

Curriculum Innovation in Informatics and Computing Education: A Systematic Review of AI Integration, Educational Models, and Graduate Competencies

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Abstract - Artificial intelligence (AI) is revolutionizing informatics and computing education and raising the stakes for both curriculum innovation and workforce-centric competency development. However, existing research is dispersed across curriculum innovation, education models, and graduate competency viewpoints. To this end, this paper systematically reviews the current body of evidence regarding AI-influenced informatics and computing curriculum innovation. Twenty-six open access journal papers published between 2021 and 2026 were identified by a search of the Scopus database and included based on PRISMA 2020 guidelines; data were analyzed through thematic synthesis. The results show five dominant approaches to curriculum transformation; these include: AI-integrated modules, curriculum overhaul, competency-centric curriculum innovation, inter-disciplinary infusion and curriculum transformed by AI enriched learning environments. Project-based learning, inquiry-based learning, experience-based learning, competency-based education, and AI facilitated teaching and learning support effective integration. Additionally, the five crucial competence areas that future graduates in the AI-centric age need to possess are, knowledge about AI systems (AI literacy); mastery in coding, system design and deployment (technical expertise); problem solving approaches; interpersonal skills, team working skills and communication (professional skills); ethical application of AI tools. Based on the synthesized information, we present a model to facilitate AI- Responsive Curriculum to be designed through the confluence of AI tools, innovation curriculum, pedagogical models, competence development, and workforce preparedness. This conceptualization provides a basis for current information education reforms and readiness of graduates for careers in AI-driven workplaces.

Keywords - Artificial Intelligence, Curriculum Innovation, Informatics Education, Educational Models, Graduate Competencies.

I. INTRODUCTION

Artificial intelligence (AI) is playing an increasingly important role in designing, delivering, and continuously improving informatics and computing education. Recent advances in machine learning, large language models (LLMs) and other intelligent technologies have accelerated the attempts to modernize computer curriculum, learning environments and instructional processes in higher education institutions [16, 18, 24]. Technological innovations are changing the material given in computer programs, how knowledge is communicated, tested and applied in authentic learning environments. In

response to these changes, educational institutions are increasingly embedding AI-related knowledge, skills and applications into existing curriculum to prepare graduates for technology-driven professional environments defined by rapid innovation and digital transformation [25]. In addition, the increasing focus on AI and machine learning skills across educational disciplines underscores the importance of AI literacy as a foundational competency to empower future graduates to interact with, assess, and effectively utilize intelligent technologies throughout their academic and professional paths.

Traditionally, informatics and computing courses have concentrated on programming, algorithms, software development, database systems, and computer architecture as the core subject areas of the science. However, the broad uptake of AI technology has dramatically increased the set of skills demanded from graduates entering today's workplaces [24]. Apart from technical knowledge, educational institutions are increasingly called upon to address the larger human characteristics of technological transformation such as uncertainty, adaptation, resilience and the reaction of learners to fast changing technological environments [11]. Recent research highlights the increasing necessity of AI literacy,

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digital skills, computational thinking and problem-solving skills to prepare students to handle new technological challenges and complicated real-world situations [4], [25]. [5], [6]. Moreover, AI-related competencies are widely regarded as an essential part of the professional preparation of computing and information technology disciplines in response to the evolving demands of employers and industry stakeholders.

In response to these developing problems, higher education institutions have embraced numerous curriculum innovation projects aiming at integrating educational programs with technological and workforce advancements. AI principles and applications have been incorporated into the current courses in machine learning, neural networks, cloud computing, cybersecurity, and informatics education [16], [23], [24] through curriculum reform efforts. These programs aim to ensure that students gain relevant information and practical skills and do not necessarily require comprehensive curriculum redesign. Also, many research have shown that the specific curriculum models have been developed to match the educational outcomes with fast-changing technological developments and industry demands [2], [8]. Other curriculum frameworks have been proposed to meet rising educational concerns such as sustainability, digital transformation, and interdisciplinary computing education, reflecting the increasingly complex and interrelated structure of current technological ecosystems [9], [12].

Besides the work on transforming the curriculum, academics have also been investigating various educational models and pedagogical approaches targeted at promoting the development of abilities relevant to AI. Project-based and practice-oriented learning methodologies have been widely adopted in computing education to enhance students' technical expertise, while at the same time improve professional skills such as communication, cooperation and problem-solving [10], [23]. Pedagogies that are inquiry-based and oriented towards critical thinking have also been shown to be useful in increasing students' deeper conceptual comprehension, analytical reasoning and independent learning capabilities [7], [22]. More recently, advances in educational technology have led to the development of AI-driven learning environments and interactive digital learning platforms that foster active student participation, personalized learning experience, and authentic engagement with real-world issues [16], [18], [26]. These trends signify that pedagogical innovation is becoming a more and more significant aspect of curriculum modernization in the AI era.

A further important trend is growing emphasis on competency-based education in educating students for changing workforce needs. The literature describes competency frameworks for computer science, AI education, healthcare informatics and cyber-security programmes, whereby graduates of the discipline should acquire the relevant knowledge, competencies and attitudes required to succeed in contemporary practice [2,5,6,15]. These frameworks often emphasize not only the technical competencies, but also the interpersonal competencies like communication, critical thinking, professional integrity, teamwork and lifelong learning skills [7, 15, 25]. This implies that curricula innovation must move beyond simply imparting technical knowledge, and should focus more extensively on wider competencies, which support graduates in navigating through

our rapidly evolving technological, organizational, and social landscapes.

Research into AI integration and curriculum building is rising, although the literature remains scattered across diverse educational settings, disciplinary domains and teaching methodologies. Some of the studies are principally concerned with curriculum reform and curriculum design projects [2], [8], [12], some others investigate educational technology [16], [18], [26], pedagogical approaches [7], [10], [23] or competency development frameworks [5], [15], [25]. Consequently, there is little synthesis of how AI integration, educational models, and graduate competence frameworks jointly inform curricular innovation in informatics and computer education. Such fragmentation also prevents the possibility of gaining a holistic understanding of the interconnections between technological changes, curricular transformation, educational practices, and competency development for workforce purposes.

This study systematically reviews recently conducted curriculum innovation research within informatics/computing to fill these research gaps. In particular, this literature review includes work concerning how AI technology is implemented in the process of the curriculum reforms and the models or frames of graduate competence applied to designing the educational and program reforms aiming to orient learners toward preparing for the future AI-enabled professions. By synthesizing data from multiple contemporary sources, this review aims to build a deeper knowledge of both current emerging curriculum innovations and possible future developments. The review is conducted based on the following research questions:

RQ1: How are AI technologies being integrated into curriculum innovation and transformation strategies in informatics and computing education?

RQ2: What educational models and graduate competency frameworks are proposed to prepare learners for the demands of the AI-driven workforce in informatics and computing fields?

II. METHODS

The present paper employs a Systematic Literature Review (SLR) to collect information about curriculum innovation in the field of informatics and computing education, notably with the integration of Artificial Intelligence, educational models, and skill development of graduate capabilities. The assessment was conducted in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines to promote transparency, rigor, and reproducibility of the review process.

The Scopus database was used to conduct a literature search on 24 June 2026. Scopus was selected for its broad coverage of high quality peer-reviewed papers in computer science, information technology, educational technology and higher education. The search strategy was developed according to the research questions and the aim of the investigation.

The following search query was applied to the Title, Abstract, and Keywords fields:

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TITLE-ABS-KEY ( ("informatics education"
OR "computer science education" OR
"computing education") AND (curriculum OR
curricula OR "curriculum development" OR
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"curriculum design") AND ("higher education" OR university OR undergraduate OR "tertiary education"))

The first search yielded 1,583 documents. To increase relevance and fit the aims of the study, the search results were filtered to the following: publications indexed in the period 2021 to 2026, document type “Article”, source type “Journal”, language “English” and “All Open Access”. These filters resulted in 77 articles for further screening.

The screening technique was carried out using pre-defined inclusion and exclusion criteria (Table 1). The studies were selected due to their relevance to informatics and computing education, curriculum innovation, AI integration, educational paradigms, and graduate competency development. We excluded publications that were only about technical aspects of AI research without any pedagogical implications, articles that were outside the scope of higher education, and articles that were not peer-reviewed journal articles.

Table 1
Inclusion and Exclusion Criteria

Code	Criterion	Description
IC1	Informatics and Computing Education	Studies focusing on informatics, computer science, computing, information technology, or related higher education programs.
IC2	Curriculum Innovation	Studies discussing curriculum innovation, curriculum transformation, curriculum development, curriculum redesign, or curriculum reform.
IC3	AI and Emerging Technologies	Studies addressing artificial intelligence, machine learning, generative AI, large language models (LLMs), or other emerging digital technologies in educational contexts.
IC4	Educational Models	Studies examining pedagogical approaches, learning models, instructional strategies, teaching innovations, or educational practices.
IC5	Graduate Competencies	Studies reporting competency frameworks, graduate attributes, learning outcomes, workforce readiness, employability skills, or professional competencies.
EC1	Non-Higher Education Context	Studies focusing primarily on K–12 education, secondary education, or non-tertiary educational settings.
EC2	Non-Educational Focus	Studies focusing exclusively on technical system development, algorithms, software engineering, or AI applications without educational implications.
EC3	Insufficient Curriculum Relevance	Studies lacking substantial discussion of curriculum innovation, educational models, or competency development.
EC4	Non-Article Publications	Conference papers, book chapters, editorials, notes, reviews, dissertations, and other non-journal publications.
EC5	Non-English or Non-Open Access	Publications not written in English or not available through Open Access.

Titles and abstracts were screened and 31 papers were retrieved for full-text review. Each article was thoroughly examined against the criteria stated in Table 1 to assess its relevance to the research problems. At the eligibility screening step, five publications were excluded because of insufficient evidence on curricular innovation, educational models, or graduate competence frameworks. This resulted in 26 papers

that met all eligibility criteria for inclusion in the final qualitative synthesis.

To enable systematic analysis of the selected research, a structured data extraction process was created. Information was gathered across multiple dimensions, including curriculum transformation techniques, approaches to AI integration, educational models, competence frameworks, core competencies for AI, professional competencies, implementation obstacles, and primary results. The retrieved information was structured into a review matrix for cross-study comparison.

Thematic synthesis was used to analyse the collected data. Similar concepts and findings were used to derive higher order themes and categories to detect recurrent patterns within the literature. The synthesis was performed based on the study questions. The first step was concerned with the identification of the ways in which AI technologies are embedded in curriculum innovation and transformation strategies in informatics and computing education. The second stage was dedicated to the educational models and frameworks for graduate competencies developed to equip learners for AI-driven professional situations. The emerging topics were synthesized to produce an integrated view of the curriculum innovation in informatics and computing education.

The total procedure of study selection was performed in four stages recommended by PRISMA 2020: identification, screening, eligibility evaluation and inclusion. The whole process of research selection is illustrated in the PRISMA flow diagram.

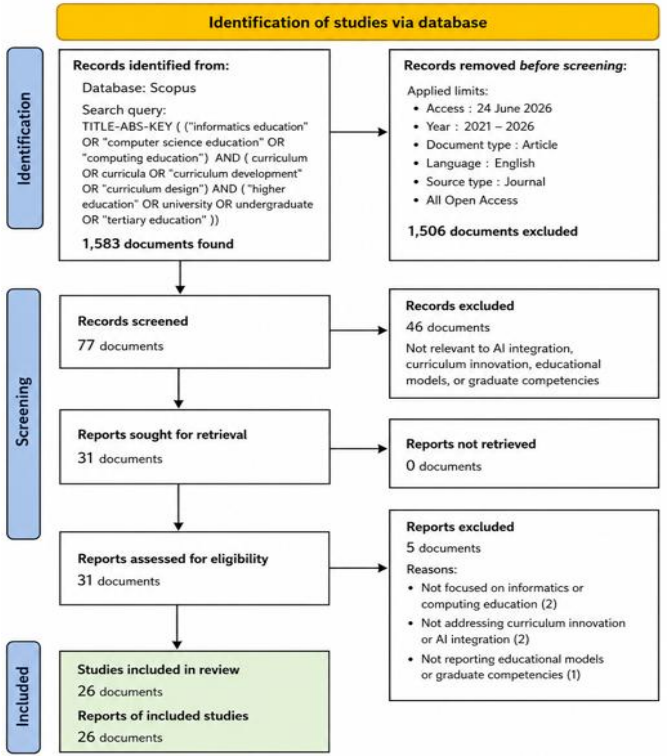


Figure 1. PRISMA 2020 Flow Diagram of Study Selection Process

As illustrated in Figure 1, the initial search yielded 1,583 records from the Scopus database. After applying the predefined filtering criteria, 77 articles remained for screening. A total of 31 articles were selected for full-text review, and 26

studies met all eligibility criteria and were included in the final qualitative synthesis. The PRISMA process ensured a systematic and transparent selection of studies relevant to curriculum innovation, AI integration, educational models, and graduate competencies in informatics and computing education.

III. RESULTS AND DISCUSSION

A. Study Selection and Characteristics

PRISMA 2020 flow diagram of the study selection procedure A preliminary search in the Scopus database returned 1,583 results. We applied specified filters, such as publication year (2021-2026), document type (Article), source type (Journal), language (English) and Open Access status, leaving 77 items. The title and abstract screening resulted in 31 papers for full-text assessment. Five articles were excluded after eligibility assessment based on the inclusion and exclusion criteria provided in Table 2. Thus, 26 studies were included in the final qualitative synthesis.

The chosen cases represent a diversity of educational situations in the field of informatics and computing education. Literature encompasses computer science education, computing education, information technology education, cybersecurity education, cloud computing education, and health informatics education. The bulk of the papers were published in the years 2024-2026, suggesting a growing interest in curriculum innovation and AI-related educational transformation.

Table 2 Summarizes the General Characteristics of the Included Studies		
Category	Subcategory	Frequency
Publication Year	2021	1
	2022	2
	2023	2
	2024	10
	2025	10
	2026	1
Educational Domain	Computer Science / Computing Education	11
	Informatics Education	5
	Health Informatics Education	5
	Cybersecurity Education	2
	Cloud Computing Education	1
	Interdisciplinary Computing Education	2
Main Focus	Curriculum Innovation / Curriculum Development	8
	Educational Models / Pedagogical Approaches	7
	Competency Frameworks	5
	AI Integration in Education	4
	Graduate Competencies / Workforce Readiness	2
Research Context	Undergraduate Education	17
	Higher Education (General)	7
	Teacher / Faculty Development	2

The highest number of publications occurred between 2024 and 2025, accounting for more than three-quarters of the total literature (Table 2). This tendency is a clear evidence of the growing effect of generative AI, large language models and AI-powered technology on curriculum design and educational practice. The results also reveal that curriculum innovation is not only in the traditional computer science degrees, but also in health informatics, cybersecurity, cloud computing, and transdisciplinary computing education.

The most popular research subjects are curriculum innovation and educational models, but also competency frameworks and AI integration projects. This distribution indicates that current research has shifted from the development of AI technologies to the knowledge of how curricula, pedagogic methodologies, and competency development need to be changed to prepare graduates for AI-driven work scenarios.

B. AI Integration in Curriculum Innovation

The literature presented above clearly reflects AI as a significant influencer on curriculum development across informatics and computer education disciplines. Instead of incorporating new technologies into existing classrooms, institutions are rapidly altering their curricula, objectives, and student learning experiences to align with ongoing technological advances and workplace demands. Based on the abovementioned literature review, we have proposed five curriculum development options: integration of an AI module, redesigning curriculum, competency-based curriculum development, transdisciplinary curriculum development, and creation of an AI-enabled learning environment. Table 3 summarizes the synthesis of AI integration and curricular reform methodologies identified in the analyzed studies.

Table 3 AI Integration and Curriculum Transformation Strategies		
Strategy	Description	Representative Studies
AI Module Integration	AI-related topics are embedded into existing computing courses without major curriculum restructuring.	[16], [18], [24], [26]
Curriculum Redesign	Existing curricula are redesigned to incorporate AI competencies as core learning outcomes.	[2], [8], [12], [24]
Competency-Based Curriculum Innovation	Curriculum structures are organized around AI-related competencies and workforce requirements.	[2], [5], [6], [15]
Interdisciplinary Integration	AI concepts are integrated with sustainability, ethics, healthcare, business, and other disciplinary domains.	[9], [12], [20]
AI-Enhanced Learning Environments	AI technologies are incorporated into learning activities through intelligent tools, LLMs, and interactive educational platforms.	[16], [18], [21], [26]

The most popular strategy was the inclusion of AI modules. Research has shown certain ways to incorporate ideas from AI into existing courses, without completely revamping the curriculum. In computer science courses, neural network education was integrated with classical computing to expose students to new AI techniques [24]. Similarly, the education of

cloud computing is increasingly embracing AI-related content and intelligent learning resources to support the growing technological competencies [16]. For example, the use of large language models in teaching machine learning is a good illustration of how AI may be introduced into existing teaching frameworks to improve the learning experience of the students [18].

The second major strategy is curriculum revision. However, curriculum reform includes larger modifications to program structures and learning objectives than modular integration. Research on curriculum of cybersecurity and informatics proposed new models of curriculum that treat AI competencies as essential graduate outcomes rather than extra skills [2]. Nursing informatics and health informatics schools have also made curriculum adjustments to match the rising role of AI and digital technologies in healthcare practice [8], [20]. These initiatives are part of a larger movement to better educate graduates for technology-rich professional environments.

The literature shows an increasing trend in the competency-based approach in the innovation of curriculum. Numerous authors highlighted the need to drive curriculum development with well-defined competency outcomes instead of disciplines content [5], [6]. Many competency frameworks contain an increased share of the skills on AI literacy, data and decision making, computational thinking and digital problem solving as a set of the expected graduate attributes [15]. This indicates a shifting trend away from content-based teaching in academia towards an outcome-oriented, competency-based teaching for workforce preparedness [6].

Another major concern was the cross-disciplinary approach of this field. The domain of Artificial Intelligence is indeed not just a computer science course. A great number of different professional fields nowadays employ Artificial Intelligence [3], [9]. Research on sustainability, Healthcare Informatics or the digital transition already demonstrated that students must be provided with computer skills as well as with skills in a specific field, and in the societal sphere [9], [20]. Curricular reform on teaching AI then tried to foster students' participation in activities where the Artificial Intelligence became more transdisciplinary.

Last but not least, curriculum innovation in the field of AI-enabled learning environments. Various papers in the present study mentioned artificial intelligent pedagogical tools, such as intelligent textbook, AI teaching-aid tools, or Large Language Model that could be applied into the process of learning and teaching [16], [18], [26]. Intelligent systems help the students and teacher to achieve personalization and gain some practical knowledge through the use of these intelligent.

The findings reveals that innovation of the curriculum in informatics and computing education is more than the addition of AI-related topics. Curriculum architecture, competence goals, and learning environments are being increasingly customized by institutions to prepare graduates for AI-powered industries. The evidence suggests a movement toward more flexible, competency-based, multidisciplinary curriculum that can respond to rapid technological change.

C. Educational Models for AI-Era Informatics Education

In addition to curriculum change, the educational models are emphasized as important to assist the development of AI-related competences in the examined research. Curriculum

innovation is not an end in itself unless it is complemented by pedagogical approaches that can support the development of higher order thinking, practical problem solving and adaptable learning skills. The synthesis identified five prevailing educational approaches that characterize contemporary informatics and computing education in the AI era: project-based learning, inquiry-based learning, experiential learning, competency-based education, and AI-supported learning. Table 4 summarizes the educational models identified in the reviewed studies.

Table 4
Educational Models in AI-Era Informatics Education

Educational Model	Characteristics	Representative Studies
Project-Based Learning (PBL)	Students develop solutions to authentic problems through projects and collaborative activities.	[1], [10], [16], [23], [24]
Inquiry-Based Learning (IBL)	Learning is driven by questioning, investigation, exploration, and critical reflection.	[7], [13], [14], [22]
Experiential Learning	Learning occurs through practical activities, experimentation, and real-world applications.	[1], [10], [16], [23]
Competency-Based Education (CBE)	Learning outcomes are structured around measurable competencies and professional skills.	[2], [5], [6], [15]
AI-Supported Learning	AI technologies, LLMs, and intelligent learning tools are integrated into the learning process.	[16], [18], [26]

Project-Based Learning (PBL) was the most frequently cited educational paradigm. Research in coding education, cybersecurity education, and cloud computing education has showed that project-based activities allow learners to apply theoretical knowledge to real and challenging issues [10], [16], [23]. Project-based learning teaches students technical skills, as well as teamwork, communication and problem-solving skills that are highly sought after in the workplace. The increased integration of AI technologies into project activities also enables learners to experience real-world human-AI collaboration [24].

Another major pedagogical approach is Inquiry-Based Learning (IBL). Inquiry-based learning emphasizes the investigation of computer concepts, the formulation of questions, evaluation of evidence, and construction of understanding by the students themselves [7], rather than procedural knowledge. Inquiry-based approaches are known in computer science education to foster critical thinking and conceptual comprehension, which is more relevant in contexts where AI systems can create information and answers automatically [22]. Therefore, students need to learn not only to use AI technologies but also to critically assess their outputs.

Another significant part of learning, during this age of AI, includes experiential education in the form of learning through doing. There has been an abundance of work done that demonstrate the learning through good interaction with today's real technology, industry specialists, and real work. [10] [23]. This notion of real, as opposed to simulation-using real-world context; enabling the students to "learn from what you learn in the classroom in order to apply these to solve real industry challenges in the real industry" has shown effective in

providing students with the necessary domain-specific skills for roles in, for example, cloud computing, cyber security or artificial intelligence based technologies.

Another important development is the implementation of Competency-Based Education (CBE). Competency-based models, on the other hand, are based on observable learning outcomes and professional competencies, instead of traditional content-centered approaches [2], [6]. Research in informatics, cybersecurity, and health informatics education indicates that competency-based curricula offer a more direct connection between educational goals and workforce expectations [5], [15]. This provides schools the flexibility to respond more effectively to technological change in the substance of their curriculum, but retaining a strong focus on graduate preparedness.

AI enabled learning environments are also suggested by the explored literature, with large language models (LLMs), intelligent education technology, text books, with interactive format and AI driven educational systems, are extensively employed for instructional and learning process [16], [18], [26]. They offer individual level of learning, rapid feedbacks and enriched learners’ participation. Whereas a cautionary observation could be made over- dependence of AI output and emphasizes more human reasoning ability, human intellect as well as academic integrity [18].

In summary, the findings imply that no single educational model is sufficient to fulfill the different learning needs of informatics education in the AI era. Instead real curriculum implementation seems to be a mix of project-based, inquiry-based, experiential, competency-based and AI enabled learning techniques. This mix helps students to acquire technical skills and simultaneously strengthens critical thinking, teamwork, adaptability and professional skills required in AI-powered workplaces.

D. Graduate Competency Frameworks

One of the main findings from the literature reviewed relates to the competences required of graduates entering professional settings driven by AI. The widespread adoption of AI in computing-related professions has increased the area of graduate competencies beyond classical programming and technical skills. Five competency domains emerged recurrently in the examined studies: AI literacy, technical capabilities, computational thinking, professional competencies and ethical competencies. Table 5 presents a synthesis of the major competency domains identified across the reviewed studies.

Table 5
Graduate Competency Frameworks for AI-Era Informatics Education

Competency Domain	Core Components	Representative Studies
AI Literacy	Understanding AI concepts, capabilities, limitations, applications, and societal impacts	[16], [18], [24], [25]
Technical Competencies	Programming, machine learning, neural networks, data analytics, cloud computing, cybersecurity	[2], [16], [23], [24]

Computational Thinking	Problem decomposition, abstraction, algorithmic thinking, problem-solving	[4], [7], [19], [22]
Professional Competencies	Communication, teamwork, adaptability, creativity, lifelong learning	[5], [15], [25]
Ethical Competencies	Responsible AI, ethical reasoning, digital responsibility, societal awareness	[3], [9], [20]

AI literacy was the most discussed competency domain. The evaluated papers unanimously underline that future graduates should have a basic knowledge of AI technology including their capabilities, limits, practical applications and societal repercussions [16], [18]. As generative AI and huge language models become more popular, AI literacy is no longer a niche skill for AI workers but a core competency [24]. In addition, AI literacy equips graduates to critically appraise AI-generated outputs and make educated judgments regarding the application of intelligent technology in the workplace [25].

Technical competencies continue to be a basic part of preparing students for graduate work. In support of AI-enabled applications, competence in programming, machine learning, neural networks, data analytics, cloud computing and cybersecurity have been highlighted as important in several studies [2], [23], [24]. However, the evidence indicates a progressive transition from tool-specific knowledge toward broader technological understanding that enables graduates to adapt to developing technology environments [16]. This statistic is indicative of the high rate of technology development and the necessity for graduates who can acquire new technical abilities throughout their careers.

Computational thinking remains a fundamental capability inside the computing curriculum. Important aspects of computer science and computing education include abstraction, decomposition, algorithmic reasoning, and structured problem solution [4], [7]. While AI technologies are progressively automating basic computing processes, computational thinking is still necessary to analyze, evaluate and improve AI-assisted solutions [22]. Thus, AI is not considered as a substitute of computational thinking but as a technology that allows the application of computational thinking in situations of complicated problem solving.

The literature studied also shows the increasing importance of professional abilities. Communication, teamwork, adaptability, creativity and lifelong learning are often cited as key skills for graduates entering AI-driven companies [5], [15]. Modern computer projects require technical and non-technical stakeholders to work collaboratively and graduates need to communicate successfully across professional barriers [25]. Moreover, the ever-changing nature of AI technology requires ongoing learning and adaptability for long-term career success.

Similarly, another emerging area is the ethical competences. Based on a number of pieces of research it can be asserted that students have knowledge about the ethic of impact of AI technologies on people. Students also have the ability to develop AI technology and its implementation in responsible manner [3]. Ethics includes knowledge of fairness, responsibility, transparency, privacy and on the societal impact of AI system [20]. Similar, new multicultural approaches and multidisciplinary frameworks for designing curriculum

recommend to embed ethic reasoning into the computer engineering education.

This synthesis illustrates how the practice of informing education can be enhanced by increasingly holistic competence frameworks being enacted in the AI-age. The present ones are expanding from solely technical knowledge domains towards a more encompassing development of technical, cognitive, professional and ethical competencies. This is the necessary reaction to the wider realization that the application in the modern workplaces based on AI implies. Graduates must now only build as well as use the smart applications, yet in order to be part of sophisticated workgroups as well they need to take critical position towards their consequences.

AI literacy was found to be an enabling competency that connected the other competency domains. For example, the results confirmed that while technical skills created and used AI solutions, computing thinking made analytical solution development easier, professional competencies enhanced the skills of working together, flexibility was a hallmark of a successful professional when complemented with ethics. Together these domains created a whole picture competency that enabled graduates to face a world shaped by the challenges and opportunities that AI posed.

E. Proposed AI-Responsive Curriculum Framework

The synthesis analysis of research indicates that the link between technology change, curricular transformation, educational paradigm, and development of graduate competency impacts curriculum innovation in informatics and computing education. Previous literature has considered these factors in isolation, but this review integrates them into an integrated conceptual framework, called the AI-Responsive Curriculum Framework.

The method considers artificial intelligence as the key driver of the modification of the curriculum. The rapid adoption of AI technology, including machine learning, generative AI, large language models, and intelligent systems, introduces new competency needs that educational institutions must meet through curriculum innovation [16], [18], [24]. Thus curriculum transformation is more a planned response to change in technology than a routine updating of the curriculum.

The second component of the framework is curriculum innovation strategies. The review identified five major approaches, namely incorporation of AI modules, curriculum restructuring, competency-based curriculum innovation, multidisciplinary integration, and AI-enhanced learning environments. These solutions provide the structural means to integrate AI related competencies into the educational curricula [2], [8], [16].

The third component is the educational models that operationalize the application of the curriculum. The most prominent methods in the reviewed literature include project-based learning, inquiry-based learning, experiential learning, competency-based education and AI-supported learning [7], [10], [16], [23]. These pedagogical models are didactic tools that promote the learning and practice of AI-related abilities.

The fourth element is development of graduate competencies. The review identified five main competency areas: AI literacy, technical competencies, computational thinking, professional competencies and ethical competencies. This mix of these abilities is the knowledge, skills and

attributes needed for effective involvement in AI-driven professional environments [5], [15], [25].

The last part of the framework is workforce readiness. The research repeatedly points out that the curricular innovation should ultimately help to the training of graduates who can act effectively in contexts characterized by rapid technological change, interdisciplinary collaboration and responsible use of AI [2], [6], [20]. Thus, the end goal of the curriculum innovation process is workforce preparedness.

The proposed AI-Responsive Curriculum Framework is illustrated conceptually as follows:

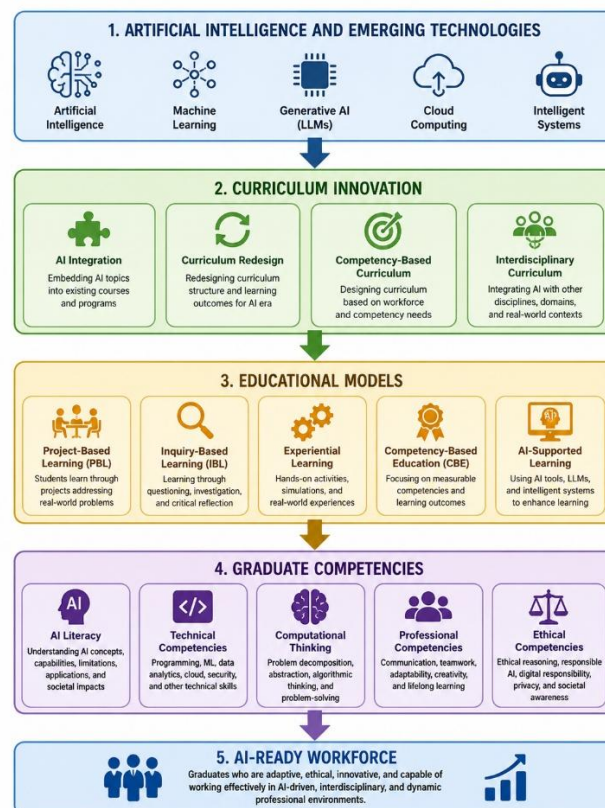


Figure 2. AI-Responsive Curriculum Framework for Informatics and Computing Education

This holistic framework emphasizes the necessity of coherence between these various elements to design and deliver an AI curriculum responding to emergent contexts effectively. Rationale: The impetus for curriculum change comes from tools and services the AI resources offers; The innovativeness in design forms the conceptual structure of the curriculum; A wide array of learning modes enables learners to gain competence in the learning and outcomes are driven by Graduate profile competencies, this interaction produces AI ready graduates workforce.

The framework provides a useful reference for curriculum developers, policy makers and educators aiming to improve the way they approach informatics/computing curriculum reform. The framework argues against transforming the curricula by simply teaching standalone courses on AI and suggests a holistic approach to achieve the following through appropriate curriculum design, curriculum development, pedagogical practices, competencies and the demand for the workforce to ensure our graduates remain relevant and able to compete.

IV. CONCLUSION

Through this systematic literature review we searched curricular innovation in the field of informatics and computer education concerning the integration of artificial intelligence (AI), curriculum delivery and curriculum to prepare graduate students. Based on 26 articles that went under a systematic review and thematic analysis we concluded that AI represents a remarkable force in shaping curriculum innovations in higher education, such as: incorporating artificial intelligence into existing university curricula by either integrating specific artificial intelligence modules, redeveloping of current programs, focusing on innovative competencies with the aim of reforming curricula, cross- disciplinary curriculum designing, development of environments for artificial intelligence supported teaching learning. Therefore we concluded that this not only leads to introduce some topics on artificial intelligence into programs but it is about reforming entire structures in and on a university curriculum.

In addition, the literature suggests that AI oriented curriculum can be effectively executed with several pedagogical approaches: PBL (Project-Based Learning), IBL (Inquiry-Based Learning), EL (Experiential Learning), CBE (Competency-Based Education) and AL (AI-supported Learning). With these approaches, students have opportunities to develop their technical as well as higher-order competencies in their authentic and collaboration with technology enhanced learning experiences. Additionally, the literature shows common5 key areas for competencies for graduates in the AI era, namely AI literacy, technical skills, computational thinking, professional competencies and ethical competences, which together establish a sound foundation for students in their success in the future world.

The practical contribution of this study is to suggest a curriculum, a learning strategy framework for AI-inclusive Informatics and Computer Education The framework defines and structures elements from AI-enabled Technologies and their implementation in education, learning strategies and approaches, graduate competencies development and readiness to enter workforce into an overall framework of study. The central idea is that successful future readiness, and utilization of the opportunities and challenges introduced by AI, depend on the curriculum structure, the learning processes and strategies and their' effectiveness in developing the necessary graduate competency.

The outcome of this literature study can provide the necessary guidance and knowledge base for those curriculum writers, teachers and academic leaders/policy makers wishing to revamp computing education. Further studies would build on this paper and explore innovative ways of developing computing curricula in other disciplines, analyse and assess AI-inclusive learning programmes as practice, and investigate new skills sets that will be required in AI driven professions of the future.

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