

# **STANDARD FOR CONTINUAL FACULTY DEVELOPMENT: INNOVATING TEACHING AND LEARNING WITH GEN AI**

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## **ABSTRACT**

This paper calls for a review of CDIO's 2 standards on faculty competency to firstly make them more relevant to today's AI-rich educational environment, and secondly to better reflect the dynamic nature of professional development in educational setting. This is predicated on the need to equip faculty with capability to maintain oversight over generative artificial intelligence (GenAI) use as human-in-the-loop. To this end, the paper argued for a need to prepare faculty for one's teaching role using a continuous improvement approach guided by the use of key AI Frameworks, namely the European Union's Digital Competency Framework for Educators and the United Nations Education Science and Culture Organization AI Competency Framework for Teachers. To accommodate this aspiration, while cognizant of the desired not to have a laundry list of CDIO standards, this paper suggests that existing Standards 9 and 10 be merged to better reflect how they had been implemented in practice. The need for continual professional development can then make up the new Standard 10. The advantage of doing so preserves the use of standards 9 and 10 as addressing faulty teaching and learning competency but emphasized the importance of professional development. This is demonstrated through the plan-do-check-act cycle of continual improvement which perfectly complements the CDIO approach's focus on the self-evaluation for program evaluation. By aligning continual faculty professional development, the paper further make the case that the approach can better support innovations in teaching and learning focusing on the Rumsfeld Matrix adapted for educational research. The key focus here is on the "unknown unknowns" where neither human intelligence nor artificial intelligence know what they don't know. This is an area where faculty leverage on the strength of GenAI to identify potential areas for innovation and uses one's own creativity to drive the change process consistent with curriculum redesign needs. The last concludes with suggested revisions Standard 9 and new Standard 10 for considerations.

## **KEYWORDS**

Continuing Professional Development, GenAI Competency, Teaching & Learning Innovation, CDIO Standards: 9 & 10.

## **INTRODUCTION: USE OF STANDARDS IN CDIO**

The main role of the 12 CDIO Standards is to serve as guidelines for educational program reform and evaluation, create benchmarks and goals with worldwide application, and provide a framework for continuous improvement. Over the years, there had been no lack of calls for additional standards for CDIO (Cheah & Leong, 2018; Maneeratana & Wangsaturaka, 2017; Campbell & Beck, 2010). As recent as the 2025 International CDIO Conference hosted by Monash University in Melbourne, Australia; there continued to be calls for the review of the CDIO Standards and Syllabus. The matter was again discussed at the 2025 CDIO International Working Meeting (IWM) hosted by Linköping University in Linköping, Sweden. For the CDIO Standards, possibility of new standards in areas of leadership, curriculum agility and student support had been floated.

The notion of having optional standards for CDIO can be traced back to the proposal by Malmqvist, Edstrom & Hugo (2017). The most recent changes made to the CDIO Standards is perhaps also the most significant to-date, that in moving from version 2 to version 3, the notion of optional standards was introduced (Malmqvist *et al*, 2020; Malmqvist, Edstrom & Rosen, 2020). A total of 4 topics, namely Sustainable Development, Simulation-Based Mathematics, Engineering Entrepreneurship, Internationalization & Mobility were introduced. All 12 existing standards were to become core standards, with improvements made in them, most notably the topic of sustainability and sustainable development were emphasized.

Among the 4 optional standards, sustainable development had proven to be problematic, resulting in many members questioning its “optional” status; pointing to the need to consider sustainability issues already mandated in the core standards. The confusion over the “optional” standard on sustainable development was again raised in Melbourne in June 2025. At the 2025 CDIO IWM, it has been decided that the “optional” standards will be re-categorized as “additional” standards. The question of faculty development was also discussed, and a team of CDIO members including this author will be taking a deep dive into the topic. Notwithstanding this development, this paper presents this author’s current thinking on existing standards for faculty competencies – namely Standards 9 and 10 – and a way to move forward in light of the advent of Generative Artificial Intelligence (GenAI).

## **GEN AI AND FACULTY COMPETENCE: SCOPE OF THE PAPER**

Faculty needs to be equipped with the necessary competencies to leverage GenAI to enhance one’s teaching and students’ learning. Faculty GenAI Competency in the context of this paper refers to the knowledge, skills and attitudes that faculty possessed to enable him/her to undertake curriculum design efforts in an ethical and responsible manner when using GenAI, and to be able to exercise human judgment in analyzing outputs produced by GenAI, the be the “human-in-the-loop”. It elaborated on the importance of faculty professional development so that humans remain in control in key aspects of curriculum design, to protect mankind against being made irrelevant due to overuse of GenAI such that fundamental human traits (e.g. critical and creative thinking) are eroded (Cheah, 2026a).

This paper is built on the author’s view that GenAI – when handled responsibly – afforded educators with the opportunity to innovate teaching and learning practices in ways never before imagined. To take advantage of this opportunity faculty needs to be well equipped with the still-evolving AI Literacy and continue to pursue excellence in this area via professional development programs. The paper suggests using the CDIO approach in conjunction with 2 key AI frameworks, namely from the European Union (EU) and United Nations Education

Science and Culture Organization (UNESCO), to form the basis of generic faculty professional development program towards developing AI Competency. The paper then introduces the author's view on how to handle the balance of knowledge between human intelligence and GenAI adapted from Rumsfeld's Matrix. The author argued that faculty should make use of GenAI to venture to the "Unknown Unknowns" in a systematic way to identify opportunities for teaching and learning innovations.

This is followed by a call to revise the 2 CDIO Standards on faculty competency which currently stood at version 3, to better prepare faculty for the challenges ahead in a world dominated by AI that is evolving ever-rapidly. More specifically, this paper made the following 2 related proposals:

1. Merge existing Standard 10 *Enhancement of Faculty Teaching Competence* into existing Standard 9 *Enhancement of Faculty Competence*, to form a single Standard 9 renamed *Enhancement of Faculty CDIO Competencies*; and to introduce a new standard to replace Standard 10 which is now named *Faculty Continuing Professional Development*.
2. Include faculty competency in using AI in general and GenAI in particular, into both the expanded Standard 9 and new Standard 10; and adopt a more forward-looking approach in faculty professional development to address challenges in today's AI-dominated world.

## **DRIVER 1: GEN AI FRAMEWORKS FROM DIGCOMPEDU AND UNESCO**

In this section, we will first briefly look at 2 prominent frameworks that aim to prepare human beings for work and life in a world with AI: (1) The EU's Digital Competence Framework for Educators (DigCompEdu) and (2) UNESCO AI Competency Framework for Teachers.

The DigCompEdu is a direct outcome from earlier EU initiative called the Digital Competence Framework for Citizens (DigComp) to define and support the development of digital skills. The DigCompEdu Framework aimed at identifying and delineating the digital competences educators require to foster effective teaching and learning in the digital age (Bekiaridis & Attwell, 2024). The comprehensive framework is structured around 22 elementary competences, organized into six distinct areas: (1) Professional Development, (2) Digital Resources, (3) Teaching and Learning, (4) Assessment, (5) Empowering Learners, and (6) Facilitating Learners' Digital Competence. It outlines six stages of development: Newcomer (A1), Explorer (A2), Integrator (B1), Expert (B2), Leader (C1), and Pioneer (C2). Each stage represents a phase in the development of digital competencies, from assimilating new information and developing basic digital practices to critiquing existing practice and developing new ones. It is designed to be universally applicable, serves not only as a guide for educators seeking to enhance their digital skills but also as a benchmark for curriculum development and professional training programs in educational institutions across Europe and beyond.

A supplement to The DigCompEdu Framework (henceforth referred to in this paper as DigCompEu-AI) was later published to enhance and extend the framework to include AI-specific competencies and serves as a critical addition, recognizing the growing influence and importance of AI in education (Attwell & Bekiaridis, 2024). This supplement focuses on integrating AI literacy and competencies into the existing framework, ensuring that educators are not only digitally competent but also proficient in understanding and applying AI technologies in their teaching practices. It includes competencies such as understanding AI concepts, ethical implications, data literacy, and the ability to leverage AI tools for personalized learning, assessment, and enhancing student engagement. Effectively this means that educators must now fulfil 2 roles: (1) They must be adept at leveraging GenAI tools to enhance

teaching and learning, and (2) They must prepare students for a future unlike the one they were trained – a world where AI is part of daily life and work.

Another organization, UNSECO, recently also introduced AI Competency Framework for Teachers along with another framework for students (UNESCO, 2024). The document defines the knowledge, skills, and attitudes teachers must master in the age of AI and outlines 15 competencies across five dimensions: (1) Human-centered mindset, (2) Ethics of AI, (3) AI foundations and applications, (4) AI pedagogy, and (5) AI for professional learning. These competencies are categorized into three progression levels: Acquire, Deepen, and Create. The framework is meant to guide the development of national AI competency frameworks, informs teacher training program, and helps in designing assessment parameters. It also provides strategies for teachers to build AI knowledge, apply ethical principles, and support their professional growth. This framework is henceforth referred to as “UNESCO Framework”.

The DigCompEdu-AI and the UNESCO Framework both aim to develop educators' AI skills, but they differ in their primary focus. DigCompEdu-AI offers a more granular, practice-oriented approach, integrating AI skills directly into educators' existing digital teaching activities. In contrast, UNESCO framework provides a broader, policy-oriented perspective, focusing on how AI can transform education systems as a whole, from curriculum to ethics. The primary difference is in their structure and focus. Table 1 below highlight some key differences.

Table 1. Comparison between frameworks: DigCompEdu-AI and UNESCO

| Aspect                | DigCompEdu-AI                                                                                           | UNESCO                                                                                                 |
|-----------------------|---------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
| Origin & Scope        | European Commission initiative, extended via AI Pioneers project for VET and adult education            | Global UNESCO initiative aligned with SDGs, applicable across all education levels                     |
| Philosophy            | Builds on existing digital competence framework; AI is treated as an extension of digital fluency       | Treats AI as a transformative force requiring ethical, human-centric rethinking of education           |
| Focus areas           | 6 areas, provide guidance on operational integration of AI into teaching practices and digital pedagogy | 5 dimensions, provide normative guidance on ethical, human-rights-based AI use and teacher empowerment |
| Progression Model     | 6-level proficiency scale (Newcomer to Pioneer)                                                         | 3-level progression (Basic, Proficient, Advanced)                                                      |
| Ethical Emphasis      | Embedded within areas like professional engagement and digital resources                                | Explicit dimension: Ethics of AI, with strong emphasis on human agency, fairness, and sustainability   |
| AI as Subject vs Tool | Balanced view: AI as both pedagogical tool and curricular content                                       | Stronger emphasis on AI as a subject requiring critical literacy and ethical reflection                |

One way to understand the difference is to consider DigCompEdu-AI as a practical framework organized around an educator's professional activities, i.e. "What you do". On the other hand, UNESCO's aspects are organized around higher-level overarching principles and themes: "How you should think and what you should know". In short, the 2 frameworks are highly complementary: an educator might use 5 dimensions from UNESCO to build their foundational understanding and ethical compass and then use DigCompEdu-AI to put those principles into practice in their daily teaching activities. DigCompEdu-AI is a practice-oriented scaffold for embedding AI into teaching workflows, and UNESCO as a normative compass for ensuring ethical, inclusive, and sustainable AI adoption. Together, they form a powerful combination for educators: one for doing AI well, the other for doing AI right.

## DRIVER 2: RESOLVING CONFUSION OVER STANDARDS 9 AND 10

From the onset, the CDIO Framework had been introduced as a viable approach to address curriculum design or redesign by offering a systematic way to review one's program with focus on the "what" and the "how" of teaching and learning, and faculty capability to use the framework is encapsulated in the 2 standards 9 and 10. Hence it stands to reason that there would be 2 standards, one each to address the needs of "what" and "how". The initial version 1.0 of CDIO Standards 9 and 10 were named *Enhancement of Faculty CDIO Skills* and *Enhancement of Faulty Teaching Skills* respectively to reflect this distinction.

With the revision of the CDIO Framework to version 2.0, the 2 standards were renamed as *Enhancement of Faculty Competence*, and *Enhancement of Faculty Teaching Competence*, respectively, and the key differences between the 2 are shown in Table 1.

Table 1. Comparison between focus areas of Standards 9 vs 10

| Standard 9 <i>Enhancement of Faculty Competence</i>                                                                                                                                                                                    | Standard 10 <i>Enhancement of Faculty Teaching Competence</i>                                                                                                                                                                                                                                                                                                                      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Developing faculty's <b>disciplinary fundamentals</b> : this is a given! Not further elaborated in CDIO...                                                                                                                             | Developing faculty ability to design learning tasks that help students to acquire the necessary skills and attitudes alongside disciplinary knowledge, i.e. " <b>how to teach</b> "<br>→ Namely Integrated Learning Experiences ( <b>Standard 7</b> ) & Active Learning ( <b>Standard 8</b> ); as well as in assessing such learning had indeed taken place ( <b>Standard 11</b> ) |
| Developing faculty skills and attitudes as espoused in <b>CDIO Syllabus Parts 2, 3 and 4</b> , i.e. " <b>what to teach</b> "<br>→ This is faculty understand what skills and attitudes to impart to students so that they acquire them |                                                                                                                                                                                                                                                                                                                                                                                    |
| Develop faculty in expanded topics of CDIO Syllabus: Leadership, Entrepreneurship and Research                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                    |

The renaming of the 2 standards, however, did not illuminate the key difference in focus areas between them if one just made a cursory read of the name of the standard, as they only differ by one word – the extra word of "teaching" that was found in Standard 10.

More importantly, in most actual applications, both the 2 standards are used at the same time – for example, during self-evaluation. This is especially the case for a faculty who is responsible for both course development and course delivery. Furthermore, taking a literal interpretation of the words "teaching competence" also means that faculty are teaching students the skills and attitudes alongside the domain knowledge; meaning that students learn from activities designed using CDIO Standards (for example Standard 7 Integrated Learning Experiences) to understand the competencies expected of them when they enter the workforce upon graduation. All these happen within the same learning setting: "Dual-Impact Learning" (Crawley *et al*, 2007).

The 2 standards complements one another: faculty need to develop both competencies – first to be well-versed with the domain knowledge, personal, professional, interpersonal skills and attitudes, as well as product, process, system and service building skills plus their assessment (Standard 11); and second to develop expertise to design various learning tasks to engage students in developing these competencies, namely via design-implement experiences (Standard 5), integrated learning experiences (Standard 7), and active learning teaching methods (Standard 8).

As such, the author opined that there is no need for such "separation" of faculty capability into 2 different standards. This paper advocated the use of the terminology "Faculty CDIO Competencies" to mean capability to use BOTH the CDIO Syllabus as building blocks for skills

and attitudes, learning assessment as well as the ability to design CDIO-type learning using CDIO Standards. Merging the 2 standards into one focus the attention of faculty capability: one will work on both “what” to teach and “how” to teach within the same course review setting. This will “free up” one standard, enabling a new standard to be added without extending the list of core standards. As mentioned earlier, a discussion thread on faculty development had been initiated at IWM 2025, and the idea presented in this paper can serve as input for deliberation as we move ahead with the review of the CDIO Framework.

## **PROPOSAL: REVISED & EXPANDED STANDARD 9, NEW FOCUS FOR STANDARD 10**

It is proposed that the 2 standards 9 and 10 be retained, with both still address faculty competency needs, but to be different in focus: One is on *current, immediate needs* to get faculty off-the-ground into one’s teaching duty, and the other is on *emerging future needs* so that faculty can be equipped with new capabilities in response to changing educational demands.

This preference is first and foremost, based on the author’s belief that it will provide a sense of familiarity among members as new version of the CDIO Standard (presumably to be called version 4.0) is introduced. This will avoid potential confusion if the new Standard 10 is named to reference other areas of interest such as student support system, or curriculum agility.

To address faculty’s *current immediate needs*, it is proposed that Standard 9 be retained and its scope expanded to absorb the requirements of current Standard 10. The new Standard 9 should be renamed as *Enhancement of Faculty CDIO Competencies*. Hence there is only one standard that focus attention on equipping faculty with competencies needed to design and deliver existing curriculum as needed. It also serves as a basis for preparing incoming faculty new to CDIO to quickly assume one’s role as an educator and start teaching using the CDIO approach; and also includes the use of GenAI in designing learning tasks for students.

For *emerging future needs*, a new standard on faculty continuing professional development can be introduced to take the place of Standard 10, retaining the standard number but carry a new name, entitled *Faculty Continuing Professional Development* to focus on faculty’s on-going continual improvement. It highlights the need to maintain the faculty’s CDIO competencies to be on par with changing educational requirements, that upgrading of one’s capability is needed as soon as new demands on curricular outcomes are identified.

This new Standard 10 is thus differentiated from the revised Standard 9 by its forward-looking nature, taking into considerations new developments impacting education in general and teaching in particular; that require faculty to continually renew one’s capability in all aspects – technical domain, pedagogy or pedagogies, use of technology in teaching and learning, etc. This is also consistent with the call for a more forward-looking CDIO program by Cheah (2023). The need to be forward-looking is especially important in today’s world of AI, where technological advancement is progressing at a very rapid pace. As education is inherently lagging behind any change in its external operating environment, the need to be able to predict with great accuracy the needs of future workplace requirements before students graduated are more pressing than ever. We need a CDIO Standard that mandates program owner and faculty alike to look ahead at what competencies are needed on an on-going continual basis.

Along with the use of DigCompEdu-AI and UNESCO frameworks, these suggested revisions can better serve the needs to prepare faculty for using AI in one’s teaching responsibilities, as explained in the next section.

## How to Use Standard 9 and Standard 10

Figure 1 below shows how the expanded Standard 9 and new Standard 10 work together in accordance with the PDCA (plan, do, check, act) quality improvement cycle adapted for faculty professional development (Samuel & Farrer, 2025). This makes the 2 standards well-aligned with the continual improvement nature espoused in CDIO Standard 12 Program Evaluation. This demonstrates the forward-looking nature in faculty professional development that the author had been alluding to. Making faculty continuing professional development explicit in the new Standard 12 clearly communicates this to all key stakeholders of the importance of human capital in teaching and learning in today's world dominated by AI.

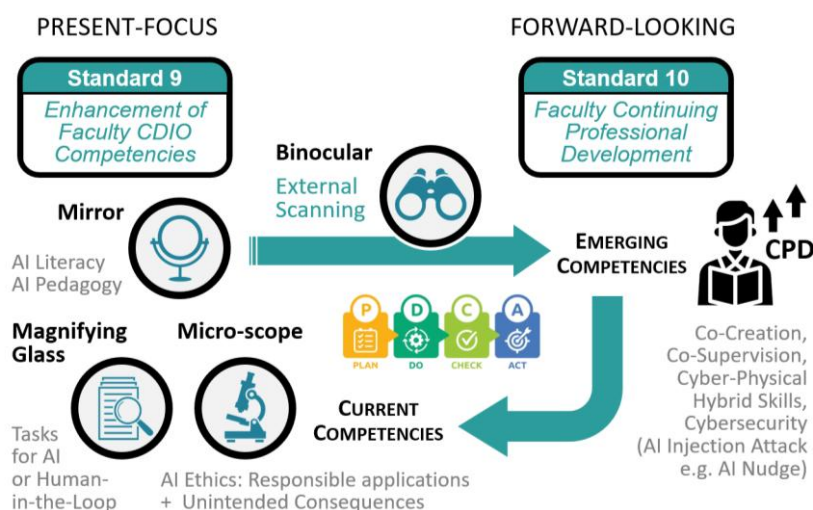


Figure 1. Using Standards 9 and 10 to develop faculty GenAI competency

It can be seen from Figure 1 there are 4 circles labelled mirror, magnifying glass, microscope and binocular. The mirror, microscope and binocular are metaphors the author first used in his earlier paper on improving faculty reflective practice (Cheah, 2022). The author had earlier argued that there is a need to strengthen reflective practice as a key element towards faculty self-improvement and the program's continual improvement; and it be made explicit in CDIO standards. In this paper another item – the magnifying glass is now added, and together the 4 metaphors can guide faculty development in GenAI competency as follows:

- **Mirror**: Guides self-evaluation to ascertain one GenAI Competency, using DigCompEdu-AI's 6 proficiency levels (Standard 9)
- **Magnifying Glass**: Identify areas where GenAI can be used in one's program and/or courses, to achieve the desired outcomes (Standard 2) via meaningful student learning activities (Standards 5, 7, 8)
- **Microscope**: Scrutinize the use of GenAI (human-in-the-loop) to ensure it is responsible and ethical, and plan the assessment accordingly (Standard 11)
- **Binocular**: Look ahead for emerging trends of AI technologies and plan one's own professional development program (Standard 10)

Standards 9 and 10 contributed to continual improvement for curriculum quality assurance by ensuring that faculty AI competency always remained current and up-to-date, via the PDCA cycle, adding to the pool of generic competencies new requirements delivered by faculty professional development program. For example as shown in Figure 1, AI Literacy is now an essential requirement for all faculty, especially on the ethical and responsible use of GenAI in education. Such requirements would fall under Standard 9. As noted by Cheah (2026b) an area where GenAI use that is hotly contested is learning assessment. As each iteration of the

GenAI will result in its greater sophistication, it will continue to render existing practices questionable. An example is the long-held superiority of authentic assessment the validity of which is now challenged (e.g. Gonsalves, 2025; Arnold & Croxford, 2024). Emerging areas for research include the contextual assessment model based on expanding Gilberts Model of Contest (Gonsalves, 2025), GenAI Assessment Literacy (Moorhouse *et al*, 2023), Product vs Process Assessments (Fawns, 2024), just to name a few. These can form the basis of faculty professional development under Standard 10. When new competencies got recognized and adopted essential competencies, they will “move” from Standard 10 to become essential feature of teaching and learning under Standard 9 as shown in Figure 1, reflecting the dynamic nature of faculty competency that need constant monitoring to keep abreast of technological developments.

Figure 1 can go one step further. The cyclical nature of PDCA will mandate continual improvement of faculty capability not just to keep up with the development in AI technologies, but it can also drive faculty to innovate one’s teaching and learning practices using AI.

## OPPORTUNITY FOR INNOVATIONS IN TEACHING & LEARNING USING CDIO & GEN AI

The distribution of intelligence possessed by humans and GenAI can be represented by an adaptation of the Rumsfeld Matrix as shown in Figure 2.

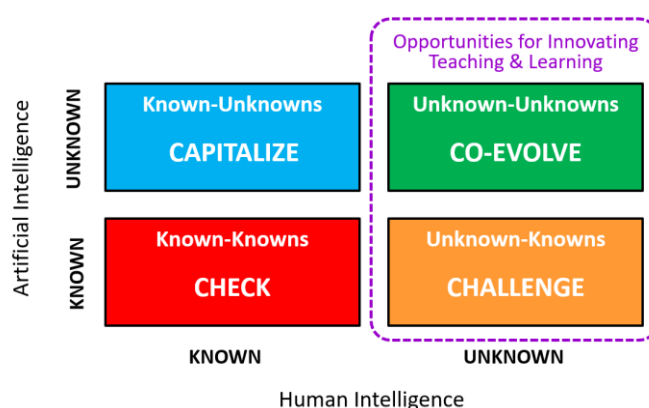


Figure 2. Engaging with GenAI under different scenarios and opportunity for innovation

The 4 quadrants of the matrix represent different balance of knowledge between human intelligence and AI, in the form of the famous “Known Knowns”, “Known Unknowns”, “Unknown Knowns” and “Unknown Unknowns”. The 4 C’s in the quadrants represent different actions that faculty can take when engaging with GenAI. Of most interest is the 2 top quadrants where educators can make use of GenAI to innovate teaching and learning practices. This matrix is briefly explained below:

- **Check (Known Knowns):** This is a case where both knowledge types are well-informed among humans and machines. In this case, faculty will play a key role of human-in-the-loop, to stay on top of any GenAI-produced outputs to guard against GenAI misuse of the information. See Cheah (2026b) for more details.
- **Capitalize (Known Unknowns):** This is a ‘fortunate’ case whereby humans still possess superior knowledge and know-how than GenAI, at least before GenAI catches up. Hence this may not be a tenable position in the long run as GenAI advances. Faculty should take advantage of this situation to innovate one’s teaching approaches where possible.
- **Challenge (Unknown Knowns):** In this case, educators need to know what GenAI knows. This can form the basis for faculty development programs to keep one apprised on the



latest developments with regards to AI usage in education. This will then provide the springboard from which faculty can check on GenAI (Known Knowns), rethink how one's current teaching was carried out, and attempt at innovating teaching and learning.

- *Co-evolve (Unknown Unknowns)*: This is the most intriguing aspect where both humans and machines don't know what they don't know. This is also the quadrant that appears most promising for innovating teaching and learning. Hence the word 'co-evolve' is suggested to mean both educators and GenAI join forces to explore the education terrain, leveraging on the best of both: humans in one's curiosity and creative potential, critical thinking, sense-making, etc to complement what GenAI did best.

The last quadrant, to co-evolve to discover unknown unknowns to obtain insights and identify opportunities for innovating teaching and learning, is an area worthy of further research. The way faculty approach teaching and learning research can take on a new spin in this age of GenAI. An area for faculty professional development is how to write intelligent prompts (Cain, 2023; Korzynski *et al*, 2023) for educational research. The aim is to harness the power of GenAI to uncover knowledge unknown to both humans and machines and then uses human intelligence to identify opportunities and potentials for innovation in teaching and learning, while providing oversight via human-in-the-loop. Doing so will demand that faculty continue to nurture human traits – “foundational core” (Cheah, 2026a) from being replaced by GenAI. The research here can further support this endeavor.

With the author's recommended revisions to Standard 9 to become *Enhancement of Faculty CDIO Competence*, and a new on *Faculty Continuing Professional Development* to replace the old Standard 10, there is a need to review the write-ups for these 2 standards. The suggested amendments are shown in Appendix 1. This author suggested removing examples of how enhancement of faculty can be achieved, to allow program owners to explore new opportunities afforded by use of GenAI. Also removed are suggestions on hiring practices which the author opine can be left to the institution's policies. The initial text that were removed are shown using strikeouts. These suggested changes can be considered when Council decided to embark on revising entire CDIO Standards to bring it to version 4.0, to include among other things, the use of GenAI.

## **LIMITATION OF WORK DONE AND MOVING AHEAD**

At the time of this writing, the proposed changes to the 2 standards had not been reviewed and debated within the CDIO Community. It is the author's contribution to the ongoing discourse on evolution of CDIO standards as part of continual improvement. The rationale for changes mentioned in this paper are based on the author's perspective and it is probable that other points of view are not included. As an academic paper, this work serves to stimulate the required discussions. Likewise, the approach presented in Figure 2 remained at this stage still a theoretical exploration and not yet validated with any programs within SP or other institutions. This approach is also somewhat contingent of the acceptance of the changes proposed to the 2 standards.

To advance innovation in teaching and learning, it is essential to study the underlying mechanics of how the PDCA cycle operates, particularly in navigating domains of “unknown unknowns” of Figure 2. Research shows that PDCA provides a systematic framework for continuous improvement and curriculum adaptation in higher education (Samuel & Farrer, 2025). However, traditional applications often struggle with unpredictable challenges that require novel solutions. The iterative nature of PDCA, when combined with the use of GenAI, offers a structured yet adaptive pathway for discovery. Recent studies highlight that GenAI

can surface hidden patterns, simulate alternative pedagogical strategies, and generate novel insights that feed into each stage of the cycle (Creely & Carabott, 2025; Ogunleye *et al*, 2024). This integration enables educators to move beyond incremental improvement toward transformative curriculum innovation, particularly in contexts where future challenges are uncertain and knowledge gaps remain undefined.

Moving ahead, we would like to invite fellow CDIO members to adopt the model and test it out within their respective programs; and make the necessary adaptation and suggest further refinements to the model to drive innovation in teaching and learning. Faculty professional development should be driven by the PDCA cycle, using Figure 2 to target the “unknown unknowns” for innovation where neither humans nor GenAI know what they don’t know. Research in this space must explore co-evolution: designing intelligent prompts, experimenting with GenAI in novel teaching contexts, and systematically reflecting on outcomes to surface new competencies and learning pathways. The priority is to uncover insights beyond current knowledge, combining GenAI’s pattern discovery with human creativity and judgment to generate fresh directions for curriculum redesign and educational research.

## CONCLUSIONS

This paper presented a compelling reason to revise both Standards 9 and 10; to highlight the strategic importance of faculty professional development so that faculty continue to keep abreast with technological progress in particular the use of GenAI in teaching and learning. It is suggested to use both the EU DigCompEdu-AI Framework and the UNESCO AI Framework for Teachers to complement one another as the basis to guide the development of AI competency. A dynamic relationship between the revised Standard 9 and new Standard 10 is envisioned, where faculty continue to enhance one’s AI competency in line with technological advancements. Special emphasis is placed on faculty leveraging on GenAI tools to explore knowledge unknown to both humans and machines, to innovate one’s teaching and learning practices to better prepare students to thrive in today’s ever-evolving digital world.

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Full Declaration: Comparison between DigCompEdu-AI and UNESCO had been carried out with the aid of GenAI, namely Gemini. The prompts used and responses obtained are available for review via the link below. Copilot was used to help the author refine the understanding and selection of the ‘C’ words for each of the quadrant in Figure 2 – in what Copilot called analyzing the ‘semantic terrain’ to match the context of use suggested by the matrix. A copy of the activity can be found in same below. (Note: Select PDF marked 105 for this paper) <https://drive.google.com/drive/folders/1h5gPaRxba899Yjk2GbR5JqJ4jeeqMqLo?usp=sharing>

## REFERENCES

- Arnold, L. & Croxford, J. (2024). Is It Time to Stop Talking about Authentic Assessment? *Teaching in Higher Education*, 30(3), pp.1-9. <https://doi.org/10.1080/13562517.2024.2369143>
- Attwell, G. & Bekiaridis, G. (2024). Supplement to the DigCompEdu Framework – Outlining the Skills and Competences of Educators related to AI in Education, *AI Pioneers*, Work Package 3
- Bekiaridis, G. & Attwell, G. (2024). Integrating Artificial Intelligence in Vocational and Adult Education: A Supplement to the DigCompEdu Framework. *Ubiquity Proceedings*, 4(1): 20.  
DOI: <https://doi.org/10.5334/uproc.142>
- Cain, W. (2023). Prompting Change: Exploring Prompt Engineering in Large Language Model AI and its Potential to Transform Education, *TechTrends*, 68, pp.47-57
- Campbell, D. & Beck, H. (2010). Toward Internationalized Engineering Curriculum and Student Mobility, *Proceedings of the 6th International CDIO Conference*, Jun 15-18; Montreal, Canada
- Cheah, S.M. (2026a). CDIO Framework and Cognitive Science: Human-in-the-Loop for GenAI Use, *Proceedings of the 22nd International CDIO Conference*. Liverpool, United Kingdom: University of Liverpool
- Cheah, S.M. (2026b). Appraising CDIO Standards for Guiding Responsible GenAI Use in Curriculum Design, *Proceedings of the 22nd International CDIO Conference*. Liverpool, United Kingdom: University of Liverpool
- Cheah, S.M. (2023). Education as Complex System: Need for More Forward-Looking CDIO Program Evaluation, *Proceedings of the 19th International CDIO Conference*. Trondheim, Norway: Norwegian University of Science & Technology
- Cheah, S.M. (2022). Continual Improvement in CDIO – Enhancing Faculty Competency in Reflective Practice, *Proceedings of the 18th International CDIO Conference*. Reykjavik, Iceland: Reykjavik University
- Cheah, S.M. & Leong, H. (2018). Relevance of CDIO to Industry 4.0 – Proposal for 2 New Standards, *Proceedings of the 14th International CDIO Conference*. Kanazawa, Japan: Kanazawa Institute of Technology
- Crawley, E.F., Malmqvist, J., Östlund, S., & Brodeur, D. (2007). Rethinking Engineering Education: The CDIO Approach, 1st edition. New York: Springer-Verlag
- Creely, EL & Carabott, K. (2025). Teaching and Learning with AI: An Integrated AI-oriented Pedagogical Model, *The Australian Educational Researcher*, 52, 4633-4654
- Fawns, T. (2024). *Process Over Product – What is the Utility of Process Based Assessments?* Higher Education Research & Development Society of Australasia. <https://herdsa.org.au/herdsa-connect/>
- Gonsalves, C. (2025). Contextual Assessment Design in the Age of Generative AI, *Journal of Learning Development in Higher Education*, Vol.34
- Korzynski, P., Mazurek, G., Krzybowska, P. & Kurasinski, A. (2023). Artificial Intelligence Prompt Engineering as a New Digital Competence: Analysis of Generative AI Technologies such as ChatGPT, *Entrepreneurial Business and Economics Review*, 11(3), pp.25-37
- Malmqvist J., Edström K., Rosén A., Hugo R., & Campbell D. (2020). Optional CDIO Standards: Sustainable Development, Simulation-Based Mathematics, Engineering Entrepreneurship, Internationalisation & Mobility. *Proceedings of the 16th International CDIO Conference*. Gothenburg, Sweden (online): Chalmers University of Technology
- Malmqvist, J., Edström, K., & Rosén, A. (2020). CDIO Standards 3.0 – Updates to the Core CDIO Standards. *Proceedings of the 16th International CDIO Conference*. Gothenburg, Sweden (online): Chalmers University of Technology
- Malmqvist, J., Edstrom, K. & Hugo, R. (2017). A Proposal for Introducing Optional CDIO Standards, *Proceedings of the 13th International CDIO Conference*. Calgary, Canada: University of Calgary
- Maneeratana, K. & Wangsaturaka, D. (2017). Student Engagement: A Proposed Optional Standard, *Proceedings of the 17th International CDIO Conference*. Bangkok, Thailand (on-line): Chulalongkorn University & Rajamangala University of Technology Thanyaburi

Moorhouse, B.L., Yeo, M.A. & Wan, Y. (2023). Generative AI Tools and Assessment: Guidelines of the World's Top-Ranking Universities. *Computers and Education Open*, 5:100151. <https://doi.org/10.1016/j.caeo.2023.100151>

Ogunleye, B., Zakariyyah, K.I., Ajao, O., Olayinka, O. & Sharma, H. (2024). A Systematic Review of Generative AI for Teaching and Learning Practice, *Education Sciences*, 14(6), 636

Samuel, S. & Farrer, H. (2025). Integrating The PDCA Cycle for Continuous Improvement and Academic Quality Enhancement in Higher Education, *Journal of Comparative & International Higher Education*, Vol.17, Issue 2, pp.115-124

UNESCO. (2024). *AI Competency Framework for Teachers*. The United Nations Educational, Scientific and Cultural Organization, France

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## APPENDIX 1. Proposed CDIO Core Standards 9 and 10 incorporating use of GenAI

### Standard 9 Enhancement of Faculty CDIO Competencies (REVISED)

**Actions that enhance faculty CDIO competence, defined as knowledge, skills and attitudes pertaining to the CDIO Syllabus and skills in designing and delivering various CDIO-type learning tasks (design-implement experiences, integrated learning experiences, active learning lessons) and in assessing student learning. Also include actions that develop faculty competence in using GenAI tools.**

#### Description

CDIO programs provide support for improving the collective competence of the engineering faculty with regards to *what to teach*, according to the full set of intended learning outcomes of the program as described in Standard 2. Faculty **CDIO** competence refers to personal, **professional** and interpersonal skills, product, process, system, and service building skills, including concepts and competences related to sustainable development. Faculty **CDIO** competence also refers to the ability to support students (*how to teach*) to achieve a deeper working understanding of the relevant disciplinary fundamentals **by designing appropriate CDIO-type learning tasks such as design-implement experiences (Standard 5), integrated learning experiences (Standard 7), active learning lessons (Standard 8) and the assessment of student learning (Standard 11).** Reflective practice is a key element of faculty undertaking to identify one's own training needs; and taking part in community of practice or formal training programs are ways to enhance faculty's CDIO competencies. Proficiency in using GenAI tools in ethical and responsible manner form the basis of faculty CDIO competency. ~~One way to strengthen the collective competence of faculty is to take these needs into account in faculty recruitment and promotion processes. Another way is to systematically support the competence development of the existing faculty members. The nature and scope of faculty development vary with the resources and intentions of different programs and institutions.~~

#### Rationale

If engineering faculty are expected to teach a curriculum of personal, **professional** and interpersonal skills, and product, process, system, and service building skills integrated with disciplinary knowledge, as described for instance in Standards 3, 4, 5, and 7, they as a group need to be competent in those skills. Engineering professors tend to be experts in the research and knowledge base of their respective disciplines, with only limited experience in the practice of engineering in business and industrial settings, and its role in sustainable development. A key aspect of expertise is **technological** pedagogical content knowledge, which refers to the ability to effectively support students in learning the subject, **with aid of technology enhanced with use of GenAI.** The rapid pace of technological innovation also requires continuous updating of engineering skills. The collective faculty needs to enhance its engineering knowledge and skills so that they can provide relevant examples to students and also serve as individual role models of contemporary engineers.

#### Rubric for self-assessment

|   |                                                                                                                                                                                                                                                                                                                                                            |
|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5 | Faculty competence in disciplinary knowledge and personal, <b>professional</b> , interpersonal, product, process, system, and service building skills <b>as well as in designing CDIO-type learning tasks (with or without using GenAI)</b> are regularly evaluated and enhanced where appropriate.                                                        |
| 4 | There is evidence that the collective faculty is competent in disciplinary knowledge and personal, <b>professional</b> , interpersonal, product, process, system, and service building skills; <b>as well as in designing CDIO-type learning tasks (with or without using GenAI).</b>                                                                      |
| 3 | The faculty participates in competence development activities, and faculty recruitment <b>considers</b> the need for faculty competence, with regards to disciplinary knowledge and personal, interpersonal, product, process, system, and service building skills, <b>as well as in designing CDIO-type learning tasks (with or without using GenAI).</b> |
| 2 | There is a systematic plan for faculty enhancement in disciplinary knowledge and personal, <b>professional</b> , interpersonal, product, process, system, and service building skills; <b>as well as in designing CDIO-type learning tasks (with or without using GenAI).</b>                                                                              |
| 1 | The need of a faculty competence development plan in disciplinary knowledge and personal, <b>professional</b> , interpersonal, product, process, system, and service building skills <b>as well as in designing CDIO-type learning tasks (with or without using GenAI)</b> is recognized.                                                                  |
| 0 | There are no programs or practices to enhance faculty competence in disciplinary knowledge and personal, <b>professional</b> , interpersonal, product, process, system, and service building skills, <b>as well as in designing CDIO-type learning tasks (with or without using GenAI).</b>                                                                |

## APPENDIX 1. (cont'd)

### Standard 10 Faculty Continuing Professional Development (NEW)

**Actions that ensure faculty's CDIO competencies is up-to-date in response to changing teaching and learning environment brought about by rapid changes in today's fast-changing world to provide students with required new skills in the workplace, or emerging industry.**

#### Description

CDIO programs take actions to enhance faculty teaching competence required for effectively creating, delivering and improving courses in the curriculum **via continuing professional development is necessary in today's fast-changing world.** ~~The need for faculty teaching competence include for instance the ability to provide integrated learning experiences (Standard 7), including design-implement experiences (Standard 5) and other active and experiential learning (Standard 8), as well as assessing student learning (Standard 11) and evaluating and improving courses and programs (Standard 12). One way to strengthen the collective faculty teaching competence is to take these needs into account in faculty recruitment and promotion processes. Another way to address the need is to systematically support the development of the existing faculty members' teaching competence. The nature and scope of faculty development practices will vary with programs and institutions.~~ **This is particularly so, with regards to advancement in technology, faculty need to learn new skills such as prompt engineering for GenAI in research or in designing new CDIO-type learning tasks, in using GenAI for various research applications (e.g. identifying insights, performing sentiment analysis, designing performance rubrics to guide assessment of new skills, etc).**

#### Rationale

If faculty members are expected **to integrate new skills and/or attitudes (e.g. arising from new developments in the workplace, technological advances, etc), and hence to teach and assess in new ways,** ~~as described in the CDIO Standards, they need opportunities to develop and improve these competencies. Many universities have faculty development programs and services that might be eager to collaborate with faculty in CDIO programs. In addition, if CDIO programs want to emphasize the importance of teaching, learning, and assessment, they must recruit and promote faculty with these needs in mind, and they must commit adequate resources for faculty development in these areas.~~ **Programs should have a systematic way to assess faculty training requirements and work with the institution's faculty professional development department to provide the required training. The impact of professional development program on teaching and learning should be evaluated.**

#### Rubric for self-assessment

|   |                                                                                                                                                                                                                                                                                                                                                |
|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5 | Faculty <b>teaching and learning competency framework, AI competency framework and continuing professional development program</b> is regularly evaluated <b>with key stakeholders</b> and updated where appropriate.                                                                                                                          |
| 4 | There is evidence that the collective faculty <b>continuing professional development</b> had been translated to <b>has the teaching competence needed for</b> <del>effectively creating, delivering and improving courses in the curriculum,</del> <b>as well as ethical and responsible of GenAI.</b>                                         |
| 3 | Faculty members participate <b>in continuing professional development</b> activities to develop their <b>CDIO competence and AI competence based on the institution's faculty teaching and learning competency framework and AI framework.</b> <del>and faculty recruitment takes into account the need for faculty teaching competence.</del> |
| 2 | A systematic plan for ensuring and enhancing faculty <b>continuing professional development</b> is developed <b>(for example, training needs analysis, faculty teaching and learning competency framework, AI framework)</b> and budgeted.                                                                                                     |
| 1 | A need for ensuring and enhancing faculty <b>continuing professional development</b> is recognized and accepted within the team.                                                                                                                                                                                                               |
| 0 | There are no programs or practices <b>for faculty continuing professional development.</b>                                                                                                                                                                                                                                                     |