Rethinking Engineering Education in the Age of GenAI: Policy Guidelines on Ethics, Integrity, Competency, and Evaluation

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***Abstract*—The proliferation of generative AI (GenAI) in higher education demands not only institutional regulation but also a fundamental rethinking of pedagogical values, assessment ethics, and the conditions under which students learn, create, and demonstrate understanding. In engineering education, where procedural competence, reflective iteration, and authentic authorship are integral to learning, the uncritical adoption of GenAI tools risks eroding core educational goals. This paper offers a set of policy guidelines tailored to these concerns, rooted in the ethical imperatives of transparency, intention, responsible mastery, and data awareness. Drawing on global models—UNESCO, AI Assessment Scale (AIAS), IDEEAS, and CAIAF—the guidelines are not presented as universal directives, but as locally adaptable principles shaped by the structural, linguistic, and political complexities facing Palestinian universities.**

Rather than opposing GenAI, the proposed approach reorients its use toward formative learning, ethical discernment, and critical engagement. It promotes policies that safeguard academic integrity while enabling innovation in teaching, assessment, and design. By strategically synthesizing international frameworks and contextualizing their implementation, the paper contributes a coherent, justice-aware vision for GenAI adoption in engineering education—one that preserves learner agency, upholds professional standards, and reflects the realities of under-resourced yet resilient academic systems.

I. Introduction

In recent years, Generative Artificial Intelligence (GenAI) has emerged as one of the most transformative developments in digital technologies. Defined broadly as AI systems capable of producing novel content—such as text, images, code, simulations, and designs—GenAI models like OpenAI's GPT-4 and Google's Gemini represent a shift from narrow, task-specific automation toward systems that support open-ended cognitive and creative processes [1, 2]. These models are trained on massive datasets and fine-tuned to perform tasks that traditionally require human language, design, or problem-solving capabilities. As such, GenAI systems are becoming increasingly embedded in education, scientific research, and professional practice, raising new opportunities and ethical concerns alike. Among all academic disciplines, engineering education stands out as a particularly fertile but challenging domain for integrating GenAI technologies.

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Engineering programs are not only content-heavy and technically rigorous, but also emphasize iterative problem-solving, systems thinking, design under constraint, and applied creativity—features that map closely to GenAI's affordances [3]. Moreover, engineering graduates are expected to master both conceptual understanding and design-based application, including collaborative teamwork, lifelong learning, and ethical decision-making. GenAI tools can support learning in these areas by automating feedback, simulating systems, supporting programming tasks, or helping visualize design alternatives. However, such affordances also bring risks: over-reliance on AI-generated solutions may hinder critical thinking, erode academic integrity, or obscure the sources and assumptions behind technical decisions [4, 5].

Despite a growing global literature on GenAI's pedagogical use, there is a pressing need to contextualize policy frameworks for specific educational systems. This paper focuses on the context of Palestinian engineering education, where GenAI technologies hold great promise for enriching learning experiences, supporting innovation in teaching practices, and aligning educational outcomes with evolving global standards. By addressing the specific needs and aspirations of Palestinian universities, this paper contributes to a localized yet globally informed understanding of how GenAI can be thoughtfully integrated into engineering education.

To address this challenge, the paper draws on the ethical and pedagogical framework developed in *"Academic Integrity in the Age of Generative AI"* [6], which argues that generative AI introduces not only regulatory and procedural dilemmas, but deeper philosophical and educational ones. In that work, academic integrity is reconceived as a developmental goal, not merely the avoidance of violations. It is understood as a moral capacity that includes ethical intention, reflective practice, and transparency in the use of AI tools.

This reconceptualization is essential in light of two major transformations. First, the AI-driven job market is rapidly shifting expectations, automating cognitive and design tasks once performed solely by humans [7]. Second, the role of the university must adapt accordingly—from transmitting fixed content to cultivating ethically aware, critically engaged learners who can collaborate with AI systems while maintaining academic and professional standards [8, 9]. In this new

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environment, universities are expected to prepare students not only for technical competence but also for ethical discernment and adaptability.

To meet this need, the earlier study proposed a model of ethical integration to replace policies based on prohibition and surveillance. This model is grounded in three key principles:

- Transparency as a core academic value
- Intention and context as criteria for ethical evaluation
- Responsible mastery as a long-term educational goal

Rather than treating AI tools as a threat to integrity, this approach treats them as a pedagogical opportunity—tools that must be ethically framed, critically examined, and used responsibly. It calls for a redefinition of integrity that fits the digital age, one that embraces AI as a reality and guides its use through ethical frameworks, instructional design, and updated assessment strategies.

Accordingly, this paper proposes a structured approach through policy guidelines for integrating GenAI into engineering education, with a focus on four interdependent lenses: ethics, academic integrity, competency, and evaluation. These lenses are not treated in isolation, but as mutually reinforcing dimensions of a reimagined educational ecosystem—one that recognizes GenAI as both a pedagogical tool and a catalyst for systemic transformation. Grounded in the realities of Palestinian higher education and informed by global best practices, this aims to safeguard academic and professional values while equipping students with the ethical reasoning, evaluative judgment, and adaptive expertise necessary for engineering in an AI-augmented world.

II. The Rise and Use of Generative AI in Engineering Education

Over the past three years, generative AI (GenAI) has moved rapidly from experimental research into widespread application across educational settings, with engineering education emerging as one of its most active domains. GenAI technologies—particularly large language models (LLMs), code generators, and design tools—are transforming how students interact with technical content, solve problems, and engage in creative design tasks. The shift is driven by advancements in natural language processing, multi-modal models, and the increasing integration of AI platforms into educational and professional ecosystems [10, 11].

In engineering education, GenAI is being adopted in ways that support content generation, simulation, coding, design prototyping, and automated feedback. Students are now able to use AI-powered tools to write reports, debug code, generate technical explanations, and produce initial design drafts in fields ranging from mechanical and civil engineering to computer and electrical engineering. This is particularly evident in design-centric courses, project-based learning, and programming modules, where GenAI systems enhance productivity and accelerate iteration cycles [9]. This aligns with findings by Aboalgasm and Al-Samarraie [12], who demonstrated that AI-assisted tools significantly enhance engineering students' design abilities.

Among the most widely used tools in this space are:

- ChatGPT: Used for explanation, drafting, summarization, and generating engineering documentation
- GitHub Copilot: Employed for writing and completing code in various programming languages, especially in software and systems engineering
- DALL·E and Midjourney: Utilized in architectural and product design education for concept visualization
- Wolfram Alpha and Mathematica AI integration: Support analytical computation and symbolic mathematics in engineering coursework
- AutoDesk's AI-enhanced tools and Siemens NX with AI plugins: Used in advanced modeling, simulation, and CAD applications

The extent of GenAI integration is still evolving, but surveys suggest rapid adoption at both the student and instructor levels. In a 2023 global review, over 60% of engineering students in higher-income institutions reported regular use of GenAI for coursework, particularly for code generation and report structuring [13]. Parallel trends are emerging in lower-resource contexts, where open-access tools like ChatGPT are lowering barriers to technical content engagement, especially in environments where language or content accessibility had previously limited learning outcomes [8].

As a result, engineering education is undergoing a quiet but profound pedagogical shift—from static content delivery to dynamic, co-creative interactions between students, machines, and instructors. This change does not eliminate traditional methods, but supplements them with a new layer of AI-enhanced engagement, where learning becomes more iterative, contextualized, and student-driven [14, 15]. Rohde and Linder [16] argue that such shifts in learning interactions reflect a deeper epistemic re-framing within engineering disciplines.

III. Specific Concerns of Generative AI in Engineering Education

To translate the ethical and pedagogical principles outlined in the previous section into effective policy, it is necessary to first identify the specific vulnerabilities that GenAI introduces into engineering education. These concerns are not hypothetical or incidental—they directly impact how students build procedural competence, uphold academic integrity, engage in ethical reasoning, and are evaluated fairly. Analyzing these risks through the lenses of ethics, integrity, competency, and evaluation provides the diagnostic foundation needed for designing responsive, context-aware policy guidelines. Accordingly, this section outlines six major concerns that must be addressed to ensure that GenAI adoption supports, rather than undermines, the goals of engineering education.

1. *Loss of Procedural Competence in Engineering Practice*

Engineering education is deeply rooted in the development of procedural competencies—those hands-on, iterative skills that enable students to troubleshoot, adapt, and solve problems in dynamic real-world systems. With the advent of GenAI tools capable of instantaneously generating solutions, students increasingly bypass foundational engineering practices such as debugging, dimensional analysis, or systems modeling. As a result, they may develop a false sense of proficiency without engaging in the effortful processes that build transferable expertise [17].

This erosion of procedural practice leads to a loss of engineering competency, not merely academic performance. Unlike theoretical fields, engineering demands the cultivation of tacit knowledge—skills that cannot be acquired through passive observation or imitation.

When students rely on GenAI to generate responses without iterative engagement, they forgo critical opportunities to develop diagnostic reasoning, error tolerance, and design judgment—capacities that define professional engineers. This not only affects classroom learning but compromises long-term adaptability in rapidly evolving engineering environments.

To protect engineering competence in the age of GenAI, curricula must preserve problem-solving fluency through hands-on activities, peer learning, and scaffolded AI use that fosters—not replaces—procedural engagement.

2. *Disruption of Iterative Design Pedagogy in Engineering*

Engineering design education depends on an iterative process—students are expected to ideate, prototype, fail, and refine solutions through repeated engagement with constraints. This process fosters critical competencies such as design judgment, creative risk-taking, and decision-making under uncertainty. However, GenAI tools can rapidly generate polished design concepts, visualizations, and simulations that tempt students to bypass exploration and adopt surface-level outputs [18].

This outsourcing of the creative process to GenAI short-circuits one of the most essential competencies in engineering education: the ability to learn through iteration and failure. Without the struggle inherent in designing from scratch, students may fail to build the resilience and reflective habits that underlie long-term innovation and responsible engineering.

Design becomes a process of editing rather than thinking, eroding the very competencies that project-based engineering courses are meant to cultivate.

To preserve the pedagogical integrity of design education, institutions must emphasize transparency in tool use, documentation of design iterations, and reflective critique—ensuring that GenAI serves the design process without substituting it.

3. *Challenges to Assessment Validity in Engineering Problem-Solving*

Engineering education relies heavily on structured assessments—problem sets, design reports, code submissions, and technical calculations—to evaluate students' mastery of foundational knowledge and applied reasoning. However, these formats are particularly vulnerable to the capabilities of generative AI tools, which can produce answers that appear correct but mask a lack of conceptual understanding. Tools like ChatGPT, GitHub Copilot, and Wolfram Alpha allow students to skip key cognitive steps in reasoning or problem decomposition, offering polished outputs without demonstrating internalized problem-solving skills [19, 20].

This poses a specific threat to evaluation validity in engineering, where assessments are meant to verify students' ability to apply principles in high-stakes, real-world contexts. When GenAI is used without proper scaffolding or disclosure, educators may misinterpret performance as competence. Furthermore, such use reduces opportunities for formative feedback, a crucial element in engineering instruction that helps instructors diagnose misconceptions and provide targeted support. In its absence, learning becomes opaque and harder to remediate.

To maintain the credibility of evaluation in engineering programs, educators must move beyond outcome-based assessment and adopt methods that emphasize process transparency, traceable reasoning, and multi-modal validation of student work.

4. *Academic Integrity and Authorship in Engineering Artifacts*

Engineering education increasingly relies on student-generated artifacts—code repositories, CAD models, schematics, and simulations—that reflect technical thinking and creative decision-making. In the age of GenAI, however, these outputs can be partially or fully generated by AI tools, making authorship attribution increasingly opaque. Unlike written essays, these artifacts rarely carry clear indicators of AI involvement, complicating the evaluation of student effort, originality, and ethical engagement.

This lack of transparency presents a direct challenge to academic integrity in engineering education. It becomes difficult to determine whether students actively engaged in problem-solving or simply curated outputs from GenAI systems—especially when tools produce highly contextualized responses that appear original.

In engineering, where demonstrating design intent, constraint negotiation, and iteration are core learning goals, this opacity undermines the very metrics used to assess student growth.

Moreover, failure to disclose AI use in technical work may constitute academic misconduct, particularly when students submit AI-generated designs or code as evidence of their own learning without instructor awareness.

To uphold integrity in engineering programs, institutions should establish clear disclosure policies, adopt version-controlled submissions, and train students to articulate their process—enabling evaluators to differentiate between tool use and intellectual engagement.

5. *Engineering Ethics and AI-Supported Decision-Making*

Engineering decisions often carry significant ethical and societal weight, particularly in fields involving public infrastructure, environmental impact, or human safety. When GenAI tools are used to generate technical solutions—designs, calculations, system parameters—students may adopt outputs uncritically, lacking awareness of underlying assumptions, potential failures, or unintended consequences. This raises ethical concerns not just about learning, but about future professional responsibility [6].

In engineering education, failing to verify AI outputs or understand their limitations may instill habits of overreliance and unchecked automation—behaviors that could lead to design flaws or safety oversights in practice.

A critical ethical question emerges: Who is accountable when an AI-assisted design fails? If engineering students are not trained to interrogate, adapt, and justify AI-generated results, they may enter the profession without the ethical maturity or technical confidence to assume responsibility for their decisions.

To prepare ethically responsible engineers, GenAI must be taught as a decision-support tool—not a decision-maker. This requires embedding accountability discussions, verification routines, and ethical reflection directly into the design process and associated evaluations.

6. *Accreditation, Competency Gaps, and Professional Readiness*

Engineering programs are accredited based on their ability to develop both technical knowledge and essential professional competencies—such as ethical reasoning, teamwork, systems thinking, and lifelong learning. Frameworks like ABET's learning outcomes emphasize integrating these competencies across curricula [21]. However, GenAI can lead to superficial achievement, where students meet formal requirements without engaging in the deeper cognitive and ethical effort those outcomes are intended to measure.

When students use GenAI to produce reports, designs, or calculations without reflection or adaptation, they may succeed on paper while lacking critical skills such as trade-off analysis, constraint negotiation, and systems integration. This gap between procedural success and substantive understanding raises concerns about graduates' readiness to operate effectively in complex engineering environments. Moreover, if accreditation benchmarks are met only in form, the credibility of engineering programs may be undermined. Programs must carefully consider whether their use of GenAI aligns with the spirit—not just the letter—of professional standards [9, 21].

To ensure that GenAI use aligns with accreditation goals and professional readiness, engineering programs must implement integrative strategies that couple GenAI with reflective practice, iterative assessments, and competency-based evaluations. Institutions should require students to demonstrate not only outputs but also their reasoning, trade-off justifications, and ethical reflections. Embedding GenAI-related tasks within capstone projects, professional ethics courses, and portfolio-based assessments can help reinforce authentic engagement and verify readiness for complex real-world engineering challenges.

IV. Generative AI in Engineering Education: The Palestinian Context

While the global discourse on generative AI (GenAI) in higher education continues to evolve, the Palestinian context introduces a distinct set of structural, pedagogical, ethical, and political challenges. These challenges are not merely peripheral but deeply interwoven with the realities of engineering education under constrained resources, complex sociopolitical conditions, and emergent institutional capacities. This section outlines four core concerns that shape the integration of GenAI into Palestinian engineering programs.

1. *Absence of Policy and Infrastructure for GenAI Integration*

Palestinian universities remain at the early stages of institutionalizing GenAI use in engineering education. While isolated faculty initiatives are emerging, formal policies, ethical guidelines, and coherent frameworks are largely absent. This policy vacuum generates confusion among both students and instructors. Students may use GenAI tools without malicious intent but in ways misaligned with unstated expectations, while instructors respond inconsistently, undermining trust and fairness across departments [23, 24].

Even where basic infrastructure—electricity and internet—exists, institutional access to advanced GenAI tools is hindered by financial limitations, licensing restrictions, and administrative uncertainty. Students and faculty often resort to free, generic platforms without institutional support or alignment with educational goals. Without structured environments, AI use becomes informal, inconsistent, and educationally disconnected [25, 26].

To establish a foundation for meaningful GenAI integration, universities must develop localized policies, faculty training programs, and investment strategies that combine access to tools with clear norms for responsible use. Policy must be paired with institutional infrastructure and sustained dialogue among educators to ensure that GenAI becomes a transparent, ethical, and pedagogically aligned component of engineering education.

2. Instructional Pressures and Erosion of Engineering Practice

Engineering programs in Palestine often prioritize theoretical content and summative assessments over design-based, exploratory learning. Instructors face pressure to cover large amounts of material and prepare students for standardized exams, limiting opportunities for integrating GenAI into iterative, hands-on projects. This instructional structure marginalizes GenAI use or relegates it to informal, unsupervised student experimentation [27, 28].

Students, in turn, face demanding academic loads and performance-driven evaluation systems. These conditions incentivize the use of GenAI to rapidly generate code, diagrams, or reports—bypassing reflective problem-solving and undermining engineering judgment. Studies confirm that unstructured GenAI use can reduce student motivation, engagement, and classroom participation [29].

To reverse this trend, engineering programs should reconfigure course structures to accommodate design-based learning, reduce overload, and promote the ethical and reflective use of GenAI. Institutions should create protected spaces—such as project studios or iterative lab courses—where students engage with GenAI tools in transparent, documented, and pedagogically meaningful ways.

3. Language Barriers and Misuse of GenAI Outputs

While English is the language of instruction in Palestinian engineering education and the default interface for most GenAI tools, many students struggle with academic English. This affects their ability to craft effective prompts, interpret nuanced outputs, or critically evaluate AI-generated content. As a result, students may uncritically accept incorrect or superficial outputs and unintentionally plagiarize or misuse information.

Studies from both local and global contexts show that limited AI competence and language proficiency correlate with shallow learning and epistemic distortion [17, 26]. Additionally, most GenAI systems are optimized for English, underperforming in Arabic or multilingual contexts [30, 31]. This "digital language divide" reinforces educational inequality and leaves non-native users more vulnerable to misinformation and marginalization.

To mitigate this challenge, universities must introduce bilingual AI literacy initiatives, encourage the use of Arabic prompts where possible, and embed GenAI competence training in the curriculum. Supporting student use of GenAI as a translation, comparison, or critique tool—rather than a final output generator—can foster deeper engagement and linguistic awareness.

4. Geopolitical Vulnerability and Data Sovereignty

The political context of Palestine raises critical concerns around the use of GenAI platforms that require uploading academic content to servers controlled by foreign entities. Academic materials such as designs, schematics, civil infrastructure, datasets, population statistics, student surveys, and personally identifiable information may be exposed to surveillance or unauthorized access. Such vulnerabilities are particularly worrisome when these platforms lack transparent data policies. Moreover, several major global tech companies that provide GenAI services—including Amazon, Microsoft, Meta, and Google—have been accused of complicity in Israel's military operations and surveillance infrastructure, particularly in the context of the genocidal war on Gaza and the ongoing repression of civilians in the West Bank. This raises profound ethical concerns about the neutrality and safety of the platforms used in Palestinian academic settings. These accusations have been documented by Amnesty International [32], The Guardian [33], and independent investigations published by Al Jazeera [34] and Middle East Eye [35].

To navigate these geopolitical and data-related challenges, Palestinian universities should prioritize raising awareness about data ethics and digital risk among students and faculty. Basic digital literacy training should include guidance on how GenAI tools handle data, which platforms are more vulnerable to surveillance, and what types of content require caution. In parallel, institutions can advocate for cautious use of GenAI in sensitive academic fields and promote anonymization, local storage, or offline workflows when working with critical materials. While full data sovereignty may not be feasible, fostering a culture of informed, cautious engagement is both possible and necessary.

V. Policy Guidelines for Integrating Generative AI into Engineering Education

Building on the global and local concerns outlined in the previous two sections, this section presents a structured set of policy guidelines for integrating generative AI into engineering education. These guidelines respond directly to the risks and gaps identified — from the loss of procedural competence and the disruption of design pedagogy, to institutional constraints and the absence of clear policy frameworks in the Palestinian context. They are built around seven core components that align with the educational values of transparency, intentionality, and responsible mastery. Rather than imposing prescriptive rules, the guidelines offer a flexible yet principled foundation to help institutions, instructors, and students engage with GenAI in ways that uphold ethics, academic integrity, and professional competence.

1. Purpose and Scope

These guidelines are intended to support engineering programs in responsibly integrating GenAI technologies into their teaching, learning, and assessment practices. They apply to instructors, students, curriculum designers, and academic leadership across Palestinian. The objective is to ensure that GenAI tools enhance learning without compromising academic integrity, procedural competence, or ethical awareness.

2. Foundational Principles

All recommendations in this document are grounded in the following ethical, pedagogical, and political principles:

- Transparency: All AI use should be disclosed clearly and honestly in academic work.
- Intention and Context: The ethical evaluation of GenAI use depends on the purpose and educational setting in which it is used.
- Responsible Mastery: GenAI tools should be used to support learning, not replace it. Students should develop the ability to critically engage with and improve upon AI-generated outputs.
- Data Awareness: GenAI use should reflect awareness of risks associated with external platforms, particularly those involved in surveillance or in practices that undermine Palestinian rights and sovereignty. Institutions should adopt protective and context-sensitive practices.

In line with these foundational principles, the policy guidelines presented in this document align with the 2023 UNESCO Guidance for Generative AI in Education and Research, which outlines eight strategic measures for ethical and inclusive GenAI integration in education systems worldwide:

- Promote inclusion, equity, and cultural-linguistic diversity
- Protect human agency and learner autonomy
- Mandate data privacy and protection
- Set age-appropriate usage limits
- Require ethical validation and pedagogical review
- Establish institutional and governmental governance frameworks
- Train educators and build institutional capacity
- Monitor and evaluate the impact of GenAI

3. Domains of Application

GenAI affects multiple dimensions of engineering education. For clarity, these can be grouped into two distinct categories: student-centered usage and institutional-level implications.

A. <u>Student Use of GenAI</u>

- Design and Prototyping: Including CAD, simulation, and visualization tools.
- Engineering Analysis: Using GenAI tools to perform symbolic or numerical analysis in areas such as mechanics, circuits, or fluid dynamics.
- Problem Solving: Applying GenAI to solve structured or open-ended problems, including step-by-step reasoning, assumption framing, and solution validation.
- Programming and Coding: Use of tools like GitHub Copilot and code-generating LLMs.
- Student-Created Artifacts: Code, schematics, models, and other project outputs.
- Academic Writing and Reporting: Research summaries, lab reports, and documentation.

B. <u>Institutional and Assessment Contexts</u>

- Assessment and Evaluation: Includes exams, quizzes, problem sets, design reports, and other graded tasks. GenAI introduces challenges related to performance validity, originality, and transparency, making this a critical domain for policy intervention.

4. Recommended Practices

Recommended practices form the core operational guidance for ethically and effectively using GenAI in engineering education. They are designed to preserve the core values of learning, creativity, and responsibility, while enabling innovation and enhanced engagement.

A. <u>Teaching and Curriculum Design</u>

- Integrate GenAI into project-based and experiential learning environments where students can interact with AI as a tool within broader design, problem-solving, or analysis tasks.
- Design assignments that emphasize process over product, requiring students to document steps taken, compare AI-generated alternatives, and justify their choices.
- Introduce scaffolded AI use, where early-stage students receive structured guidance on prompt design, evaluation of outputs, and error-checking, while advanced students are encouraged to engage in independent critique and ethical reflection.

- Encourage interdisciplinary modules (courses) that combine AI literacy with ethics, systems thinking, and human-centered design.
- Reallocate a portion of content-heavy instruction to AI-supported independent study (e.g., recorded lectures or AI summaries) in order to create classroom space for experimentation, critique, and iterative practice.

B. Student Use and Ethical Engagement

- Require all students to include an "AI Use Statement" in submitted assignments specifying where, how, and why AI tools were used.
- Promote reflective writing that explains the student's reasoning process and distinguishes between human-generated and AI-assisted work.
- Train students to interrogate the assumptions, sources, and limitations behind GenAI outputs.
- Encourage students to verify AI-generated code, calculations, and technical results through independent reasoning or peer review.
- Support bilingual workflows where students translate AI outputs into Arabic for interpretation and critique, especially in conceptually complex subjects.
- Introduce exercises where students must complete a problem manually, then use AI to compare results and reflect on differences — reinforcing procedural competence and surfacing misconceptions.
- Require layered authorship annotation for design and simulation files (e.g., indicating which parts were AI-generated vs. student-created), especially in CAD or programming environments.

C. Feedback, Assessment, and Evaluation

- Develop assessment formats that reward iterative thinking, design judgment, and analytical transparency rather than polished correctness.
- Use version control systems and process logs in design or programming assignments to track student engagement and discourage outsourcing of work to AI.
- Employ multimodal assessment strategies (e.g., oral defense, live demonstrations, collaborative critique) to validate authentic student competence.
- Encourage students to use AI tools to create first drafts, and then work with their instructors to review, improve, and learn from those drafts through feedback.
- Include checkpoints for productive failure in design-based courses, allowing students to document flawed or incomplete early ideas and reflect on how GenAI helped or hindered improvement.

D. Institutional Culture and Learning Ecosystems

- Normalize conversations about GenAI through classroom dialogue, co-created rubrics, and open discussions about evolving norms.
- Embed GenAI literacy training in orientation programs, especially for new students and teaching assistants.
- Encourage departments to create internal working groups or task forces to regularly review and adapt GenAI-related teaching practices.
- Raise awareness about data sovereignty and surveillance risks by incorporating modules on data ethics and platform politics, especially in programs dealing with civil or critical infrastructure data.
- Promote the use of anonymized datasets and offline/local tools where feasible, especially for projects involving politically sensitive or private information.
- Require every course and lab outline to include a clear GenAI use policy that defines what is allowed and not allowed, outlines its role in assessments, and explains how academic integrity will be upheld.

These practices aim not only to mitigate risks but to build a culture of thoughtful, context-aware, and ethical engagement with AI across all dimensions of engineering education.

5. Boundaries and Risks

These guidelines explicitly discourage the following practices:

- Using GenAI to complete assignments without instructor knowledge or reflective engagement.
- Treating AI-generated content as inherently correct or academically sufficient.
- Uploading sensitive data (e.g., personal information, infrastructure plans, population datasets) to external servers without caution.
- Relying on GenAI to replace foundational engineering learning such as debugging, modeling, or trade-off analysis.

6. Institutional Implementation Strategies

To operationalize these guidelines, institutions should:

- Offer training workshops for faculty and students on ethical GenAI use.
- Include an "AI Use Statement" in course syllabi that sets expectations.
- Develop a university-wide GenAI policy adapted to the engineering context.
- Establish curriculum protected spaces (e.g., design studios, capstones) for supervised GenAI exploration.

- Use local AI infrastructure where possible, or implement safeguards in cloud-based environments.
- Draw on internationally recognized frameworks such as the AI Assessment Scale (AIAS) [37], the Comprehensive AI Assessment Framework (CAIAF) [38], UNESCO Guidelines [8], and the ethical-pedagogical model developed by the IDEEAS Lab [26]. Institutions should prioritize testing and adapting these frameworks to the Palestinian context rather than designing entirely new models from scratch. This ensures alignment with international standards while remaining responsive to local realities.
- When designing new academic programs, institutions should incorporate AI as a pedagogical and technological asset from the outset. Accreditation proposals submitted to the Accreditation and Quality Assurance Commission [38] in Palestine should explicitly demonstrate how AI integration supports — rather than compromises — intended learning outcomes especially in areas such as design thinking, ethical reasoning, and collaborative problem-solving.
- Launch pilot projects within departments or courses to experiment with AI integration strategies. Use these pilots to collect feedback, refine instructional models, and build institutional readiness for broader implementation.
- Develop GenAI policy through inclusive, participatory processes involving faculty, students, administrators, and IT staff. Use faculty-led working groups, student consultations, and open campus-wide feedback to ensure the policy reflects real instructional needs, builds institutional trust, and reinforces shared values of transparency and ethical engagement.

7. Monitoring, Reflection, and Adaptation

To ensure continued relevance, institutions should:

- Periodically review the effectiveness of GenAI-related teaching and assessment.
- Collect feedback from students and instructors to refine implementation.
- Align updates with emerging international standards, but contextualize them for local ethical, political, and pedagogical realities.
- Treat the guidelines as a living document subject to ongoing revision.

These guidelines offer a starting point for aligning engineering education with the ethical, cognitive, and practical demands of the GenAI era. Their implementation will help ensure that students graduate not only with technical skills, but with the critical judgment and ethical awareness to use these tools responsibly in a rapidly evolving professional world.

To support these aims, institutions may adopt simple but meaningful mechanisms such as:

- Course-level reflections: Encourage instructors to write brief internal reflections at the end of each semester on GenAI use, challenges encountered, and adaptations made. These can inform departmental discussions and future policy revisions.
- Student feedback cycles: Use course evaluations or targeted surveys to gather student perspectives on GenAI's role in their learning, including its perceived fairness, clarity, and effectiveness.
- Policy review checkpoints: Establish a fixed interval (e.g., annually or per academic cycle) for reviewing GenAI policies, ensuring updates reflect new risks, platform developments, or shifts in institutional capacity.
- Pilot evaluation rubrics: When running GenAI-integrated pilot projects, use structured rubrics to assess outcomes such as ethical awareness, learning transparency, and design fluency—beyond just performance.
- Institutional tracking indicators: Track the number of courses with declared GenAI use policies, the availability of training workshops, and the uptake of documentation-based assessment strategies.

VI. Recommended Frameworks for Guiding GenAI Integration in Engineering Education

In the context of integrating Generative AI (GenAI) into engineering education, frameworks play a critical role in providing structured, tested, and adaptable guidance. Rather than building a framework from scratch, educational institutions—particularly those in resource-constrained or emerging contexts like Palestine—are encouraged to adopt and localize existing internationally recognized frameworks. These frameworks offer foundational principles, classification models, and institutional strategies that align with the policy guidelines developed in this paper.

Frameworks offer structure and consistency by helping educators and institutions align practices with educational goals and ethical standards. They enhance institutional credibility, especially when vetted by international organizations or accepted by accreditation bodies. Their adaptability allows for modification to suit local pedagogical, cultural, and political contexts. Finally, they improve efficiency by providing ready-to-use models that reduce the time and effort needed to develop policy from scratch.

The following internationally recognized frameworks provide concrete guidance on how to ethically and effectively integrate GenAI into engineering education.

Each has unique strengths and areas of application, and together they offer a rich foundation for adaptation to local needs. These frameworks are suggested based on their compatibility with the policy guidelines developed in this paper and are recommended for institutions seeking practical, credible, and context-aware models to guide implementation.

1. UNESCO Guidelines for Generative AI in Education [8]

Offers a comprehensive framework for the ethical and practical integration of GenAI in educational settings. As outlined in Section 2, the guidance identifies eight strategic measures that establish a global foundation for responsible AI use in education. In addition to these high-level priorities, the document provides concrete directions for implementation, including: providing institutional guidance and training; building GenAI prompt-engineering capacity; supporting multilingual interaction and culturally relevant uses; encouraging co-creation, reflection, and responsible authorship; stimulating collaborative research; and designing feedback-rich, formative uses of AI within coursework. These elements make the UNESCO framework both ethically grounded and operationally applicable for institutions aiming to foster responsible, innovative, and inclusive AI use in education.

Use: The UNESCO guidelines serve both as a high-level ethical compass and as a practical implementation reference for national and institutional policy development. They are particularly valuable when drafting GenAI charters, codes of conduct, training programs, or institutional declarations of responsible use. The integration of both strategic measures (as presented in Section 2) and practical focus areas (such as prompt engineering, co-creation, and multilingual use) offers institutions a dual pathway for designing GenAI policies that are ethically grounded and operationally actionable.

Relation to Policy Guidelines: The UNESCO guidelines support the Foundational Principles outlined in Section V by emphasizing transparency, learner autonomy, and responsible use. They inform Section VI (Boundaries and Risks) through strategic safeguards on data privacy, equity, and age-appropriate application. Additionally, they reinforce Section VII (Recommended Practices) and Section VIII (Institutional Implementation Strategies) by promoting formative use, capacity building, and inclusive engagement. These global priorities are localized in this paper through context-specific strategies such as bilingual AI workflows, data awareness, and institutional readiness planning—ensuring that UNESCO's vision is meaningfully adapted to the realities of Palestinian engineering education.

Adaptation: While globally framed, the UNESCO guidance must be locally contextualized to align with the sociopolitical and infrastructural realities of Palestinian higher education. This includes addressing power asymmetries in GenAI infrastructure, limited local data governance, and the ethical risks of relying on platforms connected to global surveillance regimes. Palestinian institutions can adapt the UNESCO measures by integrating the foundational principle of data awareness and autonomy, fostering multilingual interaction (e.g., Arabic-English prompts), and embedding reflective, justice-oriented approaches into policy and instruction. The implementation elements—such as educator training and prompt engineering—can also be tailored to support engineering-specific competencies and culturally grounded pedagogical goals.

2. AI Assessment Scale (AIAS) – [37]

Offers a structured five-level model to classify the permitted extent of GenAI use in academic assessments:

1. **No AI**: AI must not be used at any point during the assessment.
2. **AI-assisted idea generation and structuring**: No AI content is allowed in the final submission.
3. **AI-assisted editing**: AI can be used, but the student's original work with no AI content must be provided in an appendix.
4. **AI task completion, human evaluation**: The student will use AI to complete specified tasks in the assessment. Any AI-created content must be cited.
5. **Full AI**: The student may use AI throughout the assessment to support their own work and does not have to specify which content is AI generated.

These levels help instructors and students distinguish between appropriate and inappropriate uses of GenAI tools based on ethical, pedagogical, and evaluative criteria.

Use: Useful for instructors and program leaders to design nuanced AI use policies at the course or assignment level. AIAS supports student awareness by clarifying boundaries and expectations around AI involvement.

Relation to Policy Guidelines: This framework directly supports Section 4 (Recommended Practices), particularly in establishing course-level clarity on what GenAI uses are appropriate. It aligns with the principle of transparency and helps avoid misuse by integrating classification into rubrics and student training.

Adaptation: In the Palestinian engineering context, AIAS can be adapted to include culturally relevant ethical concerns, local technological access levels, and the pressure students face to deliver results under structural constraints. Instructors may contextualize these levels to reflect local pedagogical and ethical concerns, such as integrating culturally sensitive tasks (e.g., using GenAI for bilingual interpretation of scientific texts) within the existing categories, especially at the levels of AI-assisted editing and task completion.

3. IDEEAS AI in Engineering Education Assessment Framework – IDEEAS Lab, Virginia Tech (https://ideeaslab.com)

Developed by the Improving Decisions in Engineering, Education, Agents, and Systems (IDEEAS) Lab at Virginia Tech's Department of Engineering Education, the IDEEAS AI in Engineering Education Assessment Framework provides one of the most comprehensive and practice-oriented models for assessing generative AI integration in engineering education. It addresses challenges such as authorship attribution, procedural skill erosion, opaque AI interaction processes, and disparities in AI access and proficiency.

The framework is structured around five guiding principles—emphasizing higher-order thinking, balanced AI-restricted and AI-enhanced components, process documentation, critical reflection, and comparative analysis. It includes a wide array of practical tools:

- An Assessment Strategy Matrix mapping GenAI integration levels to degrees of student autonomy
- A robust AI Literacy Rubric measuring competencies in tool use, prompt engineering, output evaluation, and metacognitive reflection
- An Output Evaluation Framework addressing technical accuracy, methodological soundness, engineering judgment, and communication clarity
- Structured tools for self-assessment, peer review, and AI documentation
- Templates for layered assignments, portfolio-based assessment, and comparative analysis of AI vs. traditional approaches
- A documentation-based integrity model that prioritizes transparency and ethical learning over surveillance and prohibition

Use: This framework is especially well-suited for design-centric, systems-based, and project-oriented engineering courses, including capstones, studios, and labs. It provides scaffolding for instructors to assess not just end products, but also iterative thinking, prompt development, and student reflection on AI use.

Relation to Policy Guidelines: The framework strongly supports Section 4 (Recommended Practices) by operationalizing reflective learning and ethical engagement with AI tools. It informs Section 5 (Boundaries and Risks) through its emphasis on transparency over detection and strengthens Section 6 (Institutional Implementation Strategies) by providing actionable models, rubrics, and templates ready for adaptation and pilot deployment.

Adaptation: For Palestinian universities, the IDEEAS AI in Engineering Education Assessment Framework is particularly valuable given its attention to assessment equity, transparent documentation, and flexibility across access levels. It can be adapted to address multilingual engagement (e.g., Arabic-English prompts), limited technical infrastructure, and student unfamiliarity with advanced AI workflows. The framework's emphasis on documentation and reflective integrity makes it well-suited for educational contexts where formative assessment and student trust are prioritized over detection-based enforcement. Local implementations can begin with small-scale pilots—especially in project-based or lab-intensive courses—accompanied by training workshops and reflection cycles that build a culture of ethical AI fluency.

4. Comprehensive AI Assessment Framework (CAIAF) – [37]

Developed by Mehmet Kılınç, the Comprehensive AI Assessment Framework (CAIAF) offers a structured, values-driven approach to integrating AI into educational evaluation. It is designed to ensure that AI-supported assessment remains pedagogically aligned, ethically sound, technically robust, and institutionally supported. The framework balances innovation in GenAI applications with rigorous protections for academic integrity and learner development.

CAIAF is organized around four interrelated dimensions:

- Pedagogical Alignment: Assessment must maintain coherence with intended learning outcomes, favor authentic and context-aware evaluation, and prioritize learning processes over final products. AI tools should support—not obscure—educational aims.
- Ethical Safeguards: Transparent AI use, protection of academic integrity, and mitigation of algorithmic bias are foundational. The framework encourages reflective use of AI, clear authorship attribution, and active prevention of overdependence on automation.
- Technical Robustness: Institutions must ensure that any GenAI tools used in evaluation are reliable, valid, explainable, and secure. This includes selecting systems with transparent reasoning capabilities and minimal risk of misinformation or data leakage.
- Institutional Capacity and Governance: Successful implementation depends on university-wide readiness, including policy development, staff training, monitoring mechanisms, and a culture of responsible adaptation. CAIAF emphasizes organizational accountability alongside individual ethical agency.

Each of these domains is supported by self-evaluation rubrics, reflective prompts, and practical guidelines for instructors, curriculum designers, and academic leadership. Together, they help institutions navigate both the strategic integration and operational risks of GenAI in assessment.

Use: CAIAF is best applied at the institutional and programmatic levels, especially when developing or revising GenAI-related assessment strategies. It supports faculty working groups, academic senate discussions, accreditation reviews, and policy audits. It is also useful for cross-functional committees tasked with overseeing ethical AI use in education.

Relation to Policy Guidelines: CAIAF complements Section 4 (Recommended Practices) by providing a high-level framework to evaluate how well GenAI-integrated assessments align with core educational values. It informs Section 5 (Boundaries and Risks) with concrete ethical criteria and supports Section 6 (Implementation Strategies) by offering policy and governance tools that can be localized within Palestinian higher education institutions.

Adaptation: Palestinian universities can use CAIAF as a strategic blueprint to shape both faculty-level assessment redesign and institution-wide AI policy. Its modular structure allows adaptation in resource-constrained environments and provides a scaffold for building internal quality assurance mechanisms that reflect Palestinian pedagogical values, technological realities, and political sensitivities. CAIAF's attention to data security and authorship transparency is particularly relevant in contexts where external platform use may pose risks to academic freedom or student privacy.

Strategic Synthesis and Local Supplementation

When taken together, the four recommended frameworks—UNESCO, AIAS , IDEEAS, and CAIAF —provide a comprehensive foundation for integrating generative AI (GenAI) into engineering education. Each contributes distinct layers of ethical, pedagogical, technical, and institutional guidance. As a collective, they form a well-aligned ecosystem of tools and principles.

- **UNESCO's guidelines** offer high-level ethical orientation and strategic priorities for national and institutional policy. They help define the values that should underlie GenAI use—equity, inclusion, transparency, and governance—but do not directly engage with the specific needs of engineering curricula or technical assessment design.
- **AIAS** provides a practical model for setting course-level boundaries on GenAI use. Its five-tiered classification clarifies what forms of AI use are appropriate under various pedagogical intentions. While it supports transparency and academic integrity, it does not offer curricular or institutional strategies for integration or adaptation.
- The **IDEEAS** AI in Engineering Education Assessment Framework introduces highly detailed tools for reflective, process-centered assessment design, particularly in engineering and design-based learning environments. However, it remains focused on course-level instructional implementation and presumes access to professional development and institutional readiness for pilot adoption.
- **CAIAF** supplies a strategic lens on institutional readiness, governance, and ethical oversight. It offers criteria for technical robustness, policy infrastructure, and educator capacity building. Yet it operates at a high level of abstraction and requires translation into pedagogical practice and discipline-specific application.

These frameworks, while individually powerful, are not intended to serve as stand-alone solutions. None of them fully accounts for the political, infrastructural, and pedagogical conditions that shape AI implementation in Palestinian higher education—such as uneven access to AI platforms, risks of data exposure through foreign cloud services, underdeveloped faculty training systems, and language barriers in AI interaction.

The policy guidelines presented in this paper do not aim to replace or critique these frameworks, but rather to strategically synthesize their strengths and supplement them with context-specific elements. These include:

- Local ethical imperatives such as data sovereignty and resistance to surveillance infrastructure;
- Bilingual AI literacy development, addressing the dominance of English-language interfaces and outputs;
- Pedagogies of integrity and iteration, which emphasize student reflection, versioning, and responsible authorship rather than detection and punishment;
- And structural adaptations that accommodate variability in faculty readiness, course design formats, and institutional capacity.

This policy model thus serves as a bridge—connecting global frameworks with on-the-ground realities and values of Palestinian engineering education. It enables institutions to adopt globally respected models while tailoring them to foster equity, resilience, innovation, and ethical growth in local GenAI adoption.

VII. Workshop Validation and Local Application

To test the applicability of the proposed frameworks in the Palestinian context, a workshop was organized at the Palestine Polytechnic University with the participation of 23 individuals, including deans of engineering, faculty members of various ranks, teaching assistants, and fresh graduates. The workshop served both as an orientation to the paper's central ideas and as a participatory exercise in validating challenges, refining policy directions, and experimenting with framework-based applications to actual engineering courses. Participants engaged in hands-on trials with two frameworks: the AI Assessment Scale (AIAS) and the IDEEAS AI in Engineering

Education Assessment Framework developed at Virginia Tech.

The discussion highlighted three additional context-specific challenges for Palestine: (1) weak infrastructure, particularly in terms of connectivity and institutional access to stable AI platforms; (2) limited preparedness and awareness among both students and faculty, underscoring the urgent need for systematic training; and (3) concerns about the sustainability of AI access, given recurrent disruptions such as internet outages. Participants emphasized that reliance on GenAI without foundational procedural competencies may leave students vulnerable when tools become inaccessible.

Feedback on the frameworks was instructive. The AIAS model was appreciated for its conceptual simplicity, but participants noted that it did not sufficiently address the deeper pedagogical and ethical questions facing Palestinian institutions. By contrast, the Virginia Tech framework was found to be highly aligned with engineering education needs, offering rich tools and rubrics that could support gradual, scaffolded adoption if proper training were provided. The workshop also underlined the necessity for universities to articulate clear institutional policies on GenAI use to ensure fairness, transparency, and consistency across programs.

Finally, when participants attempted to apply the frameworks to course outlines, they demonstrated both adaptability and creativity in rethinking assessment and instructional practices. The Virginia Tech framework in particular proved useful in guiding such course-level adaptation, with participants showing readiness to incorporate its tools into local practice once appropriate training and support are established.

VIII. Conclusion

The integration of generative AI into engineering education is neither a temporary trend nor a neutral technological shift—it is a systemic transformation that reshapes how knowledge is constructed, demonstrated, and evaluated. This paper has examined the pedagogical, ethical, and institutional challenges that GenAI introduces, particularly within the structurally constrained and politically sensitive context of Palestinian higher education. It has shown that without intentional policy design, GenAI may erode procedural fluency, obscure authorship and evaluation standards, and disrupt design-centered learning—all of which are foundational to engineering education.

To respond constructively to this challenge, the paper has proposed a seven-part policy framework grounded in the principles of transparency, intention, and responsible mastery. It outlines practices that preserve the integrity of learning while leveraging the affordances of GenAI, emphasizing formative assessment, student reflection, and context-aware tool use. By supplementing global frameworks such as UNESCO, AIAS, IDEEAS, and CAIAF with local adaptations, the guidelines provide institutions with a model for ethical AI use that is both academically credible and culturally responsive.

Ultimately, the task is not simply to regulate GenAI in education, but to reimagine engineering learning as a space where humans and intelligent tools collaborate ethically, creatively, and accountably. This requires universities to act not only as sites of knowledge transmission, but as critical stewards of technological ethics, educational justice, and professional responsibility in an AI-augmented world.

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