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FROM RESTRICTING TO INTEGRATING AI: A UNIVERSITY-WIDE STRATEGY FOR DIGITALIZATION AND AI IN ENGINEERING EDUCATION

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ABSTRACT

Many engineering programs initially responded to generative AI by trying to restrict student use, mainly to protect academic integrity, while work life demands AI-literate graduates across all disciplines and regulation such as the EU AI Act raises requirements for transparency, safety and accountability. Against this backdrop, Chalmers University of Technology has developed a university-wide Strategy for Digitalization and AI in Education that shifts focus from blocking AI to systematically integrating digitalization and AI into curricula, learning processes, pedagogy, faculty competence, support services and the digital infrastructure. A central feature is a three-level learning-outcome model ("for all, for many, for some") that guarantees basic digital and AI literacy for every student, offers discipline-specific deepening for many, and provides advanced expertise for some in specialized master's programs. Pedagogical principles stress that digital tools and AI should support rather than replace student thinking and effort, and that assessment must remain valid and fair in an AI-rich environment. The strategy, grounded in current-state and SWOT analyses, is implemented through Chalmers' matrix governance with program-level ownership, shared guidelines, coordinated faculty development, and investments in infrastructure. The paper presents the strategy as a roadmap for aligning pedagogy, regulation and labor-market demand, and discusses implications for curriculum design, assessment and faculty competence.

KEYWORDS

Digitalization, AI, Curriculum design, University strategy, Standards: 2, 3, 7, 9, 11

INTRODUCTION

The rapid development of AI has reshaped how engineering students learn, write, code, and collaborate, with most now using AI tools for drafting, summarizing, coding, and problem solving in ways that challenge traditional assessment practices (Stöhr et al., 2024; Ovi et al., 2025). Many Western universities initially responded by restricting AI in exams and assignments and tightening plagiarism control, framing AI mainly as a threat to academic integrity (Chen, 2025), whereas some global competitors, including several Chinese universities, require students to use AI in assignments and capstone projects, provided the use is documented and technically grounded (Chen, 2025). Studies show that generative AI is already deeply embedded in student workflows, making blanket restrictions poorly aligned with practice, and highlight student preferences for structured, discipline specific guidance and adapted assessment rather than prohibitive policies (Jooste *et al.*, 2025). At the institutional level, analyses of university policies reveal fragmented strategies that emphasize integrity while offering limited direction for curriculum design, pedagogy, and faculty development (Jin *et al.,* 2025). These findings underscore the need for integrated, institution level approaches to generative AI in engineering education, motivating the structured learning outcome framework proposed in this paper.

Interviews with Chalmers students mirror international findings. Many describe lectures as a way to obtain structure and overview while relying almost entirely on AI during self-study to summarize texts, support problem solving and provide explanations. Textbooks are no longer their primary source. At the same time, students often express a rather naive view on source criticism, bias, copyright, and the broader social and environmental impact of large AI services. These observations are consistent with Leino Lindell and Stöhr's (2026) recent interview study, which shows how generative AI reshapes engineering students' norms and practices. They identify transformations in students' self-directedness, their views of the aims of learning, their expectations of teachers and the ethical rules they apply to AI use, concluding that institutions need context-sensitive strategies rather than implicit or blanket bans.

A scenario-based study by Leino Lindell and Stöhr (2025) explores educators' perspectives through six near-future scenarios, highlighting tensions between efficiency-driven AI use and pedagogical values and pointing to both manageable challenges and potentially paralyzing contradictions for higher education. Together, these studies suggest that responsible implementation of AI in engineering education requires strategies that respond to changing student practices, support teachers and align institutional rules and infrastructures with rapidly evolving technologies.

Regulation and labor-market expectations reinforce this need. The EU AI Act (European Union, 2024) defines AI systems and risk categories and sets out obligations for high- and limited-risk systems, including transparency, documentation and human oversight. Educational settings are affected when AI is used for assessment, personalized feedback, or admissions. For engineering programs, AI competence must therefore encompass not only technical skills but also understanding of regulation, safety, bias, privacy, and accountability. Industry reports likewise highlight growing demand for AI-literate graduates in all engineering and business domains, emphasizing interdisciplinary collaboration, data-driven decision making, and ethical awareness (Ellucian, 2024).

Chalmers' previous digitalization strategy from 2017 did not address AI and, thus, required substantial revision. In a situation where student use of AI is already pervasive, labor-market expectations are rising, and regulation is tightening, isolated course-level initiatives are insufficient. A clear, university-wide roadmap is needed to ensure that digitalization and AI are integrated systematically and at scale, so that all students develop the necessary competences. This paper presents the rationale, current state and analyses that motivated the new Chalmers Strategy for Digitalization and AI in Education, outlines the development process, and describes the resulting vision, goals and implementation roadmap for integrating digitalization and AI into engineering education at Chalmers. Adopting a design-based, research-informed perspective (Baumgartner et al., 2003), the paper further examines how such a strategy can be developed and implemented in alignment with pedagogical principles, regulatory requirements, and labor-market needs.

RESEARCH DESIGN AND METHODOLOGY

This study followed a design-based and action-oriented research approach, where the development of the strategy constituted both the object of study and a structured process of change (Baumgartner et al., 2003). The research was conducted in an institutional context characterized by rapid technological change, evolving student practices, and increasing regulatory and labor-market demands. The strategy development process was therefore used to explore how digitalization and AI can be systematically integrated into engineering education.

The research combined multiple complementary methods:

- Document analysis (existing policies, prior strategies)
- Current-state and SWOT analyses across programs, infrastructure, and support functions
- Iterative co-design within a cross-functional expert group
- Stakeholder consultation (program leaders, faculty, students, and industry representatives)
- External benchmarking of AI strategies and practices in higher education

The work was iterative, involving cycles of analysis, design, feedback, and refinement. From a research perspective, this can be understood as iterative design inquiry integrating empirical observations, theory, and stakeholder input.

The outcome is twofold: (i) the Chalmers Strategy for Digitalization and AI in Education as a designed artifact, and (ii) insights into how such strategies can be developed and implemented

CURRENT STATE AND SWOT ANALYSIS AT CHALMERS

The development of the Chalmers Strategy for Digitalization and AI in Education began with a current state analysis and a SWOT analysis across programs, infrastructure and support functions. The working group carried out this scanning and SWOT work jointly, and iteratively revised its conclusions based on feedback from specialists and stakeholders inside and outside Chalmers to ensure broad ownership and anchoring of the results.

Current state analysis

The analysis confirmed that Chalmers has a strong foundation to build on including established digital systems (LMS, examination systems, software platforms), a clear campus profile where digital tools such as simulations, virtual labs and digital exams are already used, and a growing number of initiatives around AI in education, research and administrative support.

At the same time, several critical weaknesses and gaps were identified. The integration of digitalization and AI varies substantially between programs, meaning that some student groups risk graduating without essential competencies. In several engineering programs, coverage of programming and mathematical statistics is limited, despite these being fundamental for working with digitalization and AI in technical development. Infrastructure for advanced AI education is insufficient. Local resources for deep learning, large models, and big data are lacking, and students have restricted access to computing resources in courses and projects.

There is also a lack of structured, continuous professional development for faculty in digital pedagogy and AI. This leads to varying levels of knowledge, uncertainty about which tools to use, and divergent views on how and to what extent students should use AI in their learning, with a risk of unequal treatment. Guidelines for student use of AI at course and program level are often unclear or absent. Several digital tools and systems are underutilized, meaning that earlier investments do not realize their full potential.

On the support side, work has begun on data-driven processes and AI-supported systems in administration and the library, but these efforts are still in an early phase and need coordination and formalization. Meanwhile, students already use generative AI extensively and independently, often as shortcuts rather than as learning support, echoing international patterns of changed study behavior and reduced campus engagement (Ovi *et al.*, 2025; Leino Lindell & Stöhr, 2025).

Externally, demand for AI competence in industry and society is growing rapidly, creating strong potential for Chalmers but also pressure to act. At the same time, the EU AI Act introduces stricter requirements on transparency, data protection and risk management for AI systems in education, while fast technological change risks making current tools and skills quickly obsolete.

SWOT

The SWOT analysis structured these findings into internal strengths/weaknesses and external opportunities/threats in Table 1.

Table 1. SWOT for digitalization and AI in education at Chalmers

Strengths	• Established digital systems • Experience from earlier educational reforms • Strong AI/digital competence in research and some teaching initiatives
Weaknesses	• Uneven and sometimes insufficient integration of digitalization and AI across programs • Gaps in programming and statistics in some engineering programs • Limited and fragmented faculty development in digital pedagogy and AI • Underutilized digital tools • Many separate digitalization and AI initiatives lacking clear coordination, prioritization and communication • Unclear or missing guidelines for student use of AI
Opportunities	• Strong labor-market demand for AI-competent graduates across sectors • Potential to improve learning, flexibility and retention via digitally and AI-enhanced pedagogy • Use of AI and learning analytics to support students and program quality management • Initiatives and experimentation in digitalization and AI that foster a culture of innovation and interdisciplinary exploration • National and international collaboration on AI in higher education
Threats	• Loss of competitiveness if AI is not systematically integrated in curricula • Rapid technological change making current tools and skills obsolete • Stricter requirements on data protection and AI (*e.g.*, the EU AI Act). • Risk that assessment validity, academic integrity and deep learning are undermined if AI use is not explicitly managed • Growing dependence on large non-EU technology providers.

Main Challenges

From the current state and SWOT analyses, three overarching, interrelated challenge areas were identified that must be addressed in a coordinated way, as failure to do so risks weakening the quality, relevance and competitiveness of Chalmers' education.

1. **Pedagogy, content, guidelines, and ethical use of AI**. Digitalization and AI now affect both how they are integrated into courses and projects and how students are expected to use it. Digitalization and AI are still unevenly embedded in programs, which risks some students graduating without essential competences. To stay at the forefront, AI and digitalization must be built into curricula at all levels, from mathematical and technical foundations to applications, tools, and an understanding of sustainability and ethics, and this must be supported by continuous faculty development in digital didactics and AI, as well as robust, ethical, and legally sound assessment practices.
2. **Changed student behavior and learning culture**. Generative AI is rapidly reshaping the ecology of learning and has already changed how students plan and carry out their

studies. Many use AI tools as shortcuts rather than as learning support, which can undermine deep learning and reduce campus attendance. Chalmers needs a pedagogy and learning culture that promotes motivation, academic integrity and collaboration in an environment where AI is a natural part of education, while campus remains a central meeting place for learning, creativity and community.

3. ***Infrastructure for advanced digitalization and AI.*** Chalmers currently lacks a coordinated, scalable infrastructure that fully supports education and development in AI and digitalization. AI-intensive courses, such as deep learning, large-scale simulation and data analysis, require access to powerful computing resources, large datasets, and local language models (LLMs). A shared infrastructure is crucial for pedagogical innovation, secure data management, and ethically sound use of AI in line with the EU AI Act, and it forms an essential backbone for implementing the strategy.

These main challenges became central design drivers for the new Digitalization and AI strategy for education at Chalmers.

DEVELOPMENT OF THE CHALMERS DIGITALISATION AND AI STRATEGY

Working group and mandate

The Vice Rector of Education mandated a cross-functional working group to develop a strategy and roadmap for digitalization and AI in BSc and MSc education at Chalmers. The group was chaired by a dean of education (with CDIO and curriculum-design expertise), and included:

- three educational leaders (faculty) from three different disciplines/departments,
- an educational developer (faculty),
- a specialist in AI ethics (faculty),
- a director of studies from the Student and Education Office,
- a digital strategist and a head of unit from IT Systems and Services,
- a staff scientist specializing in ML/AI from Computing and Digital Infrastructure Unit,
- a librarian with responsibility for information literacy, and
- two student representatives with backgrounds in cognitive science and neuroscience, currently enrolled in master’s programs in pedagogy and AI.

This composition reflected the intention that digitalization and AI should be addressed as both a pedagogical and an organizational issue, not only as a technical one. The breadth of the group ensured that all key dimensions of digitalization and AI in education were considered, from learning and assessment to infrastructure, ethics to support and governance. It also provided the necessary expertise to formulate a robust strategy and the organizational legitimacy needed for it to be accepted and implemented across the university.

Process

Between April and October, the working group followed an iterative, mixed-method process. The cross-functional group met roughly every second week, using the meetings to discuss draft texts, carry out joint current-state mapping and SWOT analyses, and align emerging ideas with Chalmers’ overall vision and priorities. Between meetings, members worked individually on sections where they had expertise and reviewed successive full-draft versions. The work combined analysis of existing Chalmers policies and initiatives, external benchmarking of digitalization and AI strategies in higher education, and dialogue with AI specialists in industry and consultation with program boards and educational schools. The group also reported back to the executive committee for education led by the Vice Rector of Education and invited early feedback from internal experts, key industrial partners and an external AI specialist. The process explicitly drew lessons from earlier large-scale reforms at Chalmers such as CDIO, education for sustainable development and entrepreneurial learning where matrix governance and strategies were crucial for implementation (Karlsson-Bengtsson *et al.*, 2021).

THE CHALMERS STRATEGY FOR DIGITALIZATION AND AI IN EDUCATION

Vision and scope

The strategic vision is that Chalmers shall be a leading technical university where digitalization and AI are integrated in education, research and support services in ways that strengthen learning, quality and industrial and societal relevance. It defines digitalization as the use of digital technologies to develop, streamline and renew educational processes, content and learning environments, and adopts the EU definition of AI systems (European Union, 2024, Artificial Intelligence Act, Art. 3). There, “AI system’ means a machine-based system that is designed to operate with varying levels of autonomy and that may exhibit adaptiveness after deployment, and that, for explicit or implicit objectives, infers, from the input it receives, how to generate outputs such as predictions, content, recommendations, or decisions that can influence physical or virtual environments”.

The strategy is explicitly framed as a steering document to ensure that digitalization and AI are systematically and sustainably embedded in all programs in a way that equips every student with technical competences, and ethical awareness, and that supports inclusive, sustainable and future-oriented learning. The strategy covers content and learning processes, pedagogy, faculty competence and role, support services and digital infrastructure, and is implemented via an action plan with defined responsibilities and periodic revision. The action plan and its implementation follow Chalmers’ matrix-based organization and existing quality cycles, where educational schools commission and agree on AI-related course content and program development with departments through annual agreements (Karlsson-Bengtsson *et al.*, 2021).

Digitalization and AI in education and learning processes

Digitalization and AI are explicitly framed as enablers of learning, innovation, creativity and preparation for future working life, rather than as purely technical add-ons. All students are expected to develop knowledge and skills required to understand, apply and critically evaluate AI technologies and the material they generate, to interact with AI tools in a responsible and purposeful way, and to reflect on the social, societal and environmental consequences of their use.

A central design feature is a three-level model for digitalization and AI-related learning outcomes and opportunities across the curriculum: *for all, for many, for some.* The *for all* level is expressed in terms of explicit learning outcomes which will be part of the outcomes for each educational program.

For all (mandatory for every student): All students should develop AI literacy, *i.e.*, the ability to understand, use and critically evaluate digital and AI technologies and the material they generate. This includes being able to:

- describe opportunities and implications of digitalization and AI for society, profession and discipline,
- explain basic principles of AI and recognize common limitations and biases,
- use digital and AI tools within their field to solve or explore problems,
- assess the reliability and appropriateness of AI-based tools and apply principles for ethical and sustainable use,
- actively seek transparency in AI use by questioning sources, answers, and limitations of AI-generated outputs, and
- use AI in learning ways that support metacognitive practices.

For all engineering students, this also includes being able to:

- explain the mathematical and technical foundations of digital technology and AI (linear algebra, optimization, statistics, programming), and
- apply and evaluate AI techniques for analysis, modelling, and simulation in their technical area.

For many (elective deepening): A broad selection of elective courses should be offered allowing many students to deepen their knowledge of digitalization and AI within their discipline, including:

- exploring advanced AI methods and applications,
- practicing identification, development and implementation opportunities for digitalization and AI in technology, design, and systems development,
- use AI for advanced analysis, simulation, and innovation,
- developing general competencies such as analytical and critical thinking, problem-solving, creativity, and ethical responsibility when working with digital and AI-based solutions, and
- further development of analytical, critical, and ethical competences in AI-related work, guided by the FATE framework (fairness, accountability, transparency, and ethics; Memarian & Doleck, 2023).

For some (specialized master's program and tracks): Selected master's programs should offer deep specialization to:

- develop future digital and AI tools,
- contribute to research and development of foundational methods within AI,
- identify, design and implement new applications of AI,
- lead strategic digitalization in industry and society, and
- design, apply, and maintain responsible, ethical and secure AI systems.

This three-level model allows Chalmers to guarantee a common minimum digital technical competence base and AI literacy for all graduates, while still developing deep expertise among those students who are interested and need it for their future careers, including those who will work at the technological frontier. Among the learning goals of this model, AI ethics is framed in terms of FATE (Memarian & Doleck, 2023). In this context, ethics emphasize students' responsibility to critically engage with AI, avoid competence illusion, and maintain transparency and accountability for AI-supported reasoning and learning outcomes.

Pedagogical principles

In alignment with Chalmers' long-term vision and strong culture of innovation, Chalmers' AI strategy seeks to encourage students to explore, master, and ultimately contribute to shaping the future of AI. This implies that AI must be meaningfully integrated into pedagogy, rather than the pedagogy being adapted to AI. The strategy emphasizes that digital technology and AI must be pedagogically justified, not technology-driven. Key principles include:

- Digital tools and AI should support individualized formative feedback, deeper subject understanding, problem-solving and metacognitive practices, rather than shortcuts to ready-made solutions.
- Exams and assignments must remain valid and fair in a digital and AI-rich environment and should be designed so that AI cannot be employed, for instance through oral exams or monitored written exams, when a learning outcome requires that AI is not used (*e.g.*, to secure core analytical skills).
- The use of AI is regulated at course level and clearly linked to learning outcomes and assessment criteria. Examiners are responsible for communicating what forms of digital and AI use are allowed or required in each course and assignment.
- All AI use follows a risk-based approach, where high-risk contexts (e.g., assignments, certifications, grading) require greater transparency and human oversight than in low-risk contexts (*e.g.*, formative learning activities).

The key principles stress that digital technologies and AI are tools for learning. It is essential to distinguish between learning activities and assessment. Furthermore, pedagogical research at Chalmers aims to explore when and how digital technology and AI best support learning, providing evidence on effective digital and AI-supported teaching methods and their impact on understanding, motivation and equity.

Faculty competence and role

Faculty must be well equipped to understand and continuously evolve in the use of digital and AI-based tools and processes in education. This requires basic understanding of the technical development, as well as domain-specific up-to-date knowledge of relevant tools and applications, and the ability to reflect on and integrate these in education content, learning outcomes, and forms of teaching and assessment. This includes awareness of the pedagogical, ethical, and societal challenges posed by digitalization and AI, including integrity, bias, transparency, and responsibility.

To achieve this, all faculty have a responsibility to continuously reflect on and evolve their teaching practice, support for such evolution must be available both in terms of access to continuous skill development and in terms of sufficient time to engage with it. Our faculty must not only be users but also evaluators, developers and role models that can prepare students for a society where digitalization and AI drive rapid change.

The obligation placed on faculty, instructors, and pedagogical leaders in Chalmers' AI strategy should be understood as acknowledging that the design of metacognitive support necessarily varies across disciplines and according to the specific tasks and learning outcomes in question.

Support services and Library

The Chalmers operations support function enables institution-wide support in line with educational, research, and management needs as well as regulatory requirements, providing personalized student guidance and AI-based decision support for educators, while improving administrative efficiency through automation without compromising integrity or quality.

Chalmers Library plays a significant role in AI-related information literacy and evaluation of AI-based tools for students and staff by providing access to information resources and digital tools, and by integrating AI-related information and media literacy into its teaching.

Digital infrastructure

An accessible and robust digital learning environment is identified as a basic condition for high-quality education. Students should have secure, simple and platform-independent access to the software, hardware and digital tools needed to develop competences relevant both for their studies and for their future professional lives, regardless of location and program affiliation. This includes:

- Standard software and advanced tools (*e.g.*, CAD, simulation, AI/ML, visualization).
- Virtual environments for medium-scale computation.
- Locally provided infrastructure for more demanding AI and simulation workloads, including locally trained AI models where needed.

The vision is that advanced AI and large-scale simulation needs can be met via Chalmers' own infrastructure or controlled environments, enabling secure handling of personal and sensitive data. This, in turn, opens possibilities for personalized support, adaptive learning and advanced analytics without compromising privacy or data protection. Resources are to be made available in a pedagogically sound and resource-efficient way to strengthen students' learning, innovation capacity, and technical competence. Essential digital and AI-based tools are to be afforded to the faculty for maintaining up-to-date knowledge of relevant tools for pedagogy, evaluation and development of programs and courses.

IMPLEMENTATION

Implementation is driven by a university-level action plan that specifies goals, responsibilities and follow-up mechanisms across programs, professional development for faculty members, infrastructure and support services, and builds on Chalmers' matrix organization and its management model as described by Karlsson-Bengtsson *et al.* (2021). Key elements are:

1. University-level principles for AI use in education. Guidelines and ethical frameworks are developed jointly by educational developers and specialists in higher education and ethics.
2. Program-level ownership. Heads of programs translate the "*for all, for many, for some*" model into program-specific learning outcomes, mapped across the curriculum, and negotiate responsibilities and development needs with departments in annual processes. Heads of programs allocate development funding for these developments.
3. On the infrastructure side, a steering group for learning support, together with Chalmers IT organizations develop scalable, robust infrastructure, including local computational resources, locally trained AI models and environments for simulation.

4. Faculty competence development. All teachers are offered opportunities to strengthen their digital didactics and AI competence through pedagogical courses and workshops.
5. Continuous evaluation through program reviews, course evaluations, faculty development and infrastructure usage.

Overall, the strategy functions as a roadmap for implementation and follow-up. The Vice Rector for Education, together with the executive committee for education, is responsible for steering, prioritizing and periodically revising the strategy approximately every three years, and for ensuring that its directions are translated into concrete actions across programs, support functions and infrastructure.

DISCUSSION AND CONCLUSIONS

From blocking AI to including and guiding AI-supported learning

Chalmers, like many universities, initially addressed generative AI by restricting its use in examinations due to concerns about cheating and plagiarism, but its new strategy represents a clear shift from blocking AI to actively guiding AI supported learning, moving from trying to keep AI out of the learning process to helping students and staff use it critically, responsibly, and in ways that deepen understanding rather than bypass it (Prather et al., 2024). The aim is to enhance student learning without replacing students' own effort, analysis, or reflection. Instead of drawing a strict line between AI as course content and AI used in assessments, the strategy emphasizes the need for metacognitive scaffolding that supports students' development of metacognitive abilities. Within this approach, the integration of digital tools and AI systems should be designed to function as cognitive offloading by reallocating cognitive capacity to enable deeper and more complex problem solving rather than providing an outsourcing shortcut that circumvents the thinking process itself (Risko & Gilbert, 2016).

The three-level learning model ("for all, for many, for some") makes AI literacy a central learning outcome, giving all students basic understanding, many develop practical competence, and some advanced expertise (Walter, 2024). It also includes ethical principles aligned with FATE to support responsible AI use in learning (Memarian & Doleck, 2023). In this way, the strategy follows international calls to move from prohibition to clear and structured integration of AI in teaching, while still addressing integrity and equity.

Aligning pedagogy, regulation and labor-market demand

By defining learning outcomes for all students that include understanding AI's societal implications and being able to critically assess AI tools, Chalmers responds to employers' demand for AI-competent graduates across disciplines, not only in specialist roles. Employers increasingly expect engineers in all disciplines to be able to use digital and AI-based tools for modelling, simulation and computation, and to be able to retrieve relevant information for analysis and decision-making. All students therefore need a basic understanding of the mathematical and technical foundations of digitalization and AI, including statistics and coding, to interpret, evaluate and meaningfully use these tools. The *for some* level, with specialized master's programs, targets the need for experts who can develop new digital tools and methods, AI methods, applications and governance models.

At the same time, strong emphasis on ethics, assessment validity and secure infrastructure reflects regulatory demands for transparency, safety and data protection. Courses and exams are expected to make the role of AI explicit, rather than ignoring it, and to balance openness to innovation with compliance and trust.

Implications for CDIO community

The Chalmers strategy illustrates how a technical university can move from fragmented initiatives to a coherent, multi-level approach to digitalization and AI in education. Several implications may be particularly relevant:

- The three-level learning-outcome model (“*for all, for many, for some”)* offers a simple structure for embedding AI across programs.
- Learning outcomes need to be formulated so that AI supports, rather than undermines conceptual understanding. This includes:
    - distinguishing between outcomes requiring independent mastery and those where AI-supported problem solving is appropriate,
    - designing outcomes that emphasize explanation, reasoning, and critical evaluation, not only solution generation, and
    - ensuring that students can interpret, validate, and critique AI-generated outputs, rather than relying on them uncritically.
- Assessment must distinguish between tasks where AI can legitimately be used and tasks where independent mastery is required.
- A matrix organization with strong program leadership can be a powerful organizational framework for integrating AI as a cross-cutting theme, provided that Heads of Program have mandate, resources and support.
- Teachers’ roles gradually expand from being mainly subject experts to also guiding students in how to work well with AI in their discipline, courses and projects.
- Faculty competence needs to develop both in terms of digitalization and AI within their own fields and in terms of pedagogical use of digital and AI tools in courses and projects.
- Digital infrastructure, including local AI models and services, must be designed to support authentic problem solving, pedagogical needs, and regulatory requirements.

For the CDIO community, this underlines that AI is not only a new technical topic but also a driver of change in learning outcomes and integrated curriculum (Standards 2 and 3), teaching and integrated learning experiences (Standard 7), assessment (Standard 11), faculty competence (Standard 10) and curriculum agility efforts.

Methodological reflections and contributions

This study illustrates how the development of a university-wide educational strategy can be approached as design-based research, where the strategy functions as a designed artifact and the process as a structured inquiry into integrating digitalization and AI in engineering education. Key insights include the importance of cross-functional collaboration, iterative co-design with stakeholders, and the use of analytical tools (e.g., current-state and SWOT analyses) to link empirical observations to strategic decisions. More broadly, the findings suggest that institutional strategy development in rapidly evolving areas such as AI should be understood as a research-informed design process, integrating empirical evidence, theory, and practice.

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REFERENCES

Baumgartner, E., Bell, P., Brophy, S., Hoadley, C., Hsi, S., Joseph, D., Orrill, C., Puntambekar, S., Sandoval, W., & Tabak, I. (2003). Design-based research: An emerging paradigm for educational inquiry. *Educational Researcher*, 32(1), 5–8, 35. https://doi.org/10.3102/0013189X032001005

Chen, C. (2025, July 28). Chinese universities want students to use more AI, not less. MIT Technology Review. https://www.technologyreview.com/2025/07/28/1120747/chinese-universities-ai-use/

Ellucian. (2024). *AI industry report 2024: AI in higher education*. Ellucian. https://www.ellucian.com/resources/industry-reports/ai-industry-report-2024

European Union. (2024). *Artificial Intelligence Act (AI Act).* Retrieved from https://artificialintelligenceact.eu

European Union. (2024). *Artificial Intelligence Act, Article 3 – Definitions*. Retrieved from https://artificialintelligenceact.eu/article/3/

Jin, Y., Yan, L., Echeverria, V., Gašević, D., & Martinez-Maldonado, R. (2025). *Generative AI in higher education: A global perspective of institutional adoption policies and guidelines.* Computers and Education: Artificial Intelligence, 8, 100348.

Jooste, M., Wolff, K., & Joubert, M. (2025). *Engineering students' perceptions and use of generative artificial intelligence*. Computers and Applications in Engineering Education, 33(1), 1–15.

Karlsson-Bengtsson, A., Enelund, M., & Bingerud, M. (2021). Chalmers University of Technology: Overcoming resistance and inertia in education through the dynamics of a matrix organization including student co-creation. *Advances in Engineering Education,* 9(3).

Leino Lindell, T., & Stöhr, C. (2025). Navigating generative AI in higher education – six future scenarios. *Learning, Media and Technology.* Advance online publication, 1–16. https://doi.org/10.1080/17439884.2025.2562405

Leino Lindell, T., Stöhr, C. (2026). The AI disruption in engineering education: an analysis of changing student norms through cultural historical activity theory. J *Comput High Educ*. https://doi.org/10.1007/s12528-025-09488-8

Memarian, B., & Doleck, T. (2023). Fairness, Accountability, Transparency, and Ethics (FATE) in Artificial Intelligence (AI) and higher education: A systematic review. *Computers and Education: Artificial Intelligence*, *5*, 100152. https://doi.org/10.1016/j.caeai.2023.100152

Ovi, J. A., Fierro, G., & Smith, C. (2025). Assessing Student Adoption of Generative Artificial Intelligence across Engineering Education from 2023 to 2024. arXiv preprint arXiv:2503.04696.

Prather, J., Leinonen, J., Kiesler, N., Jamie Gorson Benario, Lau, S., MacNeil, S., Norouzi, N., Opel, S., Pettit, V., Porter, L., Reeves, B. N., Savelka, J., Smith, D. H., Strickroth, S., & Zingaro, D. (2024). Beyond the Hype: A Comprehensive Review of Current Trends in Generative AI Research, Teaching Practices, and Tools. *In 2024 Working Group Reports on Innovation and Technology in Computer Science Education (ITiCSE-WGR 2024)*, July 8–10, 2024, Milan, Italy. ACM, New York, NY, USA, 39 pages. https://doi.org/10.1145/3689187.3709614

Stöhr, C., Ou, W., Malmström, H. (2024). Perceptions and usage of AI chatbots among students in higher education across genders, academic levels and fields of study. *Computers and Education: Artificial Intelligence,* 7.http://dx.doi.org/10.1016/j.caeai.2024.100259

Walter, Y. (2024). Embracing the future of Artificial Intelligence in the classroom: the relevance of AI literacy, prompt engineering, and critical thinking in modern education. I*nternational Journal of Educational Technology in Higher Education*, 21(1), 15–29. https://doi.org/10.1186/s41239-024-00448-3

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