The State of 21st-Century Skills in STEM Higher Education Institutions in Indonesia, the Philippines, and South Korea: An Exploratory Study Grounded in Kezar's Change Framework

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Abstract

STEM higher education is critical for national and regional development in Asia, yet many engineering programs face challenges in preparing graduates for rapidly changing technological and workplace demands. This paper examines a key issue across higher education institutions (HEIs) in Indonesia, the Philippines, and South Korea: prevailing pedagogical approaches do not sufficiently support students' development of 21st-century skills, broadly defined as competencies such as communication, collaboration, ethical reasoning, adaptability, and lifelong learning. To ground this analysis, we apply Kezar's (2018) change framework and focus on the "context for change" to examine how social, political, and economic conditions, external environments, and institutional cultures shape reform possibilities in engineering education. Methodologically, we employ an exploratory research design using targeted document analysis of publicly available policies, curricula, and institutional materials from selected flagship universities in the three countries. We identify three recurring sub-issues that constrain 21st-century skill development: (1) limited education on responsible and ethical AI use, (2) insufficient pathways for meaningful industry experience during undergraduate study, and (3) limited opportunities to develop professional competencies such as ethics, communication, and teamwork. These patterns reflect both shared regional pressures (e.g., workforce expectations and accreditation influences) and context-specific constraints related to institutional resources and cultural norms. Based on these findings, we propose change-oriented recommendations for HEIs and stakeholders to strengthen AI governance education, expand and improve industry experience structures, and integrate professional skill development through intentional curricular design and faculty support. We also discuss practical pathways and potential barriers to enacting these reforms across diverse Asian higher education contexts.

1. Introduction

Higher education plays a central role in national and regional development by preparing their future engineers to contribute to economic growth, innovation, and societal well-being (Monterio et al., 2019). Across Asia, governments and universities increasingly emphasize the need to modernize engineering education to respond to rapid technological change, shifting labor-market expectations (Lee et al., 2019), and also the growing influence of artificial intelligence (Chakraborty et al., 2025). These changes require not only strong technical preparation, but also broader competencies often described as 21st-century skills. Based on Chen's (2023) systematic review, "21st-century skills" is often used as an umbrella term for the broad set of competencies needed to live and contribute in contemporary society. Chen (2023) organizes these competencies into seven categories: physical well-being; foundational literacies and skills; individual productivity (e.g., critical thinking, problem-solving, and self-management); relation with others (e.g., communication, collaboration, and entrepreneurship); social-emotional well-being; ethics, morals, and citizenship; and lifelong learning.

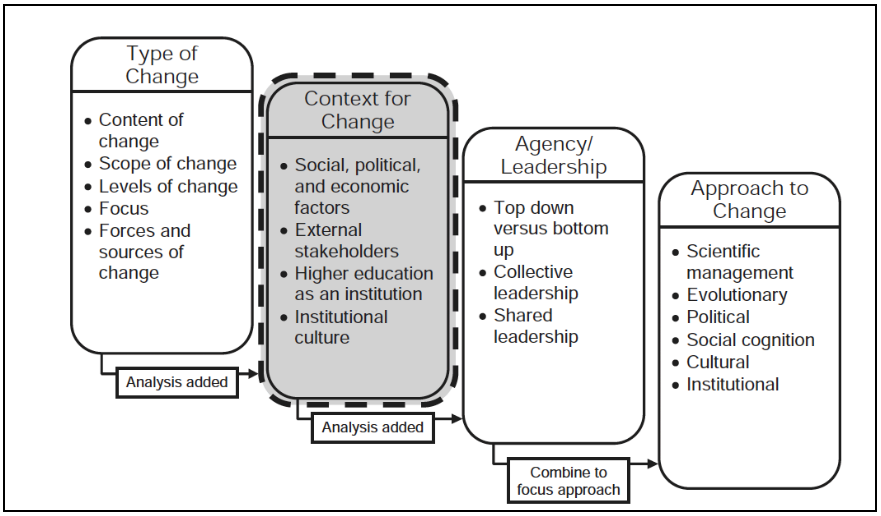
Despite the importance of fostering 21st-century skills, many higher education institutions (HEIs) in Asia continue to rely on pedagogical approaches that do not sufficiently support students' development of such competencies. In particular, this study focuses on three persistent gaps that have become more visible in the 21st-century engineering education landscape: limited education on responsible and ethical AI use, insufficient pathways for meaningful industry experience during undergraduate study, and inadequate opportunities for students to develop professional skills such as communication, collaboration, and ethical decision-making. We then investigate how contextual factors influence the persistence of these gaps in three selected Asian countries: Indonesia, the Philippines, and South Korea.

2. Theoretical Framework

To analyze issues related to fostering 21st-century skills in Asian HEIs, we use Kezar (2018)'s change framework, illustrated in Figure 1, as it offers strong conceptual fit with change recommendations in higher education. In this paper, we focus our analysis on the highlighted part of the change framework, defined as Context for Change. Our analysis of the components outlined in the "Context of Change" in our specific context will enable us to triangulate the key issue affecting HEIs in the three selected countries.

Figure 1.

Kezar (2018)'s Change Framework



3. Method

This study employs an exploratory research design, grounded in a targeted document analysis, to investigate the current state of engineering education in Indonesia, the Philippines, and South Korea, focusing on three identified sub-issues: AI ethics, industry pathways, and 21st-century skills. We used a purposive sampling strategy to select three nations (Indonesia, South Korea, and the Philippines), taking into account the researchers' backgrounds and linguistic expertise to ensure a culturally nuanced interpretation of local policies and institutional contexts. Furthermore, we prioritized these specific contexts because they have been relatively underrepresented in the global academic literature compared to territorially larger Asian countries, such as India and China.

Within each country, we examined publicly available documents, curricula, and strategic plans from educational governing bodies and several flagship HEIs. These HEIs were chosen as "critical cases" based on the premise that they possess the highest levels of resources and prestige in their respective regions. Consequently, evidence of significant gaps or pedagogical failures in these elite institutions serves as a strong indicator of systemic deficiencies affecting the broader engineering education landscape in these nations.

4. Result

4.1. Analysis of Context of Change in HEIs in Asia

We analyzed the components of Kezar (2018)'s Context of Change Framework within HEIs in Indonesia, the Philippines, and South Korea. Because of substantial overlap in our data, we merged the third and fourth components into one category, "Institutional culture and values."

4.1.1. Social, political, and economic factors

Improving higher education attainment is a shared priority across Asian countries, as STEM graduates' 21st-century skills influence national competitiveness and development.

Attitudes toward AI in education vary across contexts: while AI is often viewed as a tool for reducing educational gaps, it is also seen as a risk that may deepen existing inequities (Rakuasa et al., 2024). These concerns are amplified by uneven AI literacy and persistent socioeconomic disparities. Another contextual factor is the widening misalignment between HEIs and industry expectations, which negatively affects students' development of 21st century skills (Jesiek et al., 2016). Socioeconomic constraints and uneven distribution in institutional resources limit HEIs' capacity to implement AI-related initiatives, establish industry partnerships, and redesign curricula. To promote equity, national governing bodies must ensure more consistent funding and support across institutions.

4.1.2. External environment

Accreditation agencies are influential external stakeholders shaping engineering education priorities. For example, the Washington Accord supports the recognition of tertiary engineering qualifications across member countries, including South Korea, Indonesia, and the Philippines through their national accreditation boards. The Graduate Attributes published by the International Engineering Alliance (2021) align with the sub-issues discussed in this paper, including the responsible use of modern engineering and IT tools and lifelong learning (WA5, WA11), as well as ethics, teamwork, and communication competencies linked to industry readiness and professional skill development (WA3, WA7, WA8, WA9). Accreditation pressures can accelerate reform when proposed changes are perceived as consistent with existing standards and institutional priorities. However, excessive reliance on accreditation can also generate resistance and cynicism within universities, especially when engineering reforms create tension with broader institutional requirements and liberal education priorities (Sheppard et al., 2021).

4.1.3. Institutional culture and values

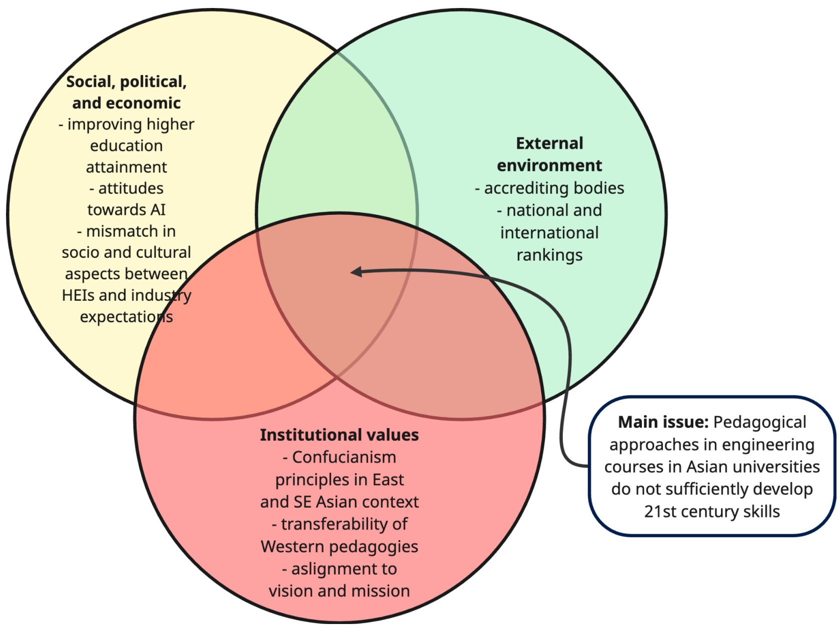
Institutional culture also shapes the feasibility of change. Many Asian HEIs have historically favored top-down leadership structures, influenced in part by Confucian traditions, which makes leadership alignment essential for reform implementation (Jung, 2020). In addition, pedagogical innovations often originate from Western contexts, raising concerns about cultural transferability. For example, norms of classroom participation in many Asian universities may not support sudden shifts toward highly vocal or discussion-driven learning. Therefore, reforms targeting professional skills development should respect local norms and introduce active learning strategies gradually to support sustainable change.

4.2. Identification of Key Issues in HEIs in Indonesia, the Philippines, and South Korea

Next, we synthesized our context-of-change analysis to identify the main issue affecting HEIs in the selected three countries in the 21st century. We formalize the key issue as follows: "Pedagogical approaches in engineering courses in Asian universities do not sufficiently develop 21st-century skills." We divide this key issue into three sub-issues in the following subsections.

Figure 2.

Visualization of the context of change analysis and identification of the main issue



4.2.1. Sub-issue 1: Lack of sound education about how to use AI wisely

Despite the growing importance of AI literacy in STEM curricula, current engineering education often lacks systematic instruction on responsible and ethical AI use. A scoping review by Laupichler et al. (2022) found that AI literacy education in higher and adult education remains in its infancy: although interest is increasing, universities have not kept pace in preparing students to use AI tools appropriately, and issues such as ethics, fairness, and accountability are often underemphasized. Similarly, Chan (2023) argues that AI governance and ethics in education "do not receive adequate attention in the current literature," which contributes to engineering graduates being underprepared to address bias, transparency, and safety concerns in real-world AI applications.

This gap is also evident across Asian contexts, where AI education frequently prioritizes technical competencies while offering limited coverage of societal and ethical implications. As a result, students may receive only minimal formal guidance on responsible AI use beyond brief course modules. Chan's (2023) findings further suggest that both students and faculty perceive an urgent need for clearer guidelines on the ethical, social, and economic implications of AI in academia. Without institutional policies addressing privacy, bias, accountability, and infrastructure, students may adopt AI tools, such as generative AI, with insufficient understanding of risks related to academic integrity and responsible practice (Chan, 2023).

4.2.1.1. Indonesia's case

In 2020, Indonesia enacted a National AI Strategy designed to position Indonesia as AI leader in Southeast Asia by 2045. The strategy identified AI education and research as one of the key sectors where AI development can have the largest impact on the nation (Brodjonegoro et al., 2020). In response to the National AI Strategy, several public and private HEIs in Indonesia partnered with external stakeholders, such as industry and overseas institutions, to launch new AI-focused programs (e.g., Bina Nusantara University, 2025; Suara Mahasiswa Editorial, 2026; Vitara, 2025).

However, education researchers have observed significant challenges in integrating AI into the Indonesian education system. Rakuasa et al. (2024) highlighted issues such as disparity in access to technology across different regions in Indonesia, uneven dissemination of AI-related knowledge, and challenges in updating the existing curriculum to properly integrate AI education. Rasyidah et al. (2024) raised concerns about the lack of comprehensive national policies and regulations on AI use in Indonesia, which are not explicitly covered in the National AI Strategy. Liriwati (2023) argued that inclusive and equitable AI policies are essential to ensure that the benefits of AI are accessible to the whole nation and that AI adoption does not exacerbate existing challenges, such as socioeconomic gaps, data privacy, and moral and ethical issues. The lack of a national AI policy for education and the concentration of new AI-focused programs within a limited number of prestigious HEIs might exacerbate disparities in AI adoption and implementation, as HEIs with limited resources face greater hurdles in establishing their own programs.

4.2.1.2. The Philippines' case

In the Philippines, two recent developments signal the country's increasing commitment to artificial intelligence (AI) and the expectation that the education sector will adapt accordingly through curriculum reform. These initiatives include the formulation of the National AI Strategy Roadmap (NAISR), first launched in 2021 and updated in 2024, and the establishment of the National Centre for AI Research (N-CAIR) (Esrellado and Miranda, 2023). Through the Department of Trade and Industry, NAISR articulates the foundational goals and strategies necessary for positioning the Philippines as a Center of Excellence in AI research and development. Among its priority actions for transforming education are the promotion of data literacy, the provision of training in Data Science and Analytics, and the development of undergraduate and graduate programs focused on AI. Established in 2024, N-CAIR serves as the country's central hub for AI research and is expected to play a critical role in strengthening the Philippines' global reputation and credibility in AI R&D (National AI Strategy Roadmap 2.0 of the Philippines, 2024).

Despite these efforts, Quimba et al. (2024) found that AI adoption in the Philippines, particularly within business and industry, remains in its early stages and is concentrated largely in urban areas. Among the key barriers identified is human capital development, as reflected in relatively low ICT proficiency and the limited quality of engineering and technology higher education. These conditions have direct implications for the availability of a reliable workforce capable of implementing and managing AI technologies. While AI has been widely recognized as a major driver for advancing educational tools and technologies, several researchers argue that resistance to its widespread adoption centers on two primary concerns: digital ethics and the digital divide (Esrellado and Miranda, 2023; Zhao, Khan, & Ahmed, 2024). Esrellado and Miranda (2023) emphasize the need for sustained dialogue to ensure that the human dimension of teaching and learning remains central. Similarly, Co (2025), in a narrative review, highlights the risk that AI may exacerbate existing educational inequalities. Asirit and Hua (2023) further argue that the varied use of AI across age groups and academic disciplines necessitates customized instructional approaches and support systems.

4.2.1.3. South Korea's case

South Korea has made substantial national investments in artificial intelligence (AI) education and research, with particularly well-documented efforts at the K-12 level and in teacher training (e.g., Park et al., 2024; Lee et al., 2024). For example, South Korea's Ministry of Education set a goal to fully adopt AI education in all K-12 schools by 2025, piloting new AI-focused curricula in hundreds of "AI-leading schools" since 2020 (Huang & Yu, 2024). These initiatives demonstrate a robust national commitment to developing AI capacity and enhancing technological competitiveness (e.g., Lee et al., 2024; Lee & Kwon, 2024; Kim & Kwon, 2023).

In contrast, a notable gap exists in the empirical literature addressing AI literacy, ethics, and governance in South Korean undergraduate education (Song & Lee, 2025). Korean universities are well aware of the importance of AI education and thus have introduced AI courses. Major universities have even established programs dedicated to AI, such as the Graduate School of AI at KAIST. Existing studies on AI in Korean higher education tend to focus more on technical competencies, instructional design, and the use of AI tools (e.g., Huang et al., 2025) than on engineering students' understanding of the ethical, social, and policy implications of AI. Lee and Ko (2022) emphasize the importance of educating Korean engineering students in non-technical AI competencies, including those related to AI ethics. Their findings showed that while students could identify some AI ethical principles (such as safety and fairness), the majority demonstrated only a "naïve" level of ethical sensitivity. Hwang et al. (2023) also found that social responsibility can be nurtured through systemic instructional approaches, which can eventually lead to increased commitment to socioscientific issues. Unfortunately, a similar vein of research is relatively sparse in Korea. As a result, the integration of formal, institution-wide AI literacy and ethics education for undergraduate engineering students appears uneven and emergent, rather than fully institutionalized nationwide, let alone across programs within a single institution.

4.2.2. Sub-issue 2: Lack of pathways for quality industry experiences in HEIs

One way to enable students to develop skills transferable to practice is to provide them with industry experience during their studies, either through internships or co-op programs. This approach enables students to gain firsthand experience in industry and to develop their 21st-century skills early, better preparing them to enter the workforce. However, the governing body does not monitor how the internship is arranged and leaves it to the discretion of the institution, student, and the related industry, which often leads to widely differing experiences and expectations. As a result, HEIs may not adequately prepare students for what to expect during their internships, leading to issues such as absenteeism. Students may feel that their industry experience falls short of their expectations, and the industry often lacks guidance on what to expect from interns and how to assign appropriate tasks. These factors contribute to the industry's ineffectiveness in developing the skills students need to succeed in the 21st-century job market.

4.2.2.1. Indonesia's case

HEIs and policymakers in Indonesia acknowledged the need to develop link-and-match with industry and workplace (Indonesian Ministry of Education, Culture, Research and Technology, 2021), which lead to enactment of policies allowing internship activities to be counted toward institutional credit hours (Indonesian Ministry of Education, Culture, Research, and Technology, 2024b) and allowing faculty members to conduct collaborative research and experience with industry (Indonesian Ministry of Education, Culture, Research, and Technology, 2024a), similar to Professor of Practice position in the United States. As of April 2025, the Ministry of Education's official website reported that more than 1,300 HEIs and more than 3,000 industries and organizations have participated in various activities related to this initiative (Indonesian Directorate of Higher Education, Research, and Technology, n.d.).

However, implementation of these policies faced significant issues and challenges, such as unclear and conflicting instructions, misaligned policies between stakeholders, communication issues between stakeholders, difficulty in converting industry activities into institutional credit hours, and a lack of infrastructure to effectively manage activities related to industry experiences (Diponegoro University Public Relations, 2024; Vhalery et al., 2022). While the government has provided the framework to bridge the gap between higher education and industry, its implementation faces significant challenges that must be addressed to improve its effectiveness. Misalignment of HEI employment policies exacerbated the difficulty for faculties to hold a second job in the industry or for HEIs to hire part-time faculty with other commitments or industry-related activities (Diponegoro University Public Relations, 2024; Junus and Putra, 2025).

4.2.2.2. The Philippines’ case

In the Philippines, industry has long been recognized as an important partner in enhancing student learning across both K–12 and higher education. For example, the K–12 curriculum designates work immersion as a key component of the Senior High School Program (DepEd Order No. 30, s. 2017). Similarly, the Commission on Higher Education (CHED) underscores the importance of providing industry experience for college students (CHED Memorandum Order No. 104, s. 2017).

Even before the enactment of these policies, Canlas et al. (2013) found significant variation in practicum-related programs across higher education institutions (HEIs), disciplines, and regions in the Philippines. Their factorial analysis of practicum programs for engineering and technology identified several best practices for student immersions, internships, and on-the-job training. These include strategies and organization; implementation and evaluation; planning; support and marketing; stakeholder responsibilities; effectiveness; proficiency and productivity; and competitiveness. HEIs, particularly those offering engineering and technology programs, are encouraged to integrate these factors when designing practicum experiences to ensure alignment with the expectations of all stakeholders, namely students, institutions, and industry partners.

Despite the establishment of more recent national policies, the Philippines has yet to fully determine their impacts on the overall quality of internship programs and on the knowledge, skills, and attributes gained by students who participate in them.

4.2.2.3. South Korea's case

Despite South Korea's strong national investment in research and development, a significant disconnection remains between HEIs and the industrial sector (Jung, 2020). To bridge this gap, the government and major global corporations, such as Samsung Electronics and SK Hynix, have established "contract departments" at prestigious universities. One example is the Department of Semiconductor Systems Engineering at Korea Advanced Institute of Science & Technology[1] and Sungkyunkwan University[2], both sponsored by Samsung Electronics. However, such departments represent exceptional, highly specialized cases rather than a systemic trend across all engineering undergraduate programs. Furthermore, because these tracks rely heavily on a few specific conglomerates, they limit students' exposure to diverse roles and industries, narrowing their professional development to the needs of a single corporate partner rather than the broader engineering landscape.

Beyond these corporate-sponsored tracks, universities have attempted to foster industry connections through entrepreneurship initiatives. For instance, the SNU Haedong Junior Startup Program, run by the Engineering Consulting Center at Seoul National University[3], provides funding, mentoring, and venture capital networking for student startup teams. While such programs demonstrate an effort to link engineering education with practical application, they primarily benefit a small minority of students inclined toward entrepreneurship. The majority of engineering graduates still lack systematic support for gaining corporate work experience, as internships remain largely optional and disconnected from the core curriculum, leaving most students without meaningful exposure to industrial practice before graduation.

4.2.3. Sub-issue 3: Lack of development opportunity for skills such as ethics, communications, and teamwork

Organizations such as the National Education Association (NEA) and the U.S. National Research Council (NRC) have long emphasized the importance of 21st-century skills, yet developmental gaps persist among younger generations (Kennedy & Sundberg, 2021). A World Economic Forum (2015) report further highlights disparities in 21st-century skill acquisition between developed and developing nations. In response, engineering education has increasingly called for integrating technical preparation with professional competencies grounded in real-world practice and complexity (Australian Council of Engineering Deans, 2021). Skills such as creativity, critical thinking, communication, and collaboration are widely recognized as essential for addressing modern challenges (Klaassen et al., 2019; Partnership for 21st Century Learning, 2019), and scholars argue that student-centered, problem-solving-oriented pedagogies are critical for fostering these competencies (Crosthwaite et al., 2019; Frache et al., 2019).

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[1] https://sse.kaist.ac.kr/introduce-summary/
[2] https://semi.skku.edu/semi/index.do
[3] https://snuecc.snu.ac.kr/

However, developing these skills in undergraduate programs remains challenging. Singh et al. (2014) found that instructors and employers in Malaysia strongly value competencies such as communication, problem-solving, critical thinking, and professional ethics, yet graduates may still face employability issues despite holding appropriate degrees. As Singh et al. (2014) note, ethics and integrity are often treated as workplace attributes that are difficult to teach authentically within curricula, except through industry attachments (p. 321).

4.2.3.1. Indonesia's case

In 2017, Indonesia introduced the Golden Indonesia 2045 Vision, which outlines the pathway for the nation to become sovereign, developed, just, and prosperous by the centennial anniversary of its independence in 2045. One of the four main pillars in the vision is human capital development and expertise in science and technology, which is designed to support the remaining pillars of economic growth, equitable growth, and national defense and governance (Indonesian Ministry of National Development Planning, 2017). National initiatives such as Independent Learning Independent Campus were enacted to give more academic freedom for HEIs to prepare high-quality workforce equipped with 21st-century skills to develop the nation (Indonesian Ministry of Education, Culture, Research and Technology, 2021). Corresponding to these initiatives, multiple HEIs established programs and policies designed to develop 21st-century skills, such as Pelita Harapan University's Liberal Arts program, which equips students with critical thinking skills, linguistic competence, and civic awareness (Pelita Harapan University, n.d.), or Bina Nusantara University, which restructured its curriculum to effectively develop 21st-century skills such as leadership, communication, and collaboration (Oktriono et al., 2021). However, there is currently no national standard or policy governing the development of 21st-century skills in HEIs. This may lead to uneven implementation, as decision-makers within institutions develop their own approaches to developing 21st-century skills, resulting in varying effectiveness across institutions or programs within institutions.

4.2.3.2. The Philippines' case

The Philippine Development Plan (PDP) 2023–2028 emphasizes inclusive growth by strengthening the country's human capital, particularly through the development of innovative and globally competitive skills. However, gaps remain in how the education sector contributes to building these competencies. For example, an exploratory study by Calica et al. (2023) at a Philippine university examined differences in perceptions between chemical engineering graduates and practitioners regarding knowledge, design, and professional attributes. Their findings revealed discrepancies related to ethical and professional responsibilities, particularly in understanding the societal and environmental impacts of engineering solutions; design competencies, especially in applying engineering design principles within specified constraints; and knowledge of contemporary local and global issues.

Chao (2024) further argued that Philippine higher education requires substantial retooling to better align with current demands. This includes the need for more relevant faculty training aimed at developing updated curricula and implementing modern, evidence-based teaching methods. Collectively, these studies highlight the need for a more coherent strategy to bridge existing skill gaps and ensure that educational institutions effectively contribute to national development goals.

4.2.3.3. South Korea's case

South Korean engineering universities have increasingly recognized the importance of developing 21st-century skills such as ethics, communication, teamwork, and creativity alongside technical competencies. For example, the Korea Advanced Institute of Science and Technology (KAIST) explicitly articulates the development of creativity, entrepreneurship, and societal responsibility as part of its institutional mission (KAIST, n.d.). KAIST's Education 4.0 initiative promotes student-centered learning approaches, including team-based projects, interdisciplinary coursework, and problem-driven learning environments designed to foster collaboration, communication, and creative problem-solving (KAIST Center for Excellence in Learning and Teaching, n.d.). These initiatives reflect an intentional effort to move beyond traditional lecture-based instruction and to cultivate competencies aligned with 21st-century engineering practice.

Similarly, Pohang University of Science and Technology (POSTECH) has pursued innovative approaches to embracing the interdisciplinary nature of engineering by creating new programs, such as the Department of Creative IT Engineering. This program emphasizes self-directed problem solving, collaboration, and entrepreneurship, positioning students to engage with complex, real-world challenges that require both technical expertise and non-technical skills (POSTECH Center for Innovation in Teaching and Learning, n.d.). POSTECH's broader educational philosophy also emphasizes integrity and ethical responsibility as core attributes of engineering graduates (POSTECH, n.d.), signaling the institution's awareness of the need for holistic engineering development. Despite these notable examples, such efforts are not uniformly embedded across South Korean engineering education. The emphasis on ethics, communication, and teamwork often remains concentrated within specific institutions, programs, or flagship initiatives, rather than being consistently integrated into undergraduate engineering curricula nationwide.

4.3. Identification of relevant stakeholders

Students are the center of efforts to address the identified issues because many students in these regions pay for their higher education. Students can benefit from AI literacy education but may also misuse AI tools without consistent guidance (Sub-issue 1). They also vary in their interest in internships and other industry experiences depending on academic priorities and career goals (Sub-issue 2). In addition, institutions must better understand which 21st-century skills students want and need to develop for long-term growth as future engineers (Sub-issue 3).

Engineering faculty are key actors because they design and implement curricula. While some may champion reforms such as AI integration, others may resist due to limited expertise or concerns about change. Faculty industry experience can also shape their ability to support practice-oriented learning. In addition, some STEM faculty may view professional competencies as “soft skills” and deprioritize them, which can negatively influence students’ perceptions of their value (Berdanier, 2022). Non-STEM faculty (e.g., ethics, law, social sciences, design, and business) can contribute to AI ethics education and professional skill development, but their unclear role expectations may create resistance within engineering curricula.

Implementation also depends on curriculum developers, educational technologists, and support staff who manage resources, instructional support, and industry partnerships. Department heads, deans, and university administrators are also critical decision-makers because they allocate resources and set institutional priorities. Finally, industry partners and AI experts can shape curriculum updates, provide authentic learning opportunities, and strengthen capstone and experiential learning through deeper collaboration beyond advisory roles.

5. Discussion

5.1. Recommendations to Address Three Sub-issues

5.1.1. Sub-issue #1

Rather than banning AI tools outright, HEIs in Indonesia, the Philippines, and South Korea should proactively integrate AI into engineering education with an emphasis on ethical and responsible use. Kezar (2018)’s change framework suggests that this requires a multifaceted approach combining cultural, political, and social-cognitive change tactics. Culturally, change agents should frame AI education as aligned with institutional missions and core values, particularly universities’ emphasis on measurable outcomes and producing innovative, socially responsible engineers. This framing can be strengthened by connecting AI literacy to national development goals and institutional success narratives. Politically, change agents can build coalitions among tech-savvy faculty, supportive department leaders, and industry partners to advocate for curriculum changes and reduce resistance. Such alliances can also address faculty concerns by negotiating clear guidelines and demonstrating that AI integration can support learning rather than undermine it. From a social-cognitive perspective, faculty and staff need structured opportunities for sensemaking through workshops, seminars, or pilot initiatives that allow low-stakes experimentation with AI tools. These activities can support collective reflection, update instructors’ mental models, and reduce fear by sharing evidence of AI’s growing relevance to engineering work and showcasing effective classroom practices. Overall, deliberate integration rather than prohibition better positions institutions to meet emerging educational and professional demands (Kezar, 2018).

5.1.2. Sub-issue #2

Higher education stakeholders in Indonesia, the Philippines, and South Korea have established policies and regulations to support attainment of industry experience before graduation, such as national policy to allow internship activities to be transferred as institutional credit hours in Indonesia, national policies requiring work immersion in basic education and internship in higher education in the Philippines, or South Korea's contract departments between major corporations and select universities (Indonesian Ministry of Education, Culture, Research, and Technology, 2024b; KAIST, n.d.). The next step for educational governing bodies is to approach HEIs to implement these regulations and revise their employment policies to allow employees to work part-time to gain industry experience, as well as to hire and recruit professors of practice. These initiatives will enable HEIs to diversify their faculty roster and allow students to gain insights and understanding from faculty members with actual experience in the field. HEIs should also conduct regular socializations of available internship and co-op programs to their students to improve participation rate. HEIs should regularly monitor their students during the internship/co-op program and conduct surveys or interviews at the end to evaluate the effectiveness of these programs and address issues or concerns that may arise along with industry partners.

5.1.3. Sub-issue #3

To address Sub-issue 3, we recommend three related strategies. First, engineering programs should clarify realistic expectations for developing 21st-century skills and strengthen alignment with industry through more frequent discussions with industry advisory boards. Because not all competencies can be fully developed within a four-year undergraduate program, skill development should be treated as a shared responsibility among academic institutions, employers, and students as part of lifelong learning. Accordingly, engineering programs should explicitly emphasize the importance of lifelong learning as a core outcome. Second, institutions should take a holistic approach to integrating professional skills into the curriculum. Allocating credits to liberal education can support the development of transferable competencies across disciplines, while engineering courses should help students apply these skills within their major through intentional learning activities. Third, engineering institutions should invest in teaching and learning approaches that foster both technical and professional development. Inductive pedagogies such as problem-based learning offer transferable frameworks for strengthening communication, collaboration, and ethical reasoning, but implementation requires time and sustained instructor support. Therefore, professional development should be designed to help faculty adopt these approaches gradually and effectively.

5.2. Enacting Changes

5.2.1. Potential Barriers to Change Enactment

We expect the most substantial barrier to be from the engineering faculty. First, we identified that the level of this change is second-order, as it requires faculties to undergo profound change to accommodate the development of 21st-century skills in their teaching approach. Second-order changes are complex because changing people's mindsets takes tremendous effort and time (Kezar, 2018). Such a hurdle can be very high, especially for faculty with their own curriculum, assessment methods, and pedagogical strategies, and/or those who are less willing to change them. Second, faculty in research-oriented universities typically have multiple workloads, encompassing not only teaching but also research projects, administrative duties, grant applications, and other responsibilities. Persuading and motivating them to allocate their effort to learning and teaching 21st-century skills will require consistent efforts from educational researchers and engineering program directors. Developing a shared vision would help faculty become involved in the change process and take ownership of the proposed change (Doten-Snitker et al., 2021).

University leadership may also be reluctant to implement the change agenda if they perceive the development of 21st-century skills as not beneficial to the institution or not aligned with its vision and core values (Sheppard et al., 2017). The change agents must ensure that the proposed change approach is well-aligned with each university's unique institutional vision and core values. The political theory of change can also be applied to build coalitions and alliances with other Asian institutions that have enacted, or are interested in enacting, similar changes in their learning pedagogy to develop 21st-century skills. This would enable us to compare and refine our change proposal while also involving our collaborators in the change process through guest speakers, workshops, and professional development opportunities.

5.2.2. Three-Step Approach to Enact Change

Enacting policy changes should involve all the stakeholders in policy-making and implementation. We outline three major steps necessary for policy-making and implementation. The scenario is that one university in one of our countries forms a committee within the College of Engineering.

Step I - Creating the Policy

1. Top management (composed of the College Dean and their Associate Deans) forms a **college committee on pedagogical approaches (hereafter, CCPA)** to 'review' the issue and draft a policy. The committee comprises engineering faculty, staff, students, and other stakeholders from the state or federal education department, as well as the relevant industry, if necessary.
2. The CCPA conducts stakeholder meetings and panel discussions. Such meetings can vary in size and frequency, from a single stakeholder to all stakeholders involved.

3. The CCPA consolidates and drafts a proposal. The draft policy should contain the following information: rationale, policy description, stakeholders and their roles, implementation and evaluation plans, and the essential timeline for these activities.
4. The CCPA presents the draft to the stakeholders for further feedback and refinement.
5. The CCPA finalizes the draft and presents it to the top management, including the report on stakeholder consultations.
6. Top management evaluates and makes the final decision, allocating resources for the consistent implementation and continuous evaluation of the approved policy.

Step II - Implementing the Policy

1. The top management forms a **college committee on implementing new pedagogies (hereafter, CCIP)** to introduce the approved policy to all stakeholders and the public.
2. The CCIP holds meetings within each department to discuss plans (e.g., proposed model to provide incentives to faculty and staff who design and implement changes)
3. The CCIP holds workshops and professional development opportunities (examples include *Integrating AI tools in engineering education*, *Designing active learning and teamworking activities in engineering classrooms*, and *Teaching engineering ethics through case studies*) to support the stakeholders in transitioning to the new policy.
4. The top management institutionalizes communities of practice within the College of Engineering.
5. The members of the communities of practice share the best practices from each department with the entire College of Engineering.

Step III - Continuous Review, Evaluation, and Possible Scaling Up

1. The top management forms an **evaluation committee (hereafter, EC)** mandated to 'evaluate' the policy.
2. The evaluation committee designs and conducts feedback surveys. The response data includes the frequency and the mode of responses, as well as the demographics of respondents, which will be used for the evaluation.
3. The evaluation committee consolidates the report and presents it to the top management.
4. The top management decides on the following actions: (1) institutionalize the policy, (2) refine the policy, and abolish the policy. The first action is our goal and will require major curricular revision and approval from the university, which is above the College of Engineering.

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