

Integrating Socio-scientific Issues Into AI Ethics Education: Curriculum Framework and Case Study

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The rapid advancement of artificial intelligence (AI) technologies presents a range of ethical challenges, highlighting the urgent need to integrate AI ethics education into curricula for young learners. This paper examines the implementation of AI ethics education across primary, secondary, and tertiary education levels, utilizing the framework of socio-scientific issues (SSI) pedagogy. We begin by exploring the pressing need for AI ethics education and then propose a set of curriculum design principles. A comprehensive curriculum framework is developed, which includes learning objectives, content, and pedagogical strategies tailored to each educational stage. Additionally, we present a case study focused on “generative AI technology” to demonstrate the practical application of the proposed framework. The paper concludes with recommendations for effective curriculum implementation, offering strategies to deepen the SSI approach, enhance teaching methods, integrate educational technologies, and address potential challenges.

Keywords: artificial intelligence ethics, socio-scientific issues, curriculum development, pedagogical practices, ethical values, interdisciplinary studies

Introduction

With the exponential growth of artificial intelligence (AI) technology in recent times, it has undeniably served as a catalyst for profound societal progress. Nevertheless, this rapid advancement has concurrently given rise to a constellation of complex ethical quandaries. Notable among these are the content perils associated with generative AI, the profound ethical dilemmas presented by AI weapons, the insidious issue of algorithmic bias, and the persistent threat of data privacy breaches (UNESCO, 2021). These challenges extend their tentacles far and wide, permeating the fabric of human society and exerting a profound influence on individual lives. Consequently, there is an acute and pressing need for comprehensive AI ethics education. Such education is not only essential to shepherd the development of this technology along a path of benevolence but also to safeguard the interests and well-being of society at large. In other words, given the far-reaching ramifications of these issues, the immediate implementation of AI ethics education becomes an imperative to direct technological evolution towards the greater good.

Within the academic realm, a broad consensus has crystallized regarding the fundamental rationale behind AI ethics education. Scholars unanimously concur that, as the digital natives of the contemporary era, young people necessitate formal instruction in AI ethics (UNESCO, 2021). However, when it comes to translating this

theoretical accord into practical action, a significant lacuna becomes evident. Specifically, there is a pervasive dearth of systematic programs engineered to operationalize the “how” aspect of AI ethics education. Although a handful of pioneering studies have delved into the domain of interdisciplinary AI ethics education, leveraging embodied contextualization and critical thinking workshops to augment students’ ethical sensitivities and analytical capabilities (Sun Tian, Jin, & Kou, 2024), the practical landscape remains bereft of tangible, field-tested implementation strategies and methodologies.

Socio-scientific issues (SSI), which have found extensive utilization in science education, are inherently constituted by a triad of scientific, social, and often contentious elements (Li et al., 2021). From an educational perspective, the integration of SSI into classroom pedagogy offers a multifaceted array of benefits. It not only bolsters students’ scientific acumen but also functions as a crucible for forging their sense of social responsibility, sharpening their critical thinking faculties, and endowing them with the competencies required to untangle and resolve complex problems (Meng & Li, 2010; Xiao, Zhu, & Liu, 2014; Yu & Liu, 2024). Significantly, the merits of basing AI theory education on SSI, especially in terms of fostering students’ critical thinking and social responsibility, present novel and fertile avenues for AI ethics education. By accentuating the nexus between AI technology and social concerns, the SSI teaching modality empowers students to apprehend the ethical dimensions of AI from diverse vantage points, fortify their ethical judgment, and inculcate correct ethical values (Kolong, Salic-Hairulla, Buan, & Pitiporntapin, 2023).

The overarching aim of this study is to probe into the optimal modalities for integrating SSI into school-based AI ethics education. Through meticulous curriculum design and implementation, followed by a rigorous evaluation of its impact on students’ ethical awareness and sense of responsibility, this study aspires to furnish both theoretical scaffolding and real-world exemplars for AI ethics education. In so doing, it endeavors to foster an ethical milieu within which AI technology can flourish and progress in a healthy and sustainable fashion.

The Need for AI Ethics Education

In the current epoch, AI technology has experienced explosive expansion, infiltrating every facet of social life at an astonishing velocity. Ranging from mundane daily consumption and entertainment pursuits to sophisticated industrial production processes, and from streamlined transportation systems to precise healthcare provisions, it vividly showcases its revolutionary prowess, comprehensively reconfiguring human production modalities, living patterns, and cognitive architectures. The younger generation, growing up amidst the digital wave, is inherently intertwined with diverse digital technologies. Undoubtedly, they are set to emerge as pivotal figures in the future progression of AI, functioning not only as primary end-users but also as prospective developers and trailblazers. Consequently, the prompt and meticulously targeted implementation of AI ethics education within the realm of basic education has transmuted into an urgent and ineluctable obligation.

Cultivating Ethical Awareness

Basic education constitutes a linchpin in the molding of youthful values. The educational and guiding initiatives during this formative stage exert a decisive sway over the crystallization of their personalities and moral frameworks. By instituting a methodical curriculum centered on AI ethics, the seeds of ethical awareness can be sown deep within their psyches. This empowers them to acutely perceive the ethical tenets and latent hazards embedded within AI technology, thereby fostering a potent sense of social responsibility and moral acuity. Such an educational underpinning will furnish them with steadfast ethical guidance when confronted with the

complex and perpetually evolving AI application landscapes in the future. It will enable them to make sagacious decisions in strict accordance with ethical benchmarks, effectively forestalling the eruption of ethical crises and social unrest that could potentially be incited by the misapplication of the technology.

Stimulating Critical Thinking

The ethical quandaries stemming from AI technology are marked by their intricate complexity and ceaseless dynamism, necessitating that stakeholders possess razor-sharp critical thinking capabilities to discriminate between right and wrong, judiciously weigh the pros and cons, and render rational and well-founded judgments within the convoluted information flux (Li, 2023). AI ethics education can aptly serve as an incubator for nurturing such cognitive faculties. Through meticulously devised teaching materials and engaging pedagogical activities, it steers young people towards mastering the art of interrogating, dissecting, and appraising the manifold ethical challenges posed by AI technology. It further galvanizes them to actively partake in public deliberations on AI ethics, thereby honing their thinking to be more discerning and rational. This, in turn, lays a robust foundation for their future forays into the intertwined arenas of technology and ethics.

Shaping Future Civic Literacy

AI ethics education transcends the mere conveyance of technical knowledge; its profound significance resides in the perpetuation and amplification of the humanistic ethos. Commencing from the bedrock of basic education, such education can play a crucial role in cultivating young people's sense of social responsibility, civic consciousness, and a panoramic global perspective. It enables them to apprehend their mission and obligations as members of the future global community during this critical juncture of their growth. Through this educational odyssey, young people will gradually metamorphose into responsible, empathetic, and astute citizens of the AI era. They will be equipped to actively engage in the development and governance of AI technology on a global scale, coalescing their efforts to propel AI's evolution in a more humane and sustainable trajectory. Ultimately, this will contribute to the construction of an AI-empowered community of shared destiny, replete with harmony and promise.

Curriculum Design Principles

As a vanguard domain, AI ethics education has amassed the requisite conditions across diverse aspects to be initiated from the upper elementary grades. In accordance with Piaget's theory, junior high school students commence their progression towards the stage of formal operations, wherein their nascent abstract thinking capacitates them to apprehend elementary ethical concepts, thereby paving the way for more profound studies and priming them for further educational pursuits. The SSI (socio-scientific issues) teaching paradigm, by assimilating contemporary social hot topics into the classroom milieu, efficaciously augments students' STEM (science, technology, engineering, and mathematics) literacy and ethical awareness, delineating a viable practical pathway for the implementation of AI ethics education in secondary schools. Specifically, this model, through the integration of social concerns, not only bolsters students' understanding of scientific, technological, engineering, and mathematical concepts but also heightens their sensitivity to ethical dimensions, proffering a tangible blueprint for secondary educational institutions to actualize AI ethics education.

Student-Centered Learning

Adapting to developmental stages. The SSI approach accentuates the infusion of social issues into the pedagogical setting, and AI ethical quandaries are, by their very nature, inextricably intertwined with social

matters, such as algorithmic discrimination and privacy breaches. Incorporating these social elements into AI ethics education empowers students to better fathom the practical significance and social ramifications of such ethical conundrums, thus facilitating a more profound comprehension of abstract ethical precepts. Nevertheless, the selection and presentation of these issues must be calibrated to align with the developmental phase of the youth, ensuring congruence with the physiological and psychological maturation patterns of students.

Drawing upon Piaget's (1969) theory of cognitive development and Kohlberg's (1976) theory of moral development, pupils in the upper elementary grades are on the cusp of transitioning to the stage of formal arithmetic and are beginning to exhibit preliminary abstract thinking faculties. For youngsters at this juncture, the curriculum ought to inaugurate the introduction of straightforward and easily digestible artificial intelligence ethical concepts, amalgamated with real-life exemplars like smart toys and intelligent learning software. This enables students to perceive the existence and influence of AI, laying a foundational bedrock for subsequent learning endeavors.

At the middle school level, students' abstract thinking capabilities burgeon further, permitting them to engage in structured socio-scientific reasoning (SSR) activities (Sadler, 2011). In the curriculum design for this stage, relatively intricate concepts such as algorithmic fairness and privacy safeguarding can be contextualized within specific social scenarios. Students can then be steered to partake in a gamut of activities, ranging from informal to formal reasoning, via the utilization of case studies and small-group deliberations. This cultivates their critical thinking and problem-solving acumen, while simultaneously facilitating the transition of their ethical cognition from the customary level to the post-customary level (Kohlberg, 1983).

For high school and university students, with the maturation of their cognitive faculties, by referencing the research findings in AI ethics (e.g., Wallach & Allen, 2008; Floridi & Taddeo, 2016), the course content can be rendered more profound and specialized. Incorporation of cutting-edge academic material such as the responsibility ethics of AI and ethical decision-making models becomes feasible. Additionally, students can be organized to undertake academic research and project-based practical activities, catering to their thirst for in-depth knowledge exploration. This concurrently nurtures their capacity to comprehensively apply knowledge to surmount complex problems, equipping them to confront the labyrinthine ethical challenges posed by AI in the future.

Encouraging active exploration. Rooted in the constructivist learning theory, we engineer a multiplicity of contexts proximate to students' lives, such as "the utilization of smart devices on campus" and "the contention surrounding the privacy settings of intelligent social networking platforms". These scenarios encourage students to proactively explore issues predicated on their personal experiences and understandings. They are thus motivated to actively unearth problems and pose questions in real-world situations, seeking resolutions through independent investigation and group collaboration. This metamorphosis from passive knowledge absorption to active knowledge construction nurtures their independent learning and thinking capabilities, while simultaneously enhancing their interpersonal intelligence and cooperation aptitude.

Goals of Ethics Education

Knowledge and skills. The ethical knowledge framework of AI that students ought to master is delineated, encompassing the fundamental principles, evolutionary history, principal technical applications of AI, as well as the sundry ethical predicaments engendered by AI, such as data leakage, algorithmic bias, and ambiguous responsibility, along with their specific manifestations and real-world case studies. Concurrently, by leveraging

the SSI teaching theory and the theory of multiple intelligences, students' proficiencies in resolving practical ethical quandaries are cultivated. This includes the application of ethical analysis frameworks to appraise the potential risks of AI systems and the formulation of ethical guidelines at both individual and organizational levels. Through diversified pedagogical modalities such as case studies, role-playing, and ethical debates, students are afforded opportunities to exercise their multiple intelligences across disparate learning activities. This ensures that they not only possess knowledge of ethical issues but also possess the wherewithal to address them, thereby furnishing robust support for their future encounters with AI ethical dilemmas in their professional and personal lives.

Shaping values. Sound ethical values are interwoven throughout the curriculum. Guided by the constructivist learning theory, students are led to engage in profound introspection regarding the limitations of the "technology first" and "technology neutral" paradigms, and to institute the value orientation of "people-oriented, ethics first". Through classroom discussions, case reflections, role-playing, and other activities, in tandem with the best practices in ethics education (Simm, 2021), students internalize these values as their personal ethical guidelines and behavioral habits. This cultivates a sense of responsibility and mission for the application of AI technology, guaranteeing that the technology serves the sustainable development of humanity. Simultaneously, it propels students to ascend the ladder of ethical development, culminating in the formation of a stable and correct value system.

Interdisciplinary Approach

Integrating multidisciplinary knowledge. Artificial intelligence ethics represents an interdisciplinary terrain, and the course design amalgamates knowledge from philosophy, law, sociology, computer science, and other disciplines. This integration affords students a panoramic and in-depth perspective. From a philosophical vantage point, the course delves into the moral subject status of AI and the nature of ethical dilemmas. From a legal perspective, it scrutinizes how to formulate legislations and regulations to govern the research, development, use, and supervision of AI. Sociologically, it examines the impact of AI on social structure, interpersonal relations, employment patterns, and so forth. In conjunction with computer science and technology knowledge, it provides students with an intimate understanding of the operational mechanisms of AI algorithms and their attendant ethical risks. The overarching aim is to enable students to dissect the ethical issues of artificial intelligence from multiple dimensions, broaden their cognitive horizons, enhance their comprehensive analytical capabilities, forge a systematic knowledge structure, and cultivate their interdisciplinary thinking aptitude and literacy.

Fostering interdisciplinary literacy. Based on the theory of multiple intelligences and the SSI teaching theory, we place emphasis on nurturing students' interdisciplinary thinking and research capabilities. We encourage them to shatter disciplinary boundaries and employ the methods and tools of multiple disciplines to tackle complex AI ethical issues. For instance, students can be organized to conduct interdisciplinary project research, which necessitates their comprehensive utilization of legal interpretation, social research, technology assessment, ethical thinking, and other means to perform a comprehensive ethical analysis of specific AI application scenarios (e.g., intelligent medical care, autonomous driving) and propose holistic solutions. Through diversified teaching activities and project practice, students are trained to possess the ability to flexibly convert and synergistically apply knowledge and methods from different disciplines. This adaptation to the demand for composite talents in the AI era augments their competitiveness in resolving practical problems in the complex

and ever-changing social environment of the future, while also catering to the learning needs and styles of students with diverse intelligence strengths, thereby promoting their all-round development.

Meeting the Demands of the Times

Keeping abreast of technological developments. In light of the rapid and iterative evolution of AI technology, the course content doggedly tracks the latest trends and research outcomes in the field. It promptly incorporates emerging AI application scenarios (e.g., the confluence of quantum computing and AI, ethical issues in brain-computer interfaces) and the novel ethical challenges they precipitate, while also referencing AI ethical research findings. This ensures that students are exposed to timely and forward-looking knowledge and case studies, enabling them to keep abreast of the tempo of the times. They can thus understand and cogitate upon the most avant-garde AI ethical issues, cultivate their sensitivity to new technological developments, and hone their capacity to contend with the unforeseen ethical risks that lie ahead, laying a solid foundation for their sustainable development in the volatile realm of AI.

Fostering social adaptability. Centering on the comprehensive literacy requisites of society in the era of artificial intelligence, the course accentuates the cultivation of students' abilities in communication and collaboration, critical thinking, innovation, and creativity. This empowers them to effectively grapple with the ethical issues of artificial intelligence in the complex and changing social environment. Through group cooperation projects, debates, simulated ethical decision-making meetings, and other activities, in tandem with the constructivist learning theory and the theory of multiple intelligences, the course hones students' abilities to communicate and cooperate with individuals from diverse backgrounds, analyze problems rationally, and propose innovative solutions. It also cultivates students' sense of responsibility and proactivity to actively engage in public discussions and promote the rational regulation of technological development in the context of the widespread application of AI technology. This augments students' social adaptability and potential to lead the development of the times, rendering them a constructive force in promoting the healthy and sustainable development of AI. Simultaneously, it fully equips them for their future career development and social life.

Designing SSI-based AI Ethics Curriculum

The principal objective of this section is to meticulously conceive and efficaciously implement an AI ethics education curriculum founded on the socio-scientific issues (SSI) paradigm. This curriculum is engineered to foster ethical values among students at the upper elementary, middle school, high school, and college levels, thereby enabling them to utilize AI responsibly. It is specifically designed to shepherd students away from the stance of "technology neutrality" and towards embracing "ethics first". At the elementary school stage, the curriculum centers on "perception and experience", allowing students to initially sense and engage with the AI realm. As students progress to junior high school, the focus shifts to "understanding and analysis", wherein they delve deeper into the ethical connotations and implications of AI. Subsequently, at the senior high school and university levels, the curriculum gravitates towards "application and research", empowering students to apply their knowledge and explore novel frontiers. Concomitantly, as the educational stage advances, the curriculum content becomes progressively more profound and specialized, and the teaching strategies diversify and grow in complexity.

Module Planning and Content Selection

Taking middle school as an exemplar, the curriculum will be organized around four pivotal units. Each unit will integrate SSI teaching concepts to guide students in probing and reflecting upon the ethical challenges that

AI technologies present, as well as in constructing their own ethical value frameworks. As depicted in Table 1, a selection of possible learning activities is presented.

Table 1

Basic Information for the Middle School AI Ethics Curriculum Unit

Module	Main elements/activities
Module I: AI and ethics	This module provides an overview of AI, encompassing its concept, historical evolution, cross-disciplinary connections, and prevalent application scenarios. It also prompts students to reflect on the fallacy of “technology neutrality” by examining instances such as algorithmic design bias and the privacy risks associated with face recognition. Moreover, it advocates for the “ethics first” principle through activities like product design and guideline development, and imparts the fundamental ethical tenets of fairness and transparency.
Module II: Ethical dilemmas of AI	Here, students engage with various ethical quandaries. Algorithmic discrimination is explored through case studies and role-playing, privacy leakage is dissected by investigating threats and protective measures, responsibility attribution is analyzed via case studies and moot courts, the employment impact is evaluated by considering thoughts and responses, and security risks are examined through exploration and prevention strategies.
Module III: Ethical practices in AI	This unit focuses on practical applications of ethics. Students partake in group discussions to make ethical decisions in dilemma cases, design applications with ethical considerations in mind, and develop norms and practices for responsible use.
Module IV: AI and future society	Students explore the impact of AI on society through movie viewing and subsequent discussions. They also review relevant documents to understand governance aspects and engage in reflections and participatory activities. Additionally, keynote speeches are incorporated to stimulate contemplation about the future of humanity in the context of AI.

Teaching Strategies and Methods

In junior high school education concerning the ethics of artificial intelligence, a plethora of teaching strategies, grounded in the SSI concept, are deployed.

- Case study method: Educators meticulously select pertinent cases, such as those involving algorithmic discrimination. Through a sequential process of presenting the case, facilitating in-depth problem exploration, orchestrating group discussions, and culminating in summarization and conceptual elevation, students’ ethical literacy is augmented. Furthermore, the integration of VR technology can be harnessed to amplify the pedagogical impact, providing students with a more immersive learning experience.

- Group discussion strategy: Teachers craft open-ended questions, like “the impact of artificial intelligence on the employment pattern”, and leverage online platforms to galvanize student discussions. This not only kindles students’ learning enthusiasm and initiative but also cultivates a diverse array of skills, including communication, critical thinking, and collaboration.

- Role-playing teaching method: For instance, in the context of “autopilot accident liability determination”, students are assigned distinct roles to engage in debates. This exercise enables them to grasp the intricacy of the problem and bolsters their capacity for divergent thinking and situational analysis, as they step into different perspectives.

- Project-based learning method: Instructors design projects, such as “Ethical Practice Guidelines”, with the assistance of project management tools. This approach fosters students’ inquiry, innovation, and cooperation capabilities, facilitating the transformation of knowledge into practical skills as they work towards a tangible outcome.

- Classroom debates: Debates on contentious topics, such as “Should Artificial Intelligence have rights?”, exercise students’ thinking and expressive faculties. They are compelled to deeply contemplate ethical issues and

adhere to the ethical baseline, refining their ability to argue and defend their viewpoints.

- Value conflict simulation teaching: A scenario, akin to the self-driving version of the “Trolley Dilemma”, is fabricated to guide students to deliberate on their choices from disparate ethical frameworks. This augments their ability to make ethical judgments and value selections, as they navigate complex moral landscapes.
- Ethical reflective writing training: Students are tasked with composing reflective journals or essays, which promotes the internalization of knowledge and values. This practice nurtures the capacity for moral self-discipline and personal growth, as they reflect on their learning and ethical development.

Evaluation

The teaching evaluation of this course will adopt a diversified suite of evaluation methodologies, encompassing both formative and summative evaluation. This comprehensive approach is designed to holistically appraise students’ learning outcomes, with particular emphasis on assessing the construction of their ethical values. To more accurately and comprehensively gauge students’ learning achievements, this study draws inspiration from Biggs and Collis’ (2014) SOLO taxonomy and Bloom’s taxonomy of educational objectives, among other evaluation techniques. These are then amalgamated with the unique characteristics of AI ethical education to formulate bespoke evaluation indicators, as detailed in Table 2.

Table 2

Teaching Evaluation Indicators for Ethics in Artificial Intelligence Classes

Evaluation dimensions	Description of evaluation indicators	Evaluation methods
Level of knowledge acquisition	Understanding and knowledge of AI ethics (e.g., basic concepts, ethical principles, social implications, etc.)	Formative assessment: Classroom observation, questioning, homework correction Summative assessment: Examinations
Ethical awareness	Includes ethical sensitivity (ability to recognize potential ethical risks), ethical judgment (ability to weigh conflicting values and make sound decisions using ethical principles), and ethical responsibility (willingness to make efforts to use technology responsibly)	Formative assessment: Classroom observations, group discussions Summative assessment: Essays, classroom presentations
Critical thinking	The ability to identify, analyze, and evaluate ethical issues of artificial intelligence, such as multiple perspectives, identifying logical fallacies and proposing solutions	Formative assessment: Classroom observation, questioning, group discussion Summative evaluation: Thesis, presentation of project results
Problem-solving skills	The ability to apply ethical principles and critical thinking to ethical issues of artificial intelligence	Formative assessment: Group discussions, homework corrections Summative evaluation: Presentation of project results
Participation and sense of cooperation	Motivation to participate in classroom discussions and group work	Formative assessment: classroom observations, group discussions
Creativity and expression	Performance in ethical reflective writing, program design, etc., reflecting an understanding of the application of ethical values	Formative assessment: Homework correction Summative assessment: ethical reflective writing, evaluation of program design outcomes Evaluation of work: Evaluation of students’ relevant work
Synthesized evaluations	Designing self-assessment and mutual assessment forms to allow students to reflect on the learning process and obtain feedback from others, through student self-assessment and mutual assessment	Student self-assessment and mutual assessment

Case Study: Generative AI Technology

This section presents a case study on generative AI technology to illustrate the application of SSI in AI ethics education.

Rationale for Case Selection

As a state-of-the-art application within the purview of artificial intelligence, generative AI technology bears a proximate and palpable connection to students’ quotidian lives. This proximity readily kindles students’ interest and elicits their empathetic engagement. Concurrently, generative AI technology is beleaguered by a litany of ethical conundrums. For instance:

- Responsibility for content generation: When the content engendered by generative AI becomes a subject of contention, how ought the locus of responsibility to be demarcated? Should it rest with the developer, the end-user, or the AI system per se?
- Ethical decision-making dilemma: In the act of content generation, how should AI navigate the labyrinth of ethical decision-making? To illustrate, when generating content that potentially encroaches upon the rights of others, how can the equipoise between freedom of expression and ethical accountability be struck?
- Social equity issues: Will the proliferation of generative AI technologies exacerbate social disparities? As an example, could it precipitate the extinction of certain vocations or engender discrimination against particular demographic cohorts?

By leveraging the SSI methodology, students can be shepherded to probe these issues with profundity, transitioning from the stance of “technology neutrality” to embracing “ethics first”, and concomitantly forging values conducive to the responsible utilization of AI technology.

Teaching and Learning Process

The instructional process of this case will be segmented into five discrete components, with the fundamental layout delineated in Table 3.

Table 3
Generative Artificial Intelligence Ethics Teaching Session Arrangements

Session	Times	Main content	Design purposes
Contextual introduction	10 mins.	Exhibition of a video centered on AI technology, followed by students’ ruminations on its merits, demerits, and attendant ethical quandaries	To kindle interest, instigate discursive issues, and lay the groundwork for subsequent deliberations
Case presentation and problem solving	20 mins.	Presentation of ethical case studies, prompting students to contrive coping strategies from multifarious perspectives	To foster an appreciation for the complexity inherent in ethical decision-making
Panel discussion and values discernment	30 mins.	Orchestration of group discussions under the tutelage of the teacher, aimed at identifying ethical dilemmas and charting pathways for decision-making	To catalyze interactive reflection and hone ethical judgment
Role-playing and in-depth experiences	40 mins.	Students engage in role-playing debates, with the teacher proffering critiques	To afford an in-depth immersion into adversarial scenarios, heightening sensitivity and a sense of responsibility
Extended inquiry and ethical reflection	20 mins.	Exploration of the tenets underpinning ethical decision-making, culminating in the composition and internalization of the “ethics first” ethos	To internalize ethical values through profound introspection and inquiry

Assessment of Teaching Effectiveness

In order to appraise the pedagogical efficacy of this course, and particularly to gauge the impact of the SSI teaching modality on the construction of junior high school students' ethical values vis-à-vis AI, a diversified array of evaluation methodologies will be employed. This will encompass both quantitative and qualitative assessment, facilitating a comprehensive and objective adjudication of students' learning outcomes. As illustrated in Table 4.

Table 4

Teaching Effectiveness Assessment Categories, Programs, and Details

Assessment categories	Evaluating projects	Assessment details
Assessing the objectives	The impact of the program on students' ethical knowledge, critical thinking, and ethical values	Analysis of alterations in student scores on the Ethical Knowledge Test, the Critical Thinking Test, and the Ethical Values Scale, both pre- and post-course. Additionally, scrutiny of the evolution of students' ethical awareness and values as manifested in interviews, classroom observations, and the dissection of assignments
	The impact of SSI pedagogy on student learning outcomes	Evaluation of the level of student participation, the depth of cognitive engagement, and the quality of collaborative efforts in SSI-infused teaching and learning activities, such as case studies, group discussions, and role-playing. Furthermore, determination of the influence of these activities on the development of students' ethical awareness and values
	The overall effectiveness of the program and directions for improvement	Summation of the strengths and limitations of the course, accompanied by recommendations for enhancement, including optimization of the instructional content, refinement of the teaching methodology, and amelioration of the teaching evaluation
Quantitative assessment	Ethical Knowledge Test	Administered both pre- and post-course; the purview of the content encompasses fundamental concepts of AI ethics, ethical principles, and social ramifications. The question typology includes multiple choice, true/false, and short answer formats
	Critical Thinking Test	Utilization of questions sourced from the California Critical Thinking Skills Test (CCTST), which encompass tasks such as argument identification, analysis, evaluation, and the formulation of solutions
	The Ethical Values Scale	Employment of a Likert scale format, populated with statements germane to AI ethics, spanning three dimensions: ethical sensitivity, ethical judgment, and ethical responsibility
Qualitative assessment	Student interviews	Conducted with a selection of students, with interrogatories encompassing impressions of the course, novel insights gleaned regarding AI ethics, the utility of the course, and suggestions for pedagogical refinement
	Classroom observations	Structured observation of students' classroom participation, as well as their manifestations of ethical sensitivity, judgment, and responsibility during instruction
	Assignment analysis	Dissection of the ethical awareness, critical thinking, and values enshrined in student assignments, such as case studies, project outcomes, and learning experiences
Expected learning outcomes	Knowledge enhancement	Augmentation of the level of comprehension and knowledge pertaining to AI ethics
	Thinking up	Fortification of critical thinking capabilities, enabling the analysis and evaluation of AI ethical issues from multiple vantages
	Consciousness-raising	Heightened ethical awareness, augmented sensitivity to AI ethics, and enhanced capacity for reasoning and decision-making
	Values development	Cultivation of ethical values, inclusive of sensitivity, judgment, and responsibility, and the ability to operationalize ethical principles

Recommendations for Curriculum Implementation

In the practical exploration of the SSI-based AI ethics education program, we have amassed a certain degree of experience and ascertained that the program framework exhibits a certain rationality and is capable of attaining the anticipated objectives. Concurrently, we have also encountered a series of problems and challenges. These cumulative experiences, as well as the identified problems and challenges, will furnish an essential foundation for further refining the implementation of the program and envisioning future development trajectories.

Deepening the SSI Approach

Practitioners should further deepen the application of SSI teaching mode, for example, the scope and depth of introducing social issues can be broadened, teachers are encouraged to guide students to independently explore the ethical cases of AI around them, and more diversified classroom activities are organized, such as field research and community discussion, so that students can better apply their ethical knowledge and strengthen the construction of ethical values in the real situation. Through the introduction of actual social issues, students can deeply understand the complexity of AI ethical issues in the process of inquiry, discussion, and reflection, so as to effectively enhance students' ethical sensitivity and critical thinking ability. For example, in the case study of "Generative Artificial Intelligence Technology", students can experience ethical dilemmas from multiple perspectives and try to solve them, so as to deepen their knowledge of different values.

Optimizing Teaching Methods

In their pedagogical practice, front-line teachers should place emphasis on the optimal amalgamation of diversified teaching methodologies. They should adeptly and flexibly select and combine teaching methods in accordance with varying teaching contents and students' learning states. For example, the case study approach is well-suited for steering students towards a profound understanding of specific ethical issues; the group discussion strategy can foster interaction and communication among students; and the role-playing teaching method can assist students in more vividly experiencing ethical dilemmas. Simultaneously, it is recommended that enhanced guidance and supervision be implemented throughout the execution of these teaching methods to ensure that teachers can proficiently utilize them, fully exploit their advantages, and elevate the quality of instruction. The combination of multiple teaching methods can significantly pique students' interest and enhance their participation in learning, thereby improving the teaching efficacy. Taking the case study of "Ethics of Face Recognition Technology" as an example, group discussion can prompt students to dissect the problems and formulate solutions, thereby augmenting their ethical awareness and sense of responsibility.

Integrating Technology

Curriculum practitioners can explore the utilization of modern technologies, such as VR, AR, and artificial intelligence tools, to augment the interactivity and immersion of ethics education and offer novel learning experiences for students. For example, VR technology can fabricate virtual ethical dilemma scenarios, permitting students to immerse themselves in the decision-making process and facilitating their understanding of the complexity of ethical issues. Furthermore, it is advisable to further augment the application of information technology in the curriculum and develop more digital teaching resources that are closely intertwined with AI ethics education, such as virtual laboratories and online ethical decision-making simulation platforms. Teachers should be encouraged to learn and master new information technology tools, innovate teaching methods, and enhance the allure and effectiveness of teaching.

Addressing Challenges

Currently, AI ethics education is confronted with challenges including disparate levels of teacher professionalism, insufficient resources for teaching materials, and constrained teaching time. These issues have circumscribed the widespread implementation and in-depth development of the curriculum, impinging on the quality of teaching and the learning outcomes of students. Specific countermeasures encompass the following:

- Strengthening professional training for teachers: It is recommended that regular training courses, seminars, and workshops focusing on ethical knowledge and teaching methodologies of artificial intelligence be organized to enhance teachers' pedagogical competencies and ethical acumen.
- Increasing the development of teaching materials and resources: Experts and front-line teachers should be coordinated to compile systematic and practical teaching materials and teaching references, thereby providing high-quality teaching resources for AI ethics education.
- Reasonably optimizing the curriculum: It is proposed that AI ethics education be organically integrated into the existing curriculum, and that teaching activities be carried out by making full use of after-school hours and online platforms to enhance teaching efficiency.

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