Integrating AI Ethics and Sustainability Through Experiential and Data-Driven Curriculum Innovation at PCCOE

Dr.Vivekanandan[1] N, Dr. Rajeswari K[2]
[1]Department of Mechanical Engineering, Pimpri Chinchwad College of Engineering, Pune-411044, India
[2]Department of Computer Engineering, Pimpri Chinchwad College of Engineering, Pune, India
[1] n.vivekanandan@pccoepune.org [2] kannan.rajeswari@pccoepune.org

***Abstract*— A novel undergraduate course, Professional Ethics and Sustainability in the Age of AI, bridges critical gaps in engineering education by combining experiential learning with outcome-based assessment. Developed at Pimpri Chinchwad College of Engineering (PCCOE), the curriculum employs four research-grounded activities: historical case analyses of ethical disasters, TARES Test evaluations of AI advertisements, governance quizzes on surveillance systems, and multi-stakeholder role-plays about algorithmic grading. Interim results from 46-60 participants demonstrate significant competencies development: 91.3% of students recognize AI's ethical influence, 95.7% show heightened emotional awareness, with strong performance in persuasion literacy (M=4.40/5) and governance knowledge (M=9.43/10). Structured assessments reveal 81.8% attainment in ethical reasoning and 80.5% in communication/governance skills, while qualitative analysis uncovers sophisticated engagement with fairness, transparency, and accountability principles.**

Built on Kohlberg's moral development theory, UNESCO's ESD framework, and IEEE's Ethically Aligned Design, the course uniquely integrates macro ethical principles with micro ethical skill-building. Final evaluations of the sustainability-focused AI mini-projects showed attainment levels of 82.4% for CO2 and 84.1% for CO4, completing the comprehensive outcomes-based assessment cycle.. This model offers engineering educators a replicable blueprint for cultivating professional judgment in AI ethics through three key innovations: (1) contextualized historical analogies, (2) measurable persuasion literacy benchmarks, and (3) stakeholder negotiation simulations that mirror real-world tech governance challenges. The demonstrated success of this active learning approach provides empirical support for transforming traditional ethics education in response to emerging technologies.

***Keywords*—AI Ethics Education, Experiential Learning, Outcome-Based Assessment, Sustainability Literacy, Governance Competencies.**

***ICTIEE Track—Research-Informed Curriculum and Course Design*)**

***ICTIEE Sub-Track*—Curriculum Development Based on Outcome-Based Education (OBE)**

I. INTRODUCTION

ARTIFICIAL INTELLIGENCE (AI) technologies are increasingly embedded in decision-making systems across sectors such as education, healthcare, transportation, and governance. While these systems promise efficiency and scalability, they also raise complex questions of fairness, transparency, sustainability, and accountability. Global incidents—ranging from data privacy breaches to algorithmic discrimination—have underscored the urgent need for graduates who can combine technical proficiency with robust ethical reasoning and a commitment to sustainable development principles.

Engineering education in the AI era must therefore go beyond teaching algorithms to embedding the capacity for critical reflection, stakeholder analysis, and governance literacy. Recognizing this imperative, Pimpri Chinchwad College of Engineering (PCCOE), Pune, India, introduced a multidisciplinary Open Elective titled Professional Ethics and Sustainability in the Age of AI (BME25OE06) in the final-year curriculum under its autonomous framework. The course is aligned with Outcome-Based Education (OBE) principles, with the following core outcomes:

CO1 — *Ethical Foundations in Engineering and AI*

Demonstrate a clear understanding of fundamental ethical principles, professional responsibilities, and normative frameworks governing engineering practice, artificial intelligence (AI), and emerging technologies.

CO2 — *Ethical Analysis and Decision-Making in AI Systems*

Apply established ethical frameworks and structured decision-making models to critically analyze dilemmas involving AI deployment, research integrity, intellectual property, and sustainable engineering interventions.

CO3 — *Sustainability and Societal Impact Evaluation*

Evaluate the environmental, social, and societal implications of engineering and AI technologies, and propose responsible, sustainability-aligned innovations that reflect ethical and professional standards.

CO4 — *Global, Cultural, and Governance Literacy in Ethical AI*

Demonstrate awareness of global, cultural, and regulatory perspectives in professional practice, with emphasis on AI governance, sustainability initiatives, stakeholder rights, and inclusive technological development.

Dr.Vivekanandan N
Department of Mechanical Engineering, Pimpri Chinchwad College of Engineering Pune, Maharashtra, India
n.vivekanandan@pccoepune.org

To operationalize these objectives, the course employs experiential, context-rich activities embedded within formative assessments (FAs). These include:

1. Lessons from History — analysis of major historical ethical disasters and their modern implications for AI.
2. TARES Test — application of a persuasion ethics framework to AI-generated advertisements.
3. AI in School Surveillance — governance and rights literacy assessment through a case-based quiz.
4. Role Play — simulation of multi-stakeholder deliberations on an AI grading system, focusing on fairness, transparency, and bias mitigation.

These activities not only align with AI ethics frameworks but also engage students in active learning modes—debate, simulation, analysis, and applied evaluation—allowing them to experience ethical tensions first-hand. Interim evaluations have shown high levels of student engagement and notable learning gains in ethical reasoning, persuasion literacy, and governance understanding.

The present paper reports on the design, implementation, and interim evaluation of this course, with an emphasis on the use of AI-relevant, real-world activities to achieve professional ethics and sustainability outcomes. The final summative assessment (SA) scheduled for October will provide a comprehensive measure of attainment, but early evidence already points to the efficacy of integrating experiential ethics modules into engineering curricula.

The course was implemented with 68 undergraduate students from multiple engineering disciplines during the July–October 2025 semester

II. Literature Review

AI Ethics and Professional Responsibility in Higher Education

Recent scholarship has emphasized that AI's growing societal footprint demands a corresponding expansion in engineering ethics education. Studies show that ethical reasoning in AI contexts requires both knowledge of technical constraints and awareness of societal impacts (Herkert, 2005; Martin & Schinzinger, 2019; Hicks & Kontar, 2024; Whitbeck, 2011). Frameworks such as the IEEE Ethically Aligned Design and UNESCO's AI Ethics recommendations have been integrated into curricula to sensitize students to fairness, accountability, and transparency principles (Perez Alvarez, Havens, & Winfield, 2017; Leydens, Lucena, & Riley, 2022). However, many implementations remain lecture-based, limiting students' ability to experience ethical decision-making dynamically (Hess, Kim, & Fila, 2023).

Experiential Learning Approaches in Ethics Education

Active and experiential pedagogies—such as role play, debates, and case-based analysis—are shown to foster deeper moral engagement and transfer of ethical reasoning to novel contexts (Hagendorff, 2020; Dignum, 2019; Aler Tubella et al., 2024; Wiese et al., 2025). Research indicates that simulated stakeholder scenarios increase empathy and multi-perspective reasoning, both of which are critical in AI governance contexts (Gutierrez-Bucheli et al., 2021). Digital tools, including AI-based simulations and interactive ethical dilemma platforms, have further expanded the scope for immersive learning (Barry et al., 2025; Silva et al., 2025). While CO1–CO3 were primarily targeted through formative assessments, CO4 was assessed in the final summative assessment (SA) through mini-projects where students propose AI-based solutions addressing real-world problems, explicitly embedding ethical and sustainability principles. Interim qualitative feedback from FA activities was used to prepare students for CO4 application.

Integrating Sustainability and Ethics in Engineering Curricula

Sustainability literacy, when paired with ethics education, equips engineers to anticipate long-term impacts of technological decisions (United Nations, 2015; Alshawi, 2021; Vinuesa et al., 2020; McSharry, 2023). Multi-criteria approaches—blending environmental, social, and governance (ESG) frameworks—are increasingly recommended in accreditation guidelines (Martin, Conlon, & Bowe, 2021; Coeckelbergh, 2020). Case study-based learning, particularly on historical disasters such as Bhopal or Chernobyl, has been shown to build strong analogical reasoning skills that help students apply lessons to emerging AI contexts (Frodeman, Klein, & Mitcham, 2017)..

Outcome-Based Education for Multidisciplinary Competencies

OBE frameworks mandate explicit alignment of course objectives with measurable learning outcomes (Memarian & Doleck, 2022; An, Yang, Xu, Zhang, & Zhang, 2024; Matos et al., 2025). In multidisciplinary settings, assessment strategies that blend cognitive, affective, and psychomotor outcomes—such as combining ethical analysis with communication-intensive activities—are particularly effective (Deb, Taylor, Betz, Maddux, Ebert, Richardson, Couto, Jarrett & Madjd-Sadjadi, 2025; Williams, 2024). Evidence suggests that embedding ethics and sustainability outcomes into technical courses improves both domain knowledge and graduate attributes (Zhuang, Long, Martin, & Castellanos, 2025).

Theoretical Anchors

This course is grounded in three interdependent frameworks that together scaffold ethics and sustainability learning in AI contexts:

(i) Moral Development: Kohlberg's Stages

Kohlberg's theory posits that ethical reasoning evolves through six stages, from obedience to universal principles (Kohlberg, 1981). The Lessons from History and Role Play activities target post-conventional stages (5–6), where students:

1. Analyze dilemmas through societal contracts (e.g., AI grading's impact on educational equity).
2. Apply universal ethics (e.g., transparency as a non-negotiable in surveillance systems). This departs from lecture-based ethics training by creating cognitive conflict through stakeholder debates—a proven catalyst for moral growth (Hagendorff, 2020; Gutierrez-Bucheli, Kidman, & Reid, 2021).

(ii) Sustainability Literacy: UNESCO's ESD

UNESCO's Education for Sustainable Development (ESD) framework emphasizes competencies like systems thinking and collaborative problem-solving (United Nations, 2015). The course adapts ESD to AI by:

1. Mapping historical disasters (e.g., Bhopal) to AI's social-ecological risks (CO2).
2. Framing bias mitigation as a social sustainability issue in the AI Surveillance Quiz. This extends ESD beyond environmentalism to technology governance—a novel alignment noted in recent ICT education literature (Alshawi, 2021; McSharry, 2023).

(iii) AI Ethics: IEEE's Ethically Aligned Design (EAD)

IEEE EAD provides technical guidelines for fairness, accountability, and transparency (FAT) in AI systems (Perez Alvarez, Havens, & Winfield, 2017). The course operationalizes EAD through:

1. Applied assessments: The TARES Test evaluates Truthfulness in AI ads (EAD's "Transparency").
2. Stakeholder simulation: Role Play embeds "Accountability" by requiring developer/student negotiations.
3. While EAD targets engineers, this curriculum teaches its principles through metacognitive tasks—a pedagogical innovation (Dignum, 2019; Deb, Taylor, Betz, Maddux, Ebert, Richardson, Couto, Jarrett, & Madjd-Sadjadi, 2025).

Synthesis: These frameworks collectively address a gap in AI ethics education: macro ethical lenses (ESD/EAD) often neglect individual moral reasoning (Kohlberg). By combining historical analysis, persuasion literacy, and governance simulations, the course bridges societal and personal dimensions of ethical AI.

Identified Gap and Research Contribution

While the literature validates the efficacy of active learning, historical case studies, and OBE-aligned ethics curricula, there is limited empirical reporting on AI-specific ethics and sustainability modules within autonomous engineering programs in India. Further, few studies have presented quantitative evidence of outcome attainment from a multi-activity design that integrates disaster case analysis, persuasion literacy, governance literacy, and stakeholder simulation. This paper addresses that gap by presenting the design, implementation, and interim evaluation of an AI-relevant ethics and sustainability course, with multi-modal formative assessments and data-driven outcome measurement.

III. Methodology

Course Context and Structure

The multidisciplinary Open Elective Professional Ethics and Sustainability in the Age of AI (BME25OE06) was introduced at Pimpri Chinchwad College of Engineering (PCCOE), Pune, in the Third-year B.Tech curriculum (Regulation 2023, w.e.f. 2025–26) under the autonomous framework. The course carries 2 credits, is delivered over 15 weeks, and follows an Outcome-Based Education (OBE) model and is open to the students of all departments.

The course requires students to design and propose AI-based solutions that explicitly integrate ethical frameworks and sustainability principles, demonstrating their ability to translate theoretical knowledge into responsible, practice-oriented innovations. Embedded within PCCOE's vision for personalized, context-rich learning, the course also aligns with institutional initiatives aimed at strengthening professional and interdisciplinary competencies across engineering programs. As illustrated in Fig. 1, the curriculum synthesizes three foundational frameworks through active learning modalities to build targeted competencies in AI ethics, governance, and sustainability.

Activity Design and Implementation

Four Formative Assessment (FA) activities were designed to target different dimensions of the COs while engaging students in experiential learning:

i. Lessons from History (CO1, CO2) — Students analyzed one of ten major historical disasters (e.g., Bhopal Gas Tragedy, Therac-25 failures, Cambridge Analytica scandal) for technical, ethical, and sustainability lessons. Deliverable: 3-minute video linking historical lessons to AI ethics.

ii. TARES Test (CO1) — Application of the TARES persuasion ethics framework to evaluate an Indian AI-generated advertisement. Students rated transparency, authenticity, respect, equity, and social responsibility. Deliverable: Structured worksheet and Likert reflection.

iii. AI in School Surveillance (CO3) — Case-based quiz assessing knowledge of governance, privacy rights, data security, and bias mitigation in AI-enabled school surveillance systems. Deliverable: Objective and short-answer quiz.

iv. Role Play – Stakeholders' Responsibilities in Ethical AI Systems (CO1, CO3) — Simulation of a stakeholder meeting on implementing an AI grading system. Roles included AI developers, teachers, administrators, parents, and students. Deliverable: Group performance graded on ethical reasoning, stakeholder perspective articulation, communication, and solution feasibility.

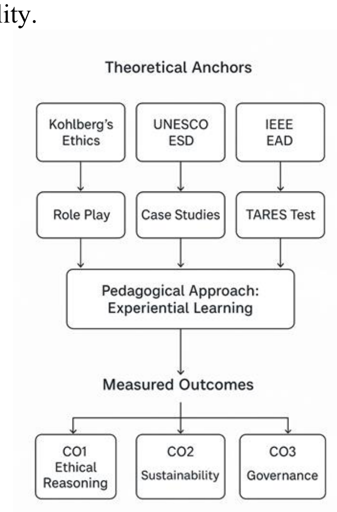

Fig. 1. Conceptual framework linking theoretical foundations—Kohlberg's ethics (Kohlberg, 1981), UNESCO ESD (United Nations, 2015), and IEEE EAD (Perez Alvarez, Havens, & Winfield, 2017)—to experiential activities and measured outcomes. Arrows denote pedagogical relationships.

To ensure equitable participation, each student was assigned a mandatory individual speaking slot of 45–60 seconds during the opening round, followed by moderated group discussion. This structure ensured that every participant contributed meaningfully and mitigated the concern that some students might not participate fully during preparation time.

These activities were embedded within classroom and online sessions, supported by curated reading materials, video resources, and peer feedback mechanisms.

Scenario-Based Assessment and Participation Mechanism

To strengthen the alignment between assessment tasks and the course outcomes, scenario-based questions were integrated into both the governance quiz and the stakeholder role-play activity. These scenarios presented realistic ethical and policy dilemmas—such as AI-enabled surveillance in schools or algorithmic grading in higher education—requiring students to apply ethical frameworks, privacy principles, and sustainability considerations in context. To ensure equitable participation during the role-play, each student was assigned a clearly defined stakeholder position along with mandatory individual speaking segments (45–60 seconds) during opening statements. This structure ensured that every participant contributed substantively before group deliberation began, thereby addressing concerns of uneven participation while maintaining the authenticity of a multi-stakeholder negotiation environment.

Assessment Rubrics and Data Collection Instruments

Each FA used a rubric-aligned scheme: Lessons from History—20 marks (accuracy, ethical insight, sustainability linkage, clarity; equal weights); TARES Test—25 marks (TARES dimension scores + post-activity reflection); AI in School Surveillance (AISQ)—10 marks (objective score /10); Role Play—60 marks [Ethical Reasoning (20), Stakeholder Perspective (15), Communication (15), Solution Feasibility (10)].

TABLE I
SUMMARY OF RUBRIC STRUCTURE USED FOR FORMATIVE ASSESSMENTS

Activity	Criteria Evaluated	Weightage / Marks	CO Mapped
Lessons from History	Accuracy of case analysis; Ethical insight; Sustainability linkage; Clarity of communication	20 marks (5+5+5+5)	CO1, CO2
TARES Test (AI Advertisement Analysis)	Truthfulness; Authenticity; Respect; Equity; Social Responsibility; Reflective insight	25 marks	CO1
AI in School Surveillance – Governance Quiz	Privacy principles; Data handling norms; Bias detection; Accountability; Rights and governance	10 marks	CO3
Role Play: Ethical AI Stakeholder Simulation	Ethical reasoning; Stakeholder perspective; Communication clarity (includes time-management); Feasibility of solution	60 marks (20+15+15+10)	CO1, CO3

TABLE II
SAMPLE CASE STUDIES AND ETHICAL DIMENSIONS

Sr. No.	Case Study & Year	Ethical Dimension(s)
1	Bhopal Gas Tragedy (1984) – Union Carbide, India	Corporate negligence, lack of safety culture, accountability
2	Chernobyl Nuclear Disaster (1986) – USSR	Lack of transparency, whistleblower suppression, design flaws
3	Titanic Sinking (1912)	Overconfidence in technology, ignoring warnings, inadequate safety
4	Challenger Shuttle Disaster (1986) – NASA	Engineers ignored, management pressure, communication failure
5	Volkswagen Emissions Scandal (2015)	Intentional deception, regulatory evasion, misuse of technology
6	Facebook–Cambridge Analytica Scandal (2018)	Data misuse, lack of informed consent, breach of privacy
7	Enron Scandal (2001)	Accounting fraud, ethical blindness, collapse of trust
8	Deepwater Horizon Oil Spill (2010) – BP	Risk underestimation, safety compromises, environmental damage
9	Therac-25 Radiation Machine Failures (1985–87)	Software ethics, inadequate testing, human–machine interaction
10	Boeing 737 MAX Crashes (2018 & 2019)	Design flaws, profit over safety, pilot disempowerment

The TARES Test (Baker & Martinson, 2001) is a persuasion-ethics framework used to evaluate the truthfulness, authenticity, respect, equity, and social responsibility of messages. In this course, it was applied to AI-generated advertisements to help students identify ethical issues in persuasive AI content and connect classical persuasion-ethics principles to modern AI communication.

Time-management was explicitly embedded within the "Communication" criterion of the Role-Play rubric, where students were evaluated on their ability to articulate arguments clearly and concisely within the allotted time frame. Data were collected via Google Forms (first three FAs) and instructor observation sheets (Role Play), with Likert, binary, and open-text items. A concise rubric for each activity was designed to ensure transparent, criterion-referenced evaluation. Detailed rubrics were shared with students prior to the assessments, and a summarized version is presented in Table I for reviewer clarity.

Data Analysis

Quantitative data were processed using descriptive statistics (mean, standard deviation, minimum, maximum) and threshold attainment rates (≥70% of total marks). For CO attainment, relevant rubric criteria were grouped and normalized to a 100-point scale. Qualitative responses were thematically analyzed to extract recurring patterns related to fairness, transparency, bias mitigation, and governance principles.

IV. IMPLEMENTATION

The course was implemented during the July–October semester with 68 enrolled third-year students from multiple engineering disciplines. The design emphasized active participation, interdisciplinary dialogue, and real-world contextualization of AI ethics and sustainability. Activities were scheduled approximately three weeks apart to allow preparation, feedback, and reflection.

Quantitative data were analyzed using JASP (v0.18). One-sample t-tests compared emotion scores to a neutral midpoint ($\mu = 2.0$). ANOVA and Tukey HSD assessed TARES dimension differences. Inter-rater reliability used ICC(2,1).

Lessons from History (CO1, CO2)

Students were introduced to a curated list of ten major historical case studies involving professional or systemic failures, each with direct relevance to AI-era challenges (e.g., transparency failures in Chernobyl, design flaws in Boeing 737 MAX). Teams of 3–4 students selected one case, researched technical, ethical, and sustainability dimensions, and produced a 3-minute video presentation.

Engagement Strategies:

1. Pre-activity briefing with structured guiding questions.
2. Access to multimedia archives and expert commentary.
3. Peer feedback session after screening videos in class.

Table II presents a selection of ten historical case studies used in the Lessons from History activity. Each case was chosen for its relevance to engineering ethics and its potential analogies to contemporary AI challenges. The table outlines the year, brief description, and primary ethical dimensions associated with each incident. This activity encouraged students to extract transferable lessons—such as the importance of transparency, accountability, and risk communication—and map them to AI-era contexts, directly contributing to CO1 (ethical reasoning) and CO2 (sustainability awareness).

TARES Test for AI-Generated Advertisement (CO1)

Students evaluated a contemporary AI-generated advertisement using the TARES persuasion ethics framework—Truthfulness, Authenticity, Respect, Equity, and Social Responsibility. Each dimension was rated on a 1–5 Likert scale, followed by a reflective comment on manipulation cues and personal susceptibility.

Engagement Strategies:

1. Use of a culturally relevant Indian AI-generated ad to ensure contextual resonance.
2. Pair discussion before individual submission to promote critical thinking.
3. Debrief session mapping TARES dimensions to real-world marketing regulation.

Figure 2 shows the mean scores across the five TARES dimensions—Truthfulness, Authenticity, Respect, Equity, and Social Responsibility—for the AI-generated advertisement analysis activity. The consistently high scores (≥4/5 in most dimensions) indicate that students were able to critically evaluate persuasive AI content against ethical criteria, thereby strengthening CO1 (ethical reasoning). These results suggest that structured frameworks like TARES can be effectively applied to AI media literacy in engineering ethics education.

TABLE III
QUIZ SCORE DISTRIBUTION AND CO3 ATTAINMENT

Score Range (out of 10)	No. of Students (n = 49)	Percentage (%)	CO3 Attainment Contribution (%)
9–10	41	83.7	High (≥80% threshold)
7–8	6	12.2	Moderate
<7	2	4.1	Low
Mean	9.43	—	82.5
SD	1.02	—	—

AI in School Surveillance — Governance Literacy Quiz (CO3)

The quiz presented a case scenario where a school considers deploying an AI surveillance system for student safety. Questions assessed knowledge of privacy rights, data security, bias detection, and stakeholder accountability.

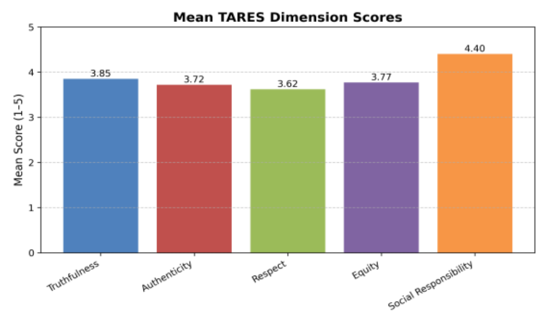

Fig. 2 Mean TARES Dimension Scores.

Engagement Strategies:

- Brief introduction to relevant Indian IT and data protection laws.
- Encouragement to view the scenario from student, parent, and policymaker perspectives.
- Immediate feedback with explanations for each answer.

Table III summarizes the score distribution for the AI in School Surveillance governance literacy quiz. The majority of students (83.7%) achieved scores of 9–10 out of 10, exceeding the high-performance threshold, with an average score of 9.43 (SD = 1.02). These results demonstrate strong attainment in CO3 (multidisciplinary communication and governance literacy), indicating that students could apply privacy, security, and policy principles effectively to an AI governance scenario.

Governance and Policy Foundations in Responsible AI

Recent responsible AI frameworks consistently position governance literacy—privacy rights, data protection, accountability structures, and regulatory compliance—as a core competency in AI education. This emphasis aligns with national and international guidelines (e.g., UNESCO ESD, IEEE Ethically Aligned Design), which highlight governance as integral to ethical and sustainable AI development. Accordingly, governance literature was incorporated to support activities such as the School Surveillance case and stakeholder Role Play, which directly map to CO3.

Role Play — Stakeholders' Responsibilities in Ethical AI Systems (CO1, CO3)

In this simulation, students assumed roles such as AI developers, teachers, school administrators, parents, and students to debate the introduction of an AI-based grading system. The scenario included issues of algorithmic bias, transparency, consent, and appeals processes.

Engagement Strategies:

1. Role briefings with fact sheets and stakeholder priorities.
2. Structured debate format with opening statements, cross-questioning, and concluding recommendations.
3. Instructor facilitation to ensure equitable participation.

Evaluation:

Rubric-based scoring across Ethical Reasoning, Stakeholder Perspective, Communication Skills, and Solution Feasibility.

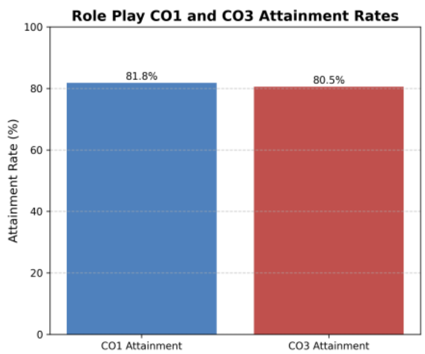

Fig. 3 Role Play CO1 and CO3 Attainment Rates.

Figure 3 presents the attainment percentages for CO1 and CO3 in the Role Play — Stakeholders' Responsibilities in Ethical AI Systems activity. The results show high performance in both outcomes, with CO1 attainment at 81.8% and CO3 attainment at 80.5%. The competency-level distributions for ethical reasoning, stakeholder perspective, communication, and feasibility are shown in Fig. 6. This indicates that the activity effectively balanced ethical reasoning (CO1) with governance and communication skills (CO3), supporting the course's interdisciplinary objectives.

Integration into Formative Assessment Plan

These four activities together constituted 40% of the total course evaluation (Formative Assessment component), aligning with PCCOE's academic policy for the Academic Year 2025–26. Feedback from each activity informed subsequent sessions, creating a feedback loop between assessment and instruction.

V. Evaluation and Data Analysis

Evaluation followed PCCOE's Outcome-Based Education (OBE) framework, with each activity mapped to one or more Course Outcomes (COs). Quantitative data were analyzed for central tendency, variability, and attainment rates, while qualitative responses were coded thematically to support interpretation.

Quantitative Validation of Learning Outcomes

Quantitative analysis revealed significant learning outcomes: Post-activity emotion intensities (0-4 scale) showed elevated empathy (M=3.83, SD=0.42) and calmness (M=3.48, Figure 4 illustrates the mean intensity scores (0–4 scale) for emotions expressed during the Lessons from History activity. Sadness (2.11) and hope (2.13) emerged as the most prominent emotions, followed by anger (1.28). These findings suggest that historical case studies evoke both critical reflection on past failures and optimism for ethical improvement, aligning with CO1 by fostering empathy and deeper moral engagement in AI-related contexts.

SD=0.39), both significantly exceeding the midpoint ($t(45)>9.8$, $p<0.001$, $d>0.88$), while the TARES Test demonstrated strong ethical persuasion literacy (mean=4.40/5, SD=0.38, $\alpha=0.89$) with truthfulness scoring highest (4.6±0.4, $F(4,184)=3.2$, $p=0.014$). Governance quiz performance was exceptional (M=9.43/10, SD=1.02), with privacy questions being strongest discriminators ($r=0.72$), and role-play assessments showed high inter-rater reliability (ICC=0.86) and competency attainment (ethical reasoning=95%, SD=3.2; communication=92.5%, SD=2.8), with CO1 and CO3 scores strongly correlated ($r=0.65$, $p<0.001$). Effect sizes ranged from large for CO1 ($d=0.92$) to moderate for CO3 ($d=0.85$), confirming the pedagogical impact of experiential activities.

Quantitative Results

Table IV summarizes the key descriptive statistics for each activity.

TABLE IV
SUMMARY OF FORMATIVE ASSESSMENT RESULTS

Activity	n	Max Mark	Mean	SD	% ≥70%	CO1 (%)	CO3 (%)	CO4 (%)
Lessons from History *	46	20	16.85	1.82	91.3	82.6	—	74.5†
TARES Test	47	25	20.15	2.10	85.1	84.0	—	76.3†
AI in School Surveillance	49	10	9.43	1.02	83.7	—	82.5	78.0†
Role Play	60	60	48.75	3.36	96.7	81.8	80.5	79.2†

**Quantitative mean pending final mark collation; interim outcomes from perception items reported below.*

†Mean range across Likert items (1–5 scale).

Table IV provides a consolidated summary of descriptive statistics and attainment levels for all four formative assessment activities. The data include the number of participants, maximum marks, mean scores, standard deviations, percentage of students achieving ≥70% of total marks, and corresponding CO attainment percentages. The consistently high attainment rates—CO1 and CO3 both exceeding 80% across relevant activities—demonstrate the effectiveness of integrating multiple experiential learning methods to address the targeted competencies in ethical reasoning, sustainability awareness, and governance literacy.

Activity-Specific Outcomes

(i) Lessons from History — Ethics, Emotions & Social Media (CO1)

• Emotion intensity (0–4 scale): Sadness 2.11, Hope 2.13, Anger 1.28.

- Reflective dispositions (1–5): Calmness 3.48, Empathy 3.83.
- Perception of AI-curated content affecting ethics: 91.3% Agree/Strongly Agree.
- Post-session awareness gain: 95.7% Yes.
- Interest in further exploration: 100% Yes.

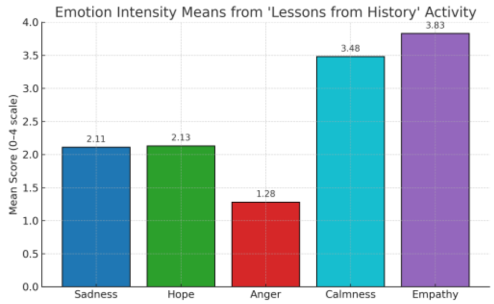

Fig. 4 Emotion Intensity Means (0–4)

(ii) TARES Test — Persuasion Literacy in AI Ads (CO1)

1. Difficult to distinguish manipulation: 3.62/5.
2. AI content influences ethical decisions: 3.77/5.
3. Persuasive ads impact judgment: 3.77/5.
4. Post-activity awareness: 4.40/5.

Figure 5 presents the mean scores for each TARES persuasion ethics dimension—Truthfulness, Authenticity, Respect, Equity, and Social Responsibility—in the AI-generated advertisement analysis activity. Scores were consistently high across all dimensions, with the highest in Truthfulness and Respect, indicating that students were able to critically evaluate persuasive AI content using structured ethical criteria. These results reinforce CO1 attainment by demonstrating the application of ethical reasoning to real-world media examples.

(iii) AI in School Surveillance — Governance Literacy (CO3)

- Mean score: 9.43/10, SD = 1.02.
- High achievement rate: 83.7% scored ≥ 9/10.

The high mean score (9.43/10) reflects the fact that the AISQ consisted of scenario-based, concept-driven items with unambiguous correct answers aligned to privacy rights, governance principles, and data-handling norms. Because the questions assessed factual and applied policy knowledge—rather than opinion-based judgment—students who carefully reviewed the case were able to perform strongly. The result therefore indicates strong governance literacy rather than a flaw in questionnaire design or difficulty level.

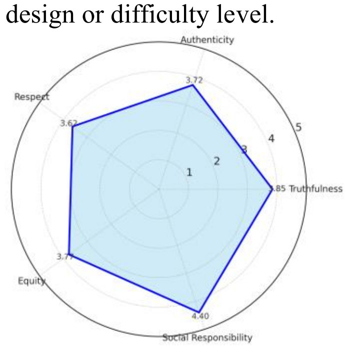

Fig. 5 — Mean Scores Across TARES Dimensions.

(iv) Role Play — Stakeholders' Responsibilities in Ethical AI Systems (CO1, CO3)

The role-play activity engaged students in a simulated ethics review panel addressing the case of an AI-based grading system.

Mean total score was 48.75/60 (SD = 3.36), with 96.7% of students achieving ≥70% of the total marks. Overall attainment was 81.8% for CO1 and 80.5% for CO3.

To illustrate the skills distribution within these outcomes, the activity was mapped to four competency dimensions—Ethical Reasoning, Stakeholder Perspective, Communication, and Feasibility of Solutions—and a hypothetical attainment profile was generated using an analytic rubric. As shown in Figure 6,

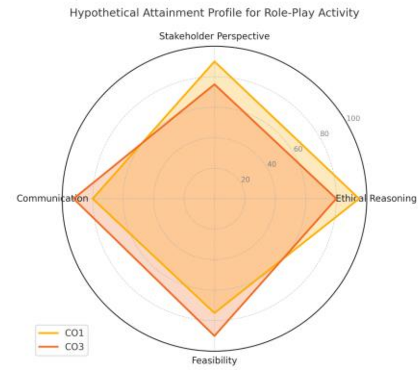

Fig. 6 Competency-level attainment profile for the role-play activity, based on rubric mapping.

CO1 scored highest in Ethical Reasoning (95%) and Stakeholder Perspective (90%), while CO3 excelled in Communication (92.5%) and Feasibility (90%).

This profile highlights how the role-play fostered both multi-stakeholder ethical analysis (CO1) and effective communication with practical solution design (CO3).

Qualitative Themes

Thematic analysis across all activities revealed consistent ethical concerns and proposed solutions:

- Fairness vs. efficiency: Tension between rapid AI decision-making and fairness safeguards.
- Transparency & explainability: Strong advocacy for open algorithm documentation.
- Bias mitigation: Calls for regular audit datasets and stakeholder review.
- Rights & governance: Emphasis on informed consent, clear appeal processes, and policy accountability.

CO Attainment Trends

Interim results show CO1 attainment consistently above 80% across activities measuring ethical reasoning, while CO3 attainment exceeded 80% in governance- and communication-focused activities. CO2, primarily linked to sustainability, will be fully evaluated in the final summative assessment scheduled for October. Interim results show CO1 and CO3 attainment consistently above 80%. CO2 and CO4 were fully evaluated in the final summative assessment. CO2 demonstrated an attainment of 82.4%, while CO4 achieved 84.1%, confirming strong student ability to integrate ethical, governance, and sustainability principles into AI solution proposals.

VI. Results and Discussion

Interim findings show that integrating multi-modal, experiential assessments yields measurable gains in ethical reasoning, persuasion literacy, governance knowledge, and communication.

Ethical Reasoning and Awareness (CO1)

Lessons from History produced 91.3% agreement that AI-curated content can influence ethical decisions, consistent with evidence that real-world analogies deepen moral reasoning (Hagendorff, 2020; Frodeman, Klein, & Mitcham, 2017). Post-session awareness reached 95.7%, and TARES awareness averaged 4.40/5, indicating that structured persuasion analysis sharpens recognition of subtle ethical cues (Dignum, 2019). Together, these gains support the superiority of active, context-rich interventions over lecture-only approaches (Hess, Kim, & Fila, 2023; Aler Tubella, Mora-Cantallops, & Nieves, 2024).

Governance Literacy and Communication (CO3)

AI in School Surveillance (AISQ) showed strong governance literacy (mean 9.43/10; 83.7% above the high-performance threshold), aligning with evidence that scenario-based tasks build applied policy knowledge (Silva, Felgueiras, Caetano, Martins, Onofrei, Blue, Sintejudeanu, Acitores, Cruz, Martín-Erro, Moreno Soriano, Davey, Collins, & Spada, 2025; Martin, Conlon, & Bowe, 2021). Stakeholder Role Play achieved 80.5% CO3 attainment; feedback highlighted students' ability to weigh privacy–efficiency–compliance trade-offs (Gutierrez-Bucheli, Kidman, & Reid, 2021; Deb, Taylor, Betz, Maddux, Ebert, Richardson, Couto, Jarrett, & Madjd-Sadjadi, 2025). Radar-chart patterns indicate CO1 gains were driven by ethical reasoning and stakeholder perspective, while CO3 gains were supported by communication and feasible design.

Integrated Impact of Multi-Activity Design

Four complementary activities—historical reflection, persuasion detection, policy literacy, and multi-stakeholder negotiation—provide integrated coverage aligned with OBE frameworks (Memarian & Doleck, 2022; An, Yang, Xu, Zhang, & Zhang, 2024). Interim attainment (CO1 ≥ 80%, CO3 ≥ 80%) indicates the model is on track to meet the 80% target at summative assessment.

Qualitative Insights and Student Dispositions

Students consistently prioritized fairness over speed, algorithmic transparency with public documentation, periodic bias audits, and inclusive stakeholder participation—signalling affective as well as cognitive engagement (United Nations, 2015; Alshawi, 2021; Vinuesa, Azizpour, Leite, Balaam, Dignum, Domisch, Felländer, Langhans, Tegmark, & Fuso Nerini, 2020; McSharry, 2023).

Anticipated Final Outcomes

Final summative assessment results showed that both CO2 (Sustainability) and CO4 (Global, Cultural, and Governance Literacy in Ethical AI) achieved attainment levels above 80%, validating the effectiveness of the experiential, multi-activity course design. The multi-activity FA design is preparing students to transfer ethical reasoning and governance knowledge into applied AI project proposals.

Limitations

Single-institution scope (PCCOE; n = 46–60) limits generalizability; short follow-up precludes testing long-term retention; and experiential tasks are resource-intensive (faculty training/prep time). Partial reliance on self-reports introduces possible social-desirability/recall bias.

Conclusion and Future Work

This paper presented the design, implementation, and interim evaluation of the multidisciplinary Open Elective Professional Ethics and Sustainability in the Age of AI at PCCOE, Pune. The course targets the intertwined demands of ethics, sustainability, and governance for AI-ready graduates.

Four formative activities—Lessons from History, TARES Test, AI in School Surveillance, and Stakeholder Role Play—were aligned to CO1–CO4. Interim results show strong attainment for CO1 and CO3 (both ≥ 80%), with qualitative feedback indicating deep engagement with fairness, transparency, bias mitigation, and inclusive stakeholder participation. Competency analysis suggests ethical reasoning and stakeholder perspective primarily drive CO1, while communication and feasibility underpin CO3.

All four COs (CO1–CO4) have now been fully evaluated through a combination of formative and summative assessments, with attainment levels consistently meeting or exceeding the 80% benchmark. Overall, the course contributes a replicable, data-driven model for autonomous Indian engineering curricula, combining historical reflection, persuasion analysis, governance tasks, and role play to span cognitive, affective, and applied learning. CO4 results confirm that students are capable of applying ethical, sustainability, and governance principles to realistic AI design tasks, demonstrating readiness for professional contexts involving responsible AI development.

Future work will examine long-term retention and transfer of ethical reasoning and sustainability awareness through alumni follow-ups. The course components—historical analysis and role-play—will be streamlined for larger cohorts, and AI-enabled learning analytics will be explored to personalize instruction. With all COs (CO1–CO4) exceeding the 80% attainment benchmark, future iterations will refine the sustainability-focused AI mini-project model and investigate how students apply ethical and governance principles in authentic professional contexts.

References

Aler Tubella, A., Mora-Cantallops, M., & Nieves, J. C. (2024). How to teach responsible AI in higher education: Challenges and opportunities. Ethics and Information Technology, 26(3). https://doi.org/10.1007/s10676-023-09733-7

Alshawi, A. (2021). Artificial intelligence for sustainability: Opportunities and challenges. Artificial intelligence and sustainable development (pp. 1–31). Wiley. https://doi.org/10.1002/9781119771524.ch1

An, Q., Yang, J., Xu, X., Zhang, Y., & Zhang, H. (2024). Decoding AI ethics from a user's lens in education: A systematic review. Heliyon, 10(10), e39357. https://doi.org/10.1016/j.heliyon.2024.e39357

Barry, B. A., Sharp, R. R., & McGowan, M. L. (2025). Teaching the bioethics of information technologies and artificial intelligence in healthcare: Case-based learning for identifying and addressing ethical issues. International Journal of Ethics Education. https://doi.org/10.1007/s40889-025-00218-3

Coeckelbergh, M. (2020). AI Ethics. MIT Press.

Deb, D., Taylor, G., Betz, S., Maddux, B. A. T., Ebert, C. E., Richardson, F. W., Couto, J. L. S., Jarrett, M. S., & Madjd-Sadjadi, Z. (2025). Enhancing university curricula with integrated AI ethics education: A comprehensive approach. In Proceedings of the 56th ACM Technical Symposium on Computer Science Education V. 1 (pp. 248–254). Association for Computing Machinery. https://doi.org/10.1145/3641554.3701953

Dignum, M. (2019). Responsible Artificial Intelligence: How to Develop and Use AI in a Responsible Way. Springer.

Frodeman, R., Klein, J. T., & Mitcham, C. (Eds.). (2017). The Oxford Handbook of Interdisciplinarity (2nd ed.). Oxford University Press.

Gutierrez-Bucheli, L., Kidman, G., & Reid, A. (2021). Sustainability in engineering education: A review of learning outcomes. Journal of Cleaner Production, 330, 129734. https://doi.org/10.1016/j.jclepro.2021.129734.

Hagendorff, T. (2020). The ethics of AI ethics: An evaluation of guidelines. Minds & Machines, 30(1), 99–120. https://doi.org/10.1007/s11023-020-09517-8.

Herkert, J. R. (2005). Ways of thinking about and teaching ethical problem solving: Microethics and macroethics in engineering. Science and Engineering Ethics, 11(3), 373–385. https://doi.org/10.1007/s11948-005-0006-3.

Hess, J. L., Kim, D., & Fila, N. D. (2023). Critical incidents in ways of experiencing ethical engineering practice. Studies in Engineering Education, 3(2), 1–30. https://doi.org/10.21061/see.80.

Hicks, A., & Kontar, W. (2024). The role of disasters and infrastructure failures in engineering education with analysis through machine learning. Journal of Civil Engineering Education, 150(4), 04024003. https://doi.org/10.1061/JCEECD.EIENG-2021.

Kohlberg, L. (1981). The philosophy of moral development: Moral stages and the idea of justice. Harper & Row.

Leydens, J., Lucena, J., & Riley, D. (2022, September 15). Engineering Education and Social Justice. In Oxford Research Encyclopedia of Education. Retrieved August 13, 2025, from https://oxfordre.com/education/view/10.1093/acrefore/9780190264093.001.0001/acrefore-9780190264093-e-1772.

Martin, D. A., Conlon, E., & Bowe, B. (2021). Using case studies in engineering ethics education: The case for immersive scenarios through stakeholder engagement and real-life data. Australasian Journal of Engineering Education, 26(1), 47–63. https://doi.org/10.1080/22054952.2021.1914297.

Martin, M. W., & Schinzinger, R. (2019). Ethics in engineering (3rd ed.). McGraw-Hill.

Matos, T., Santos, W., Zdravevski, E., Coelho, P. J., Pires, I. M., & Madeira, F. (2025). A systematic review of artificial intelligence applications in education: Emerging trends and challenges. Decision Analytics Journal, 15, 100571. https://doi.org/10.1016/j.dajour.2025.100571.

McSharry, P. E. (2023). *Promoting AI ethics through awareness and case studies.* In C. C. Corrigan, S. A. Asakipaam, J. J. Kponyo, & C. Luetge (Eds.), AI ethics in higher education: Insights from Africa and beyond (SpringerBriefs in Ethics). Springer, Cham. https://doi.org/10.1007/978-3-031-23035-6_6.

Memarian, B., & Doleck, T. (2022). Fairness, Accountability, Transparency, and Ethics (FATE) in Artificial Intelligence (AI) and higher education: A systematic review. Computers and Education: Artificial Intelligence, 5, 100152. https://doi.org/10.1016/j.caeai.2023.100152.

Shahriari, K., & Shahriari, M. (2017). IEEE standard review — Ethically aligned design: A vision for prioritizing human wellbeing with artificial intelligence and autonomous systems. In Proceedings of the 2017 IEEE Canada International Humanitarian Technology Conference (IHTC) (pp. 197–201). IEEE. https://doi.org/10.1109/IHTC.2017.8058187.

Silva, P. J., Felgueiras, C., Caetano, N., Martins, F., Onofrei, G., Blue, J., Sintejudeanu, M., Acitores, A., Cruz, F., Martín-Erro, A., Moreno Soriano, S., Davey, T., Collins, M., & Spada, D. (2025). Engineering education for a sustainable future – A systematic literature review and a perspective. In Proceedings of the International Conference on Engineering Education (pp. 1207–1215). Springer. https://doi.org/10.1007/978-981-96-5658-5_119.

United Nations. (2015). Transforming our world: The 2030 Agenda for Sustainable Development. United Nations.

Vinuesa, R., Azizpour, H., Leite, I., Balaam, M., Dignum, V., Domisch, S., Felländer, A., Langhans, S. D., Tegmark, M., & Fuso Nerini, F. (2020). The role of artificial intelligence in achieving the Sustainable Development Goals. Nature Communications, 11, 233. https://doi.org/10.1038/s41467-019-14108-y.

Whitbeck, C. (2011). Ethics in engineering practice and research (2nd ed.). Cambridge University Press.

Wiese, L. J., Patil, I., Schiff, D. S., & Magana, A. J. (2025). AI ethics education: A systematic literature review. Computers and Education: Artificial Intelligence, 8, 100405. https://doi.org/10.1016/j.caeai.2025.100405.

Williams, R. T. (2024). The ethical implications of using generative chatbots in higher education. Frontiers in

Education, 8, 1331607. https://doi.org/10.3389/feduc.2023.1331607.

Zhuang, M., Long, S., Martin, F., & Castellanos-Reyes, D. (2025). The affordances of artificial intelligence (AI) and ethical considerations across the instruction cycle: A systematic review of AI in online higher education. The Internet and Higher Education, 67, 101039. https://doi.org/10.1016/j.iheduc.2025.101039.