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The Role of the Philosophy of Science in Critical Thinking and Ethical Decision-Making: A Systematic Literature Review

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Abstract: The philosophy of science plays a vital role in shaping scientific inquiry, guiding the way knowledge is constructed, validated, and applied across disciplines. However, there remains a lack of comprehensive understanding regarding its relevance and application in the context of contemporary education and technology. Therefore, this study aims to systematically review recent research trends and conceptual developments related to the philosophy of science within the 21st-century academic landscape. This study employed a Systematic Literature Review (SLR) approach using publications indexed in Scopus from 2015 to 2025. A total of 85 articles were analyzed through bibliometric mapping and qualitative synthesis to identify emerging patterns and dominant themes. The results reveal three major synthesized themes: (1) the integration of the philosophy of science in educational practices to strengthen epistemological awareness; (2) its role in navigating the ethical and epistemic challenges of digital technology; and (3) its contribution to fostering critical and reflective scientific thinking. The novelty of this study lies in highlighting the evolving interface between philosophy of science and technological transformation in education. Practically, the findings provide a conceptual framework for integrating philosophical reflection into scientific and technological curricula. This study contributes to the advancement of science and technology by offering a holistic understanding of how philosophical foundations can support the development of responsible, innovative, and reflective scientific practices.

Keywords: Critical Thinking, Ethical Decision Making, Philosophy of Science, Systematic Literature Review

A. Introduction

Philosophy has long provided the foundation for human reasoning and the pursuit of truth. It offers a systematic framework for reflection, enabling individuals to construct meaning, question assumptions, and evaluate moral and intellectual claims. Within this intellectual tradition, the philosophy of science occupies a central role in

understanding how knowledge is produced, validated, and ethically applied. It engages with the dimensions of ontology, epistemology, and axiology, which together explain the nature of reality, the sources and justification of knowledge, and the moral values guiding scientific practice (Hambali et al., 2024; Imam et al., 2023; Rifqi et al., 2024). Beyond theoretical discourse, the philosophy of science serves as a reflective compass, ensuring that scientific inquiry remains both methodologically sound and ethically grounded.

The rapid integration of Artificial Intelligence (AI), Big Data, and the Internet of Things (IoT) in the era of Society 5.0 has transformed the relationship between humans, knowledge, and technology (Martini et al., 2024; Özdemir & Hekim, 2018; Tavares et al., 2022). While these innovations promise progress, they also pose complex ethical challenges related to autonomy, authenticity, and human values. Technological advancements often outpace moral reflection, underscoring the need to reaffirm philosophical perspectives that guide ethical decision-making and safeguard human dignity in the development of science and technology. Despite the recognized importance of the philosophy of science, a significant gap remains in understanding its practical contribution to fostering critical thinking and ethical decision-making, especially in educational and technological contexts. Much of the existing literature emphasizes theoretical debates but rarely integrates how philosophical principles are applied in real-world settings. This lack of synthesis limits our understanding of how philosophical inquiry can shape reflective, value-based approaches to education and innovation.

To address this gap, this study uses a systematic literature review to explore how philosophy of science contributes to the development of critical thinking and ethical decision-making in education and technology, particularly within the framework of Society 5.0. The paper is structured as follows: the next section outlines the methodology of the systematic literature review. The results section synthesizes emerging themes from the reviewed literature, followed by a discussion of their implications for educators, policymakers, and scholars. The paper concludes by reflecting on the role of philosophical inquiry in developing ethically responsible knowledge and human-centered innovation in the digital age.

B. Methods

This study employed a Systematic Literature Review (SLR) approach following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta Analyses) protocol to ensure transparency, replicability, and methodological rigor (Rethlefsen & Page, 2022; Sarkis-Onofre et al., 2021). The SLR method was selected because it allows for a comprehensive synthesis of existing studies on the philosophy of science and its applications in education and technology, thereby identifying research trends, gaps, and conceptual developments within the field. The literature search was conducted across two major academic databases: Scopus, and Google Scholar. Scopus was

selected for its comprehensive indexing of peer-reviewed international journals; Google Scholar provided broader coverage of interdisciplinary studies. The search was conducted in October 2025 and limited to publications from 2015 to 2024 to reflect recent developments in the digital era and Society 5.0.

The search used a combination of keywords and Boolean operators to ensure relevance and inclusiveness: (TITLE-ABS-KEY (Philosophy of Science OR Philosophy of Ethics) AND TITLE-ABS-KEY (Critical Thinking) AND TITLE-ABS-KEY (Decision Making)) AND PUBLICATION YEAR > 2014 AND PUBLICATION YEAR < 2026. To improve the accuracy and reproducibility of the bibliometric process, data retrieved from Scopus were analyzed using RStudio with the Bibliometrix package (Büyükkidik, 2022). This software facilitates data cleaning, merging, and mapping of bibliometric indicators, including co-occurrence networks, thematic evolution, and trend analysis. The use of RStudio ensured a systematic and transparent approach in identifying dominant research themes, author collaborations, and emerging patterns related to the intersection of philosophy of science, critical thinking, and ethical decision making. Scopus database processing using R Studio with keywords according to the Boolean operators is shown in Figure 1.

(a) (b)

Figure 1. (a) WordCloud and (b) CoWordNet

In addition to Scopus data, Google Scholar was used to search for additional articles not indexed in Scopus but relevant to the research scope (Hirt et al., 2023). These articles were identified through a manual search conducted directly within the Google Scholar web interface, using the same combination of keywords and logical operators. This manual screening enabled the inclusion of open-access and region-specific publications that contribute to a more comprehensive understanding of the topic. The integration of Scopus and Google Scholar sources ensures a balanced representation of global and contextual perspectives in the systematic review. This strategy aimed to capture studies that examined the intersection of philosophy of science, educational practice, and technological transformation. Studies were included if they met the following criteria: (1) Published in a peer-reviewed journal between 2015–2024; (2) Written in English; (3) Discussed philosophy of science with its relevance to education and/or technology and its relationship to critical thinking and decision making; (4)

Presented conceptual, theoretical, or empirical findings on philosophical applications in a modern context. Studies were excluded if: (1) Did not go through a peer-review process (e.g., conference abstracts, theses, or opinion papers); (2) Focuses only on general philosophy without any relation to education or technology; (3) Is a duplicate or is not accessible in full text form.

The screening process was carried out in three stages: (1) Identification: 230 initial records were retrieved from all databases; (2) Screening: After removing duplicates and irrelevant titles/abstracts, 60 articles remained; (3) Eligibility: Full-text review was conducted independently by two reviewers to ensure accuracy and consistency. After applying the inclusion and exclusion criteria, 16 articles were retained for final analysis. A PRISMA Flow Diagram (Figure 2) illustrates the selection and screening process.

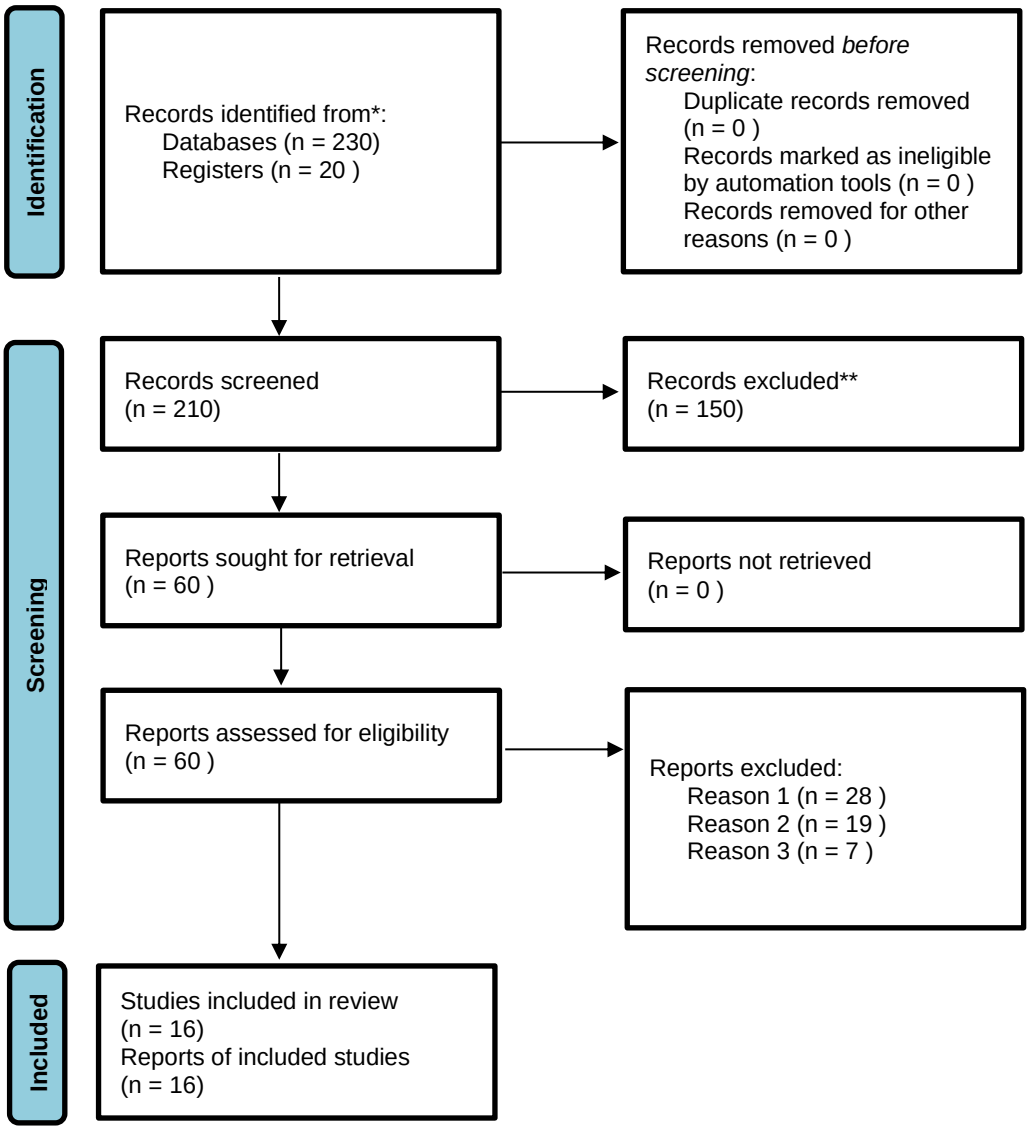

Figure 2. A PRISMA Flow Diagram

A thematic analysis approach was then used to identify, code, and synthesize emerging themes. This process involved three steps: (1) Initial coding of recurring philosophical and educational concepts; (2) Grouping the codes into broader categories (critical thinking and decision making); (3) Synthesis of these categories into overarching themes representing major philosophical directions in the literature. This method allows for a coherent understanding of how the philosophy of science is conceptualized and applied in the realms of education and technology.

C. Results and Discussion

This Systematic Literature Review (SRB) analyzes 16 peer-reviewed articles that meet the inclusion criteria and align with the research focus on the role of philosophy of science in fostering critical thinking and ethical decision-making. The selected studies were published between 2015 and 2025 and represent a variety of academic contexts, including education, philosophy, and the ethics of technology. Each article was carefully screened for conceptual relevance, methodological rigor, and theoretical contributions to ensure the validity and depth of the analysis. The review emphasizes not only the philosophical foundations of scientific inquiry but also its practical implications for fostering reflective judgment, moral reasoning, and intellectual autonomy in contemporary educational and technological environments. A summary of the review of 22 articles is shown in Table 1.

Table 1. Reviewed Articles

No	Journal title	Author	Research purposes	Research methods	Research result	Conclusion
1	The Scope of the Philosophy of Science: A Review of Philosophical Education	(Hambali et al., 2024)	This article aims to discuss the scope of the philosophy of science which consists of definition of philosophy, definition of the philosophy of science, characteristics of philosophical thoughts, and three fundamental structures of science	The researchers employ qualitative method under descriptive approach. Meanwhile, in the present study the researchers used content analysis as the data analysis technique	The results showed that philosophy is a way of humans‟ thoughts in relation to the study of the fundamental and eternal universe. Furthermore, when philosophy is connected into science, it becomes the philosophy of science. The philosophy of science then is understood as a part of philosophy whose activities to examine science in the context of science through various scientific procedures including initial principles, theoretical structures, measures of scientific truth, views of formal logic, and practical methodology and metaphysics. In addition, philosophy is inseparable from the characteristics of philosophical thoughts which consists of methodical, systematic, coherent and consistent, rational, comprehensive, radical, and univesal. Finally, philosophy examines three aspects of the fundamental structure of science including aspect of ontology, epistemology, axiology	The philosophy of science has four scopes including definition of philosophy, definition of the philosophy of science, characteristics of philosophical thoughts, and three fundamental structures of science
2	Rethinking AI with Transformative Philosophy	(Bruno, 2024)	This paper introduces the Transformative Philoso phy (T:Phil) program, an initiative designed to embed ethical	The methods used are innovative delivery, including discussion events involving technical	Philosophy, particularly the philosophy of technology, along with disciplines such as the sociology of technology and Science and Technology Studies (STS), has a rich tradition of studying the complex	Faced with the critical issues surrounding the delicate balance between the

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			and socio-political literacy into the technological development process	professionals in reflective practices that increase their understanding of the broader implications of technology, especially AI.	interactions between technology, individual behavior, societal structures, and power dynamics. Despite the numerous insights these fields have generated, their existence and contributions remain largely unrecognized by those spearheading technology development and implementation. However, the rapid digitalization and proliferation of AI demonstrate the urgent need for non-technical frameworks, theoretical foundations, and ethical considerations to effectively guide the ongoing technological transformation.	potential benefits of AI and the inevitable risks or unintended impacts, it is crucial to deepen our understanding of the essence of AI (and its limitations), as well as how we view and conceptualize it.
3	Training STEM Ph.D. Students to Deal with Moral Dilemmas	(Rashid, 2020)	The aim of this research is to train critical skills and processes that are crucial for success in academia and beyond.	This research uses a case study approach.	Some research problems are inherently complex because they pose profound moral dilemmas, such as antimicrobial resistance, sustainability, the worrisome dual-use research (defined as well-intentioned scientific research that can be misused for nefarious purposes), and human cloning. Addressing moral dilemmas is one of several core competencies required of 21st-century doctoral students. However, this may prove challenging for STEM doctoral students with limited exposure to moral philosophy. Because the task of addressing moral dilemmas in STEM research requires input from both the scientific and philosophical disciplines,	The interdisciplinary strategies described will (1) sensitize STEM doctoral students to the ethical aspects of their research, (2) inspire them to address moral dilemmas by providing an explicit decision-making process, and (3) foster key skills such as interdisciplinary

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						communication and collaboration, and (4) develop the confidence and intellectual agility needed to meet the challenges of the 21st century.
4	Critical Thinking as a Qualified Decision-Making Tool	(Turan et al., 2019)	This article aims to describe the importance of Critical Thinking as a Qualified Decision-Making Tool.	This study has the characteristics of qualitative research and has conducted a comprehensive literature review and examination.	Information obtained as a result of studies conducted within the scope of qualitative research indicates that critical thinking is an essential requirement for individuals to make better decisions, while various decision-making techniques also contribute positively to the quality of an individual's critical thinking. It is crucial for individuals who want to make more successful decisions, both in their personal and professional lives, to improve their critical thinking capacity and benefit from decision-making techniques in making important decisions.	For current and future executives who impact the lives of many people through their decisions, developing critical thinking skills will be an approach that requires determination and commitment as a sign of their respect for their profession.
5	The Philosophy of Critical Thinking in Problem-Based Science Learning	(Verawati & Sarjan, 2023)	This study aims to examine the role of critical thinking philosophy in Problem-Based Learning (PBL) in science education.	This research is a literature review, with relevant information and data sourced from the Scopus and Google Scholar databases.	The literature review findings reveal that science education is not only about content knowledge but also about thinking skills. Critical thinking is considered essential in the 21st century and requires stimulation to develop. One learning model that supports the development of critical thinking is Problem-Based Learning (PBL). The	PBL aligns with philosophical principles that emphasize active engagement and experiential learning, which inherently foster

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					literature review also reveals the philosophical context of critical thinking, the concept of critical thinking, and the philosophy of critical thinking within PBL.	students' critical thinking skills.
6	Thinking more wisely: using the Socratic method to develop critical thinking skills amongst healthcare students	(Ho et al., 2023)	This study aims to train students to develop critical thinking in biochemistry laboratory courses using learning sheets and teacher guidance based on the Socratic method and questions.	This research is semi-experimental research with a case study approach.	The dimensions of clarity and logic were identified as key elements in facilitating the development of critical thinking skills through learning sheets and teacher guidance for students in three different health majors. The results showed that metacognitive monitoring through Socratic questioning learning sheets demonstrated the potential to encourage students to develop critical thinking skills across all dimensions. Another unique contribution	Reconstructive mental review can indirectly shape pre-clinical students' actions in a challenging future, characterized by uncertainty and new circumstances.
7	Literature Review and Bibliometric Mapping Analysis: Philosophy of Science and Technology Education	(Fitria et al., 2023)	The research objective is to conduct a literature review regarding the philosophy of science views on science and technology, especially in the field of Education. Bibliometric analysis was carried out through mapping visualization using VOSviewer	The research method is Systematic Literature Review (SLR). Bibliometric analysis mapping has 4 stages: data search, data processing, data mapping, and data analysis	The results show that research development has decreased from 2018 to 2020 and has increased from 2020 to 2022. Philosophy of science in the field of science and technology has many opportunities in various fields and studies within the scope of science and technology. Issues related to the philosophy of science are still quite widespread, especially for Science, Technology, Engineering, and Math (STEM) students, due to the lack of confidence in STEM students in the philosophy of science.	More researchers associate philosophical research with science than technology.

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					The link strength value of the connection between philosophy and science is stronger when compared to the connection between philosophy and technology. This means that more researchers are linking philosophical research to science than technology	
8	Philosophy of future: analytical overview of interaction between education, science, and artificial intelligence in the context of contemporary challenges	(Storozhyk, 2024)	The purpose of this article is to interpret the future through the interaction between education, science, and AI, and to outline the potential challenges as digital transformation occurs.	A mixed methods approach was applied to answer the research questions. Quantitative and qualitative data were collected through descriptive and empirical surveys.	The findings demonstrate participants' anticipations related to cognitive load theory, constructivist theory, and sociocultural theory. Several challenges threatening innovative development emerge in educational and scientific environments. These challenges include ethical issues, misinformation, the digital divide, uneven infrastructure, lack of regulation, lack of digital skills, resistance to change, technology integration, and limitations of digital pedagogy. Ethics plays a crucial role in shaping digital transformation in education and science. The category of academic virtues is closely related to the ethical and responsible use of AI. The academic virtues paradigm encompasses the ethics of knowledge, collaboration, responsibility, honesty, accuracy, adaptability, and openness.	Research shows that the principles of effective AI implementation in education and science encompass philosophical, educational, and ethical dimensions.
9	The Role of Wisdom in Managerial	(Javadi & Damayanti, 2025)	This research aims to systematically review studies on practical	This study uses meta-analytic methods to	This study provides a comprehensive conceptual model of the role of discretion in management. The findings	Research shows that practical wisdom is crucial

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	Decision-Making: A Systematic Review with a Meta-Analytic Approach		wisdom, wise management, decision-making, leadership, organizational sustainability, and related dimensions.	systematically review studies on practical wisdom, wise management, decision-making, leadership, organizational sustainability, and related dimensions.	demonstrate that managerial discretion influences strategic and ethical decision-making and is key to effective leadership, change management, innovation, and sustainable development.	for effective decision-making, sustainable leadership, and improved organizational performance.
10	Critical Thinking in Health Sciences and How It Pertains to Sonography Education: A Review of the Literature	(Weidman & Salisbury, 2020)	This study aims to analyze critical thinking, an essential skill that sonographers must develop, from educational programs to professional practice.	The Dreyfus Model has been used as a framework to describe the acquired skills that reflect a student's progression from novice to expert physician.	This literature review describes critical thinking skills combined with a framework for understanding the various levels of cognitive thinking and how they can be assessed.	To understand the differences between undergraduate sonography students and experts, the Dreyfus model is an excellent developmental tool.
11	Exploring the role of translators' emotion regulation and critical thinking ability in translation performance	(Cheng, 2022)	This review aims to investigate the role of translation students' critical thinking, as a cognitive psychological construct, and emotion regulation, as a positive psychological construct, in translation performance.	This article uses a literature study approach.	A positive and significant relationship between translation students' critical thinking skills and their translation performance has been verified in the literature. Furthermore, research has revealed that emotion regulation and its regulatory components, such as emotional intelligence, intuition, resilience, and professional expertise, can significantly influence translation performance.	Increasing awareness of the role of critical thinking and emotional regulation in translation studies is necessary for self-development.
12	The neuroscience of morality and social decision-making	(Yoder & Decety, 2018)	This article aims to describe the neuroscience of morality and social decision-making.	The literature study approach was developed in this study	Cognitive neuroscience investigations have begun to uncover distributed neural networks that interact to implement moral judgment and social decision-	Combining neuroscience methods with psychology and

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					making, including systems for reward learning, judgment, mental state understanding, and salience processing. These processes are fundamental to morality, and their underlying neural mechanisms are influenced by individual differences in empathy, concern, and sensitivity to justice. This new knowledge has important implications for legal settings, particularly in understanding how fact-finders reason. Furthermore, recent research demonstrates how disruptions in social decision-making networks facilitate immoral behavior, such as in the case of psychopathy. Combining neuroscience methods with psychology and clinical neuroscience has the potential to improve predictions of recidivism, future dangerousness, and responsiveness to specific forms of rehabilitation.	clinical neuroscience has the potential to improve predictions of recidivism, future dangerousness, and response to certain forms of rehabilitation.
13	Philosophical paradigms as the bases for knowledge management research and practice	(Turyahikayo, 2021)	This paper examines six philosophical paradigms: positivism, interpretivism, postpositivism, pragmatism, postmodernism, and critical realism. These paradigms serve as the foundation for knowledge management research and practice.	The study was carried out with a critical review of the literature	This paper reveals that positivist managers and researchers tend to focus on explicit knowledge, while paying less attention to tacit knowledge. Similarly, interpretivists focus on tacit knowledge, while neglecting explicit knowledge. Even when postpositivist ontology provides useful insights, many managers and researchers may lack the skills to apply these insights to theory and practice. Pragmatism focuses on actions that have	This paper contributes to the understanding and debate on knowledge management research and practice.

No	Journal title	Author	Research purposes	Research methods	Research result	Conclusion
					instrumental value, but there is a tendency to focus on personal values, rather than organizational values. Postmodernism highlights the centrality of power structures and power struggles, all of which tend to influence knowledge management practices. Critical realism prioritizes tacit knowledge as a primary source of competitiveness, but tacit knowledge alone is insufficient.	
14	Advancements in predictive analytics: A philosophical and practical overview	(Oluwatoyin Ajoke Farayola et al., 2024)	The review aims to evaluate the balance between data-driven decision-making and ethical considerations. Predictive analytics has seen tremendous progress, combining philosophical considerations with practical applications to redefine decision-making processes across various industries.	The literature study approach was developed in this study	Philosophically, predictive analytics raises profound questions about determinism, human agency, and the ethical implications of data-driven decision-making. This paper explores the tension between the predictive power of algorithms and the need to preserve individual autonomy, delving into ethical considerations around privacy, bias, and accountability. Practically, this overview navigates the cutting-edge tools and techniques driving predictive analytics. From machine learning algorithms to big data analytics, this abstract examines how these technologies empower organizations to make data-driven predictions, optimize processes, and derive actionable insights.	In practical terms, this overview explores the cutting-edge tools and techniques driving predictive analytics. From machine learning algorithms to big data analytics, this paper examines how these technologies empower organizations to make data-driven predictions, optimize processes, and gain actionable insights.
15	Thinking Styles and Decision	(Phillips et al., 2016)	This meta-analysis aims to examine whether the	This research is a semi-experimental	Research results show that the relationship between thinking styles and	Stronger relationships tend

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	Making: A Meta-Analysis		tendency to use reflective and intuitive thinking styles predicts decision-making performance (normatively correct responses) and decision-making experience.	research with a case study approach.	decision outcomes depends on context. To improve decision-making performance and experience, decision designers and educators must carefully consider individual differences in decision-makers and the nature of the decision-making task.	to occur when the characteristics of the decision-making task or decision-making process align with the theoretical strengths of that thinking style. Similarly, the processes assessed by the specific decision-making task that yield the strongest effects for reflection and intuition are consistent with the processing strengths of the respective thinking styles. For future researchers, assessing the relationship between reflection and decision-making experience could be facilitated by using measures of specific thinking styles.

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16	Components of Soft Skills for University Students in the 21st Century: An Overview of Literature Review	(Mohammed et al., 2023)	The present study aimed to provide a brief description of the "soft skills" needed for 21st-century students as well as a brief literatures review on various aspects of soft skills in graduate employability	In this overview, online databases Medline, ERIC, PyscINFO, EMBASE, Web of Science, Scopus, and Google search engine were searched for peer-reviewed studies on the soft skills elements for workplace success up to December 2022.	The results showed that soft skills consisted of 20 components in two categories: Personal (including self-awareness, self-management, positive attitude, time management, critical thinking, decision-making and problem-solving, strategic thinking, lifelong learning, adaptability and flexibility, creativity, ethics and professionalism, and entrepreneurship skills), and social (including leadership, communication skills, etiquette, negotiation skills, and cultural compatibility, teamwork skills, customer orientation and respect for clients, conflict management, and networking). Soft skills are of critical importance for successful academic and professional performance. Therefore, embedding soft skills into the university curriculum through innovative teaching approaches is necessary to equip students with soft workplace skills	In addition to hard skills, there are soft skills that are crucial to employability. Hard skills aid in acquiring employment, whereas soft skills aid in retaining it. It is critical to integrate soft skills into university curricula to accelerate the progress in the professional performance of young graduates

The synthesis of the 16 reviewed studies reveals three interrelated thematic domains: philosophical foundations of science, critical thinking as a cognitive and ethical competence, and decision-making in educational and technological contexts. First, studies such as Hambali et al. (2024) and Fitria et al. (2023) underscore that the philosophy of science functions as an epistemological and axiological framework that guides scientific inquiry toward coherence, moral integrity, and humanistic values. These works reaffirm that philosophy is not merely theoretical but provides a reflective foundation for ethical reasoning within science and education.

Second, the integration of critical thinking as a philosophical and pedagogical construct appears across multiple studies (e.g., Verawati & Sarjan, 2023; Ho et al., 2023; Turan et al., 2019; Rashid, 2020). These works demonstrate that philosophical approaches particularly Socratic questioning and Problem-Based Learning (PBL) cultivate reflective judgment, metacognition, and ethical awareness. Critical thinking emerges as both a tool and a moral disposition that bridges cognition and ethical decision-making.

Third, several studies (e.g., Bruno, 2024; Storozhyk, 2024; Javadi & Damayanti, 2025; Farayola et al., 2024) highlight the growing urgency of embedding philosophical ethics within technological and managerial decision-making. The findings emphasize that without a philosophical grounding, AI development, data-driven analytics, and managerial discretion risk prioritizing efficiency over humanity and moral responsibility.

Synthesizing these perspectives, the review concludes that the philosophy of science serves a dual function: (1) as a theoretical compass, clarifying how knowledge is constructed and justified; and (2) as a practical ethic, shaping how decisions are made in complex educational and technological landscapes. The integration of ontological, epistemological, and axiological dimensions enables education and science to remain both intellectually rigorous and ethically accountable. Future studies should empirically examine how philosophical frameworkssuch as critical rationalism, constructivism, or virtue ethics can be operationalized in educational settings to strengthen students' critical thinking and ethical reasoning. Moreover, cross-cultural comparisons are needed to understand how diverse philosophical traditions inform moral decision-making in the age of digital transformation and artificial intelligence.

A closer examination of the reviewed studies reveals a methodological convergence toward literature-based approaches, particularly qualitative descriptive analyses and systematic or narrative reviews. The majority of the research such as those by Hambali et al. (2024), Fitria et al. (2023), Verawati & Sarjan (2023), and Turyahikayo (2021) relies heavily on conceptual exploration and theoretical synthesis rather than empirical investigation (Fitria et al., 2023; Hambali et al., 2024; Turyahikayo, 2021; Verawati & Sarjan, 2023). While these studies provide valuable philosophical insights and

conceptual clarity, they also indicate a methodological gap in applying the philosophy of science within real-world educational and decision-making contexts.

To advance this field, future research should diversify its methodological repertoire. For example, mixed-methods approaches can empirically assess how philosophical reasoning influences ethical decision-making and critical thinking in educational settings. Experimental and quasi-experimental designs could test the impact of integrating philosophy of science modules or Socratic dialogue practices on students' cognitive and moral development. Case study and phenomenological approaches may also illuminate how educators, scientists, or managers internalize philosophical principles in their professional practices.

Moreover, bibliometric and scientometric analyses can continue to map the intellectual structure and research trends of this domain, while cross-cultural comparative studies might reveal how different philosophical traditions inform ethical reasoning and scientific inquiry across societies. By expanding beyond literature-based methods, future scholarship can not only deepen theoretical understanding but also demonstrate the transformative potential of the philosophy of science in educational and technological practice.

The findings of this review reveal that research on the role of the philosophy of science in fostering critical thinking and ethical decision-making remains predominantly conceptual, with most studies employing literature-based or theoretical approaches. While such studies contribute valuable philosophical insights, they often lack empirical grounding or interdisciplinary integration. Future research is encouraged to adopt diverse methodologies, such as qualitative case studies, experimental designs in educational settings, or mixed-method approaches, to deepen the understanding of how philosophical principles are practically enacted in decision-making and ethical reasoning processes.

When compared with the broader international discourse, the findings align with the positivist perspectives of Karl Popper, who emphasized falsifiability and the self-correcting nature of scientific inquiry, yet also resonate with Thomas Kuhn's notion of paradigm shifts highlighting that scientific knowledge is contextually and socially situated. The growing discussions on technological ethics in the reviewed studies mirror global debates surrounding AI, data privacy, and human autonomy, underscoring the necessity for ethical reflection to balance innovation with human values.

The implications of these findings are multifaceted. For educators, integrating the philosophy of science into curricula can cultivate reflective and critical learners capable of ethical reasoning in a digital society. Policymakers can utilize philosophical insights to design science and technology policies that are not only effective but also

ethically sound. For scientists, the philosophy of science serves as a moral compass, ensuring that innovation remains aligned with societal well-being.

Nonetheless, this review acknowledges certain limitations. The analyzed studies may be subject to publication bias, as only peer-reviewed sources were included. Moreover, a significant portion of the literature stems from the Indonesian or regional context, which may not fully capture the diversity of global perspectives. Future reviews should therefore expand the dataset to include a broader range of international publications and explore empirical evidence linking philosophy, ethics, and critical thinking in various cultural and disciplinary contexts.

D. Conclusions

This review concludes that the philosophy of science functions as a crucial foundation for cultivating critical, reflective, and ethical reasoning in contemporary society. Through a systematic synthesis of 16 studies, three principal roles emerge: (1) providing epistemological and methodological grounding for scientific inquiry; (2) embedding ethical and humanistic values within educational and technological practices; and (3) fostering critical and reflective thinking as key competencies in the digital and Society 5.0 era. Moreover, the review demonstrates how epistemological, ontological, and axiological perspectives collectively inform responsible scientific practice, ensuring that technological advancement aligns with ethical and human values. Embedding philosophical reflection into education and digital literacy programs is therefore essential to strengthening educators' capacity to nurture students' critical thinking, ethical awareness, and moral accountability. However, given that most existing studies remain conceptual or literature-based, future research should employ more diverse and empirical methods such as classroom-based interventions, comparative analyses, and cross-cultural studies to examine how the philosophy of science can be effectively integrated into educational and technological contexts. Such efforts would enrich global discourse on digital ethics and promote a more human-centered approach to innovation and scientific development.

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