Philosophy of Science and Scientific Ethics as the Foundation of Professionalism for Primary Madrasah Teachers in the Digital Age

Umi Ivayatuz Zulva Nurmala[1], Putri Aulia[2], Waryunah Irmawati[3] and Muhammad Zukhruf Muwafiqi[4,*]

[1,2,3]Universitas Islam Negeri Salatiga, Indonesia
[4] Al Azhar University Cairo, Egypt
* Corresponding author: umiivayatuzzulva@gmail.com
[2]triaulia2022@gmail.com , [3]waryunahirmawati@uinsalatiga.ac.id, [4]mzvicky17@gmail.com

Abstract

Digital transformation has fundamentally reshaped teacher professionalism, requiring capacities that extend beyond technical pedagogy toward epistemological and ethical competencies. This study aims to conceptualize Madrasah Ibtidaiyah (MI) teacher professionalism in the digital era through the integration of philosophy of science, scientific ethics, and digital competence. Using a qualitative descriptive library research design, 23 peer-reviewed journal articles were systematically selected from international open-access databases, with a preference for Scopus-indexed sources. Data were analyzed through thematic and qualitative content analysis. The findings indicate that MI teacher professionalism is a multidimensional construct shaped by four interrelated dimensions: epistemological awareness, scientific and Islamic ethics, digital competence, and structural–systemic conditions. Epistemological understanding enables teachers to critically evaluate digital knowledge and mitigate misinformation, while scientific ethics provide moral integrity and responsibility in digitally mediated pedagogy. Digital competence functions as the enactment of epistemological and ethical orientations in practice, whereas institutional structures determine the sustainability of professional enactment. This study contributes to international scholarship by proposing an integrative, value-oriented framework of teacher professionalism relevant to faith-based and comparative education systems confronting digitalization.

Keywords: Teacher Professionalism; Philosophy of Science; Scientific Ethics; Digital Competence; Madrasah Ibtidaiyah

1. Introduction

Changes in the structural and pedagogical world are being experienced throughout the world, including the educational sector. The rapid transformation of education has resulted in the mixing of the pedagogical and technological elements of education. This transformation has the potential to disrupt the traditional physical classroom teacher-centered practices (Mudhol, 2025). Although the rapid transformation of education in the world has advanced technologically, including countries in the developing world, like

Indonesia, it is experiencing educational reform. Numerous studies conducted globally have shown the positive sides of digital technologies in terms of expanding and diversifying learning opportunities, however, the problem and the challenges they have brought in terms of pedagogy, the professional role and identity of educators, and the ethics of teaching remain (Rodriguez, 2025; Selwyn, 2022; Shah, 2023).

Deft changes in the landscape have caused teachers' roles to be redefined. While some contemporary studies continue to align with the view of teachers as mere transmitters of knowledge, the majority see this role as transforming to facilitators, guides and architects of supportive adaptive learning environments (Caena & Redecker, 2019; Hamida et al., 2025; Muralidhar et al., 2025; Redecker, 2024, 2024; Sadikin, Ali. Hamidah, 2020; Zhang et al., 2024). Such studies suggest the need for teachers to go beyond their pedagogical content knowledge and require them to engage, from in each of their new roles, with the dynamics of digital technologies from epistemological and ethical perspectives. Teachers are expected to be evaluators of the digital content's credibility, navigators of algorithmic biases, and educators of ethical use of technology in learning environments (Nabi et al., 2025; Williamson & Hogan, 2020). This implies that the conceptualisation of teachers' professionalism, in regard to digital age, must appreciate the strong ethical, epistemological and digital technological integration of the knowledge, as opposed to mere digital technological knowledge and skills.

International scholarship highlights a growing understanding of digital professionalism as a set of integrated competencies, including epistemic literacy, ethical understanding, and reflective practice (Caena & Redecker, 2019; Tondeur et al., 2023). Research, including the most recent publications in Scopus and Emerald, indicates the need for teachers to exercise ethical pedagogical decision-making and to be critical assessors of knowledge sources as central to the maintenance of educational quality in digitally saturated contexts (Kimmons et al., 2020; Peters et al., 2019). Nevertheless, most of the literature has centered on general and higher education, with less focus on contexts which are value based, and faith based schooling systems.

Within the context of Madrasah Ibtidaiyah (MI), the challenges of digital transformation are compounded by the unique moral and epistemological dimensions of Islamic education. Philosophy of science and scientific ethics provide critical frameworks for addressing these challenges. The philosophy of science, for example, enables teachers to foster critical understanding, as opposed to passive digital information consumption, by helping them understand the nature, construction, and limitations of knowledge (Qotrunnada et al., 2025; Vinogradov et al., 2020). Conversely, the principles of scientific ethics, which include intellectual honesty, responsibility and integrity, serve to guide pedagogical practice in contexts characterized by the predominance of algorithms, datafication, and information overload (Floridi, 2019; Limongi, 2025).

While globally there is the increasing attention on the ethical and epistemological aspects of teacher professionalism, in the case of Indonesia, empirical studies have overwhelmingly focused on concrete pedagogical and technological integrations, with little attention to philosophy and ethics, treating them as tangential (Limongi, 2025). There is also a lack of studies on the understanding and implementation of philosophy of science and ethics in the context of digital learning by MI teachers. This is a troubling gap, especially in light of the international studies that claim the existence of digitally skilled

teachers who lack epistemological awareness and who may, without intending to, advocate and reinforce misinformation, bias and the instrumentalist dichotomy of learning (Fetmawati et al., 2025; Selwyn et al., 2023).

Thus, the situation calls for a conceptual framework that reconstructs MI teacher professionalism by incorporating epistemological and ethical science along with digital competence in a single professional construct. Filling this void will not only enrich the discourse within the national context of education, but also contribute to the discourse on the international context of teacher professionalism and education on digital ethics and pedagogy with ethics.

This research intends to: (1) analyze the comprehension and application of the principles of the philosophy of science and the digital learning environment by teachers of Madrasah Ibtidaiyah; (2) analyze the position of scientific ethics as a fundamental pillar of professionalism of the teachers in the digital era; and (3) construct a model of the philosophy of science and scientific ethics for the future professionalism of teachers of Madrasah Ibtidaiyah in Islam. Thus, the current study attempts to contribute to the available research on teacher professionalism to an international audience, refine and expand the epistemological and ethical dimensions of Islamic education, and contribute to the formation of educational policies, particularly in the context of the global digital environment.

This research provides three main contributions to the international literature on teacher professionalism. First, it enriches the most influential conversations on digital teacher professionalism by emphasizing epistemological reflection and scientific ethics as central professional virtues and not considering them as peripheral or normative issues. Second, the study provides an enough context - and yet globally relevant - framework by grounding the analysis in Islamic elementary education (*Madrasah Ibtidaiyah*), as most research in this area has focused on secular or higher education. Third, the proposed conceptual model articulates the coherence in the integration of philosophy of science, ethics, and digital competence in the framework of professionalism and provides contemporary insight to value-oriented education systems worldwide that are grappling with digitalisation. This integration enriches the study of comparative teacher professionalism and contributes to the global literature on the intersection of digital education with ethics and epistemology.

2. Methods

A qualitative descriptive library research design has been used to develop a conceptual understanding of professionalism of Madrasah Ibtidaiyah (MI) teachers, grounded in the philosophy of science and scientific ethics (Snyder, 2019). As Snyder (2019) points out, this approach works well for conceptual synthesis and theory building when an articulating explanatory framework (as opposed to an empirical generalisation) is the research goal.The data were collected from 23 peer-reviewed articles that were found through a systematic search of academic databases, such as the Directory of Open Access Journals (DOAJ), Google Scholar, and open access international journals, with a preference for journals that are indexed in the Scopus database. The articles were chosen following systematic and explicit inclusion criteria, which included: (1) being a peer-reviewed article, (2) addressing the concepts of teacher professionalism, educational

epistemology, the ethics of science, or digital competence, (3) making a conceptual and/or empirical contribution in the field of educational research, and (4) being available in full-text. Articles that did not satisfy these criteria were excluded, as were those that were analytically irrelevant.

The chosen articles were subjected to thematic analysis and qualitative content analysis. Inductive thematic analysis was used whereby recurring themes were identified. A thematic framework was developed based on identified themes. A comparative analysis of themes was undertaken in the selected articles to aid in the determination of themes and to reduce bias in interpretation. This comparative analysis assisted in the determination of four dimensions of teacher professionalism in MI: digital competence, epistemological dimensions, and scientific ethics and the structural and systemic dimensions. These four dimensions became the basis of the proposed conceptual framework (Braun & Clarke, 2006; Creswell & Creswell, 2017). Even though there were no human subjects involved in this research, the research involved human subjects, and the principles and ethics of the research were upheld. The academic literature that was used was published ethically, and the proper acknowledgments to the use of other people's work were made to protect the integrity of the work (Guba & Lincoln, 1994).

3. Discussion

From 23 peer reviewed articles, results are obtained in a detailed study. This study is a result from a systematic library research process. The study is aimed to be responsive to three questions: 1. What are the understandings and applications of digital learning and the philosophy of science in the teaching of Madrasah Ibtidaiyah (MI) teachers? 2. How does scientific ethics as a foundation of teacher professionalism in the digital era apply? 3. What is the conceptual model of professionalism of MI teachers in the integration of epistemology, ethics and digital dexterity?". The analysis is directed to the recognition of the concepts, themes and relations to the conclusions of the body of the literature. Each of the articles was analysed to understand the research question that was posed, the conclusions, and the conceptual framing in the study of digital transformation of MI teacher professionalism. A table is generated to give an honest account to the reader of the literature analysis The table gives a concise picture and range of the sample articles prior to the summary of the themes to be presented.

Summary of Literature Analysis

The structured overview in Table 3.1 summarizes the 23 journal articles analyzed in the study. The table includes authorship, titles, research scope, findings, and specific contributions to MI teacher professionalism in the digital era. The table indicates that the literature on teacher professionalism encompasses diverse areas, including pedagogy, epistemology, science and ethics, digital literacy, and the socio-structural system. In almost all the studies, teacher professionalism transcends instructional competencies. Several authors referred to epistemological insight as a critical resource that empowers teachers to discern the truth, especially in digital contexts with unauthenticated and over-abundant information. Some authors referred to the professional moral identity of MI teachers as Islamic science ethics and placed Islamic values and science ethics as the dominant moral factor.

Concurrently, there is a marked shortage of articles discussing the remaining gaps in teachers' digital competence, both from a technical and ethical perspective. While digital literacy and technology integration studies indicate the most MI teachers are yet to fully integrate digital tools into their teaching, some cite the uncritical use of technology as an ethical dilemma. In addition, there is some structural studies where the author identifies workload, lack of professional training, and poor digital infrastructure as the key factors that enable or disable throttling professional realisation of teaching. The evidence presented in Table 1, to some extent, explains that MI teacher professionalism is a function of epistemological knowledge, ethical stance, digital literacy, and systemic factors.

Table 1. Summary of Literature Analysis

No	Authors & Year	Judul Artikel	Focus of Study	Main Findings	Contribution to MI Teacher Professionalism
1	(Masitoh & Purbowati, 2024)	*Enhancing Teacher Professionalism in Indonesia: Challenges and Strategies for Digital Technology Utilisation in the Society 5.0 Era*	Teachers' digital competence	Teachers still lack basic digital literacy	Strengthening digital pedagogy
2	(Rahma Fitria Purwaningsih, 2021)	*Professionalism Teachers From An Islamic Perspective*	Islamic Ethics in the Teaching Profession	Islamic ethics as the foundation of professional identity	Islamic Moral Integrity
3	(Mansir et al., 2023)	*Teachers' Responsibilities in Islamic Education (Relevance of Hamka and Hasan Langgulung Thought)*	Ethics of responsibility	The core moral responsibility of the teaching profession	Strengthening Integrity
4	(Nurdiyanto, Islam & Marjany, 2024)	*Issues of Professionalism and Competence of Islamic Religious Education Teachers in Facing the Society 5.0 Era*	Challenges for digital Islamic education teachers	Low digital literacy	Identification of Competency Gaps
5	(Vinogradov et al., 2020)	*Philosophical Foundations of Education*	Professional philosophy	Reflection on the instruments of professionalism	Epistemological foundations
6	(Farisia & Syafi, 2024)	*Professional Development on Digital Literacy for Teachers in Early Childhood Education in the Digital Era*	Digital literacy model	Digital literacy development model	Digital Competency Development
7	(Zvereva, 2024)	*Ethical Risks in Digital Learning*	Digital ethics	Significant ethical risks	The urgency of digital ethics
8	(Sagala et al., 2024)	*Challenges of character education in the digital age*	Digital character	Teachers as agents of digital character formation	Digital Ethics Integrity

9	(Fitria, 2024)	*The Influence of Workload and Work Discipline on Teacher Performance (Literature Review)*	Teachers' workload	Administration hinders professionalism	Identification of inhibiting factors
10	(Nurwataniah et al., 2022)	*Investigating the Effectiveness of the Teacher Professional Training Programme (PPG) in Improving Teacher Competences*	Effectiveness of PPG	The PPG needs reform	Strengthening basic competencies
11	(Hukubun & Kasimbara, 2024)	*Character Education in the Digital Age: Strategies for Teaching Moral and Ethical Values to a Generation that Grows Up with Technology*	Digital Age Morality	Increasing moral challenges	The Urgency of Moral Values
12	(Peechattu, 2017)	*Reflective Practices: A Means to Teacher Development*	Teacher Reflection	Reflection improves professional quality	Reflective practices
13	(Nurviana et al., 2025)	*Epistemology of Education: Western and Islamic Perspectives*	Epistemology of education	The Importance of Teacher Epistemology	Epistemological foundations
14	(Daulay et al., 2022)	*Integration of Religious Studies and Science in Islamic Education in the Modern Era*	Integration of science and religion	Science and religion are not separate	Strengthening Islamic epistemology
15	(Ardiel et al., 2023)	*Philosophy as a Foundation for Thinking about the Implication of Linguistic Elements in Pedagogical Grammar as a Necessity Teaching EFL*	Philosophy of knowledge	Teachers need scientific thinking	Epistemological construction
16	(Lysette D. Cohen, 2024)	*Integrating Technology in Primary Education: Enhancing Student Engagement in the Digital Age Age*	Technology integration	Teachers have not optimally utilised ICT	Strengthening digital pedagogy
17	(Notariil et al., 2024)	*Digital Ethics and Citizenship Challenges in Cyberspace: An Overview from the Perspective of Morals and Laws*	Digital ethics	Technology requires strong ethics	Strengthening digital ethics
18	(Prawidha & Prasetyo, 2024)	*Concept and implementation of digital citizenship education at State Senior High School 4 in Malang City*	Digital citizenship	Students need to be educated on digital ethics	Strengthening the role of teachers
19	(Zainuri, 2006)	*Level of Pedagogical Competencies of State Islamic Elementary School Teachers in Palembang City*	Pedagogical competencies	Performance is influenced by teaching ability	Strengthening pedagogical competencies

20	(Harahap et al., 2021)	*Teachers' Professional Development and Reinforcement at Integrated Islamic Schools In Indonesia*	Teacher professionalism	Multidimensional professionalism	Framework of professionalism
21	(Bishnu Maya Joshi, 2024)	*Analysing Barriers to ICT Integration in Education: A Systematic Review*	ICT Barriers	Insufficient infrastructure and training	Digital barriers
22	(Zulkifli et al., 2022)	*Application of Moral Values in Islamic Education Teaching and Learning through 21CE Activities*	Islamic values	Islamic values must be integrated	Strengthening professional identity
23	(Diannovianti, 2023)	*Implementation of Blended Learning in Science Subjects During the Covid-19 Pandemic in Madrasah Ibtidaiyah*	Implementation of blended learning	Teachers need digital adaptation	Enhancement of Digital-pedagogical

Findings by Theme

Thematic synthesis of the 23 articles led to the identification of four key findings that respond to the research questions and lay the conceptual framework of MI teacher professionalism in a digital age.

First, the construction of MI teacher professionalism was in part built around the epistemology. The literature indicates that teachers should have a good grasp of what knowledge is and how it is constructed in order to facilitate learning in a digital environment. An understanding of knowledge (or knowledge about knowledge) allows MI teachers to evaluate digital information and its credibility, differentiate knowledge from unsubstantiated claims, and assist learners in cultivating their thinking. Teachers, in this case, are consumers of knowledge, not end-users. The literature on the philosophy of science is clear that teachers without an epistemology end up being passive consumers of information and not reflective teachers who are able to critique, frame, or situate information in context.

Secondly, Islamic values and the science of ethics were considered the pillars of professional integrity. The studies agree that MI teachers have a moral duty that goes beyond teaching because it also involves shaping the character of learners and ethically guiding them. Islamic principles of ethics, such as honesty, trustworthiness, responsibility, and proper behaviour, are consistently cited as part of teacher professionalism. Furthermore, in the context of the digital world, the science of ethics also requires professionalism in contemplating and practicing the truth, using digital tools responsibly, and being mindful of ethical challenges like discrimination, injustice, and the inappropriate use of technology. This finding answers the second objective of the study, as it shows that professionalism in the digital age requires a strong ethical foundation.

In the third place, digital competence has been used to integrate epistemology and ethics in practice. The literature describes digital competence, not only as an operational skill, but as a complex construct which encompasses, epistemic and ethical dimensions. The literature on digital literacy and blended learning shows the meaningful integration of technology in teaching, not only, hinges on the teacher's ability to assess an information

source, but also on the ethical application of it and the educational value of the technology. This shows that digital competence, in this context, illustrates the enactment of epistemological and ethical dimensions in classroom practice.

In the fourth place, the structural and systemic factors were the main determinants of teacher professionalism. In the literature, the institutional factors, such as availability of digital tools, access to professional development opportunities, management of teaching loads, and supportive policies, have been described to either enable or constrain the professional development and growth of teachers. The literature also shows that even teachers with strong epistemological and ethical orientations may lack the ability to enact professional practices if the system is not supportive enough. Adequate systemic support also underlines that teacher professionalism is also an individual asset that is situated and supported within larger organizational and systemic frameworks.

Overall, the findings illustrate the multifaceted nature of MI teacher professionalism, as it is molded through the phenomenal interaction of each of its constituents, being the epistemological foundations, scientific ethics, digital competence, and structural-systemic support. These dimensions collectively fulfill the research aims and substantiate the basis for an integrative conceptual model on MI teacher professionalism. It was established that professionalism is not merely a function of one's technical-pedagogical abilities, but rather a manifestation of an individual's intellectual, moral, and social phenomenon, as well as the technological and the structural-systemic arrangements within which one operates.

4. Discussion

Teacher Professionalism in Islamic Elementary Education

The findings of the study strongly endorse the claim that in the digital age, Madrasah Ibtidaiyah (MI) teacher professionalism is a multidimensional and critically mediated phenomenon. As indicated in the Introduction of the study, the phenomenon extends beyond the technological and pedagogical framework of pedadgogy, and in this regard, the findings attest that epistemological awareness, scientific ethics, digital competence, character, and structural-systemic conditions, function synergistically, and professionally within an established socio-political environment. This phenomenon can best be understood through the critical lens of social theory whereby a synthesis of knowledge, ethics, and action is achieved in a given context.

This dimension of Ennis's (2015) views of critical thinking, as reasonable and reflective thinking, is from an epistemological perspective focused on the rationale for believing or acting in a particular way (Ennis, 2015). The intersections of the philosophy of science and epistemology indicate that professionalism in MI teaching goes beyond the appropriate mastery of knowledge to include the intellectual willingness to interrogate and source, assess, and defend the rationale for the pedagogical choices made. This is particularly the case in Islamic education, in which teachers are expected to balance the transmission of knowledge with the moral and character education of learners. Thus, epistemology, in this case, is not an abstract theoretical construct but provides a framework for responsible teaching, especially in digitally mediated environments.

The results highlighting the fusion of scientific ethics and Islamic paradigms further reiterates the ethics of critical thinking. In Facione's (2015) model of critical thinking, the

presence of truth, integrity, and ethical responsibility as a function of the disposition of critical thinking manifests the ethical paradox, which strengthens the theoretical pillars of Islamic ethics the literature reviewed, focusing on honesty (ṣidq), trust (amānah), and moral accountability (Facione & Gittens, 2015). The findings imply that MI teacher professionalism has an ethical dimension, which is most critical in today's digitally mediated contexts with sophisticated technologies characterized by algorithmic prejudice, misinformation, and the misuse of technology(Floridi, 2019; Simanjuntak et al., 2020; Zvereva, 2024).

Integrating ethics into professionalism accurately reflects Paul and Elder's (2014) perspective that critical thinking encompasses self-regulation and insight regarding assumptions, values, and implications at play. The reviewed literature reveals that teachers with technical digital skills and no ethical awareness may stimulate uncritical information consumption, reinforce superficial learning, or perpetuate ethically problematic practices. This observation helps us understand the international scholarship that critiques the digital education field for its value-neutral and often lacking ethical reasoning, as part of teacher digital professionalism (Selwyn, 2022; Selwyn et al., 2023; Williamson & Hogan, 2020).

The findings identify digital competence as a skill set that operationalizes a nexus of epistemology and ethics. This perspective is consistent with the recent Scopus-indexed literature that frames digital competence as an ethical, social, and technical capability, rather than an instrumental one (Kimmons et al., 2020; Tondeur et al., 2023). The literature reviewed reveals that MI teachers' effectiveness in digital pedagogy is contingent upon their ability to critically assess digital resources, responsibly use, and, most importantly, foster students' responsible use of digital technologies. Without critical thinking, digital competence runs the risk of being simply procedural and lacking in its educational purpose.

Structural and systemic factors further contextualise the enactment of critical professionalism. The framework emphasises the importance of critical thinking, which must be cultivated through explicit instruction and practice in supportive environments (Halpern, 2014). MI teachers' workloads, professional development opportunities, and the infrastructure available to them indicate that institutional conditions strongly determine their ability to engage in reflective and ethical practice. This reinforces the standpoint that teacher professionalism is, in fact, not an individual quality, but rather a socially and organisationally definable practice, influenced by predominant policies, provided leadership, and available resources (Caena & Redecker, 2019; Sachs, 2019).Collectively, these theoretical perspectives offer justification of the inception of a conceptual framework in MI teacher professionalism in which critical thinking is the primary integrative axis. In this framework.

5. Conclusions

This study demonstrates that teacher professionalism in Madrasah Ibtidaiyah cannot be adequately understood through a purely technical or pedagogical lens. Instead, professionalism in the digital era emerges as a critically mediated, multidimensional construct in which epistemological awareness, scientific and Islamic ethics, digital competence, and structural–systemic support interact dynamically. The synthesis of the reviewed literature confirms that epistemology equips teachers with the capacity to

interrogate the nature, credibility, and limitations of digital knowledge, preventing uncritical information consumption and fostering reflective pedagogical judgment.

Furthermore, the integration of scientific ethics—rooted in both universal principles of integrity and Islamic moral values—positions teachers as ethical agents responsible not only for instructional outcomes but also for character formation in digitally saturated environments. Digital competence, in this framework, transcends operational proficiency and functions as the practical articulation of ethical and epistemological commitments in classroom practice. However, the study also underscores that such professionalism cannot be realized in isolation; institutional policies, professional development opportunities, workload management, and technological infrastructure play decisive roles in enabling or constraining reflective and ethical teaching.

By proposing an integrative conceptual model grounded in critical thinking as its central axis, this study contributes theoretically to global discussions on digital teacher professionalism and empirically enriches the relatively underexplored context of Islamic elementary education. The findings offer implications for teacher education, professional development, and policy formulation, particularly for value-based education systems seeking to navigate the ethical and epistemological challenges of digital transformation. Future research is encouraged to empirically validate the proposed framework across diverse educational contexts and explore its applicability in comparative and cross-cultural settings.

6. CRediT Authorship Contribution Statement

Umi Ivayatuz Zulva Nurmala and Putri Aulia: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Project administration, Resources, Validation, Writing – original draft, and Writing – review & editing. Waryunah Irmawati and Muhammad Zukhruf Muwafiqi: Conceptualization, Supervision, Validation, and Writing – review & editing.

7. Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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9. Data Availability

Data will be made available on request.

10. References

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