Success

#	Use Case	Institution / Evidence	Observed Value
1	Personalized AI tutoring and student support	Arizona State University / OpenAI-ASU collaboration	Scaled student-facing experimentation and course support across hundreds of projects.
2	Course and advising chatbot creation in a closed institutional environment	University of Michigan Maizey / U-M GenAI	Institution-controlled generative AI with strong data-sovereignty posture for teaching and support.
3	24×7 enrollment, advising, and self-service student assistance	California State University system	System-scale rollout to roughly 500,000 students and faculty demonstrates enterprise viability.
4	AI early-warning and retention analytics	Sector-wide implementations	Earlier identification of at-risk students, enabling revenue protection and persistence interventions.
5	Accessibility support, captioning, and assistive academic services	Penn State AI Studio	Enterprise AI access supports inclusive learning design and campus accessibility workflows.
6	Mental-health triage and wellness engagement	Vanderbilt Amplify	Human-centered AI experimentation expands student support capacity while preserving escalation to professionals.
7	Financial-aid guidance and high-volume inquiry deflection	Sector-wide practice pattern	Reduces response latency and improves navigation of complex student-service processes.

3.2: Pillar 2 — Teaching & Learning

#	Use Case	Institution / Evidence	Observed Value
8	Course-specific RAG tutor grounded in institutional materials	Harvard CS50.ai research	Pedagogically constrained AI performs better for education than generic chatbot use.
9	Virtual teaching assistant at scale	Georgia Tech Jill Watson	Demonstrates improved classroom alignment and scalable student support.
10	AI-assisted grading and rapid formative feedback	Sector-wide adoption pattern	Reduces turnaround time for instructors and expands feedback frequency.
11	Assessment redesign and academic-integrity adaptation	Cornell Generative AI services	Supports institution-wide policy transition from prohibition to governed integration.
12	Simulation-based learning for clinical and technical disciplines	Vanderbilt	Improves experiential learning in complex environments that benefit from adaptive scenarios.
13	Faculty workflow assistance for content development and lesson preparation	Tyton Partners and sector-wide practice	Decreases time spent developing course materials and assessments.
14	AI literacy embedded across disciplines	University of Florida / HiPerGator expansion	Demonstrates how compute infrastructure and curricular ambition reinforce each other.

3.3: Pillar 3 — Research Acceleration

#	Use Case	Institution / Evidence	Observed Value
15	LLM-assisted literature review and synthesis	Leading research universities	Accelerates evidence discovery and manuscript preparation for advanced research teams.
16	Large-scale HPC and AI research infrastructure	University of Florida acquisition / HiPerGator AI 2.0	Illustrates research-compute leadership and partnership leverage.
17	AI-accelerated invention and engineering research	Princeton AI Lab	Shows how seed-funding ecosystems convert shared AI capacity into new discovery pipelines.
18	Drug discovery and computational biomedicine	Research-intensive biomedical institutions	Supports model-driven hypothesis generation and faster preclinical research cycles.
19	Climate, materials, and scientific modeling	NAIRR-aligned and HPC institutions	Extends AI factory utility beyond text into simulation-rich scientific domains.
20	Physical AI and robotics	Carnegie Mellon	Signals convergence of AI, robotics, and real-world embodied systems research.
21	Cross-disciplinary cognitive science and AI inquiry	Princeton ecosystem	Demonstrates institutional value of shared AI infrastructure for interdisciplinary scholarship.

3.4: Pillar 4 — Administrative & Operational Efficiency

#	Use Case	Institution / Evidence	Observed Value
22	Grant-writing acceleration and research administration support	Research administration teams	Improves proposal throughput, review support, and sponsored-program responsiveness.
23	IT help desk automation	Sector-wide enterprise deployments	Raises containment rates and reallocates staff time to higher-value support work.
24	Enrollment management and marketing optimization	System-scale and enterprise practice	Supports lead nurturing, communication orchestration, and agentic outreach.
25	Alumni and advancement engagement	University advancement teams	Personalizes donor communications and improves campaign targeting.
26	HR, procurement, and finance co-pilots	Enterprise AI operating model	Captures recurring productivity gains in non-academic administrative functions.
27	Facilities and sustainability analytics	Cornell and peer institutions	Extends AI from student-facing tools into campus operations and environmental planning.
28	Enterprise accessibility, workflow, and staff enablement	Penn State	Creates a controlled, reusable platform for staff productivity and institutional experimentation.

> **STRATEGIC INTERPRETATION**
>
> If each college, department, and service office pursues these use cases independently, the university buys the same capabilities repeatedly—GPUs, vector databases, IAM integration, audit logging, model hosting, and policy oversight. A standardized AI factory collapses those duplications into one reusable institutional platform.

4.0 The Economic Case for a Standardized AI Factory

269% First-Year ROI	**1,225%** Four-Year ROI
2.6× More Cost-Effective than IaaS	**4.1×** More Cost-Effective than Public API Services

Metrics based on independent ESG validation of Dell AI Factory architectures (Dell Technologies ESG, 2026b; Futurum Group; Dell Enterprise AI ROI).

4.1 Shadow-AI Spending and Cost of Not Acting

Without a central factory, universities accumulate fragmented SaaS contracts resulting in duplicated costs and governance blind spots. The economic burden of not acting also includes high student attrition costs, loss of competitive grant capacity, and lack of sovereign data compliance required for sensitive intellectual property and HIPAA/FERPA protected data.

5.0 Dell AI Factory Framework Applied to Higher Education

The Dell AI Factory provides a comprehensive, end-to-end, on-premises enterprise AI system spanning compute, storage, networking, and software. (Dell Technologies, 2024a; NVIDIA Validated Factories).

Platform Component	Role in Higher Education
PowerEdge XE9680	Workhorse node for model customization, secure fine-tuning, and faculty/research workloads.
PowerEdge XE9712	NVIDIA GB200 NVL72-scale capacity for large-model training and inference at university-system scale. (Spec Sheet)
PowerEdge XE9812	Vera Rubin generation for premier research universities seeking future-ready performance and density. (Dell PR, 2026)
PowerScale	Scale-out data layer for library RAG, archival search, course corpora, genomics, imaging, and climate data.
Dell PowerSwitch + Spectrum-X / InfiniBand	High-throughput networking to support distributed training, low-latency inferencing, and multi-tenant campus clusters.
NVIDIA AI Enterprise	Production software layer for secure deployment, orchestration, lifecycle control, and validated enterprise AI operations.
NIM Microservices	Standardized inference endpoints for advising bots, tutoring systems, research copilots, and agentic campus workflows.
Dell Enterprise Hub on Hugging Face	Simplifies validated open-model deployment under university control, including Llama and Mistral families. (Dell Blog)
Project Helix	Conceptual foundation for secure on-premises generative AI that evolved into the broader AI factory model.
Agentic AI Platform	Enables multi-step automation for admissions, research administration, help desk, and enterprise process orchestration.
NVQLink + CUDA-Q Roadmap	Future-proofs the investment for quantum-classical hybrid research in chemistry, materials, and optimization.
Sovereign AI Controls	Aligns institutional AI with FERPA, HIPAA, and cross-border research requirements by preserving data control. (Sovereign AI)

5.1 AI Factory Layer-to-Use-Case Mapping

Factory Layer	Higher-Education Application
Compute	Fine-tuning institutional tutors, research-compute acceleration, and large-scale inferencing.
Storage	Library and archival RAG, course content repositories, research data lakes, and secure retention pipelines.
Networking	Cross-department distributed training, high-bandwidth access to shared GPUs, and low-latency agentic services.
Model & Runtime Layer	Reusable endpoints for advising, tutoring, research writing, accessibility, and operations co-pilots.
Governance & Sovereignty	Institutional control over protected data, model choice, auditability, and regulatory compliance.

5.2 Reference Architecture Blueprint

A single physical architecture supporting both centralized IT (unified) and collegiate research labs (federated).

LAYER 6: GOVERNANCE, SECURITY & ETHICS

AI Steering Committee · Ethics Board · EU AI Act controls · FERPA/HIPAA audits

LAYER 5: APPLICATIONS

Unified: AdvisingBots, HelpDesk.
Federated: CS50.ai tutors, Clinical RAG, Research Notebooks.

LAYER 4: PLATFORM / MLOPS

Kubernetes · NVIDIA AI Enterprise · NIM · Triton · NeMo · ClearML

LAYER 3: MODELS

Foundation Models (Closed/Open) · Llama 3/4 ·
Mistral · Campus-specific Fine-Tuned Models

LAYER 2: DATA

PowerScale Data Lake · Vector DB (Elasticsearch/Milvus) · Synthetics · DLP

LAYER 1: INFRASTRUCTURE

Compute (XE9680/XE9712/XE9812) · Network (Spectrum-X) ·
Storage (PowerScale RAG Connector)

5.3 Unified + Federated Tenancy Model

Tenant Type	Governance Boundary	Compute & Data Isolation
University-wide (Unified)	AI Steering Committee + CIO	Reserved baseline compute; Institutional data lake
College / School (Federated)	Dean + Faculty Senate Delegate	Burstable share; College namespace (e.g. Medicine)
Department / Lab	PI Accountability + IRB-AI	Project-scoped via JupyterHub; PI data stewardship
Sponsored Research / Industry	OSP + Sponsored Programs	Isolated tenancy with billing; Contractual data enclave

5.4 Implementation Roadmap (24–36 Months)

- **Phase 0 — Foundations (Months 0–3):** Charter AI Steering Committee, publish Acceptable Use Policy, inventory shadow AI, and establish use-case baselines.

- **Phase 1 — Pilot Factory (Months 3–9):** Deploy PowerEdge XE9680/XE7745 node, PowerScale, and NVIDIA AI Enterprise. Launch flagship advising, course-RAG, and grant-writing copilots.

- **Phase 2 — Scale (Months 9–18):** Add XE9712 (GB200 NVL72), introduce multi-tenant namespaces for departmental onboarding, launch agentic AI pilots, and achieve EU AI Act documentation parity.

- **Phase 3 — Optimize and Federate (Months 18–36):** Transition to XE9812 and NVQLink for quantum-hybrid workloads, standardize federated model garden, and open cost-recovery models for sponsored research.

6.0 Funding Strategy

Source	Indicative Mechanism
Capital	Endowment-backed bond, capital campaign themes, deferred maintenance reallocation
Operating	Tuition technology fee carve-out, central IT chargeback models
Federal Grants	NSF MSRI, NSF NAIRR Operations Center alignment
Industry/Philanthropic	NVIDIA Inception, Dell partnerships, Gates/Mellon/Spencer Foundation alignment
State/Regional	State innovation hubs (e.g., NJEDA AI Hub models)

7.0 Risk Register & Mitigation

Risk Vector	Likelihood / Impact	Mitigation Strategy
Hallucination in Student Tools	High / High	Mandatory RAG grounding, human-in-the-loop validation, confidence thresholds
Bias in Admissions/Grading	Medium / High	EU AI Act high-risk procedures, UNESCO bias audit alignment
FERPA/HIPAA API Exposure	High / High	On-premises AI factory, namespace partitioning, sovereign AI posture
Faculty Resistance	High / Medium	Faculty Senate AI delegates, AAUP-aligned shared governance
Vendor Lock-In & Drift	Medium / Medium	Open-source models via Dell Enterprise Hub, continuous MLOps evaluation
Sustainability & Energy	High / Medium	Liquid-cooled infrastructure, PUE optimization, environmental tracking
Equity of Access & Over-Reliance	High / High	Subsidized universal access (e.g., CSU pattern), faculty-led AI literacy curricula
Future Obsolescence	Low / High	Modular Dell architecture, committed NVQLink/CUDA-Q roadmap upgrades

8.0 ROI Model & KPIs

When ESG's modeled economics are translated into a representative R1 university environment, approximately 50,000 students, 5,000 faculty and research staff, and roughly 10,000 power users, the resulting business case is not speculative. It is a capital-planning grade. The institution-wide gains accrue across productivity, retention, research throughput, operational efficiency, and compliance avoidance.

~$68.7M **Modeled 4-Year Total Benefit**	**500–700%** **Estimated Net ROI Range**
$8–12M **Indicative 4-Year Capex + Opex**	**5 Streams** **Productivity, Retention, Grants, Ops, Compliance**

9.0 Modeled Benefit Streams

Benefit Stream	Indicative 4-Year Value	Basis
Productivity gains across 10,000 power users	$20.0M	Staff and faculty time savings, workflow automation, and co-pilot adoption.
Retention lift	$10.0M	Illustrative 1% persistence improvement across a large tuition base.
Grant-capture acceleration	$36.0M	Small percentage increase in success over a large sponsored-research portfolio.
Operational efficiency and tool consolidation	$1.6M	Reduced duplication, ticket deflection, and central platform reuse.
Security and compliance risk avoidance	$1.1M	Lowered exposure associated with fragmented AI procurement and uncontrolled data use.

9.1 KPI Dashboard

Category	Leading Indicator	Lagging Indicator
Student Success	Advising case deflection rate (target ≥25%)	First-to-second-year retention lift (target +1.5 points)
Teaching	Faculty hours saved per course and feedback turnaround time	Course evaluations, authentic-assessment quality, and learning-outcome attainment
Research	LLM-assisted literature reviews, proposal drafts, and model runs completed	Grant capture rate, time-to-publication, and interdisciplinary project growth
Operations	Chatbot containment rate, auto-resolution rate, and shared-platform utilization	FTE redeployment, cycle-time reduction, and cost per institutional inference
Sustainability	PUE, tokens per kWh, and liquid-cooled workload share	Total emissions relative to baseline and compute-efficiency gains
Governance	% of use cases with ethics review, model cards, and documented controls	Audit pass rates, FERPA/HIPAA incidents, and AI Act readiness status

10.0 Future-Proofing & Path Forward

The standardized AI factory approach is expressly designed to absorb the next four vectors of technological advancement without tearing down initial investments:

- **Agentic AI:** Moving beyond simple chat to multi-agent automated reasoning in admissions workflows and research administration.
- **Physical AI & Robotics:** Foundational models connecting digital reasoning to physical robotics environments (e.g., CMU institutes) powered by robust on-prem GPU clusters.
- **Sovereign AI:** Hardening data control boundaries to meet accelerating geopolitical and regulatory strictures on critical intellectual property and clinical datasets.
- **Quantum-Classical Hybrid Computing:** Dell PowerEdge integration with NVQLink and CUDA-Q provides the bridge to quantum-accelerated materials science, chemistry, and optimization research natively within the established factory.

11.0 Conclusion & Call to Action

The era of pilot-stage AI is effectively over; the era of the governed, standardized AI factory has begun. Deans and Department Heads are urged to execute the following agenda:

1. **90 Days:** Charter an AI Steering Committee, audit shadow IT spending, and publish acceptable use policies.
2. **6 Months:** Deploy a pilot single-node factory (XE9680/XE7745) testing foundational multi-tenancy.
3. **18 Months:** Scale to system-wide deployment (XE9712) incorporating rigorous EU AI Act documentation parity.
4. **36 Months:** Federate the factory across all academic colleges and integrate quantum-hybrid infrastructure lines.

> *"AI won't replace the university, but universities that do not operationalize AI will be replaced by those that do."*

12.0 Doctoral Research Opportunities

The report does more than recommend a blueprint; it opens a long-horizon scholarly agenda. The following fifteen topics are dissertation-grade opportunities for doctoral candidates, postdoctoral researchers, and faculty scholars seeking to define this field rather than merely participate in it.

1. Federated AI Factory Governance

How should multi-tenant AI factories be governed across central IT, colleges, and PI-led labs?

- **Methodology:** Mixed-methods comparative case study.
- **Target journals:** *EDUCAUSE Review*, *Computers & Education: Artificial Intelligence*.
- **Grant alignment:** NSF SaTC, Spencer Foundation.

2. Sovereign AI Posture and Research Competitiveness

Does on-premises AI capacity improve grant capture, cross-border collaboration readiness, and IP retention?

- **Methodology:** Difference-in-differences or causal inference design.
- **Target journals:** *Research Policy*, *Science*.
- **Grant alignment:** NSF SciSIP, Sloan Foundation.

3. Total Cost of Ownership of Shadow AI

What is the real procurement, integration, and compliance cost of decentralized AI purchasing?

- **Methodology:** Procurement-record analysis and sector survey replication.
- **Target journals:** *Journal of Higher Education*, *Tertiary Education and Management*.
- **Grant alignment:** Lumina, institutional research partnerships.

4. **Faculty Shared Governance in AI Decision-Making**
   How can universities restore faculty voice in AI policy, procurement, and instructional governance?

- **Methodology:** National survey plus institutional case interviews.
- **Target journals:** *Higher Education*, *Academe*.
- **Grant alignment:** AAUP-Mellon initiatives.

5. **Retention Lift Attribution in AI Early-Warning Systems**
   Which persistence gains can actually be causally attributed to AI-enabled intervention workflows?

   Methodology: Quasi-experimental IV or matched cohort design.
   Target journals: *American Educational Research Journal*, *Educational Researcher*.
   Grant alignment: IES, Gates Foundation.

6. **AI-Assisted Grant Writing and Funding Equity**
   Will AI-supported proposal development reduce or widen inequalities across R1, R2, and MSI institutions?

   Methodology: Natural experiment after NIH AI-policy implementation.
   Target journals: *Nature*, *PLOS ONE*.
   Grant alignment: NSF Build & Broaden, Spencer.

7. **Carbon-Aware AI Factory Scheduling**
   Can campus AI workloads be scheduled to optimize both performance and emissions?

   Methodology: Multi-objective optimization with telemetry data.
   Target journals: *Nature Energy*, *ACM e-Energy*.
   Grant alignment: DOE-ASCR, NSF CSSI.

8. **EU AI Act Compliance Architectures for U.S.–EU Research**
   What technical and legal architecture best supports compliant transatlantic university collaboration?

   Methodology: Doctrinal legal analysis plus reference-architecture mapping.
   Target journals: *Computer Law & Security Review*, *Harvard JOLT*.
   Grant alignment: ERC, Mellon.

9. **Agentic AI in Undergraduate Advising**
   Can agentic systems improve persistence, response quality, and student satisfaction beyond chatbot baselines?

   Methodology: Randomized controlled trial at first-year scale.
   Target journals: *Science Advances*, *Educational Evaluation and Policy Analysis*.
   Grant alignment: IES, NSF EDU Core Research.

10. **Pedagogy of Course-Specific RAG Tutors**
    How do domain-constrained tutors affect learning gains, misconceptions, and academic confidence?

    Methodology: Multi-site RCT extending the CS50.ai pattern.
    Target journals: *Computers & Education*, *L@S Proceedings*.
    Grant alignment: NSF IUSE, Schmidt Sciences.

11. **Equity of Access in System-Scale AI Deployments**
    Do universal deployments reduce digital inequity or simply reproduce existing capability gaps?

Methodology: Longitudinal cohort analysis by Pell status, major, and modality.
Target journals: *Sociology of Education*, *Educational Researcher*.
Grant alignment: IES, Hewlett Foundation.

12. Quantum-Hybrid Research Acceleration in University AI Factories
What measurable scientific speedups emerge when quantum-classical workflows are integrated into campus AI factories?

Methodology: Benchmarking on CUDA-Q-enabled clusters plus case studies.
Target journals: *Nature Computational Science*, *npj Quantum Information*.
Grant alignment: DOE-NQISRC, NSF quantum programs.

13. AI Literacy Curriculum Design Across Disciplines
What does it take to embed AI literacy meaningfully beyond computer science?

Methodology: Design-based research and cross-institutional replication.
Target journals: *Journal of the Learning Sciences*, *Higher Education Pedagogies*.
Grant alignment: NSF EDU, Carnegie Corporation.

14. Faculty Mental Models of Hallucination and Pedagogical Trust
How do faculty interpret hallucination, reliability, and pedagogical risk when integrating AI into teaching?

Methodology: Phenomenological interviews across disciplines.
Target journals: *Studies in Higher Education*, *Higher Education Research & Development*.
Grant alignment: Spencer, Mellon.

15. The Doctoral Student as AI-Augmented Researcher
How is doctoral apprenticeship changing as AI becomes embedded in reading, synthesis, coding, and authorship?

Methodology: Longitudinal qualitative study across disciplines.
Target journals: *Studies in Graduate and Postdoctoral Education*, *Higher Education*.
Grant alignment: CGS-ETS, Mellon Public Knowledge initiatives.

13.0 References (APA 7th, 2024–2026)

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