

Flipped Classroom Approach in Teaching Research and AI Ethics: A Comprehensive Literature Review

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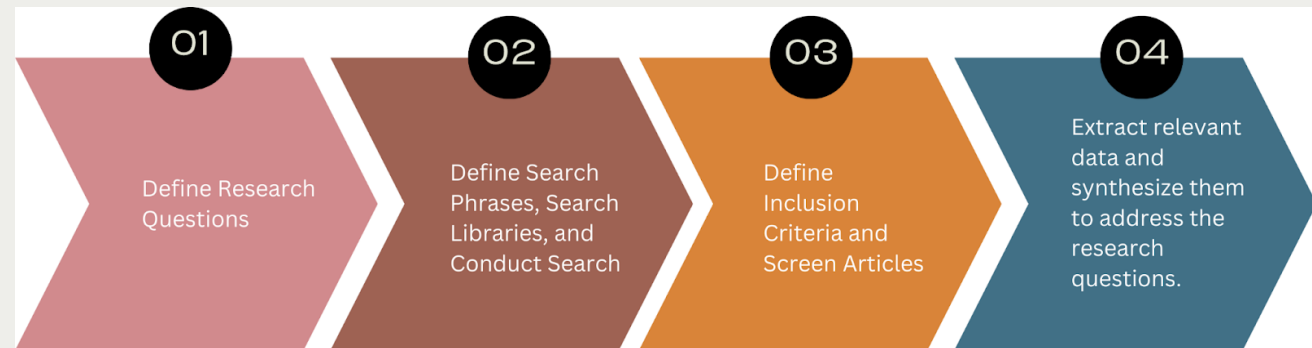
Objectives

- Examining the implementation, outcomes, challenges, and benefits of the flipped classroom (FC) approach in teaching research and AI ethics.
- Through a systematic analysis of peer-reviewed articles, we identify key strategies employed in flipped classrooms and evaluation results.
- This study systematically details the methodology employed, addresses the research questions posed, and presents a synthesis of results to offer actionable insights and directions for future research in ethics education.
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Literature Review Methodology

Literature Review Methodology

1. We defined our research questions (RQs).
2. We extracted the relevant search phrases to find literature to address the RQs. Using the phrases we searched in pre-selected literature databases. Through this search, we received numerous articles.
3. We then filtered the articles initially through screening of their titles and abstracts to determine if they follow our inclusion criteria, and in some cases through checking parts of the full text. We concluded with a set of 6 articles to study and analyze in our review.
4. For these articles, we read the full text and extracted useful data and synthesized them to address our research questions.



Research Questions

- RQ1: How are research and AI ethics being taught in FC?

This question aims to collect information on the methods used to teach research ethics in a FC approach, including media, technical tools, educational methodologies and their strategy for implementing the FC approach.

- RQ2: What are the outcomes of using a FC approach to teach research and AI ethics, as identified in the literature?

This question aims to provide information on the results of the data collection and evaluation of the FC methodology applied, including challenges and benefits.

Search Strategy

- We developed some well-specified search terms:
 - SP1: Flipped classroom AND research ethics
 - SP2: Flipped classroom AND AI ethics
 - SP3: Flipped classroom AND scientific ethics
 - SP4: Flipped classroom AND research integrity
- We conducted our search in the following databases: ACM Digital Library, IEEE Xplore, Science Direct, and Google Scholar.

Search Results

- Table 1 presents the number of articles returned from each search.

	SP1	SP2	SP3	SP4
Science Direct	829	121	318	339
ACM	1360	809	721	5893
IEEE Explore	8	2	2	6
Google Scholar	17,300	17,300	17,500	17,200

Selection Process

- The search process returned an initial set of articles, as presented in Table 1. We then filtered all articles by screening their titles, abstracts and where needed parts of the full text, checking if our inclusion criteria are satisfied. Inclusion criteria:
 - The publication year is between 2017 and 2024, covering the literature in the past 7 years.
 - Studies published in the English language.
 - The publication went through a peer-reviewing process.
 - Scientific publications (journal articles, conference papers, academic thesis/dissertations).
 - The articles must be relevant to our research questions including studies that: describe the implementation of a flipped classroom approach in teaching research ethics; evaluate the implementation of a flipped classroom approach in teaching research ethics; and discuss the advantages and disadvantages.
- All articles were screened and reviewed by at least two researchers independently.
- We concluded with 6 articles to be included in our literature review.

Data Extraction & Synthesis

- **To evaluate the articles, we extracted the following information:**
 - P1: The research and evaluation strategy of each paper, including the data collection and research aims.
 - P2: The participants' profiles and numbers.
 - P3: The flipped classroom implementation strategies. *Used to address RQ1.*
 - P4: The outcomes assessed, results, challenges, limitations and benefits. *Used to address RQ2.*

Results

Results

- Table 2, presents the findings from the data extracted for parameters P1-P2.
- Paper [1] Urfa, M., & Durak, G. (2017)

	P1	P2
[1]	<p>Theoretical Framework: Diffusion of Innovations Theory (Rogers (2003)).</p> <p>Research model: Mixed-methods design with thematic analysis and descriptive statistics.</p> <p>Data collection tools: Structured observation forms, interviews, and focus group discussions.</p> <p>Collected data: Students' views on the flipped classroom model, their satisfaction, challenges experienced in the process, and their attitudes regarding dissemination potential.</p> <p>Investigating: Advantages, disadvantages, and effectiveness of the flipped classroom model in ethics education.</p>	<p>24 Senior Students from the Department of Computer Education and Instructional Technologies at a state university in Turkey, within the scope of the Scientific Ethics Course for 11 weeks in 2016.</p>

Results

- Table 2, presents the findings from the data extracted for parameters P1-P2.
- Paper [2] Tosun, C. (2023)

	P1	P2
[2]	<p>Theoretical Framework: Situational Judgment Test.</p> <p>Research model: Pre-experimental design with quantitative data analyzed using descriptive statistics.</p> <p>Data Collection Tools: Achievement tests, project summary and research proposals.</p> <p>Collected data: Learners' performance in understanding concepts and acquiring high-level cognitive skills.</p>	<p>93 undergraduate students (pre-service teachers) at a state university in Turkey, from different teaching programmes, in the science and research</p>
	<p>Investigating: Impact of the FC model on pre-service teachers' learning and skill development, and differences in learning by gender and education program.</p>	<p>ethics course. 72% female, 28% male participants / 22.5% pre-service guidance and counselling teachers, and 21.5% pre-service Turkish language teaching teachers.</p>

Results

- Table 2, presents the findings from the data extracted for parameters P1-P2.
- Paper [3] Taylor, G., & Deb, D. (2021)

	P1	P2
[3]	<p>Data Collection Tools: Ethics-related exam questions, online discussion forum assignments, in-class group discussions, and self-satisfaction end-of-course survey.</p> <p>Collected data: Students' performance data and self-reflection data.</p> <p>Investigating: Acquisition of three learning outcomes: competency in ethical principles, collaboration in ethical discussions, and awareness of AI/ML ethical issues.</p>	24 students of AI ethics in a Business Analytics course.

Results

- Table 2, presents the findings from the data extracted for parameters P1-P2.
- Paper [4] Pugsee, P. (2017)

	P1	P2
[4]	<p>Data Collection Tools: Survey questionnaire, behaviour observation, and academic performance data (activities and exams).</p> <p>Collected data: Learners' opinions, preparation behaviours, group work performance, and exam results.</p> <p>Investigating: Whether collaborative learning techniques in the flipped classroom enhance willingness to learn and critical thinking skills.</p>	<p>28 students enrolled in the computer ethics course of the current academic year 2016, at Chulalongkorn University.</p>

Results

- Table 2, presents the findings from the data extracted for parameters P1-P2.
- Paper [5] Koterwas, A., Dwojak-Matras, A., & Kalinowska, K. (2021)

	P1	P2
[5]	Collected Data: Literature review, desk research, and a Horizon Europe survey among academic teachers. Investigating: Dialogical strategies for teaching ethical research, including the flipped classroom approach; no application or evaluation conducted.	No participants.

Results

- Table 2, presents the findings from the data extracted for parameters P1-P2.
- Paper [6] Du, B., & Guo, J. (2024)

	P1	P2
[6]	<p>Research Model: Quasi-experimental pre/post-test group design (experimental and control group).</p> <p>Data Collection Tools: Online questionnaires (before and after the teaching process), analyzed with descriptive and inferential statistics.</p> <p>Collected Data: Students' ethical awareness, ethical ability, and course satisfaction.</p> <p>Investigating: Effectiveness of integrating academic ethics into a flipped chromatographic analysis course for improving academic integrity.</p>	<p>203 undergraduate pharmaceutical students in a flipped chromatographic analysis course at a large public university in China in the second semester of the 2021–2022 academic year.</p>

Results RQ1: How are research/AI ethics being taught in flipped classrooms?

- Several methodologies have been employed to teach research ethics and AI ethics using the flipped classroom approach, encompassing both the pre-class and in-class stages of learning.
- These methodologies vary across studies but share common themes of collaborative learning, online engagement, and integration of ethics into diverse academic contexts.

Results RQ1: How are research/AI ethics being taught in flipped classrooms?

Pre-class Stage

- In the pre-class phase, students are introduced to foundational materials to prepare them for active engagement during in-class activities.
- Various tools and resources are utilized for this purpose:
 - **Online Learning Platforms:** Tools like Edmodo (Urfa & Durak, 2017), EasyClass (Tosun, 2023), Superstar-Xuexitong (Du & Guo, 2024), and CourseVille (Pugsee, 2017) provided access to instructional videos, articles, slides, press clippings, and other learning materials.
 - **Task Assignments:** Students were often required to watch videos, complete readings, or engage in exercises before class. For example, in Du and Guo's (2024) study, students received a task list five days in advance to guide their preparation.
 - **Discussion Boards:** In Taylor and Deb's (2021) study, students participated in online discussion boards, posting threads and responses to analyze case studies before class sessions.

Results RQ1: How are research/AI ethics being taught in flipped classrooms?

In-class Stage

The in-class stage emphasized active, collaborative, and problem-solving learning activities:

- **Collaborative Learning:** Group-based activities featured prominently in many studies. For instance:
 - Urfa and Durak (2017) organized students into groups to complete assignments collaboratively and participate in discussions guided by a faculty member.
 - Pugsee (2017) incorporated collaborative techniques such as group exercises, discussions on case studies, and presentations of group findings.
 - Du and Guo (2024) utilized cooperative problem-solving activities as part of their flipped classroom model.
- **Scenario-based Learning:** Tosun (2023) employed fictionalized problem scenarios related to ethical issues, which were discussed during synchronous online sessions.

Results RQ1: How are research/AI ethics being taught in flipped classrooms?

In-class Stage

- The in-class stage emphasized active, collaborative, and problem-solving learning activities:
 - **Case Study Analysis:** Taylor and Deb (2021) used the Montreal Declaration of Responsible AI Development as a framework for students to analyze ethical dilemmas in case studies during in-class group sessions.
 - **Assessment and Feedback:** Students were frequently assessed through in-class presentations (Taylor & Deb, 2021), formative assessments (Du & Guo, 2024, Taylor, G., & Deb, D. (2021), Pugsee, P. (2017), and Tosun, C. (2023)), or collaborative group assignments (Urfa & Durak, 2017). Instructors facilitated discussions and provided feedback to deepen critical thinking and ethical reasoning.

Results RQ1: How are research/AI ethics being taught in flipped classrooms?

Integration

- While most studies focused on standalone ethics courses, some integrated ethics into broader academic contexts. For instance, Du and Guo (2024) embedded academic ethics into a flipped chromatographic analysis course, exposing students to ethical topics alongside technical content.

Challenges and Variations

- The methodologies varied across contexts, influenced by factors such as delivery mode (face-to-face, online, or hybrid), available platforms, and course objectives. For example, Tosun (2023) adapted to online teaching due to the COVID-19 pandemic, leveraging synchronous discussions and asynchronous material sharing.

Results RQ2: What are the outcomes of using a flipped classroom approach to teach research/AI ethics?

The outcomes of employing a flipped classroom (FC) approach to teach research ethics and AI ethics demonstrate **several benefits, challenges, and variations across different implementations.**

Positive outcomes

- Improved Learning Outcomes and Understanding:
 - **Studies highlighted significant improvements in ethical awareness and comprehension:**
 - **Ethical Awareness and Academic Integrity:** Du and Guo (2024) found that integrating academic ethics into a flipped classroom significantly enhanced students' awareness and ability to practice academic integrity.
 - **Ethics Concepts:** Tosun (2023) reported the FC model was more effective for teaching concepts related to ethics and morality, although less so for topics related to science, research and method.
 - **Case Application:** Taylor and Deb (2021) demonstrated that 68% of students could correctly apply ethical guidelines to AI-based case studies, showing increased conceptual understanding.

Results RQ2: What are the outcomes of using a flipped classroom approach to teach research/AI ethics?

Positive outcomes

- **Collaborative activities were instrumental in promoting deeper understanding:**
 - Pugsee (2017) reported over 90% of students felt collaborative learning activities such as group discussions and brainstorming can help to support flipped classroom learning, improving critical thinking skills and comprehension of ethics content.
 - Urfa and Durak (2017) observed that the FC model encouraged active learning and fostered a better understanding of ethics compared to traditional methods.

Results RQ2: What are the outcomes of using a flipped classroom approach to teach research/AI ethics?

Positive outcomes

- **Enhanced Critical Thinking and Engagement:**
 - Collaborative learning techniques within the flipped classroom helped students practice critical thinking more effectively (Pugsee, 2017). Active group work and in-class discussions acted as catalysts for deeper enhancing student engagement and performance (Taylor & Deb, 2021).
 - Online platforms and multimedia content supported interactive and engaging environments (Urfa & Durak, 2017), which motivated students and prevented boredom.
- **Self-Paced and Flexible Learning:** The FC model enabled students to learn at their own pace through pre-class activities, including video lectures and online resources, which were highlighted as motivating factors (Urfa & Durak, 2017).
- **Adaptability Across Disciplines:** The flipped classroom approach proved adaptable for teaching ethics across various disciplines, including AI ethics (Taylor & Deb, 2021) and academic ethics in a chromatographic analysis course (Du & Guo, 2024).

Results RQ2: What are the outcomes of using a flipped classroom approach to teach research/AI ethics?

Challenges and Limitations

- **Limited Pre-class Preparation:**
 - While collaborative learning activities in class were effective, pre-class preparation was a recurring challenge: Pugsee (2017) found that students often did not engage fully with pre-class materials, with only 14% watching videos seriously and about 30% studying slides thoroughly.
 - This lack of preparation reduced the potential benefits of the flipped classroom model.
- **Variability in Learning Outcomes:**
 - Tosun (2023) noted inconsistencies in the learning of ethics concepts, with certain topics such as social responsibility and open-access publications not well-understood by half of the students.
 - Differences in cognitive skill acquisition were observed, with the FC model being moderately effective for fostering high-level skills in ethics (Tosun, 2023).

Results RQ2: What are the outcomes of using a flipped classroom approach to teach research/AI ethics?

Challenges and Limitations

- **Technical and Pedagogical Challenges:**
 - Technical malfunctions and the need for advanced digital literacy posed difficulties for both instructors and students (Urfa & Durak, 2017).
 - Students' readiness for self-directed learning was also a concern. Pugsee (2017) attributed low preparation to the inexperience of second-year students in self-study techniques.
- **Mixed Confidence Levels:** Despite increased ethical awareness, only half of the students felt confident discussing AI ethical issues professionally (Taylor & Deb, 2021)
- **No Significant Change in Satisfaction:** Du and Guo (2024) observed that while ethical awareness improved, students' overall course satisfaction remained unchanged.

Discussion & Conclusion

Discussion

- Very few studies were found addressing the teaching of research and AI ethics using the flipped classroom (FC) approach.
- Most studies were applied and evaluated based on varying methodologies and theoretical concepts, reflecting the adaptability of the flipped model to different teaching contexts.
- Across these studies, the core structure of the flipped classroom remained consistent: students studied diverse materials—videos, articles, and interactive content—at home before class, and subsequently engaged in active, often collaborative, in-class activities to apply their learnings.
- These in-class activities ranged from case study analyses and group discussions to problem-solving exercises, designed to help students demonstrate their understanding of the topics.

Discussion

- The FC model demonstrated versatility across disciplines, from standalone research ethics courses to integration into broader contexts, such as chromatographic analysis and AI ethics.
- Despite differences in execution, the underlying pedagogical philosophy remain consistent.
- Evaluation methods in the studies primarily involved student surveys or analyses of their grades and performance.
- **In most cases, the results were positive**, reflecting significant improvements in ethical awareness, critical thinking, and engagement. For example, students reported better retention of concepts, higher motivation, and increased confidence in applying ethical principles in real-world scenarios.
- The collaborative nature of in-class activities further supported critical thinking and deeper engagement, with some studies reporting over 90% of students agreeing that group discussions, brainstorming, and presentations significantly enhanced their learning experience (Pugsee, 2017).

Discussion

- **However, challenges** such as limited pre-class preparation, variability in learning outcomes, and technical barriers **were also evident**.
- The success of the FC model depends on addressing these key challenges:
 - Limited pre-class preparation emerged as a significant barrier, with some students not engaging with pre-class materials seriously or thoroughly (Pugsee, 2017).
 - Technical difficulties and the need for advanced digital literacy also posed obstacles (Urfa & Durak, 2017).
 - Furthermore, although ethical awareness improved, confidence in professional application remained moderate in some cases (Taylor & Deb, 2021).

Conclusion

- In conclusion, the flipped classroom approach shows promise as an effective model for teaching research and AI ethics, enhancing critical thinking, ethical awareness, and engagement.
- Nonetheless, its success hinges on carefully addressing implementation challenges, ensuring adequate student preparation, and providing support for technical and self-directed learning skills.
- The findings suggest that, while the FC model is a versatile and impactful tool for ethics education, more applied studies and evaluations are needed to refine its methods and extend its adoption across educational contexts.

References

- Urfa, M., & Durak, G. (2017). Implementation of the flipped classroom model in the scientific ethics course. *Journal of Education and e-Learning Research*, 4(3), 108–117. <https://doi.org/10.20448/journal.509.2017.43.108.117>
- Tosun, C. (2023). Effects of the flipped classroom model on pre-service teachers' performance in learning research ethics concepts. *Eurasian Journal of Teacher Education*, 4*(2), 134–156.
- Taylor, G., & Deb, D. (2021). *Teaching AI ethics in a flipped classroom**. Consortium for Computing Sciences in Colleges.
- Pugsee, P. (2017). The effect of collaborative learning techniques in the flipped classroom learning: Computer ethics course. *2017 IEEE 6th International Conference on Teaching, Assessment, and Learning for Engineering (TALE)*, 381–388. <https://doi.org/10.1109/TALE.2017.8252366>
- Koterwas, A., Dwojak-Matras, A., & Kalinowska, K. (2021). Dialogical teaching of research integrity: An overview of selected methods. *FACETS*, 6, 2138–2154. <https://doi.org/10.1139/facets-2021-0045>
- Du, B., & Guo, J. (2024). Improving students' awareness and ability of academic integrity in a flipped chromatographic analysis course. *Journal of Chemical Education*, 101*(1), 69-76. <https://doi.org/10.1021/acs.jchemed.3c00718>