Integrating AI, HPC, CI, and Science Gateways into the Classroom

Summary

This research is on integrating Artificial Intelligence (AI), High-Performance Computing (HPC), Cyberinfrastructure (CI), and Science Gateway tools into university classrooms.

Key Findings:

- AI integration is advancing rapidly, but it does face significant faculty adoption barriers related to training, workload, and ethical concerns like cheating and plagiarism.
- Science gateways successfully lower technical barriers and broaden access to advanced computing.
- Faculty professional development is critical, but often inadequate or inaccessible

AI integrated into Education

1. U.S. Department of Education (2023). "Artificial Intelligence and Future of Teaching and Learning: Insights and Recommendations"

Source: Office of Educational Technology Report

Context: National policy framework; K-12 and higher education

Technologies: AI-powered educational tools, learning analytics, adaptive learning systems

Key Findings:

- Educators already use AI in daily life, but need support for classroom integration
- Student privacy (FERPA) and accessibility (IDEA) compliance are critical concerns
- AI can address unmet educational prioritie,s but requires safe, effective, scalable approaches
- European guidelines emphasize ethical AI use in teaching and learning

Lessons Learned:

- Policy frameworks are essential before widespread AI adoption
- Educators need clarity on which AI uses support learning objectives
- Privacy and equity considerations must be addressed proactively

2. Southworth, J. & Migliaccio, K. (2023). "Developing a model for AI Across the curriculum: Transforming the higher education landscape via innovation in AI literacy"

Source:https://www.researchgate.net/publication/367312611_Developing_a_model_for_AI_Across_the_curriculum_Transforming_the_higher_education_landscape_via_innovation_in_AI_literacy

Context: Institution-wide AI initiative; undergraduate curriculum reform

Technologies: AIED (Artificial Intelligence in Education), AI bootcamps

Key Findings:

- 100+ faculty hired across 16 colleges with an AI focus
- The Centralized AI Academic Initiative (AI2) Center provides leadership
- AI pedagogy requires new teaching methods and strategies
- International models (Singapore, EU, Hong Kong) provide frameworks

Instructional Approach:

- AI Across the Curriculum model integrating AI into all disciplines
- Faculty hiring initiative to build institutional capacity
- Student-facing programs: "AI for Students" and "AI Bootcamps"
- Partnership with corporate philanthropy and supercomputer infrastructure

Lessons Learned:

- Institution-wide transformation requires significant investment
- Centralized leadership and coordination are essential
- AI education must span all disciplines, not just STEM
- Student capabilities must align with workforce needs

HPC in Undergraduate Education

3. Brown, S.T. et al. (2024). "Integrating High Performance Computing into Higher Education and the Pedagogy of Cluster Computing"

Source: https://dl.acm.org/doi/10.1145/3626203.3670588

Context: Wake Forest University; undergraduate HPC course (CSC191)

Technologies: DEAC Cluster, Slurm scheduler, MPI, parallel computing

Key Findings:

- Significant gap between academic preparation and industry HPC demands
- Students need hands-on experience with job schedulers and cluster architecture
- Physical datacenter tours enhance understanding of HPC infrastructure
- Course enables students to participate in Student Cluster Competition

Instructional Approach:

- Foundational command-line skills and HPC system interaction
- Midterm assessment: submitting jobs with varying parameters
- Hands-on disassembly of compute nodes to understand hardware
- Integration with undergraduate research opportunities
- Mentorship for Student Cluster Competition teams

Lessons Learned:

- Browser-based tools (Google Colab) are too limited for real HPC training
- Students need consistent access to actual cluster resources
- Tangible experiences (datacenter tours, hardware) improve retention
- Course prepares students for graduate programs and industry positions
- URECA research grants leverage HPC skills learned in class

4. Working Group Reports (2020). "High Performance Computing Education"

Source: ACM ITiCSE Conference Proceedings

Context: Undergraduate computing education; international perspective

Technologies: MPI, OpenMP, GPU programming, parallel computing concepts

Key Findings:

- HPCEd faces challenges in making inroads into standard CS curriculum
- Need for pedagogical approaches that scale to diverse student populations
- Importance of connecting HPC to real-world applications
- Integration challenges at undergraduate level across institutions

Instructional Approach:

- Moderated two-stage projects improve student performance
- Research-infused teaching brings authentic problems to classroom
- Hands-on laboratory components essential for learning
- Integration across multiple courses rather than single elective

Lessons Learned:

- HPC education benefits from interdisciplinary applications
- Early introduction (undergraduate level) is critical for pipeline
- Need for standardized competency frameworks
- Faculty development is as important as student training

5. Georgia Tech & University at Albany (2024). "Universities Invest in High Performance Computing to Support AI Education"

Source:
https://www.gatech.edu/news/2024/04/10/georgia-tech-unveils-new-ai-makerspace-collaboration-nvidia

Context: Large research universities; AI education infrastructure

Technologies: NVIDIA HGX servers, H100 GPUs, AI Makerspace, DGX Cloud

Key Findings:

- Dedicated HPC systems for instruction democratize AI access
- AI Makerspace used in 10+ courses including non-CS students
- Students build practical AI applications (e.g., campus location identifier)

- Faculty across colleges encouraged to use supercomputer resources

Instructional Approach:

- Hands-on AI application development in classroom
- Capstone projects and CREATE-X entrepreneurship program integration
- Foundation courses open to second-year students from all backgrounds
- Partnership model with industry (NVIDIA) for infrastructure

Lessons Learned:

- Dedicated instructional HPC separate from research computing is valuable
- Removes "daunting" factor through structured, doable projects
- Cross-college adoption requires proactive encouragement
- Industry partnerships can provide state-of-the-art technology

6. ACCESS Program (2022-present). "Advanced Cyberinfrastructure Coordination Ecosystem"

Source: NSF Program Documentation and University Implementations

Context: National CI ecosystem; research and education support

Technologies: Supercomputers, AI/ML systems, data storage, science gateways

Key Findings:

- Free access to advanced computing for researchers and educators
- Explore allocations enable testing without extensive applications
- Educational use supported with Discover and Explore tiers
- Training and support services integrated with resource access

Instructional Approach:

- Tiered allocation system: Explore, Discover, Accelerate, Maximize
- Instructors can request allocations for entire classes
- Students use instructor's allocation or get ACCESS IDs
- Columbia and other universities maintain Discover Allocations for fast onboarding
- Training resources and documentation freely available

Lessons Learned:

- Removing cost barrier is insufficient; ease of access matters
- Fast-track institutional allocations reduce friction
- Educational use cases require different support than research
- Integration with campus computing staff critical for adoption