frontiers | Frontiers in Education

TYPE Original Research
PUBLISHED 05 August 2025
DOI 10.3389/feduc.2025.1630073

OPEN ACCESS

EDITED BY
Azzeddine Boudouaia,
Southwest Jiaotong University, China

REVIEWED BY
Samia Mouas,
University of Batna 2, Algeria
Yam Saroh,
Xixian High School Affiliated to Central China Normal University, China
Nesma Bara,
University of Bejaia, Algeria
Aziza Koran,
University of Khemis Miliana, Algeria

*CORRESPONDENCE
Linjing Wei
✉ wlj@gsau.edu.cn

RECEIVED 26 May 2025
ACCEPTED 17 July 2025
PUBLISHED 05 August 2025

CITATION
Zhong M, Wei L and Mo H (2025) Enhancing graduate AI education through practical and values-driven curriculum integration.
Front. Educ. 10:1630073.
doi: 10.3389/feduc.2025.1630073

Enhancing graduate AI education through practical and values-driven curriculum integration

Meiqi Zhong, Linjing Wei* and Henghui Mo

College of Information Science and Technology, Gansu Agricultural University, Lanzhou, Gansu, China

Introduction: With the rapid advancement of artificial intelligence (AI) technologies, there is a growing demand in graduate education for highly skilled, application-oriented professionals equipped with both technical expertise and strong ethical values. However, traditional AI curricula often lack effective integration of practical training and values-based education.

Methods: This study describes the design and implementation of an integrated curriculum for AI master's students, combining systematic industry needs assessment, curricular reform, and pedagogical innovation. The program emphasizes the cultivation of practical skills alongside values-oriented education—specifically professional responsibility, ethical awareness, and societal engagement—through course planning, case-based learning, project-driven instruction, and interdisciplinary collaboration. Multiple evaluation tools were employed, including student and faculty surveys, focus group interviews, and analysis of performance metrics such as project outcomes and academic competition results.

Results: Evaluation results demonstrate that the integrated curriculum significantly enhances students' initiative, critical thinking ability, and sense of social responsibility. Students not only achieved higher technical competence but also exhibited improved holistic qualities, as reflected in project achievements and external competition performance.

Discussion: The core innovation of this model lies in the seamless integration of ethical and societal considerations into technical training. Although the case study is limited to a single institution, the model provides valuable insights for AI education reform and high-quality talent cultivation. These findings establish a theoretical foundation for the adaptation and application of such integrative approaches across diverse educational settings.

KEYWORDS

artificial intelligence, graduate education, practical curriculum, values guidance, educational effectiveness

1 Introduction

With the rapid advancement of artificial intelligence (AI) technologies, AI has gradually penetrated various industries and sectors, becoming a core driving force behind social progress and industrial innovation (Obreja et al., 2024). From autonomous driving to medical diagnostics, and from financial risk control to intelligent manufacturing, AI applications are ubiquitous and have profoundly transformed our work and lives. The continuous innovation and expansion of AI applications have also led to a surging demand for high-level professionals who possess both solid theoretical foundations and extensive practical experience (Holmes et al., 2019). Therefore, cultivating application-oriented AI professionals who can solve real-world problems with innovative thinking and engineering capabilities has become a central task of graduate education.

However, in the current graduate education system for AI professional degrees, there is still a tendency to emphasize theoretical instruction while underestimating practical skill development, which may lead to insufficient innovation capability in the workplace. Thus, constructing a curriculum system that meets industry demands and emphasizes practical competence has become an urgent challenge. This paper aims to explore how to design a practical curriculum system for graduate education in AI that enables students to better master the technology, enhance their comprehensive capabilities, and adapt to the evolving needs of the industry (Colbert et al., 2016).

When designing such a practical curriculum system, it is first necessary to consider the specific needs of industry for AI talent. In recent years, enterprises have not only required fundamental research skills from AI professionals, but have increasingly valued their ability to solve real-world problems and facilitate technological implementation (Aler Tubella et al., 2024). For example, in areas such as intelligent product development, system integration, and large-scale data processing, the industry demands that talent be capable of quickly applying theoretical knowledge to practical work. Therefore, cultivating students' ability to participate in project development and technological innovation has become a key focus in designing graduate curricula for AI.

Secondly, academia has raised different viewpoints on AI education. Traditional teaching models tend to emphasize the delivery of theoretical knowledge while overlooking the cultivation of students' innovative and practical capabilities (Akinwalere and Ivanov, 2022). In response, how to design a curriculum that not only ensures theoretical depth but also effectively fosters students' hands-on skills has become a major area of exploration. To adapt to this shift, many universities have begun to strengthen experimental courses, project-based learning, and collaboration with industry, aiming to bridge the gap between theory and practice (Akgun and Greenhow, 2022). Nevertheless, these approaches still face limitations, such as insufficient resources or the need for further content updates.

Moreover, the diversity and complexity of AI technologies have presented new challenges to graduate education. Today, AI encompasses multiple subfields such as machine learning, computer vision, and natural language processing, each with its own unique research directions and application scenarios (Richards and Dignum, 2019). Given this landscape, designing a flexible and interdisciplinary curriculum system that enhances students' technical competence alongside broader qualities such as teamwork and critical thinking has become increasingly important (Adams et al., 2023). To meet these needs, this paper proposes a practical curriculum system based on competency development and industry demand. The core of this design lies in integrating courses and projects to comprehensively improve students' practical skills, engineering competence, innovative thinking, and teamwork capabilities (Mouta et al., 2025). These practical components not only include lab work and project execution, but also emphasize the ability to seek solutions to real-world problems, aiming to cultivate students' capacity to apply theory in real applications.

Through the design of specific curriculum modules and practical projects, this paper further explores how to align cutting-edge industry requirements with academic training (Ren et al., 2024). For example, in project-based practice, students are given opportunities to collaborate with enterprises to tackle real technical challenges, and under the guidance of faculty, complete the entire process from requirements analysis to prototype design. This approach not only helps improve students' project management and team collaboration skills, but also enables them to better understand the industrialization process of AI technologies.

While there is growing emphasis on embedding value-oriented guidance and ethical awareness within technical training, such integration also presents potential challenges. These may include variations in student backgrounds, faculty perspectives, and the risk of value-related content being perceived as less relevant to core technical competencies. Addressing these complexities requires ongoing dialogue, flexible pedagogical approaches, and sensitivity to student and faculty diversity.

Finally, the paper proposes strategies for evaluating and optimizing the practical curriculum system. By establishing a scientific evaluation framework and regularly collecting feedback and refining the curriculum, it ensures that course design evolves in sync with industry development, thereby producing talent that is better prepared for the future. To more clearly present the structure and competency targets of the AI graduate practical curriculum system.

To provide a clearer overview of the curriculum's implementation, Table 1 has been expanded to detail not only module objectives, but also representative learning activities (e.g., group projects, coding labs, seminar discussions, case analyses) and corresponding assessment methods (such as project deliverables, peer evaluations, and reflective essays).

2 Methodology

This study adopts a comprehensive mixed-methods research design, integrating both qualitative and quantitative approaches to ensure a thorough and credible evaluation of the curriculum integration model. At the outset, a systematic needs assessment was carried out using structured questionnaires and semi-structured interviews involving 126 graduate students, 15 faculty members, and 8 industry representatives. This stage was critical in identifying the specific competencies required by industry and uncovering gaps in the existing educational system. Structured questionnaires included both closed and open-ended questions to capture students' initiative and value orientation, while classroom observation templates and reflection prompts were standardized to enhance comparability across cohorts. Quantitative analysis was performed using SPSS 25.0, and all qualitative coding discrepancies were resolved through consensus discussion between two independent raters.

Based on the findings of the needs assessment, the research team collaboratively developed a multidimensional practical curriculum that seamlessly incorporated ideological-political education elements. The integrated curriculum, covering areas such as technical training, engineering practice, professional ethics, and social responsibility, and was implemented on a pilot basis and continuously improved across selected courses. During the course

TABLE 1 Practical curriculum module design and objective comparison (expanded).

Module name	Teaching objectives	Capability cultivation	Values/ethics integration method	Learning activities	Assessment methods
Natural computing practice	Algorithm principles and programming	Practical skills, logical thinking	Case studies guiding rational analysis	Mini-hackathon, coding lab, group algorithm design	Project report, code submission, oral presentation
AI ethics and social impact analysis	Societal impact of AI	Critical thinking, ethical judgment	Cases on technology as a double-edged sword	Case debates, role-play, ethical scenario discussion	Reflection essay, participation, group presentation
Multi-objective optimization project	Project analysis and design	Engineering, collaboration	Serve the people, tech for good	Industry-sponsored project, teamwork, prototype demo	Team report, peer evaluation, demo assessment
Interdisciplinary project collaboration	Cross-domain AI application	Innovation, comprehensive ability	Social responsibility	Interdisciplinary challenge, cross-major collaboration, real-world problem-solving	Team solution, external judge review, learning diary

implementation, data were collected through multiple channels, including pre- and post-course surveys designed to measure changes in students' technical competencies, critical thinking skills, and sense of social responsibility. In addition, qualitative data were gathered from classroom observations, open-ended feedback from students, reflective journals maintained by instructors, and focus group discussions. Performance data, such as student project outcomes, academic competition achievements, and publication records, were also included to provide a comprehensive perspective on learning effectiveness.

Teaching feedback in this study is explicitly defined as information collected from both students and instructors to evaluate and improve the teaching process. This includes structured student surveys, instructor reflective journals, classroom observation notes, open-ended written feedback, and focus group discussions, all aimed at capturing perceptions of instructional effectiveness, curriculum relevance, and areas for further refinement.

For data analysis, qualitative materials were systematically examined using thematic content analysis, allowing the researchers to identify recurring patterns and key themes associated with competency development and value formation. Quantitative data were subjected to statistical analysis, including descriptive statistics and paired t-tests, to assess the significance of changes in student performance and attitudes following the curriculum intervention. To further enhance the validity and reliability of the findings, triangulation was employed by cross-verifying information from diverse sources, and inter-rater reliability was ensured by having two independent researchers collaboratively code the qualitative data. All procedures were conducted in accordance with institutional ethical guidelines, with informed consent obtained from all participants. Through this rigorous and systematic approach, the research aims to generate robust and credible insights that can inform future educational practices in the integration of practical and ideological-political teaching.

To ensure adaptability to rapid advances in AI, the curriculum is reviewed and updated annually based on feedback from industry advisors and student cohorts. Course content is modular and allows for flexible integration of emerging topics (e.g., generative AI, AI safety). Diverse student backgrounds are accommodated through optional foundational workshops and differentiated project topics, enabling personalized learning paths.

The evaluation covered all students who took the Natural Computing course in 2021, 2022, and 2023 ($N = 41$, 47, and 38, respectively). The "excellence rate" in Table 2 was defined as the proportion of students whose final course grade was 85 or above out of 100, assessed according to standardized rubrics. The "satisfaction score" was measured using an anonymous university-approved survey, employing a 5-point Likert scale (1 = very dissatisfied, 5 = very satisfied). The survey instrument's reliability was verified in a pilot test (Cronbach's $\alpha = 0.89$). Data collection involved direct extraction from the official grading system and university records for academic competitions and publications.

3 Main difficulties in implementing ideological and political education in graduate courses

Graduate education is not only the cornerstone of the nation's innovation-driven development strategy but also a critical force in the modernization of Chinese society. As times continue to evolve, graduate students are becoming increasingly mature in their thinking, demonstrating strong cognitive abilities and independent thought. However, this is accompanied by the challenge of diversified values (Chen and Wang, 2024). In an era overwhelmed by information, how to effectively integrate ideological and political education into graduate students' professional studies has become a pressing issue. Therefore, a thorough analysis of the dual challenges faced by both students and teachers in implementing ideological and political education in graduate curricula has become a key prerequisite for enhancing its effectiveness. Figure 1 illustrates the overall framework of these main difficulties and corresponding solutions.

In our teaching practice, after implementing scenario-based group discussions and project-oriented assignments, end-of-term surveys revealed that 82% of students found ideological and political content more relevant and engaging. Qualitative feedback included comments such as, "Case studies made me realize the

TABLE 2 Three-year comparative outcomes of ideological and political reform in the natural computing course.

Year	Increase in excellence rate (%)	Academic competitions	Student publications	Satisfaction score
2021	–	12	3	3.9
2022	+13.5	21	7	4.4
2023	+21.8	35	12	4.7

Excellence rate = percentage of students with a final grade $x \geq 85/100$; Satisfaction score = average on a 5-point Likert scale; N (2021) = 41, N (2022) = 47, N (2023) = 38.

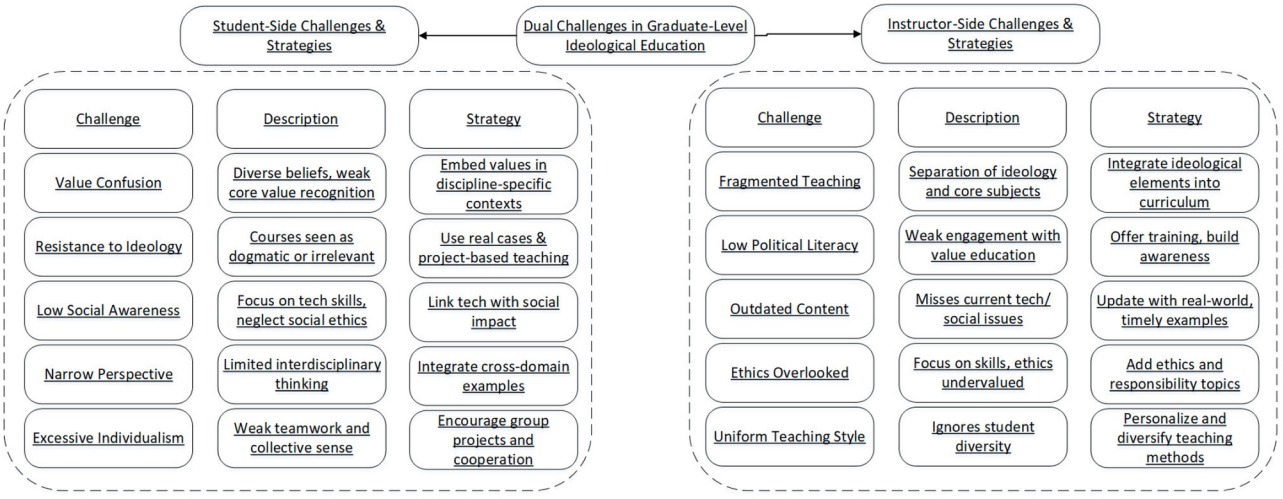

FIGURE 1
Dual challenges and solutions in ideological and political education for graduate students.

societal impact of my work in AI," highlighting the effectiveness of these solutions.

First, the current diversity and complexity of graduate students' thinking necessitate targeted guidance in ideological and political education. With the development of society and the increasing degree of informatization, various ideologies circulating online exert growing influence on graduate students. Although their thinking is relatively mature, many students may lack a deep understanding of civic values and social responsibility—important competencies emphasized in global STEM education reform (Zheng et al., 2021). This requires educators not only to impart knowledge, but also to strengthen rational guidance in ideological education, helping students form a correct worldview, outlook on life, and value system.

At this stage, graduate students are experiencing a growing sense of self-awareness and are gradually clarifying their plans for society, family, and their personal future. However, they often exhibit extreme or irrational thinking patterns during their cognitive development. Particularly when facing value conflicts, some students may be misled, resulting in flawed perceptions or behaviors. Therefore, guiding them through ideological and political courses to view social phenomena rationally and develop critical thinking and discernment skills poses a significant challenge (Hu et al., 2024).

At the same time, another major difficulty in implementing ideological and political education lies in overcoming graduate students' psychological resistance to it. During their studies, students often prefer to focus on accumulating professional knowledge and practical skills, and tend to hold a certain degree of aversion toward textit textitideological courses Many regard ideological and political education as textithollow preaching or a mere textitpolitical task, making it difficult for traditional ideological content to be effectively delivered. How to make such education truly relevant to graduate students' actual needs and integrate it with their academic development and life planning is a crucial issue for educators to address.

Currently, most educational practices still emphasize knowledge transmission while neglecting the realization of ideological goals through hands-on application, which results in limitations and fragmentation in the effectiveness of such courses.

For example, the solution to bridge the gap between knowledge and practice involved a three-step process: (1) conducting pre-course surveys to identify student concerns, (2) mid-term feedback sessions for dynamic adjustment, and (3) end-of-term reflection journals to capture attitudinal changes and collect suggestions for further improvement.

3.1 Student perspective

3.1.1 Correction of values

Contemporary society is undergoing profound transformations, with the accelerated processes of informatization and globalization leading to the coexistence and intermingling of diverse social ideologies. Amid this ideological "torrent," graduate students are particularly vulnerable to value confusion

(Boubker, 2024). Many students experience ideological uncertainty during their formative years, especially in the internet age, where the virtual world's information often conflicts with the ethical standards of the real world. In such an environment, cultivating students' recognition of the core socialist values—and more importantly, their adaptability to emerging technologies and complex social contexts—has become a central task of ideological and political education (Li and Mao, 2022).

To address this issue, the content of ideological and political courses must be deeply embedded in students' everyday learning and life. Course design should go beyond theoretical instruction and focus on students' developmental needs, starting from their academic disciplines and incorporating current social issues and real-life contexts to stimulate their critical thinking abilities (Carolus et al., 2023). By guiding students to develop sound value judgments and fostering a sense of responsibility toward the nation, society, and the people, educators can help them form a rational and scientific outlook on life and values.

3.1.2 Dissolving psychological resistance

Compared to undergraduates, graduate students tend to be more independent and mature in their thinking, making resistance to *indoctrination-style* ideological and political education not uncommon. At this stage, students gradually shift their focus from academic and career concerns to deeper reflections on societal, historical, and national issues (Yang, 2024). However, traditional teaching approaches often fail to tap into students' thinking about social realities and life planning, resulting in low recognition and engagement with ideological and political courses.

Therefore, how to transform the teaching model of ideological and political education to better align with the actual needs of graduate students and eliminate their resistance has become a critical pedagogical issue. By incorporating more real-world examples, case studies, and practical scenarios into course design—especially those tied to current social issues and students' specific areas of interest—educators can help students see the connection between personal growth and national development, thereby enhancing their motivation and enthusiasm for learning (Tang, 2023).

During class discussions of controversial topics, such as AI and privacy, some students expressed discomfort with the perceived politicization of technical content. To respect diverse viewpoints, instructors maintained a neutral, moderating role, encouraged debate, and sometimes invited guest speakers with alternative perspectives. This approach increased student participation and reduced tension.

Some faculty members were initially concerned that mandatory ideological content could limit academic freedom or be misaligned with technical learning objectives. To address these concerns, regular teaching workshops and interdisciplinary forums were organized, facilitating exchange of best practices and fostering a more open, pluralistic environment.

3.1.3 Cultivating critical thinking and social responsibility

A notable characteristic of contemporary graduate students is their strong capacity for independent thinking and critical inquiry. Teachers should encourage students not only to understand and master professional knowledge, but also to question it, think critically, and challenge existing ideas and methods during the learning process. In the field of artificial intelligence, the rapid development of technology has brought about unprecedented social issues related to ethics, law, and beyond. Students must be able to discern the tensions between technological advancement and social ethics (Shamsuddinova et al., 2024). This requires educators to employ methods such as case analysis and debate-based teaching to help students grasp the double-edged nature of technological progress and strengthen their sensitivity and sense of responsibility toward the societal impacts of technology. Cultivating critical thinking not only prepares students to better meet the challenges of academic research, but also helps them become socially responsible technological innovators who can make greater contributions to social development.

3.1.4 Balancing professional and comprehensive qualities

The goal of graduate education is not only to equip students with a solid theoretical foundation and practical abilities in their chosen fields, but more importantly, to emphasize the enhancement of their overall competencies. Many students, in the pursuit of academic research and professional skills, tend to fall into the trap of *focusing solely on specialization while neglecting broader perspectives* (Sultana and Faruk, 2024). With the continuous advancement of artificial intelligence technologies and the rapid expansion of application scenarios, students should not be confined to mastering specialized knowledge alone; they must also develop interdisciplinary integration skills, understand the relationship between their expertise and societal needs, and enhance their ability to solve complex problems. The implementation of ideological and political education should be closely aligned with real-world social and industry demands, cultivating students' innovation capacity and adaptability through project-based learning and interdisciplinary collaboration (Hamadi et al., 2024). This not only contributes to their success in academic pursuits but also better prepares them for the ever-changing social and professional environments they will encounter. Graduate students should possess not only deep insights into their disciplines but also strong comprehensive qualities, enabling them to approach problems from a broader perspective, take into account multiple dimensions such as technology, ethics, and society, and integrate knowledge with action to make meaningful contributions to both society and industry.

3.1.5 Balancing individualized development and collectivist values

With the transformation of educational models, personalized education has become a core element of modern higher education, especially at the graduate level where students' individual differences and professional interests are more pronounced. However, achieving a balance between personalized development and collectivist values—particularly in highly technical fields like artificial intelligence—remains a pressing challenge (Joseph and Uzondu, 2024). Personalized development emphasizes students' autonomy in choosing research directions and cultivating interests,

encouraging innovative thinking, but excessive freedom can lead to an overemphasis on individualism, with students potentially neglecting teamwork and collective responsibility. In implementing ideological and political education, it is essential to consider how to reinforce collectivist values and cultivate students' sense of teamwork and social responsibility, while respecting individual differences and supporting independent innovation. Through classroom discussions, collaborative projects, and other interactive forms (Salo-Pöntinen, 2021), students can come to understand that personal success depends on team support and cooperation, and that the development and application of technology must be accompanied by a responsibility to society and humanity. Ideological and political education should help students establish a balanced value system—one that enables them to think independently and unleash their creative potential, while also recognizing the importance of collectivism and social responsibility, which is especially crucial for their holistic development in future careers.

3.2 Teacher perspective

3.2.1 Integrating ideological education with teaching practice

In promoting ideological and political education in graduate courses, teachers must first understand how to organically integrate such education with professional curriculum. Many instructors are accustomed to separating subject teaching from ideological instruction; however, at the graduate level, ideological and political education should not be treated as an additional component, but rather as an integral part of all courses. Teachers should not only impart professional knowledge in the classroom, but also incorporate core socialist values and a sense of contemporary responsibility into their teaching through case studies, interactive discussions, and other methods, enabling students to gradually develop correct worldviews, outlooks on life, and value systems while mastering their disciplines. Therefore, innovation in course design and teaching methods is essential, as teachers explore how to achieve deep integration between ideological education and subject-specific instruction.

3.2.2 Dissolving psychological resistance

Teachers' own ideological and political literacy and value orientation play a critical role in promoting ideological and political education within courses. In addition to being experts in their academic fields, teachers should also possess a high level of ideological and political awareness, enabling them to influence students through their words and actions and guide them in forming correct values and outlooks on life. However, some teachers still view ideological and political education as an additional burden, lacking initiative and awareness. Therefore, in the context of ideological and political education, teachers must first strengthen their theoretical learning and deepen their understanding and recognition of the core socialist values. Only by cultivating their own ideological consciousness can they effectively serve as positive role models and transmit appropriate values and perspectives to students (Liao et al., 2020).

3.2.3 Updating and innovating teaching content

The rapid advancement of artificial intelligence technologies requires teachers to continuously update their teaching content and methods, and ideological and political education must also incorporate new perspectives in this process. For instance, AI is not only a field of technical innovation, but also one that intersects with ethics, law, and other disciplines. Teachers should incorporate discussions on AI's social responsibilities and ethical challenges into their classroom instruction. This not only helps students understand the development and application of technology, but also makes them aware of its potential social impacts. Such multidisciplinary integration in teaching not only improves students' overall competence but also enhances their sense of social responsibility and humanistic awareness. In this process, teachers are expected to possess interdisciplinary knowledge and be capable of organically embedding such content into their courses, thereby improving the curriculum's relevance and timeliness.

3.2.4 Guiding correct professional values

In the teaching of frontier disciplines such as artificial intelligence, students' career development and future positioning are of vital importance. Teachers should actively guide students to establish correct professional values and help them understand the social needs and ethical issues behind technological innovation (Alves et al., 2017). With the rapid development of AI, industry demands not only technical competence but also ethical standards, teamwork, and social responsibility. Therefore, teachers should not only cultivate students' technical skills but also help them comprehend the social functions and responsibilities of technology. Through diverse methods such as research projects, academic exchanges, and social practice, teachers can lead students to deeply reflect on the relationship between technology and the future of humanity, as well as the interplay between technology and ethics. This process fosters critical thinking and a strong sense of professional ethics among students.

3.2.5 Emphasizing personalized and differentiated ideological education

Each graduate student has a unique academic background, personality traits, and value orientation, which requires teachers to adopt differentiated educational strategies when implementing ideological and political education. Especially at the graduate level, where students demonstrate strong self-awareness and independent thinking, instructors need to pay more attention to the individual ideological development of students, guiding them to establish self-identity and foster a sense of connection with society and the nation during their personal growth (Folorunso et al., 2025). Teachers should employ individualized mentoring, thematic discussions, and other flexible approaches to help students explore their own value orientations and consider how technological innovation can serve social development. At the same time, educators must respect the diversity among students and avoid

forcing uniform agreement on specific viewpoints. Instead, by encouraging students to reflect on a variety of social issues and philosophical questions, teachers can promote the formation of independent thinking and pluralistic values.

4 Curriculum ideology design concept: cultivating "responsible and innovative professionals" for the new era of AI graduate education

The core objective of ideological and political education in the curriculum is to enhance educational effectiveness by cultivating "responsible and innovative professionals" who possess both social responsibility and innovative capabilities—especially in the high-tech field of artificial intelligence. With the rapid advancement of technology, AI is no longer solely an academic subject; it also involves crucial issues such as ethics, social responsibility, and national development. Therefore, the design of ideological and political education should focus on how to integrate value-based education with professional skills training—guiding students not only in technical competence but also in forming sound values, ways of thinking, and a sense of social responsibility.

In the AI domain, the application of scientific methodology is essential. Marxist philosophy, particularly dialectical materialism, provides a scientific cognitive framework for understanding and transforming the world. Ideological and political curriculum design should emphasize the organic integration of Marxist philosophy with professional courses to help students develop systematic thinking and problem-solving abilities. By guiding students to apply scientific methods while learning AI technologies, they will be better equipped to identify the essence of problems, enhancing both their technical competence and their ability to think critically and judge deeply. This methodological approach aims to cultivate students' comprehensive ability to solve complex problems—allowing them to contribute rational insights to technological innovation while also examining and optimizing the use of technology from a philosophical perspective.

In practical teaching, instructors can guide students in analyzing concrete AI-related cases to help them understand the underlying theories and methodologies behind the technologies, and to encourage them to examine the application and limitations of such technologies through a philosophical lens. For example, when explaining AI algorithms, instructors can lead discussions on the social impact of these technologies and the ethical dilemmas they may pose. This not only helps students learn how to design more effective algorithms, but also teaches them to identify the potential ethical risks associated with these technologies. This process strengthens students' technical skills while simultaneously cultivating critical thinking and philosophical analysis, helping them maintain rational perspectives during the process of technological innovation.

Innovation is the core driving force behind the development of the artificial intelligence field. However, innovation is not limited to technological breakthroughs—it also involves the integration of new ways of thinking, social responsibility, and practical applications of technology. The design of ideological and political education in AI curricula should focus on cultivating students' spirit of innovation, encouraging them not only to tackle technical challenges, but also to reflect on the long-term societal and human implications of technological progress. In practice-oriented modules, the curriculum should adopt project-based learning and interdisciplinary collaboration to encourage student participation in socially meaningful AI projects, which can enhance their technical skills while also developing their teamwork, social responsibility, and other comprehensive competencies. For example, students may engage in AI-powered projects aimed at addressing societal issues, enabling them to apply their knowledge while gaining deeper insights into the relationship between technology and society. These practical activities help students apply what they have learned in real-world contexts, solve concrete problems, and develop a better understanding of the interaction between technology and society, thereby fostering both their practical skills and capacity for innovation.

To ensure the optimal implementation of ideological and political education, it is essential to achieve deep integration between ideological content and professional courses. In the AI discipline, ideological and political education should not exist as an isolated component; rather, it must be closely integrated with technical instruction and hands-on practice, forming an organic and cohesive teaching system. While delivering technical content, instructors can naturally incorporate Marxist philosophical thought, discussions on ethics, and related topics, allowing students to improve their moral and ideological awareness alongside their technical proficiency. For instance, when teaching AI ethics, instructors should guide students to consider how technology can be used to address societal problems, how to assess the societal impact of AI applications, and how to leverage technological advancement to promote social fairness and justice. Through this deep integration, ideological and political education not only enhances students' professional skills but also strengthens their sense of social responsibility, spirit of innovation, and practical capabilities. Ultimately, it aims to cultivate AI professionals equipped with critical thinking, creativity, and a strong sense of social responsibility—individuals who have the potential to lead future technological development and contribute to societal progress.

5 Exploring the integration of artificial intelligence education and ideological-political instruction

In the field of artificial intelligence—particularly within the domain of natural computing—the integration of ideological and political education into course instruction is especially important. As a class of intelligent algorithms inspired by natural phenomena and aligned with dialectical materialism, natural computing emphasizes the cultivation of both students' ideological-political awareness and their professional competence. Guided by this philosophy, the teaching team for the Natural Computing course has conducted in-depth exploration around enhancing students' modes of thinking, value formation, and innovative capabilities. The following presents a summary of practical

experiences in ideological and political education based on specific instructional cases.

5.1 Enhancing the application of methodology

In AI education, it is critical to develop students' capacity for dialectical materialist thinking. By encouraging students to apply dialectical reasoning, educators help them understand the intrinsic principles of artificial intelligence, enabling them to approach technical challenges from a broader perspective, analyze problems effectively, and propose meaningful solutions. Dialectical materialism emphasizes the universal interconnectedness of things, the dynamics of development and change, and the unity of contradictions. On this foundation, ideological and political instruction not only facilitates students' mastery of technical knowledge but also guides them to understand the deeper relationships between technology, society, and politics—thereby improving their comprehensive thinking skills. To more intuitively demonstrate the pathway for cultivating dialectical thinking and methodological competence within AI courses, Figure 2 summarizes five representative teaching strategies and their corresponding case mappings, illustrating how ideological and political instruction can systematically guide students' thinking and enhance their comprehensive abilities.

Case 1: Fostering the Ideal of Serving the People While teaching deep learning and object tracking technologies, the instructor introduces the "Eye-Controlled Smart Wheelchair for ALS Patients" project. This initiative uses AI to empower individuals with amyotrophic lateral sclerosis (ALS) to control their wheelchairs autonomously, significantly improving their quality of life. Through this case, the instructor aligns AI applications with the directive that technology should serve the people, especially vulnerable groups.

Students are encouraged to connect technical learning with social responsibility, understanding that the ultimate goal of innovation is to serve public welfare. They reflect on how technology can benefit those in need, fostering responsibility and compassion. This case deepens their awareness of social issues and instills a value system centered on service and care for others (Wang et al., 2024).

Case 2: Promoting the Scientific Spirit and Strengthening Professional Ethics When discussing AI applications, the instructor references cases such as "tech giants entering communities to sell groceries," highlighting how capital-driven behavior may disrupt local economies and create inequalities. While AI is neutral, its misuse under excessive market control presents governance challenges.

Students are guided to recognize that technical excellence must be accompanied by strong ethical awareness. They explore themes of fairness, justice, and professional responsibility, learning to uphold scientific and moral integrity in future decision-making.

Case 3: Cultivating Innovation and Social Responsibility Using the "AI + Poverty Alleviation" initiative, particularly applications in underdeveloped regions, the instructor leads students to consider how technology can address social development gaps. They explore how AI enhances education and healthcare access, supporting equity and rural revitalization.

By participating in such cases, students witness technology's power to uplift communities. They grow in patriotic feeling and social accountability, understanding that technical learning must align with national development and service.

Case 4: Fostering Long-Term Vision Through Environmental Awareness and Sustainable Development Discussing smart grids and smart cities, the instructor highlights AI's role in sustainable development. Students consider how technology can reduce resource waste, address environmental issues, and contribute to green transitions.

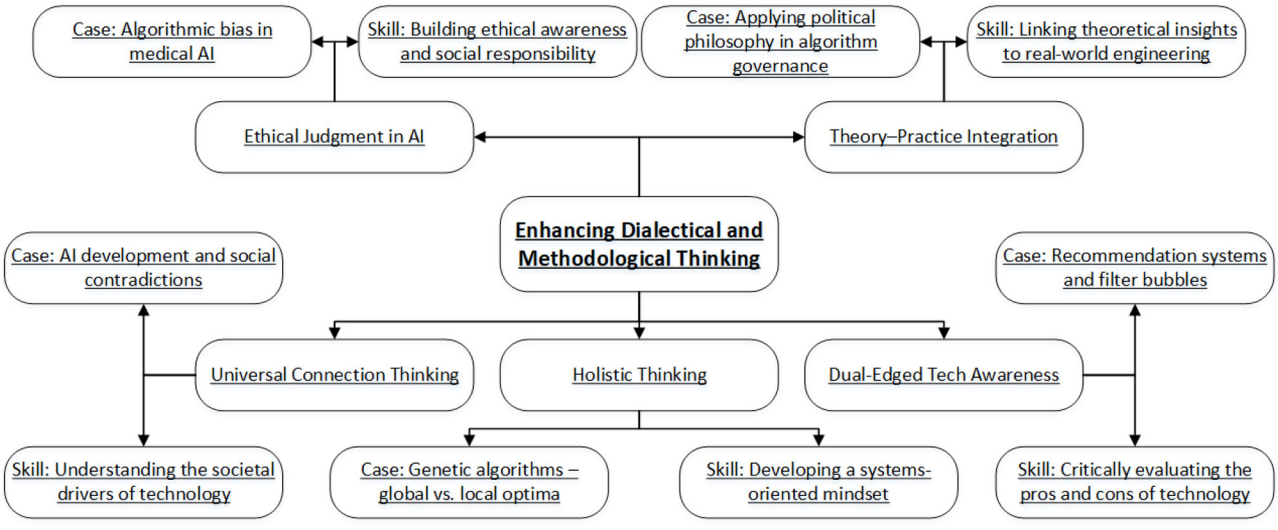

FIGURE 2
Pathways for cultivating dialectical thinking and methodological competence in AI courses.

This case encourages students to develop a long-term, global perspective, integrating environmental concerns into technical problem-solving. They refine their ethical judgment and learn to balance innovation with sustainability.

Case 5: Inspiring Global Vision and a Sense of Responsibility By incorporating China-Africa cooperation cases in "AI-powered agriculture," the instructor introduces students to international development challenges. These stories show how AI supports productivity in developing regions and inspires global citizenship.

Students explore the global relevance of their expertise and imagine their future roles in solving cross-border issues. This process cultivates patriotism alongside international responsibility and prepares students to contribute to global technological advancement.

Through these cases, students not only acquire technical skills but also build a well-rounded identity as ethical, innovative, and socially responsible professionals—prepared to serve both national and global progress.

5.2 Uncovering educational elements

In the teaching of artificial intelligence, it is important not only to develop students' technical skills but also to uncover and integrate educational elements—particularly by combining instruction with real-world cases to help students establish correct values and a strong sense of social responsibility. By thoroughly analyzing real-life problems related to AI and sharing stories of exemplary figures in the field, instructors can guide students to deepen their understanding of technological applications while reinforcing their patriotism, social responsibility, spirit of innovation, and professional ethics. This approach not only helps students master technical knowledge but also nurtures them into future scientific and technological professionals with a strong commitment to society. To systematically present the structure and implementation path of these educational elements within AI courses, Figure 3 outlines five core educational focus areas emphasized in current ideological and political education, along with representative case examples.

Case 1: Fostering the Ideal of Serving the People While teaching deep learning and object tracking technologies, the instructor introduces the "Eye-Controlled Smart Wheelchair for ALS Patients" project. This initiative uses AI to empower individuals with amyotrophic lateral sclerosis (ALS) to control their wheelchairs autonomously, significantly improving their quality of life. Through this case, the instructor aligns AI applications with the directive that technology should serve the people, especially vulnerable groups.

Students are encouraged to connect technical learning with social responsibility, understanding that the ultimate goal of innovation is to serve public welfare. They reflect on how technology can benefit those in need, fostering responsibility and compassion. This case deepens their awareness of social issues and instills a value system centered on service and care for others (Wang et al., 2024).

Case 2: Promoting the Scientific Spirit and Strengthening Professional Ethics When discussing AI applications, the instructor references cases such as "tech giants entering communities to sell groceries," highlighting how capital-driven behavior may disrupt local economies and create inequalities. While AI is neutral, its misuse under excessive market control presents governance challenges.

Students are guided to recognize that technical excellence must be accompanied by strong ethical awareness. They explore themes of fairness, justice, and professional responsibility, learning to uphold scientific and moral integrity in future decision-making.

Case 3: Cultivating Innovation and Social Responsibility Using the "AI + Poverty Alleviation" initiative, particularly applications

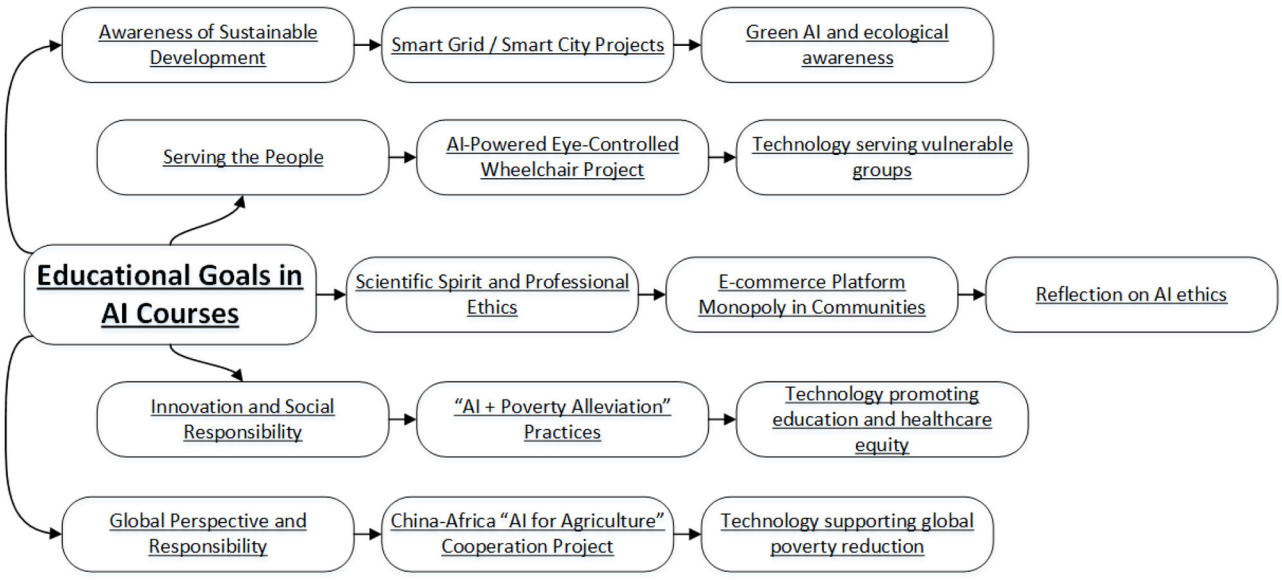

FIGURE 3
Pathways for integrating educational elements in AI courses.

in underdeveloped regions, the instructor leads students to consider how technology can address social development gaps. They explore how AI enhances education and healthcare access, supporting equity and rural revitalization.

By participating in such cases, students witness technology's power to uplift communities. They grow in patriotic feeling and social accountability, understanding that technical learning must align with national development and service.

Case 4: Fostering Long-Term Vision Through Environmental Awareness and Sustainable Development Discussing smart grids and smart cities, the instructor highlights AI's role in sustainable development. Students consider how technology can reduce resource waste, address environmental issues, and contribute to green transitions.

This case encourages students to develop a long-term, global perspective, integrating environmental concerns into technical problem-solving. They refine their ethical judgment and learn to balance innovation with sustainability.

Case 5: Inspiring Global Vision and a Sense of Responsibility By incorporating China-Africa cooperation cases in "AI-powered agriculture," the instructor introduces students to international development challenges. These stories show how AI supports productivity in developing regions and inspires global citizenship.

Students explore the global relevance of their expertise and imagine their future roles in solving cross-border issues. This process cultivates patriotism alongside international responsibility and prepares students to contribute to global technological advancement.

Through these cases, students not only acquire technical skills but also build a well-rounded identity as ethical, innovative, and socially responsible professionals—prepared to serve both national and global progress.

6 Teaching practice outcomes and feedback

To more intuitively demonstrate the effectiveness of ideological and political education reform in the Natural Computing course, this paper summarizes students' learning performance and course development achievements over the past three years, as shown in Table 2. Following the integration of ideological and political instruction in the Natural Computing curriculum, a trend of improvement was observed in students' learning initiative and enthusiasm. Over the three-year period, students' academic engagement and attention to the societal implications of AI appeared to increase. While these improvements coincide with the reform, causality cannot be firmly established, as other factors (such as updates in teaching methods or changing student cohorts) may have contributed (Shamsuddinova et al., 2024).

Faculty reflection journals documented improved teaching confidence and peer collaboration following the adoption of new instructional strategies. For instance, one instructor noted, "I was initially skeptical about integrating values discussions, but observed students' technical presentations became richer in ethical reasoning after these reforms."

Specifically, the proportion of students achieving excellent assessment results has increased year by year, while the proportion of lower-performing students has steadily declined. Additionally, students have demonstrated substantial improvements in innovation capacity, research competence, and participation in various academic competitions. More importantly, the implementation of ideological and political education has enhanced interaction and communication among students, as well as between students and instructors. Students who previously studied solely to improve their grades have gradually transformed into individuals who care about personal development, academic inquiry, and national priorities.

This shift indicates that ideological and political education has been effective not only in knowledge transmission but also in value formation and the cultivation of social responsibility.

In summary, these targeted strategies—supported by both quantitative and qualitative feedback—have demonstrably improved the effectiveness and acceptance of ideological and political education in our graduate AI curriculum. Future efforts will continue to refine these approaches in response to student and faculty feedback, as well as ongoing societal developments in AI.

Paired t-tests indicated that both the excellence rate and satisfaction score increased significantly after curriculum reform ($p < 0.05$), supporting the observed improvements. It should be noted that these results are correlational and may have been influenced by additional variables such as concurrent changes in teaching strategies or differences in student cohorts. As this was a single-institution case study without a control group, further research is necessary to clarify the specific contribution of the integrated curriculum reform.

In the process, the teaching faculty also experienced significant growth. In 2023, the course leader was honored as a extquotedblleftDistinguished Teaching Professor of Higher Education in Gansu Province extquotedblright a recognition of both their teaching excellence and outstanding contributions to educational reform. Furthermore, the course was awarded the title of extquotedblleftOutstanding Grassroots Teaching Organization of Gansu Province extquotedblright and secured support for three textbooks under the Ministry of Agriculture's 14th Five-Year Plan initiative in 2023. These achievements serve as strong evidence of the course's success in improving teaching quality, advancing ideological and political education, and closely aligning instruction with disciplinary development and societal needs.

Qualitative feedback supported these trends. For example, one student remarked, "The course helped me think more deeply about how AI can benefit society," while another noted, "Project-based cases made the learning experience more meaningful."

7 Research implications

7.1 Theoretical implications

This study significantly advances the theoretical integration of practical teaching systems and ideological-political education within the context of artificial intelligence education. By constructing and empirically validating a structured curriculum integration model, the research contributes new perspectives to educational theory, particularly in bridging the gap between competency-based learning and value-oriented educational goals.

The results demonstrate how embedding ideological-political elements into technical curricula can foster not only students' professional abilities, but also their ethical awareness and sense of social responsibility. Furthermore, the study enriches the discussion on interdisciplinary education by showing that the convergence of technical and humanistic training can lead to a more holistic approach to talent development. These insights offer a theoretical foundation for subsequent studies exploring the synergy between professional competence and moral cultivation in other high-tech or rapidly evolving disciplines.

7.2 Practical implications

From a practical standpoint, this research provides concrete and actionable strategies for enhancing the effectiveness of graduate-level AI education. The proposed curriculum model and its successful implementation serve as a reference for educators seeking to optimize course design, teaching content, and assessment methods. Educational policymakers and curriculum developers can utilize the research findings to update curricular standards, placing greater emphasis on interdisciplinary collaboration, critical thinking, and the cultivation of ethical reasoning and social responsibility. The integration of case-based learning, project-driven practice, and real-world problem-solving is shown to improve student engagement, teamwork skills, and the ability to apply knowledge in practical contexts. Moreover, the study underscores the value of continuous feedback, dynamic course adjustment, and active participation by both instructors and students in the teaching process. Institutions aiming to train well-rounded AI professionals can draw on these experiences to establish their own systems that balance technical expertise with humanistic qualities, better preparing graduates to address the complex ethical and societal challenges posed by emerging technologies.

8 Conclusion

The integration of value-oriented elements into university curricula appears to enrich approaches to moral and character development, and may contribute to improvements in the overall quality of talent cultivation in higher education. In the context of artificial intelligence and related courses, embedding ethical and social responsibility considerations into the curriculum has provided students with a more diverse and holistic learning experience, supporting the development of not only technical skills but also broader competencies such as ethical awareness, critical thinking, and a sense of social responsibility.

However, as a single-institution case study, this research may be subject to potential biases in sample selection, data collection, and the interpretation of qualitative feedback. The absence of a randomized control group also limits the strength of causal inferences. The findings are primarily based on data from Gansu Agricultural University and may not fully generalize to different institutional or cultural contexts.

Looking forward, further research should include longitudinal impact assessments, cross-institutional comparative studies with control groups, and in-depth investigations of both student and faculty perspectives on values integration. It is also recommended to expand the evaluation system by incorporating mixed-methods approaches, employing control groups, and tracking students' development over multiple years.

One unresolved challenge is ensuring the consistent and meaningful integration of value-oriented elements across diverse faculty and student backgrounds, as well as measuring changes in attitudes and ethical reasoning in a robust, standardized manner. Planned next steps include establishing a participatory course review mechanism involving students, faculty, and industry partners, as well as providing ongoing professional development for instructors on the integration of values education.

As higher education continues to evolve, the integration of values-based education into technical curricula presents both opportunities and challenges. To ensure the sustained progress of such educational reform, university educators are encouraged to engage in reflective practice and continuous innovation, while remaining attentive to changing societal needs. Practical experience suggests that a nuanced and immersive approach to values integration may help foster students' critical thinking and engagement, serving as a positive influence throughout their academic and personal development.

By continuing to adapt and improve curriculum design, educators can better support the holistic development of students and prepare technologically skilled professionals equipped with both expertise and a strong sense of social responsibility for an increasingly complex world.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

MZ: Writing – original draft, Writing – review & editing. LW: Writing – review & editing, Validation, Funding acquisition, Supervision, Methodology, Resources, Formal analysis, Conceptualization. HM: Supervision, Investigation, Data curation, Resources, Writing – original draft, Formal analysis.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. This research was supported by the National Foreign Experts Project of the Ministry of Science and Technology (G2022042005L), Gansu Higher Education Industry Support Project (2023CYZC-54), Gansu Key R&D Plan (23YFWA0013), Lanzhou Talent Innovation and Entrepreneurship Project (2021-RC-47), Gansu Agricultural University Graduate Education Research Project (2020-19), "Three-dimensional Education" Teaching Research Project (2022-9), and Comprehensive Professional Reform Project (2021-4).

Acknowledgments

The authors thank Gansu Agricultural University, the College of Information Science and Technology, and Linjing Wei for their support and guidance throughout this research.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

Publisher's note

References

Adams, C., Pente, P., Lemermeyer, G., and Rockwell, G. (2023). Ethical principles for artificial intelligence in k-12 education. *Comput. Educ. Artif. Intell.* 4:100131. doi: 10.1016/j.caeai.2023.100131

Akgun, S., and Greenhow, C. (2022). Artificial intelligence in education: addressing ethical challenges in k-12 settings. *AI Ethics* 2, 431–440. doi: 10.1007/s43681-021-00096-7

Akinwalere, S. N., and Ivanov, V. (2022). Artificial intelligence in higher education: challenges and opportunities. *Border Crossing* 12, 1–15. doi: 10.33182/bc.v12i1.2015

Aler Tubella, A., Mora-Cantallops, M., and Nieves, J. C. (2024). How to teach responsible ai in higher education: challenges and opportunities. *Ethics Inf. Technol.* 26:3. doi: 10.1007/s10676-023-09733-7

Alves, J., Lima, N., Alves, G., and García-Peñalvo, F. J. (2017). Adjusting higher education competences to companies' professional needs: a case study in an engineering master's degree. *Int. J. Hum. Capital Inform. Technol. Profess.* 8, 66–78. doi: 10.4018/IJHCITP.2017010105

Boubker, O. (2024). From chatting to self-educating: can AI tools boost student learning outcomes? *Expert Syst. Appl.* 238:121820. doi: 10.1016/j.eswa.2023.121820

Carolus, A., Koch, M. J., Straka, S., Latoschik, M. E., and Wienrich, C. (2023). Mails-meta AI literacy scale: development and testing of an ai literacy questionnaire based on well-founded competency models and psychological change- and meta-competencies. *Comput. Hum. Behav. Artif. Hum.* 1:100014. doi: 10.1016/j.chbah.2023.100014

Chen, J., and Wang, H. (2024). Exploration on the integration of artificial intelligence and ideological and political teaching in colleges and universities. *Appl. Math. Nonlinear Sci.* 9, 1–22. doi: 10.2478/amns-2024-2038

Colbert, A., Yee, N., and George, G. (2016). The digital workforce and the workplace of the future. *Acad. Manag. J.* 59, 731–739. doi: 10.5465/amj.2016.4003

Folorunso, S., Oladipo, F., Van Reisen, M., and Abdullahi, I. (2025). "A higher education curriculum for cultural competence, representation, and social responsibility in AI and fair data practices," in *FAIR data, FAIR Africa, FAIR world: Internationalisation of the Health Data Space*. Bamenda: Langaa.

Hamadi, M., Imtinan, U., and Namisango, F. (2024). Sustainability education in information systems' curricula: a conceptual research framework. *Educ. Inf. Technol.* 29, 14769–14787. doi: 10.1007/s10639-023-12409-w

Holmes, W., Bialik, M., and Fadel, C. (2019). *Artificial Intelligence in Education: Promises and Implications for Teaching and Learning*. Boston, MA: Center for Curriculum Redesign.

Hu, X., Sui, H., Geng, X., and Zhao, L. (2024). Constructing a teacher portrait for the artificial intelligence age based on the micro ecological system theory: a systematic review. *Educ. Inf. Technol.* 29, 16679–16715. doi: 10.1007/s10639-024-12513-5

Joseph, O. B., and Uzondu, N. C. (2024). Integrating AI and machine learning in stem education: challenges and opportunities. *Comput. Sci. IT Res. J.* 5, 1732–1750. doi: 10.51594/csitrj.v5i8.1379

Li, Y., and Mao, H. (2022). Study on machine learning applications in ideological and political education under the background of big data. *Sci. Program.* 2022, 1–9. doi: 10.1155/2022/3317876

Liao, S., Fu, L., and Liu, Z. (2020). Investigating open innovation strategies and firm performance: the moderating role of technological capability and market information management capability. *J. Bus. Ind. Mark.* 35, 23–39. doi: 10.1108/JBIM-01-2018-0051

Mouta, A., Torrecilla-Sánchez, E. M., and Pinto-Llorente, A. M. (2025). Comprehensive professional learning for teacher agency in addressing ethical challenges of aied: insights from educational design research. *Educ. Inf. Technol.* 30, 3343–3387. doi: 10.1007/s10639-024-12946-y

Obreja, D. M., Rughiniș, R., and Rosner, D. (2024). Mapping the conceptual structure of innovation in artificial intelligence research: a bibliometric analysis and systematic literature review. *J. Innov. Knowl.* 9:100465. doi: 10.1016/j.jik.2024.100465

Ren, W., Wang, R., Syamsul Nor Azlan Mohamad, Xie, Y., Chen, L., Ning, H., et al. (2024). A quantitative analysis of the influence of ideological and political education on students' learning satisfaction. *J. Infrastruct. Policy Dev.* 8:2727. doi: 10.24294/jipd.v8i1.2727

Richards, D., and Dignum, V. (2019). Supporting and challenging learners through pedagogical agents: addressing ethical issues through designing for values. *Br. J. Educ. Technol.* 50, 2885–2901. doi: 10.1111/bjet.12863

Salo-Pöntinen, H. (2021). "AI ethics-critical reflections on embedding ethical frameworks in AI technology," in *International Conference on Human-Computer Interaction* (Springer: New York), 311–329. doi: 10.1007/978-3-030-77431-8_20

Shamsuddinova, S., Heryani, P., and Naval, M. A. (2024). Evolution to revolution: critical exploration of educators' perceptions of the impact of AI on the teaching and learning process in the gcc region. *Int. J. Educ. Res.* 125:102326. doi: 10.1016/j.ijer.2024.102326

Sultana, R., and Faruk, M. (2024). Does artificial intelligence increase learners' sustainability in higher education: insights from bangladesh. *J. Data Inf. Manag.* 6, 161–172. doi: 10.1007/s42488-024-00121-4

Tang, C. (2023). Innovation of ideological and political education based on artificial intelligence technology with wireless network. EAI Endorsed Trans. *Scalable Inform. Syst.* 10, 1–9. doi: 10.4108/eetsis.3829

Wang, L., Lin, S., and Zhang, L. (2024). Technological innovation through complex networks: a study of 100 listed companies on China's growth enterprise market. *J. Knowl. Econ.* 16, 6200–6247. doi: 10.1007/s13132-024-01798-z

Yang, H. (2024). Empowerment of artificial intelligence in teaching reform of ideological and political courses in universities. *J. Contemp. Educ. Res.* 8, 80–87. doi: 10.26689/jcer.v8i1.5976

Zheng, L., Zhu, Y., and Yu, H. (2021). Ideological and political theory teaching model based on artificial intelligence and improved machine learning algorithms. *J. Intell. Fuzzy Syst.* 41, 1–10. doi: 10.3233/JIFS-219127