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An Artificial Intelligence Competency Framework for Teachers and Students: Co-created With Teachers

Research Article

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Abstract: Artificial intelligence (AI), especially generative AI (GenAI), is rapidly permeating every aspect of our lives, driving an accelerated evolution of how we work, play, and learn, thus necessitating new competencies for teachers and students. This study develops and validates an AI competency framework tailored for teachers and students, with an emphasis on researcher-teacher co-creation. The researcher-teacher collaboration highlights the importance of teacher involvement in the design process, ensuring the framework's alignment with real-world educational practices. The framework identifies four key skills: identification of AI mechanisms and their operation; effective and informed use of AI; AI agency: proactive and value-generating utilization of AI; and ethical use of AI, each with specific abilities and components. It also outlines necessary values, attitudes, and knowledge for engaging with AI in education, aiming to prepare teachers and students for an AI-saturated world. This study discusses the need for assessment indicators and assimilation models.

Keywords: *Artificial intelligence (AI); AI competency framework; Researcher-teacher co-creation; Teachers and students; Design-centric research-practice partnerships*

Introduction

The era of AI

The integration of artificial intelligence (AI), particularly generative AI (GenAI), into education systems is reshaping the paradigms of teaching, learning, and assessment. In teaching, AI can assist educators by automating administrative tasks (Zawacki-Richter et al., 2019), providing data-driven insights into student performance (Xie et al., 2019), enabling more focused and effective interventions, and generating lesson plans. For students, AI-driven tools and GenAI platforms offer personalized learning experiences, adapting content and pacing to individual learner needs (Baker & Smith, 2019), supporting knowledge and skill development, and assisting in bridging educational gaps across socioeconomic groups (Chaudhry et al., 2022). AI is revolutionizing assessment by offering real-time feedback (Heffernan & Heffernan, 2014), reducing biases (Zhou & Brown, 2020), and facilitating adaptive testing (Van der Linden & Glas, 2010). However, the use of AI in education also raises concerns about ethics, data privacy, and algorithmic bias (Akter et al., 2021; Patel, 2024). According to Chaudhry et al. (2022), students must be equipped with the awareness and understanding necessary to navigate a world increasingly influenced by AI, focusing on developing competencies for real-world educational scenarios. These scenarios should be co-designed with different stakeholders of AI in education, including teachers, ed-tech experts, and AI practitioners. UNESCO (2019) has emphasized the need to 'dynamically examine and define the roles and skills required of teachers' to work in education environments saturated with AI and recommends that organizations 'take institutional actions to improve AI literacy across all layers of society' (UNESCO, 2019). Therefore, it is imperative to determine the requisite AI competency for teachers and students. Central to this inquiry are the knowledge, skills, values, and attitudes that underpin proficiency in navigating an AI-saturated

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environment. To ensure that this framework is relevant for teachers in their work, they need to be included as full partners in its development.

Hence, this study aims to (1) identify the necessary competencies for teachers and students in an AI-saturated world, including its essential knowledge, skills, values, and attitudes and (2) co-create and validate an AI competency framework for teachers and students with teachers as research partners.

Theoretical Background

A competency is defined as a synergetic combination of skills, knowledge, attitudes, and values that enable individuals to act effectively in various situations (OECD, 2018). The competencies are essential for addressing the multifaceted challenges of the future, aiming to help individuals not only navigate but also positively impact the complex landscape of the future (OECD, 2018, 2019a, 2019b, 2023). This holistic approach underscores the significance of agency, empowering learners to actively shape their educational and life trajectories through goal setting, reflection, and responsible action.

Skills are defined as the ability to carry out processes and use knowledge responsibly to achieve goals. Skills can be categorized into cognitive and meta-cognitive (e.g., critical thinking, creative thinking, learning-to-learn, self-regulation), social and emotional (e.g., empathy, self-efficacy, responsibility, collaboration), and practical and physical (e.g., using new technology to participate in sports activities). The OECD Learning Compass 2030 framework emphasizes the holistic integration of these skills with knowledge, attitudes, and values to meet complex demands (OECD, 2019b, 2023).

Knowledge, including disciplinary, interdisciplinary, epistemic, and procedural knowledge, is crucial for preparing learners to navigate complex and uncertain futures. These types of knowledge form a comprehensive framework for developing competencies that include cognitive skills, attitudes, and values to address challenges innovatively. Attitudes and values play vital roles in guiding individuals' actions toward personal, societal, and environmental well-being. Values are categorized into personal, cultural, social, and global values. Integrating these values emphasizes ethical considerations amidst rapid technological progress and aims to foster inclusive, equitable societies (e.g., respect, fairness, responsibility, integrity, self-awareness) from early education stages (OECD, 2023).

As a member of the OECD organization, the Israeli National Pedagogical Policy (Israeli Ministry of Education, 2021a; 2021b) adopted the OECD Learning Compass 2030 framework. This policy guides the integration of academic excellence with critical life skills such as critical thinking, lifelong learning, emotional intelligence, and social responsibility. The INGC (Israeli National Graduate's Character; Israeli Ministry of Education, 2021b) focuses on the development of graduates who are not only academically proficient but also exhibit a strong moral compass, civic awareness, and the ability to engage effectively with their communities. It defines 13 different literacies needed for graduates of the educational system (e.g., digital, linguistic, and critical thinking literacies). Given that AI is a disruptive technology impacting learning, teaching, assessment, and the educational system as a whole, it necessitates an extensive examination and rethinking of the competencies required of graduates within the education system, including the necessary skills, knowledge, values, and attitudes.

AI competency frameworks

The widespread use of AI in recent years offers transformative changes in education by providing innovative tools and approaches that can enhance teaching, learning, and assessment (Chakravorti, 2022; Gill et al., 2024; Grubaugh & Levitt, 2023). AI is broadly defined as computer systems capable of performing complex cognitive tasks that are typically considered to require 'human' intelligence. These include perception, reasoning, problem-solving, natural language communication, and learning (Russell & Norvig, 2020). Traditional AI systems were predominantly focused on processing large and complex data sets and using restricted rule-based mechanisms to generate responses. GenAI marks a radical shift in its ability to create diverse, complex, and bespoke content, from textual chat responses to software code and movies (Cahane & Shwartz-Altshuler, 2023). This leap is fueled by breakthrough machine learning algorithms trained on unprecedentedly large and diverse data sets. The impact of these new technologies is accentuated by the availability of highly accessible interfaces, making the most powerful technology available to laypersons and even children. The shift from descriptive to creative capabilities has led to the production of original texts, media, and software code, blurring the line between human and machine creativity. This natural interaction with GenAI models promises to deepen abstract thinking and foster the development of complex ideas, revolutionizing human-computer interaction, expanding the demographic of users, and altering public perception of AI's role in society (Cahane & Shwartz-Altshuler, 2023). A comprehensive AI competency framework should include reference to all aspects of the use of AI.

The transformative impact of AI requires the definition of an AI competency framework for teachers and students.

Long and Magerko (2020) defined AI competency as a set of knowledge, skills, values, and attitudes that enable people to critically evaluate AI technologies, manage communication, collaborate effectively with AI, and use it actively in an AI-saturated world. Their framework articulates five core aspects: understanding AI's nature, gauging its capabilities, dissecting its operational mechanisms, AI ethics, and recognizing human interaction with AI. The framework promotes discernment of AI, including recognition, intelligence understanding, interdisciplinary considerations, and distinguishing between general and narrow applications of AI. Furthermore, it challenges learners to evaluate AI's potential and limitations. Operational mechanisms are highlighted through competencies concerning AI's representational systems, decision-making processes, and critical data interpretation and are underscored by the necessity for explainability. The framework contemplates the human dimension of AI, emphasizing the need for programmability, ethical considerations, and the impact of cultural values on the perception and utilization of AI. Intrinsically, the framework insists on ethics as a fundamental competency, thereby interweaving moral contemplation into every facet of AI literacy. This structured yet flexible approach aims to cultivate an informed, critical, and ethically conscious engagement with AI technologies within educational paradigms.

UNESCO has identified 'the emergence of a set of AI literacy skills required for effective human-machine collaboration, without losing sight of the need for foundational skills such as literacy and numeracy' (UNESCO, 2023). In September 2023, UNESCO introduced two evolving AI competency frameworks, grounded in human rights and aimed at protecting human dignity, privacy, and enhancing human activities. These frameworks offer teachers a flexible structure to adapt to various classroom environments. The teacher's framework categorizes 18 essential qualifications for teachers across three levels (acquisition, deepening, and creation) within five thematic areas. For students, the framework outlines essential competencies for engaging with AI in education, emphasizing ethical use, AI methodologies, and design principles. These frameworks were developed through incorporating Member States' insights on AI curriculum implementation, international consultation meetings, and a comprehensive peer review process involving both field experts and UNESCO colleagues; however, they were not developed in collaboration with teachers. Consequently, although these frameworks identify key areas for development in AI competencies for teachers and students, they fall short in detailing specific skill sets, highlighting a gap in addressing the practical implications of AI in education.

Within the landscape of AI Competency Frameworks for Teachers, the UNESCO Framework represents one possible approach. A critical review by Mikeladze et al. (2024) identifies five distinct types of AI competency frameworks—(1) Existing Competence Model-Oriented Frameworks: These frameworks integrate AI competencies into established theoretical models or general reference frameworks, such as the Technological Pedagogical Content Knowledge (TPACK) and UNESCO's ICT Competency Framework for Teachers (ICT CFT). This approach leverages validated structures to embed AI competencies into well-known domains (Mishra & Koehler, 2006; UNESCO, 2018); (2) Competence Areas/Domain-Oriented Frameworks: This category includes frameworks that introduce new thematic areas or knowledge domains specific to AI, providing flexibility and adaptability to incorporate emerging areas in AI education. These frameworks are designed to integrate specific new skills or attitudes necessary for educators to engage effectively with AI technologies (Olari & Romeike, 2021); (3) Process-Driven Frameworks: These frameworks emphasize the dynamics of AI applications in the classroom, focusing on how educational processes can be enhanced or transformed through AI integration. They explore how these processes can be translated into competencies or how AI competencies can address these educational dynamics, often using conceptual models to define the interactions between human educators and AI systems (Holstein et al., 2020); (4) AI Systems-Driven Frameworks: Tailored around specific AI systems or models, these frameworks categorize skills based on operational, user, and utilization competencies necessary for effectively managing and interacting with AI systems within educational settings. This approach is particularly useful for educators who need to understand and operate specific AI tools (Carolus et al., 2023); and (5) Competence Level-Driven Frameworks: Offering a multidimensional approach, these frameworks weave various levels of AI competencies into a comprehensive structure. They address a broad spectrum of AI-related skills, from foundational understanding to advanced application and innovation, often involving tiers or levels of competency development (Sattelmaier & Pawlowski, 2023).

By and large, all of these are variants of idealistic, normative top-down approaches: they stem from expert conceptualizations and not from practitioners' concerns. To our knowledge, none of the suggested frameworks had been developed or validated with teachers as partners. The theoretical background emphasizes that the foundation for an AI competency framework integrates skills, knowledge, attitudes, and values to navigate future challenges in a world saturated with AI, enhancing personal and societal well-being. Due to

the high impact of AI and its transformative power on the educational system (Mikeladze et al., 2024), and as teachers are the main change agents integrating technology and pedagogy (Hurtado-Mazeyra et al., 2022), we assert that any framework aiming for broad adoption must engage teachers as full partners in its design. This research aims to co-create and validate an AI competency framework for teachers and students with teachers as research partners. The main research question is: what is the AI competency framework needed for teachers and students in an AI-saturated era, and what are the skills, knowledge, values, and attitudes that are needed?

Methodology

Context

This research was conducted by the Institute for Applied Research of AI & Education at the R&D Division, Innovation and Technology Administration of Israel's Ministry of Education (MoE) in collaboration with the Pedagogical Secretariat and Administration of Teaching Staff following MoE policy. This research is part of an extended study aiming to identify an AI competency framework for teachers and students and the ways to implement it in the Israeli education system as a whole. In this article, we focus mainly on the consolidated AI competency framework and discuss preliminary findings regarding the implementation practices.

Research participants

The study cohort included 43 teachers and 14 school principals from 14 junior high schools (grades 7–9). At the outset of the 2023–2024 academic year, an open call was circulated widely by the MoE, inviting practitioners proficient in AI to join as research partners. A steering committee, including representatives of key directorates in the MoE was formed. This committee assessed candidates based on predefined criteria published in the MoE call and website. The selection criteria aimed for a balance of the social-geographic location, religious affiliations (Jewish, Arab, Druze, and other minorities), and religious observance levels, drawing on Gonen-Avital (2016) and Rebhun (2023) to justify the sample's composition. Such diversity was not an end in itself but was instrumental in testing the validity and cultural adaptability of the derived competence model. The inclusion of junior high educators reflected UNESCO's guidelines on AI tools in education, which recommend an age threshold of 13 years (Miao & Holmes, 2023).

The teachers were diverse in their teaching subjects, with seven teachers teaching science and five teachers teaching English as a second language. Three teachers each taught Mathematics and Computer Science. Additionally, several teachers held additional positions, such as pedagogical coordinator, and specialized roles in robotics and environmental sciences.

The study was conducted during the 2023–2024 academic year. The interactions with teachers occurred virtually, using Zoom for six plenary meetings and several individual and small group meetings. Throughout the study period, the participants employed AI tools within their educational settings, evaluated and optimized the framework, chronicled their observations in research diaries, engaged in personal interactions with the research team, and maintained continuous dialogue with their peers through a dedicated WhatsApp group.

Research paradigm

This research aims to create a theoretical, conceptualized, and practical AI competency framework that will be adopted by teachers in Israel. We employed a design-centric research-practice partnership (DC-RPP) methodology, combining design-based research (DBR) and RPP methods.

DBR is a systematic but flexible methodology intended to tackle complex, real-world problems and improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings (Anderson & Shattuck, 2012; Collins et al., 2004; Mor & Winters, 2007). In each iteration, educational practices and theories are developed and refined. It is a change-oriented methodology, with a strong emphasis on *how* effective learning and educational innovation can be driven. DBR involves a dual commitment to producing both theoretical and practical products, with researchers deeply involved in the research context, thus eschewing traditional notions of uninvolved researchers and challenging the relevance of dependent and independent variables in such a dynamic setting (Collins et al., 2004; Mor & Winters, 2007).

As teachers are in charge of implementing the framework in their classrooms, their partnership is crucial. To reach these goals, we adopted an RPP paradigm. RPP is a collaborative, mutually beneficial alliance between educational researchers and practitioners (Kali et al., 2018). Coburn and Penuel (2016) emphasized that RPPs focus on mutual engagements, where the work is jointly negotiated, and intentional strategies foster these partnerships through designed roles, routines, and protocols. This paradigm benefits researchers by grounding their work in practical educational challenges and enhances practitioners' implementation strategies in the classroom by providing evidence-based interventions.

In this study, the emphasis on the teachers' participation in the research process and its iterative nature led to the adoption of the DC-RPP method. DC-RPPs represent a collaborative endeavour that bridges the gap between theoretical research and practical application, with a strong emphasis on innovative design methodologies (Kali et al., 2018). These partnerships are characterized by their focus on addressing real-world problems through the lens of design, facilitating a symbiotic relationship where design principles and practices inform research and vice versa. Such collaborations typically involve multidisciplinary teams, including researchers and practitioners, working together to co-create solutions that are both theoretically sound and practically viable. The design-centric approach within RPPs underscores the importance of user-centred design, iterative prototyping, and the use of design thinking as a problem-solving framework (Brown, 2008; Norman, 2013). This process ensured that the AI competency framework was both grounded in theoretical underpinnings and responsive to the practical needs and experiences of teachers in primary education settings.

Research tools

The study adopted a mixed-methods approach, with an emphasis on ethnographic and auto-ethnographic tools, calibrated with automated and semi-automated analysis of surveys, interviews, observations, and content analysis.

Throughout the study, teachers meticulously chronicled their engagement with AI tools and student interactions via research diaries (Amiel & Reeves, 2008). Furthermore, group meetings and individual meetings between researchers and the teachers were conducted, and meeting notes were documented and analysed.

Research diaries

The teachers documented their use of AI tools and engagements with their students via research journals (Amiel & Reeves, 2008). The journals contain teachers' experiences, reflections, and feedback on the evolving framework through the interactions with students, ethical dilemmas that arose, and the use of AI tools during teaching. Analysing the diaries allowed researchers to gain insights from the field, understand the experiments complexity and successes of the teachers, and improve the models. Additionally, these diaries, accessible to all research partners, facilitated a community of practice, enhancing collective learning and knowledge exchange.

Group meetings

The experiment consisted of six plenary sessions conducted via the Zoom platform. Each session lasted approximately 90 min and included the following: synchronization with the experiment's timeline goals and objectives, research review, exposure to various AI tools and topics, collaborative development by teachers using shared documents, teacher practice presentations, feedback discussions on their field experiences, and presentation of an evolving framework. This collective format encouraged sharing of experiences and collaborative learning, enabling participants to visualize and discuss the implications of AI in education.

Individual meetings

The individual meetings with teachers were tailored to address personal experiences, challenges, and to provide a space for focused discussions on the integration and application of AI tools in classroom settings. These one-on-one sessions allowed researchers to offer personalized support and guidance. The individualized approach helped clarify teachers' documented experiences, ensuring that the teachers felt supported and equipped to implement AI technologies effectively in their teaching practices.

The researchers analysed the research diaries and the discussions in the groups and personal meetings through a triangulation of AI and human intelligence. This process included a combination of automated and manual analyses, which allowed for the identification of patterns, trends, and key findings from the documentation. AI tools, such as ChatGPT-4 and Claude 2, aided in mapping and analysing large quantities of data, while human analysis ensured a deep and contextual understanding of the findings. One author performed the manual analysis, while the other author used GenAI tools, and the results were then calibrated and compared. Insights from the analyses were used for developing the competency framework and experiment's outputs. Anonymous quotations extracted from the research diaries and teacher meetings were integrated into the results chapter, providing direct insights from the research partners.

Research process

The experiment followed a structured, multi-phase timeline. At the beginning of the school year, in September 2023, a public call for participation was issued, resulting in the selection of 14 diverse junior high schools, including secular, religious, Arab, Druze, and Haredi institutions, along with their school principals and 43 teachers.

This research amalgamated top-down insights and knowledge derived from the scholarly literature, alongside established frameworks from renowned organizations such as OECD, UNESCO, and the INGC.

Concurrently, it incorporated bottom-up knowledge generated collaboratively with junior high teachers and school principals. This participatory aspect was crucial in shaping the framework and ensuring its applicability and ecological validation within classroom settings.

The experiment officially began in November 2023 with an introductory plenary session, where the objectives and scope of the experiment were outlined and participants were exposed to different AI tools. Over the next six months, from November 2023 to April 2024, six plenary sessions covered various critical topics such as the basics of AI, ethical considerations, AI in education, and practical implementation strategies. These sessions were complemented by individual school meetings where tailored support and guidance were provided to integrate AI in classrooms effectively. Through all research stages, teachers documented their AI-related classroom activities and experiences, which were analysed to develop the first version of the AI competency model. This initial model was further refined after each plenary session based on feedback and additional data analysis. The final phase included concluding sessions where the outcomes and findings were shared, and a comprehensive analysis of the collected data was conducted.

Interviews conducted with school principals and teachers, ahead of the experiment, indicated that the research partners' familiarity with GenAI tools was varied, mostly beginner level. Therefore, the first iteration, began in November 2023, focused on establishing basic skills that will enable research-partners working with GenAI, prompting and generating images. After establishing the basic knowledge about the use of AI and its tools, the research team encouraged the teachers to use GenAI tools in their classroom while documenting their experiences in the research diaries. The research team analysed the data and managed to create the first version of the AI skills framework, which included four skills and different domains for each skill.

The second iteration focused on AI skills. During these meetings, the teachers presented the AI-driven activities they used in their classroom. Afterward, they were introduced to the first version of the AI skills framework that emerged from their research diaries. Throughout the meeting, teachers have used AI tools for three purposes: (1) to map AI skills that were embodied in their first classroom activities, (2) to examine the skills that had not yet been implemented in their classroom following the presented skills framework, and (3) to design a complementary activity to teach AI skills they had not yet implemented. After the second iteration, teachers were asked to implement the AI skills activity they designed and to comment on the first version of the framework. Personal meetings were conducted between teachers and researchers. The analysis included reviewing teachers' comments and suggestions to develop the second version of the framework to encompass and outline the knowledge, attitudes, and values that emerged from the data. After a careful analysis of their second report, focusing on intentionally teaching AI skills, the issue of ethical concerns stood out as teachers were dealing with it when implementing AI in their classrooms.

The third iteration focused on AI ethics and the ways to approach this issue when implementing AI tools in the classroom. After teachers presented their progress, thoughts, and concerns, AI ethical principles and issues were presented, with a focus on the ethical skill as it occurs in the second version of the AI skills framework. The teachers were grouped with other teachers participating in the research and were asked to plan activities aimed at enhancing ethical use in navigating the AI landscape and taking into consideration the requisite skills, knowledge, values, and attitudes essential for students. The teachers were provided with different materials regarding AI ethics, including Israel's MoE guidelines. The teachers were then asked to practice this activity in their classroom and document it in their diaries.

Between the third and fourth iterations, an analysis of the research diaries revealed that initially, teachers concentrated on introducing the broad principles of ethics before specifically addressing the nuances of ethics in AI. Furthermore, the diaries delineated various components constructing the core abilities within ethical skills, identified as the third layer in the skill development hierarchy, leading to the third version of the framework. Subsequent individual meetings between teachers and researchers illuminated the necessity for a step-by-step structure for teachers to fully comprehend and integrate ethical skills. These insights were essential for the skills framework structure. At this point, the research team and the teachers acknowledged that each skill consisted of different core abilities, and each ability had several components. After receiving teachers' feedback, the framework was distilled and consolidated into four skills and different domains: knowledge, values, and attitudes. The teachers also raise the need for a maturity model to improve their work with the students.

Adapting Bloom's taxonomy (Bloom, 1956), which suggests a hierarchical model that classifies different levels of cognitive skills and learning objectives, four levels of assessment were proposed: remember, understand, apply, and create. These levels paved the way to a maturity model and suggested actions that foster the skill. The fourth iteration concentrated on developing a maturity rubric, and the fifth extended the implementation of AI to encompass all school staff. Due to space limitations, the development of maturity rubric and school implementation will be discussed briefly.

Results

Throughout the study, employing DC-RPPs with teachers, the experiences of the teachers were documented in research diaries, group meetings, and individual meetings. These records were analysed using AI and human intelligence. The outcomes of this study suggest an AI competency framework for teachers and students, encompassing components of skills, knowledge, attitudes, and values. Table 1 summarizes the identified skills, knowledge, attitudes, and values of the AI competency framework for teachers and students and their domains.

Consolidated AI competency framework

Skills

This section summarizes the top level of the skill elements of the competency framework. Four distinct skills were identified: identification of AI mechanisms and their operation; effective and informed use of AI; AI agency: proactive and value-generating utilization of AI; and ethical use of AI.

Identification of AI mechanisms and their operation

> *'Both teachers and students need to understand the concept of "human rights". They also need to understand that AI is not a human figure but a machine, and they need to understand how it works' (Teacher G).*

Identifying AI mechanisms is a crucial skill for both teachers and students, as it lays the foundational knowledge required to navigate and critically engage with AI applications in various contexts. By grasping AI mechanisms, individuals can better assess the capabilities, limitations, and ethical implications of AI tools and systems, leading to more informed decisions and innovative solutions in educational settings and beyond. This skill is fundamental for comprehending the pervasive influence of AI in modern life and its potential for future advances. This skill lays the foundation for the intelligent and safe use of new technology and comprehending its impacts on our lives. The skill involves understanding the principles behind AI algorithms, the dynamics of machine learning, and addressing the challenges and opportunities they bring. This skill comprises three domains: principles of AI operation, advantages and disadvantages of AI technology, and AI applications in daily life.

Effective and informed use of AI

> *'In a world saturated with AI, the topic of research must be an integral part of the learning process. With or without me, they would have used one of the tools I suggested to them. Therefore, it was important for me to expose them to the tools I know, to experiment with them, and to understand the advantages and disadvantages of each tool. It was important to me that each student choose, based on their judgment and thinking, which tool is right for them to continue the process, and it's possible that at different stages they will choose a different tool'. (Teacher M)*

The skill of effective and informed use of AI tools fosters the utilization of AI instruments and enhances the understanding of their capabilities and limitations through the application of critical thinking. This skill involves the ability to manage interactions with AI tools, formulate prompts according to user needs, consider the risks associated with the use of these tools, and integrate various tools into comprehensive solutions. This skill encompasses three domains: prompt formulation; recognition, operation, and mapping of AI tools; and critical thinking and evaluation in the use of AI tools.

AI agency: proactive and value-generating utilization of AI

> *'I taught how to refine prompts, from Arabic to Hebrew, to create images – it was exciting. I saw wonderful results there. It's not just images but also spoken text through an AI site to something written. They explained that you can do this and turn it into a contribution to society, to help blind people. These ideas came from the students; I guided and learned through them.' (Teacher AL)*

Agency refers to the proactive and intentional use of AI, ensuring that its deployment aligns with ethical considerations, promotes equity, and enhances human capabilities without supplanting them. This approach requires a critical understanding of AI's potential and limitations, fostering an environment where AI is used as a tool for empowerment rather than being a means of passive consumption. This skill emphasizes the importance of entrepreneurial and creative use of AI tools to develop new solutions and create added value, which constitutes a significant advantage in the modern world. It highlights the human ability to harness the positive potential of AI technologies for problem-solving and impact creation, leading to positive changes in individuals' lives and their surroundings. This skill underscores the importance of understanding the interface between humans and machines, utilizing reflective and metacognitive mechanisms to evaluate the process and the outcomes produced in collaboration with AI. This skill is composed of three

Table 1. The identified skills, knowledge, attitudes, and values of the AI competency framework for teachers and students and their domains

Skill	Domains
Identification of AI mechanisms and their operation	• Principles of AI operation • Advantages and disadvantages of AI • AI applications in daily life
Effective and informed use of AI	• Prompt formulation • Recognition, operation, mapping of AI tools • Critical thinking and evaluation in AI tool usage
AI agency: proactive and value-generating utilization of AI	• Problem-solving using AI • Human-machine interface • Metacognition and reflection in AI use
Ethical use of AI	• Ethical values and principles • Ethical dilemmas • Ethical biases • Responsible use of AI
Knowledge	
Disciplinary knowledge	• Foundational definitions and concepts in AI • Types of AI technologies • AI functionality and thinking • Types of AI (predictive and generative) • Familiarity with AI tools and platforms including their features, advantages, limitations, potentials, and ethical considerations
Interdisciplinary knowledge	• Interfaces between AI and various content areas and professions, • Applications and connections between AI implementation and learning theories, • Methods for integrating AI tools into teaching and assessment. • Responsible use of AI
Epistemic knowledge	• Understanding the creation of knowledge of AI • Usage modes and impacts of AI technologies • AI's 'thinking' process • AI effects on human cognition (interaction, critical thinking, information reliability, and creation) • Ensuring data security
Procedural knowledge	• AI workflows • Required inputs for desired outputs • Training methods • Data interpretation • Problem-solving using AI tools • Responsibly and ethically sensitive use of AI
Attitudes	• Believing in AI's abilities and efficacy • Adopting or avoiding AI • Enjoyment or fear when using AI • Fostering AI technology • Curiosity • Openness for integrating AI in classroom • Collaboration with AI-skilled students
Values	• Personal values: innovation, independence, responsibility, and ethical conduct • Cultural values: adapting curricula and AI use to local culture and local school community • Social values: transparency and trustworthiness in AI interactions, fairness, collaboration, creating new value • Global values: upholding human dignity and freedom, maintaining privacy, respecting human diversity, and integrating graduates into the global landscape

AI, artificial intelligence.

areas: problem-solving using AI; human-machine interface; and metacognition and reflection.

Ethical use of AI

> *'Today more than ever, they need to be aware of the advantages and disadvantages of using these tools, know how to use them correctly, be critical towards them, and identify mistakes and biases in the information they are exposed to. Additionally, they need to know how to connect information to various sources, and produce outcomes that combine independent thinking and creativity.' (Teacher M)*

This skill aims to assist learners in navigating situations that require ethical and moral functioning in a world saturated with AI. The skill focuses on the need to integrate ethical and moral considerations, such as fairness, privacy, morality, and responsible decision-making when using and developing AI tools. Ethical functioning in the AI domain includes understanding, addressing, and managing potential biases in AI systems, striving to reduce inequality, promoting fundamental

human values, enhancing social welfare, and preventing harm. This skill also considers the long-term impacts of AI usage, such as the loss of human skills, discrimination, or manipulation of perception, and emphasizes the learner's responsibility to mitigate these effects. The skill encompasses four areas: values and ethical principles, ethical dilemmas, AI biases, and responsible use of AI.

Knowledge

> *'The most important thing is critical thinking and not taking for granted what the bot wrote, even if the answer seems logical to the students, you should teach them to examine the essence of the answer.' (Teacher H)*

Knowledge is defined as a mental network linking facts, concepts, ideas, and processes. It includes theoretical aspects of the world and practical understanding derived from task performance. Various types of knowledge have been identified, such as disciplinary, interdisciplinary, epistemic, and procedural (OECD, 2023). In this study, the knowledge component of AI competence was identified as encompassing the following:

- *Disciplinary knowledge*: Foundational definitions and concepts in AI, types of AI technologies, AI functionality and thinking, types of AI (predictive and generative), and familiarity with AI tools and platforms, including their features, advantages, limitations, potentials, and ethical considerations.
- *Interdisciplinary knowledge*: Interfaces between AI and various content areas and professions, applications and connections between AI implementation and learning theories, and methods for integrating AI tools into teaching and assessment and responsible use of AI.
- *Epistemic knowledge*: Understanding the creation of knowledge, such as the development of AI knowledge, usage modes and impacts of AI technologies, AI's 'thinking' process, and its effects on human cognition during and after interaction. It includes critical thinking, information reliability, and creating new value with AI, as well as ensuring student data security.
- *Procedural knowledge*: Knowing how to perform tasks, including AI workflows, required inputs for desired outputs, training methods, data interpretation, problem-solving using AI tools, and responsibly and ethically sensitive use of AI.

Attitudes and values

> *'My need was to enhance the digital citizenship of learners, to help them understand what ethical conduct is when using AI, to apply critical thinking and successfully identify ethical problems, and to think about possible solutions for them in order to create awareness.' (Teacher T)*

Attitudes are mental states, principles, and stances based on values and beliefs that influence human behaviour. They reflect a tendency to respond positively or negatively towards an object, situation, or idea and can change depending on context and circumstances (OECD, 2019b). These behaviours can manifest in various activities, such as using technological tools, emotional responses like enjoyment, avoidance, or anger, and cognitive behaviours like believing in AI's ability to aid teaching and learning processes. In this study, we have identified attitudes of adopting or avoiding AI for teaching, learning, and assessment; emotional behaviours such as enjoyment or fear when using AI; and cognitive aspects such as curiosity and believing in AI's efficacy to enhance learning processes. Additionally, attitudes of fostering openness, dialogue, and collaboration with students skilled in AI tools emerged, challenging the traditional hierarchical knowledge approach where educational staff hold exclusive authority.

Values are guiding principles and ideals that underpin people's beliefs and decision-making. Values identified in this study included personal values such as innovation, independence, responsibility, and ethical conduct. Cultural values: Adapting curricula and AI use to local culture and local school community. Social values: Transparency and trustworthiness in AI interactions, fairness, collaboration, creating new value. Global values: Upholding human dignity and freedom, maintaining privacy, respecting human diversity, and integrating graduates into the global landscape.

Discussion

This research aimed to identify and validate the essential competency of teachers and students in an AI-saturated world, encompassing crucial knowledge, skills, values, and attitudes. As this research was designed to create a theoretical, conceptualized, and practical AI competency framework to be adopted by teachers in Israel's MoE, teachers' partnership was essential for the co-created framework. In this section, we introduce and compare the proposed AI competency framework to alternative frameworks, elaborating on its unified nature for both teachers and students, as well as its evolving nature. In addition, we discuss assessment criteria for AI competency, the skills' maturity model, and assimilation models for schools.

Employing DC-RPPs, the research team worked with junior high school teachers as research partners and identified four distinct skills (i.e., identification of AI mechanisms and their operation; effective and informed use of AI; AI agency: proactive and value-generating utilization of AI; and ethical use of AI). The team defined the knowledge types pertaining to AI competencies—including disciplinary, interdisciplinary, epistemic, and procedural—covering foundational concepts, interfaces with other disciplines, creation of knowledge, and practical task execution within the AI field. To complete the competence framework, the team identified target attitudes and values. These describe mental states and guiding principles based on beliefs, which influence human behaviour towards AI in education. They include covering emotional, cognitive, and behavioural responses, aligning AI use with personal, cultural, social, and global values to foster openness, trust, and ethical conduct in educational settings.

Comparing the proposed AI competency framework to alternatives

While existing frameworks share some common elements with our approach, there are significant differences in both development methodology and resulting structure. UNESCO's framework (2023), for example, was developed through expert consultations and policy analysis, without direct classroom implementation or teacher co-creation. Similarly, the frameworks developed by Olari and Romeike (2021) and Holstein et al. (2020) emerged primarily from theoretical analysis and expert input rather than practitioner collaboration. This top-down development approach, while valuable, may not fully address the practical needs of classroom teachers.

Our framework's categories and sub-categories, shaped by direct teacher involvement, reflect a more practice-oriented approach. First, while other frameworks typically separate teacher and student competencies, our unified approach acknowledges the concurrent learning journey of both groups in the AI era. This theme is elaborated below. Second, our framework uniquely emphasizes AI agency: proactive and value-generating utilization of AI as a distinct skill category, moving beyond the typical focus on technical operation and understanding found in existing frameworks. The sub-categories within each skill domain were directly informed by classroom implementation, resulting in more button-up practically oriented components.

The impact of teacher collaboration on our framework's structure is particularly evident in two key areas. First, the inclusion of 'Metacognition and Reflection in AI Use' as core components within the AI agency skill domain emerged directly from teachers' experiences, as exemplified by one teacher's observation: 'The most important thing is critical thinking and not taking for granted what the bot wrote, even if the answer seems logical to the students' (Teacher H). Second, the 'Ethical use of AI' category and its sub-components were directly shaped by teachers' experiences with ethical dilemmas in classroom settings, rather than being solely derived from theoretical principles. Most frameworks refer to the ethical dimension, but their primary focus is on technical competencies or broad ethical guidelines. Our framework explicitly recognizes these practical dimensions of AI integration, reflecting teachers' real-world experiences and needs.

The role of AI competency within the Israeli National Pedagogical Policy (Israeli Ministry of Education, 2021a; 2021b) and INGC (Israeli Ministry of Education, 2021b) is fundamental. The purpose of INGC framework is to shape the character of the Israeli graduate and ensure their readiness for the ever-changing world. The INGC outlines 13 distinct literacies and skills. However, given AI's unique characteristics and pervasive impact, it is recommended to shift the approach: from perceiving technology as a tool to recognizing the existence of an innovative relationship between users and socially significant technology (Mishra & Oster, 2023; Shamir & Levin, 2022). This technology development requires reevaluating the evolving learning framework to include AI competence as the 14th competency, aiding in the formation of a clear, regulated, and integrated pedagogical policy.

The erosion of traditional boundaries between teachers and students in the era of AI integration

As opposed to the different frameworks that differentiate between teachers and students, we argue that a unified AI competency framework for both teachers and students is more appropriate. In this initial stage of AI and GenAI penetration into education systems, we are all teachers and students simultaneously. Despite its seemingly dizzying pace, it is being studied concurrently by both teachers and students. Therefore, this framework is initially designed for learners of all ages and roles. As was observed by the teachers who participated in the research, the same fundamentals of AI literacy and ethics should be common to all users. During the experimental phase process, the conventional hierarchical teacher-student role distinctions become vague as both are beginning at the same place, building their knowledge and skills together. This scenario has the potential to foster the sharing of knowledge and understanding (Mercer et al., 2020) and encourage collaborative thinking in teaching and learning dynamics.

However, teachers and students can use the framework differently. For teachers, the framework emphasizes advanced modules on curriculum integration, pedagogical strategies, and ethical decision-making in AI applications, reflecting their role in managing classroom dynamics and adapting teaching methods (Su et al., 2022). Conversely, for students, the focus is on understanding AI principles, ethical usage, and practical interactions with AI tools, fostering critical thinking and responsible use (Miao & Holmes, 2023). This dual approach ensures that while the framework serves a common purpose of promoting AI competence, it respects and addresses the distinct educational and developmental needs of each group (Kali et al., 2018).

Adapting competency to the evolving AI landscape

The model presented in this manuscript is dynamic and will evolve alongside advances in AI tools and their applications. This perspective aligns with the assertions of scholars such as Russell and Norvig (2020), who emphasize the rapid evolution of AI technologies and the consequent shifts in required competencies for effective utilization. The advancement of AI necessitates a continuous reassessment of the competency required to navigate the AI landscape and cultivate a flexible and forward-looking model (Bostrom, 2014). As AI tools continue to evolve, the necessity for updating policy and regulation becomes crucial. This approach ensures that the model remains relevant and effective in cultivating the requisite competency for engaging with AI technologies, both in their current state and as they evolve in the future.

Assessment indicators and maturity model

As teachers implemented the outlined model in their classrooms, the need for a self-evaluation skill model for teachers and students became clear. Throughout the study period, teachers were invited to participate in creating an assessment rubric to evaluate their students' AI proficiency level. The rubric defined the skills expected from junior high students at various levels, drawing from Bloom's taxonomy (Bloom, 1956). Due to space limitations, a detailed elaboration is not provided in the manuscript.

School assimilation model

The development of a framework for AI competency for teachers and students represents a significant step toward integrating AI into educational environments. However, the value of this framework is contingent upon its active utilization by teachers and students in their daily educational activities, including learning, teaching, and assessment (Zheng et al., 2020). To ensure the effective integration of the AI competency framework, it is imperative to devise a school assimilation model. This model would serve as an organizational tool, helping schools adopt and comprehensively validate the framework. The assimilation model should be designed to support schools in navigating the complexities of implementing AI-driven educational strategies, thereby fostering an environment conducive to the practical application of AI competencies in real-world educational scenarios (Wang, 2019). The formation of these assimilation models is still in progress; as such, they are not included in this manuscript. However, they represent a significant milestone toward implementing the framework for AI competency. The models are crafted with adaptability in mind, enabling them to be tailored to align with each educational institution's distinct cultural attributes. This customization is vital, as it recognizes the diversity of school cultures and emphasizes the necessity of a context-specific approach to implementing AI competencies in educational settings (Hall & Hord, 2015; Zhao & Frank, 2003).

Limitations and future work

The ongoing study presented here aims to define an AI competency framework for teachers and students. AI competency is a novel evolving field, as GenAI itself is rapidly changing. The changes that could take place in the coming years must be examined. Moreover, competency consists of a combination of skills, knowledge, values, and attitudes. At this stage of the research, we were able to detail a model of the core abilities and dimensions of the four skills that were identified; however, the definitions of values, attitudes, and knowledge are still in the process of creation. Future work should present a full model that includes all four components and the connections between them. At the next stage of the research, sharing the findings with other stakeholders (e.g., government agencies, and local, national, and international education authorities) and collaborating with them will be essential. Additional work needs to be done to elaborate the model specifically for particular age groups and communities with unique characteristics, and to fine tune the corresponding assessment rubrics.

Conclusions

This article presents an AI competency framework that addresses the multifaceted dimensions of AI integration in education. The researchers' and teachers' co-creation process not only enriched the development of the framework but also ensured its practical applicability and relevance. As AI continues to evolve and its role

in education expands, the framework's adaptability and emphasis on ethical considerations will remain crucial for preparing educators and students to navigate the complexities of an AI-integrated learning environment.

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During the Preparation of this Work

The authors used ChatGPT-4 and Claude 3 to analyse the research materials and to revise parts of the work. After using these tools, the authors reviewed and edited the content as needed and took full responsibility for the content of the publication.

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