EMBEDDING ETHICS AND PROFESSIONAL RESPONSIBILITY IN ENGINEERING EDUCATION: PREPARING FUTURE ENGINEERS FOR INDUSTRY 5.0

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ABSTRACT

Engineering education is undergoing a transformative shift to prepare students for the challenges of the 21st century, particularly as the world embraces the principles of Industry 5.0. This new industrial paradigm emphasizes human-centric innovation, ethical practices, and sustainability, placing ethics and professional responsibility at the forefront of engineering education. These values are essential for equipping future engineers with the skills and judgment to address global challenges such as climate change, equitable access to technology, and the responsible use of artificial intelligence. This paper explores the integration of ethics and professional responsibility into the engineering curricula through the CDIO (Conceive-Design-Implement-Operate) framework. By embedding these principles at every stage of the engineering lifecycle, the CDIO approach ensures that students not only gain technical competence but also develop the moral and professional accountability required to navigate complex, real-world challenges. The paper also highlights the role of interdisciplinary collaboration, experiential learning, and research-driven education in fostering ethical awareness. Additionally, the paper examines how partnerships with industry and the adoption of innovative teaching methodologies—such as problem-based learning, role-playing, and case studies—can further reinforce these principles. It underscores the importance of assessment strategies that evaluate students' ethical decision-making skills and professional responsibility. Aligning with the theme of "Forging Connections: Synergies for a Sustainable Future," this paper outlines actionable strategies for educators and institutions to prepare engineers who are technically proficient, ethically grounded, and capable of contributing to sustainable and human-centered innovation. By bridging education, research, and industry, this approach paves the way for a new generation of engineers ready to lead in the era of Industry 5.0.

KEYWORDS

Ethical competence, Engineering education, Sustainability, Industry 5.0, CDIO Framework, Ethical Decision-Making, "Standards: 1-6, 8, 10".

INTRODUCTION

Engineering plays a transformative role in addressing critical global challenges, such as climate change, resource scarcity, and social inequalities (Mihelcic et al., 2017). In this era of rapid technological advancement, engineers must not only possess technical proficiency but also demonstrate ethical integrity and professional responsibility (Van de Poel & Royakkers, 2023). These qualities are essential to ensure that engineering innovations contribute to a sustainable, equitable, and human-centered future (Longo et al., 2020). The emergence of Industry 5.0 underscores the importance of ethical and human-centric practices in engineering. Unlike Industry 4.0, which focused on automation and efficiency, Industry 5.0 emphasizes the synergy between advanced technologies and societal well-being (Ghobakhloo et al., 2024). Engineers are expected to design systems that prioritize inclusivity, sustainability, and ethical governance, making it imperative for engineering education to adapt accordingly. Future engineers must navigate complex ethical dilemmas, such as ensuring transparency in artificial intelligence, addressing environmental trade-offs in energy systems, and balancing automation with workforce stability. Ethics in engineering education encompasses principles of integrity, accountability, and fairness, while professional responsibility involves a commitment to societal welfare, environmental stewardship, and equitable resource distribution. To address these imperatives, educational frameworks must evolve to integrate ethics as a core component. This integration aligns with the values of Industry 5.0 and prepares engineers to address global challenges responsibly. The CDIO (Conceive-Design-Implement-Operate) framework provides a robust platform for embedding ethics and professional responsibility into engineering curricula (Tobias & Alvarez, 2024). This framework emphasizes real-world application, interdisciplinary collaboration, and continuous improvement, making it ideal for cultivating ethical awareness and professional accountability. This paper examines approaches to integrating ethics and professional responsibility into engineering curricula within the context of Industry 5.0. It explores how the CDIO (Conceive-Design-Implement-Operate) framework can serve as a foundation for embedding ethical considerations into engineering education. Rather than presenting a single, comprehensive framework, the paper discusses key challenges, innovative teaching methodologies, and strategies for fostering ethical awareness through research and industry collaboration. The following sections will analyze current trends in engineering ethics education, review best practices, and propose actionable recommendations for strengthening ethical and professional responsibility in engineering programs.

INTEGRATING ETHICS IN CDIO: INNOVATIVE APPROACHES TO TEACHING ETHICAL COMPETENCE

The CDIO framework provides a structured approach to embedding ethics at every stage of the engineering process (see Figure 1). During the Conceive phase, students analyze societal needs and ethical considerations when defining problems. The Design phase focuses on creating solutions that prioritize safety, inclusivity, and sustainability. In the Implement phase, ethical practices are emphasized through adherence to standards and transparent deployment of solutions. Finally, the Operate phase highlights the importance of accountability and continuous improvement in maintaining systems. By aligning the CDIO framework with the principles of Industry 5.0, educators can prepare future engineers to be not only technically skilled but also ethically aware and socially responsible (Al-Juboori and Noonan, 2024).

To further strengthen ethics within the CDIO framework, several strategies can be employed:

1. Interdisciplinary Collaboration. Engaging students with experts from law, sociology, and philosophy broadens their ethical perspectives. This approach encourages students to view engineering challenges through a multi-dimensional lens, enriching their understanding of complex moral dilemmas (Pavlidou et al., 2021).
2. Role-Playing and Simulations. Practical scenarios replicating ethical challenges, such as addressing bias in AI systems or weighing environmental trade-offs in large-scale projects (Patel, 2024), allow students to develop hands-on experience in ethical decision-making.
3. Mentorship Programs. Pairing students with industry professionals provides insight into real-world ethical challenges. Mentorship discussions about balancing innovation with accountability prepare students for the complexities of professional engineering practice (Hamilton & Brabbit, 2007).

Integrating ethics within the CDIO framework directly supports the human-centric and sustainable values of Industry 5.0. This approach cultivates empathy, social awareness, and accountability, ensuring that students develop innovative solutions that prioritize equity and sustainability. Furthermore, aligning ethics integration with institutional goals, such as producing socially responsible graduates, enhances academic reputation and accreditation compliance (Glendinning, 2022).

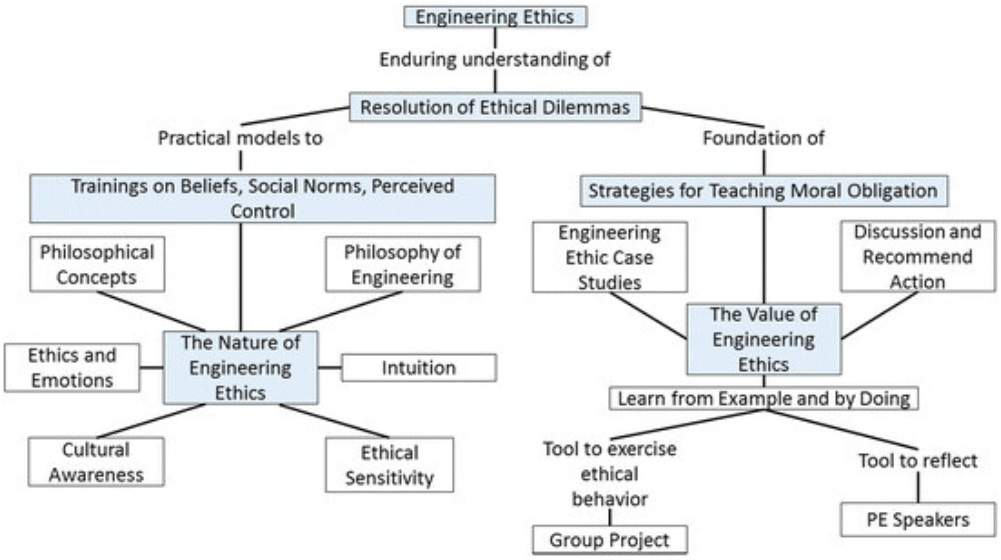

Figure 1. The concept of engineering ethics in engineering education

Engineering education must incorporate ethics and professional responsibility through engaging and forward-thinking approaches that seamlessly fit within the CDIO framework. By embedding ethics into every stage of the engineering process, these methodologies equip students with the skills to navigate the complex ethical challenges of Industry 5.0, which emphasizes human-centric innovation, sustainability, and societal well-being. Furthermore, these approaches prepare students for lifelong ethical leadership, ensuring that they not only succeed in academic settings but also contribute responsibly to global progress (Belefeldt et al., 2018).

- *Case-based learning* immerses students in real-world ethical scenarios (Yadav et al., 2014), such as AI bias in hiring systems, sharpening critical thinking and problem-solving skills. Within the CDIO framework, it is effective during the Conceive stage, aligning ethical decision-making with Industry 5.0's focus on fairness and inclusivity.

- *Role-playing* and simulations engage students in dilemmas like balancing renewable energy projects and community displacement, fostering empathy and collaboration. This approach complements the Design and Implement stages, integrating ethical trade-offs into system prototypes (Wibava et al., 2023).
- *Service-learning* blends academics with community engagement, such as designing affordable water filters for underserved areas. This method aligns with the Operate stage, connecting engineering expertise with sustainability and equity (Belefeldt et al., 2018).
- *Interdisciplinary workshops* bring diverse fields together, such as exploring autonomous vehicle ethics, enhancing holistic thinking during the Conceive and Design stages (Foski et al., 2017).
- Gamification introduces interactive tools, like VR simulations, enabling students to explore ethical trade-offs creatively (Sicart, 2015).
- *Research projects* with an ethical focus tackle issues like AI bias or environmental impacts, aligning with the Implement stage (Cacciattolo, 2015).
- Reflective journals span all CDIO stages, promoting continuous ethical learning and self-awareness (Swindell & Watson, 2006).
- *Faculty mentorship* guides students through ethical challenges, supporting all CDIO stages, while collaborative industry partnerships provide real-world experience in balancing economic and environmental priorities during the Implement and Operate stages (Oldenburg & Graves, 2024).
- *Scenario-based assessments* integrate ethics as a measurable outcome across all CDIO stages, ensuring accountability and critical thinking (Lohfeld et al., 2012)..

Collectively, these methodologies prepare engineers to address Industry 5.0's ethical complexities by balancing innovation with responsibility, contributing to sustainable and equitable solutions (Wibava et al., 2023).

Assessing ethical competence is a critical component of engineering education (Romero-Yesa et al., 2022), ensuring that students are prepared to navigate the moral and professional challenges they will encounter in their careers. In the era of Industry 5.0, where technology must align with human-centric and sustainable values, ethical competence assessment takes on an even greater significance. This process ensures that future engineers prioritize innovation that benefits society and the environment, fostering trust in engineering as a profession. To be effective, assessments must be holistic, combining theoretical knowledge, practical application, and reflective practices (see Figure 2). Embedding these assessment strategies into the CDIO framework ensures that ethics is integrated across all stages of the engineering process, enhancing both its relevance and impact (Martin et al., 2021).

Ethical competence assessment has three key objectives:

1. Moral reasoning – Evaluating students' ability to resolve ethical dilemmas in engineering contexts (Sancez et al., 2017).
2. Professional responsibility – Measuring understanding of codes of conduct, regulations, and societal impacts (Christie et al., 2003).
3. Reflective thinking – Encouraging self-awareness about the broader impact of engineering work (Lechasseur et al., 2018).

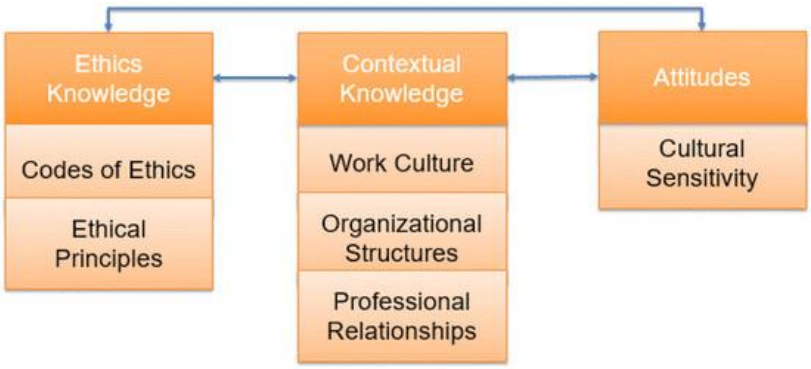

Figure 2. Theoretical framework for ethical competency assessment

These goals align with Industry 5.0's focus on sustainability, inclusivity, and ethical innovation, preparing students as responsible leaders. Methods for assessing ethical competence are:

- Scenario-Based Assessments: Engage students in dilemmas like AI in surveillance, fostering critical thinking during the CDIO's Conceive and Operate stages, addressing Industry 5.0 challenges (Ikonen & Kaasinen, 2008).
- Case Studies: Analyze real-world dilemmas like dam projects, integrating ethics into the Design and Implement stages (Al-Juboori & Noonan, 2024).
- Reflective Journals: Encourage introspection on ethical challenges, spanning all CDIO stages, enriched by peer feedback (Moloi, 2024).
- Group Discussions and Debates: Foster diverse perspectives on ethical issues like autonomous vehicles, enhancing collaborative skills in the Conceive and Design stages (Hanna et al., 2014).
- Role-Playing and Simulations: Provide practical experience in managing ethical dilemmas during the Implement and Operate stages, enhanced by VR (Schrier, 2017).
- Rubrics for Ethical Reasoning: Offer consistent evaluation across all CDIO stages, balancing qualitative and quantitative criteria (Tractenberg et al., 2016).
- Capstone Projects: Address comprehensive ethical challenges, embedding ethics across project development phases (Giacalone et al, 2003).
- Peer and Self-Assessment: Foster accountability and collaboration, applicable at all CDIO stages (Elliott & Higgins, 2005).

Challenges in assessing ethical competence include subjectivity, integration with technical assessments, and scalability for large cohorts. Solutions include co-designed rubrics, blended qualitative and quantitative methods, real-world contextual assessments, faculty training, and technology integration like AI and VR for scalability.

CASE STUDY: ETHICHS AND SUSTAINABILITY IN ENGINEERING EDUCATION AT AUSTRALIAN UNIVERSITY (AU)

Australian University (AU) has established itself as a pioneer in embedding ethics and sustainability into its engineering education programs. By aligning its initiatives with the CDIO framework and the principles of Industry 5.0, AU integrates ethics and sustainability across every phase of the engineering process, ensuring that students develop both technical and moral competence. Key Initiatives at AU include:

Ethics-Integrated Curriculum. AU's curriculum is designed to explicitly integrate ethical challenges, with a strong emphasis on sustainability and professional responsibility. Through

carefully structured coursework, students engage in critical discussions on ethical decision-making within the engineering profession. A key component of this approach is the course "Sustainable Engineering and Ethics," which delves into the ethical and environmental implications of engineering practices. Topics covered include energy production, waste management, urban development, and resource conservation, providing students with a holistic perspective on sustainability challenges. The course goes beyond theoretical discussions by incorporating real-world case studies, industry practices, and emerging global issues, allowing students to explore the ethical complexities engineers face in their professional roles. Through problem-based learning, ethical debates, and scenario analysis, students are encouraged to critically assess competing interests, consider long-term environmental and societal impacts, and formulate sustainable engineering solutions. By fostering an ethical mindset and equipping students with practical frameworks for ethical decision-making, AU ensures that graduates are prepared to uphold professional integrity while addressing the pressing challenges of modern engineering.

Real-World Capstone Projects. Capstone projects at AU provide students with hands-on experience in addressing real-world sustainability challenges. One notable project involved designing a solar-powered desalination system to supply clean water to rural communities in Kuwait. This initiative incorporated ethical considerations such as affordability, community involvement, and environmental sustainability. Students had to ensure the system was cost-effective and accessible, balancing economic feasibility with social responsibility. They also assessed the long-term environmental impact, reinforcing sustainable engineering practices. These multidisciplinary projects help students navigate complex ethical dilemmas in engineering. Through collaborative problem-solving, they gain practical exposure to real challenges. This fosters critical thinking and professional integrity. AU graduates emerge prepared to address societal issues with both technical expertise and ethical responsibility.

Industry Collaborations. AU's strategic partnerships with leading industries expose students to cutting-edge technologies and real-world ethical dilemmas. A collaboration with a renewable energy company, for instance, enabled students to design cost-effective solar panels tailored for Kuwait's climate conditions. These partnerships bridge the gap between academic learning and industry practices, equipping students with the skills to navigate ethical challenges in professional settings. Industry leaders have commended AU graduates for their ability to integrate sustainability and ethics into innovative solutions, reinforcing the university's reputation for producing industry-ready professionals. Furthermore, these collaborations provide students with internship opportunities and mentorship programs, enhancing their practical knowledge and ethical decision-making skills. As a result, AU graduates enter the workforce with a strong foundation in both technical expertise and responsible engineering practices.

Faculty-Led Ethical Mentorship. AU's faculty play a critical role in mentoring students on ethical challenges. Through programs like the "Engineering Leadership Program," faculty members provide personalized guidance on balancing innovation with ethical responsibility. Faculty development workshops equip educators with tools to integrate ethics and sustainability into their teaching, ensuring consistency and depth in mentorship. This initiative not only strengthens students' moral foundations but also prepares them for leadership roles in sustainable engineering, as reflected in the testimonials of graduates who credit faculty mentorship for shaping their professional ethics. Additionally, faculty members actively engage in industry collaborations and research projects, allowing students to explore real-world ethical dilemmas firsthand. By fostering a culture of ethical inquiry and critical thinking, AU ensures

that its graduates are well-equipped to make responsible engineering decisions in their careers.

Service-Learning Projects. AU emphasizes civic responsibility through service-learning projects that address sustainability challenges. For example, engineering students collaborated with local communities to improve water management systems in underserved regions, integrating ethical considerations such as equitable access and environmental preservation. These projects allow students to witness the societal impact of engineering firsthand, fostering empathy and a commitment to sustainability. One student remarked, "Working on this project taught me that engineering is not just about solving technical problems—it's about improving lives and protecting the environment."

While AU's initiatives have been successful, implementing them required overcoming several challenges:

- Balancing the Curriculum: Integrating ethics and sustainability into a technically rigorous curriculum necessitated significant redesign, requiring collaboration between faculty and curriculum developers.
- Resource Allocation: Securing adequate funding for sustainability-focused projects was challenging but addressed through strategic partnerships and grants.
- Cultural Sensitivity: Developing solutions that respect diverse perspectives required inclusive pedagogical approaches, such as incorporating region-specific case studies and engaging with local communities to ensure cultural relevance.

Identified challenges could be associated with the Four-Leaf Clover: A Conceptual Framework for Sustainability Education at Ohio State University shown in Figure 3 (Ohio State University, 2019). By utilizing this framework universities can facilitate collaboration between faculty and curriculum developers to balance technical rigor with ethical and sustainable considerations. Additionally, it can guide resource allocation by identifying key areas that require funding and support. Incorporating diverse perspectives within each area ensures cultural sensitivity, making the curriculum inclusive and relevant to various communities.

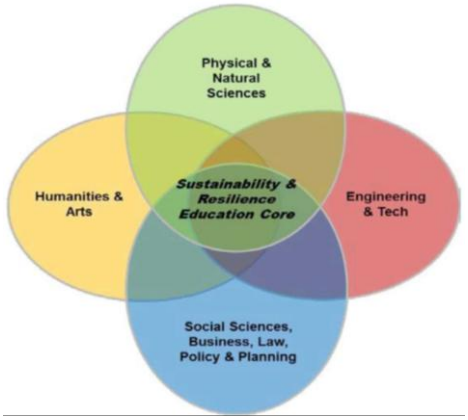

Figure 3. The Four-Leaf Clover: A Conceptual Framework for Sustainability Education at Ohio State University

AU's approach has yielded remarkable outcomes:

- Enhanced Ethical Awareness: Surveys reveal that 95% of AU engineering graduates feel confident in addressing ethical dilemmas in their professional roles.

- Sustainability-Driven Innovation: AU student projects have received national and international recognition for their focus on sustainability and innovation, including awards for renewable energy solutions and community-driven designs.
- Industry Readiness: AU graduates are highly sought after by industries prioritizing sustainability, with many securing positions in renewable energy, green technology, and socially responsible organizations.

The case study of Australian University (AU) highlights the transformative potential of integrating ethics and sustainability into engineering education. By embedding these principles into its curriculum, fostering interdisciplinary collaborations, and leveraging the CDIO framework, AU has created a robust educational model that prepares students for the challenges of Industry 5.0. Through innovative programs, real-world projects, and a commitment to cultural and professional relevance, AU equips its graduates with the technical expertise and ethical values essential for shaping a better world. This approach serves as a blueprint for other institutions, demonstrating that sustainable engineering is not just a technical pursuit but a moral imperative for addressing global challenges (Giacalone et al, 2003).

CONCLUSION

The integration of ethics and professional responsibility in engineering education is no longer optional but a vital necessity in preparing future engineers to address the multifaceted challenges of Industry 5.0. This paper has explored the essential dimensions of embedding ethical competence into engineering education, aligning with the CDIO framework to ensure that ethics permeate every stage of the engineering process. Through methodologies such as scenario-based assessments, reflective journals, and interdisciplinary projects, institutions can effectively instill ethical reasoning and professional responsibility in students (Martin et al., 2021). The implications of this approach extend beyond individual competence. By fostering ethical decision-making and a commitment to sustainability, engineering education contributes to societal well-being, environmental preservation, and economic resilience. Institutions like Australian University (AU) demonstrate how integrating ethics and sustainability into curricula prepares graduates to lead in a rapidly evolving global landscape (Martin et al., 2021). Looking ahead, the future of engineering education lies in leveraging immersive technologies, gamification, AI-driven tools, and interdisciplinary collaboration to enhance ethical awareness and sustainability practices. These innovations ensure that engineering education remains dynamic and responsive to global challenges, fostering a new generation of engineers who are not only skilled innovators but also ethical leaders (Abuliobdeh et al., 2024). In conclusion, the journey toward ethical and sustainable engineering education requires a collective effort from universities, industries, and policymakers. By prioritizing ethics and sustainability, we can ensure that engineering graduates are equipped to build a future that is not only technologically advanced but also equitable, sustainable, and human-centric—hallmarks of Industry 5.0. This commitment to ethical competence will shape not only the engineers of tomorrow but also the world they help create (Lechasseur et al., 2018).

REFERENCES

Abulibdeh, A., Zaidan, E., & Abulibdeh, R. (2024). Navigating the confluence of artificial intelligence and education for sustainable development in the era of industry 4.0: Challenges, opportunities, and ethical dimensions. Journal of Cleaner Production, 140527.

Al-Juboori, H., & Noonan, G. (2024, May). Concepts of Engineering Education Innovation and Design Thinking: Implementing the CDIO-approach Themes. In 2024 IEEE Global Engineering Education Conference (EDUCON) (pp. 1-5). IEEE.

Bielefeldt, A. R., Polmear, M., Canney, N., Swan, C., & Knight, D. (2018). Ethics education of undergraduate and graduate students in environmental engineering and related disciplines. Environmental Engineering Science, 35(7), 684-695.

Cacciattolo, M. (2015). Ethical considerations in research. In The Praxis of English Language Teaching and Learning (PELT) (pp. 55-73). Brill.

Christie, C. R., Bowen, D. M., & Paarmann, C. S. (2003). Curriculum evaluation of ethical reasoning and professional responsibility. Journal of Dental Education, 67(1), 55-63.

Elliott, N., & Higgins, A. (2005). Self and peer assessment–does it make a difference to student group work?. Nurse Education in Practice, 5(1), 40-48.

Foski, M., Mrak, G., & Lamovsek, A. Z. (2017). Interdisciplinary approach to project based learning: Experience through student workshops. New Trends and Issues Proceedings on Humanities and Social Sciences, 5(5), 95-103.

Ghobakhloo, M., Iranmanesh, M., Fathi, M., Rejeb, A., Foroughi, B., & Nikbin, D. (2024). Beyond Industry 4.0: a systematic review of Industry 5.0 technologies and implications for social, environmental and economic sustainability. Asia-Pacific Journal of Business Administration.

Glendinning, I. (2022). Aligning academic quality and standards with academic integrity. In Contract cheating in higher education: Global perspectives on theory, practice, and policy (pp. 199-218). Cham: Springer International Publishing.

Hamilton, N., & Brabbit, L. M. (2007). Fostering professionalism through mentoring. J. Legal Educ., 57, 102.

Hanna, L. A., Barry, J., Donnelly, R., Hughes, F., Jones, D., Laverty, G., ... & Ryan, C. (2014). Using debate to teach pharmacy students about ethical issues. American journal of pharmaceutical education, 78(3), 57.

Ikonen, V., & Kaasinen, E. (2008). Ethical assessment of future-oriented design scenarios. In Ethicomp (pp. 433-445).

Lechasseur, K., Caux, C., Dollé, S., & Legault, A. (2018). Ethical competence: an integrative review. Nursing ethics, 25(6), 694-706.

Lohfeld, L., Goldie, J., Schwartz, L., Eva, K., Cotton, P., Morrison, J., ... & Wood, T. (2012). Testing the validity of a scenario-based questionnaire to assess the ethical sensitivity of undergraduate medical students. Medical teacher, 34(8), 635-642.

Longo, F., Padovano, A., & Umbrello, S. (2020). Value-oriented and ethical technology engineering in industry 5.0: A human-centric perspective for the design of the factory of the future. Applied Sciences, 10(12), 4182.

Mihelcic, J. R., Naughton, C. C., Verbyla, M. E., Zhang, Q., Schweitzer, R. W., Oakley, S. M., ... & Whiteford, L. M. (2017). The grandest challenge of all: The role of environmental engineering to achieve sustainability in the world's developing regions. Environmental Engineering Science, 34(1), 16-41.

Moloi, K. C. (2024). THE REFLECTIVE JOURNAL AS A PEDAGOGIC AND ASSESSMENT TOOL IN HIGHER EDUCATION (Doctoral dissertation, Vaal University of Technology).

Patel, K. (2024). Ethical reflections on data-centric AI: balancing benefits and risks. International Journal of Artificial Intelligence Research and Development, 2(1), 1-17.

Pavlidou, I., Dragicevic, N., & Tsui, E. (2021). A multi-dimensional hybrid learning environment for business education: A knowledge dynamics perspective. Sustainability, 13(7), 3889.

Romero-Yesa, S., Ukar-Arrien, O., Bilbao-Alberdi, G., Santos, P. M. S., Casado-Mansilla, D., & Eguíluz-Morán, A. (2022). Tecnoetica: Inclusion and Assessment of the Ethical Competence in Engineering Final Degree Projects. IEEE Revista Iberoamericana de Tecnologias del Aprendizaje, 17(1), 41-47.

Sanchez, E. R., Fulcher, K. H., Smith, K. L., Ames, A., & Hawk, W. J. (2017). Defining, teaching, and assessing ethical reasoning in action. Change: The Magazine of Higher Learning, 49(2), 30-36.

Schrier, K. (2017). Designing role-playing video games for ethical thinking. Educational Technology Research and Development, 65(4), 831-868.

Sicart, M. (2015). Playing the good life: Gamification and ethics.

Swindell, M., & Watson, J. (2006). Teaching ethics through self-reflective journaling. Journal of Social Work Values and Ethics, 3(2), 4-12.

Sustainability Education and Learning Committee (SELC), Sustainability Institute. (2019, May 20). Recommendations for undergraduate sustainability education at Ohio State. The Ohio State University. https://si.osu.edu/learn

Tobias, R. G., & Alvarez, J. (2024, May). Engineering Virtue: A Behavioral Approach to Ethical Challenges in Engineering Education. In 2024 IEEE Global Engineering Education Conference (EDUCON) (pp. 1-5). IEEE.

Tractenberg, R. E., FitzGerald, K. T., & Collmann, J. (2016). Evidence of sustainable learning from the mastery rubric for ethical reasoning. Education Sciences, 7(1), 2.

Van de Poel, I., & Royakkers, L. (2023). Ethics, technology, and engineering: An introduction. John Wiley & Sons.

Wibawa, A. P., Nabila, K., Utama, A. B. P., Purnomo, P., & Dwiyanto, F. A. (2023). Social informatics and CDIO: revolutionizing technological education. International Journal of Education and Learning, 5(2), 89-99.

Yadav, A., Vinh, M., Shaver, G. M., Meckl, P., & Firebaugh, S. (2014). Case-based instruction: Improving students' conceptual understanding through cases in a mechanical engineering course. Journal of research in Science Teaching, 51(5), 659-677.

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