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Investigating the Integration of Artificial Intelligence (AI) Concepts and Applications in Primary School Computer Science Curricula in Kuwait: A Descriptive-Analytical Study

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Abstract

The study aimed to identify the extent to which the concepts and applications of artificial intelligence (AI) are integrated into the primary school computer science curricula (i.e., fourth and fifth grades) in the State of Kuwait. This research adopted a quantitative descriptive methodology, specifically utilizing content analysis technique. The researcher prepared a content analysis card after referring to educational literature and relevant previous studies. The study tool, in its final form—after verifying its validity and reliability—consisted of 35 phrases (measurement indicators) distributed over five main comprehensive domains that focus on the fundamental dimensions of AI, namely: data analysis and structuring, AI applications, AI programming, physical computing, and machine learning and deep learning. The idea/topic was adopted as the unit of analysis due to its suitability for the nature of the study and its objectives. The study sample was carefully selected to include four computer science textbooks catering to fourth and fifth graders in primary education for the 2023/2024 school year. The study was effectively implemented in the first and second semesters/terms of the 2023/2024 school year. The current study's findings reveal a conspicuous absence of AI topics, concepts, and applications within the computer science curricula for the primary stage in the State of Kuwait. Indeed, the results indicated that the inclusion/integration rate was 0.00% in all domains or dimensions of the content analysis card, without exception. This indicates that the four student textbooks for the fourth and fifth grades computer science curriculum do not contain any AI concepts or applications whatsoever. The study concluded with some recommendations, including: (1) Integrate AI concepts, applications, and ethics seamlessly into all computer science textbooks; (2) Update textbooks across all subjects to reflect modern technology, including AI's definition, uses, and ethical implications; (3) Develop interactive digital/electronic content leveraging AI technologies; (4) Equip faculty with AI knowledge, ethics, and practical applications to foster an informed generation; (5) Train teachers and administrators to effectively integrate AI into teaching and learning; and (6) Provide resources and support for AI integration in teaching and learning.

Keywords*:* artificial intelligence, AI, AI concepts, AI applications, AI ethics, AI integration/inclusion into curricula, computer science curricula, primary/elementary school/stage, PreK-12 education, general education, State of Kuwait.

المستخلص

هدفت الدراسة إلى تحديد مدى تضمين مفاهيم وتطبيقات الذكاء الاصطناعيّ في مناهج مادة الحاسوب (عالمنا الرقمي) للمرحلة الابتدائية (أي الصفّين الرابع والخامس) في دولة الكويت. وقد تبنَّت هذه الدراسة منهجية البحث الكميّ الوصفيّ، وباستخدام أسلوب "تحليل المحتوى" تحديدًا. قام الباحث بإعداد بطاقة تحليل محتوى بعد الرجوع إلى الأدبيات التربوية والدراسات السابقة ذات الصلة. وتكوَّنت أداة الدراسة في صورتها النهائية - بعد التحقّق من صدقها وثباتها - من 35 عبارة (مؤشّرات قياس) مُوَزَّعة على خمسة مجالات رئيسية شاملة تُركِّز على الأبعاد الأساسية للذكاء الاصطناعيّ، وهي: تحليل البيانات وهيكلتها، وتطبيقات الذكاء الاصطناعيّ، وبرمجة الذكاء الاصطناعيّ، والحوسبة المادية، والتعلّم الآلي والتعلّم العميق. وقد تمَّ اعتماد "الفكرة/الموضوع" كوحدة للتحليل نظرًا لملاءمتها لطبيعة الدراسة وأهدافها. وتمَّ اختيار عيّنة الدراسة بعناية لتشمل أربعة كتب مدرسية لمادة الحاسوب تخدم طلاب الصفّين الرابع والخامس في التعليم الابتدائي للعام الدراسي 2024/2023م. وقد تمَّ تطبيق الدراسة بفعاليّة في الفصلين الدراسيَّيْن الأول والثاني من العام الدراسي 2024/2023م. وكشفت نتائج الدراسة الحالية عن غياب ملحوظ لموضوعات ومفاهيم وتطبيقات الذكاء الاصطناعيّ في مناهج مادة الحاسوب للمرحلة الابتدائية في دولة الكويت. وبالفعل، أشارت النتائج إلى أنَّ معدَّل التضمين/الإدماج كان 0.00% في جميع مجالات أو أبعاد بطاقة تحليل المحتوى، دون استثناء. ويُشير هذا إلى أنَّ الكتب المدرسية الأربعة لمنهج مادة الحاسوب للصفّين الرابع والخامس لا تتضمَّن أي مفاهيم أو تطبيقات للذكاء الاصطناعيّ على الإطلاق. واختتمت الدراسة ببعض التوصيات، بما في ذلك: (1) دمج مفاهيم وتطبيقات وأخلاقيات الذكاء الاصطناعيّ بسلاسة في جميع كتب مادة الحاسوب؛ (2) تحديث الكتب المدرسية في جميع المواد لتعكس التكنولوجيا الحديثة، بما في ذلك تعريف الذكاء الاصطناعيّ واستخداماته وآثاره الأخلاقية؛ (3) تطوير محتوى رقمي/إلكتروني تفاعلي يستفيد من تقنيات الذكاء الاصطناعيّ؛ (4) تزويد أعضاء هيئة التدريس بالوعي والمعرفة بالذكاء الاصطناعيّ وأخلاقياته وتطبيقاته العملية لتعزيز جيل مُطَّلِع؛ (5) تدريب المعلّمين والإداريّين على دمج الذكاء الاصطناعيّ بشكل فعّال في التدريس والتعلّم؛ و(6) توفير الموارد والدعم لدمج الذكاء الاصطناعيّ في التدريس والتعلّم.

الكلمات المفتاحيَّة. الذكاء الاصطناعيّ (AI)، مفاهيم الذكاء الاصطناعيّ، تطبيقات الذكاء الاصطناعيّ، أخلاقيات الذكاء الاصطناعيّ، دمج/تضمين الذكاء الاصطناعيّ في المناهج الدراسية، مناهج الحاسوب، المرحلة الابتدائية، التعليم ما قبل الجامعي (من رياض الأطفال وحتى الصف الثاني عشر)، التعليم العام، دولة الكويت.

Contribution to the Littérature

- Existing research offers limited insight into the extent to which AI concepts, applications, and ethical considerations are integrated into PreK-12 and higher education curricula. Analyzing the integration of AI concepts, applications, and ethics within school textbooks, particularly computer science curricula, across all educational levels is crucial for shaping the future of education.
- The absence of Kuwaiti-specific research on this topic raises concerns about future graduates' preparedness with the knowledge, skills, and competencies necessary for success in the Fourth Industrial Revolution.
- This study investigates the integration of AI concepts, applications, and ethics within computer science curricula in Kuwait's general education system.
- This study reveals a conspicuous absence of AI topics, concepts, and applications in Kuwait's primary school computer science curriculum.
- Based on these findings, it is strongly recommended that immediate action be taken to address the significant gap in the integration of emerging AI topics, concepts, and applications within school curricula. This is crucial to equip learners with the necessary knowledge, skills, competencies, and abilities to succeed in an increasingly AI-driven world.

Introduction

The world is witnessing a tremendous and comprehensive knowledge revolution in all fields, known as the Fourth Industrial Revolution (i.e., the era of cyber physical systems), which aims to bring about change in all aspects of human life and works to change the pattern of machines and things, and patterns of thinking that rely heavily on artificial intelligence (AI). Today the world is moving towards harnessing this tremendous information revolution and employing it scientifically and economically by utilizing AI technology and its various applications in all aspects of life. One such area that has greatly benefited from the advancement of AI is the field of education (Abdulsalam, 2021; Al Darayseh, 2023; Alshidi & Alsaidi, 2022; Carlos et al., 2018; Safar, 2024a, 2024b). AI has become one of the most important key technological developments for international competition and a significant driver of social and economic development, as governments have worked to include it in economic plans (Alfayez et al., 2021; Alsaidi et al., 2023; Bin Ibrahim, 2021; Mu, 2019; Zhang et al., 2023).

The Significance of AI

AI is a crucial branch of computer science and one of the fundamental pillars of the current technology industry. It enables the design and development of computer programs that mimic human intelligence (Ghanaiem, 2023; Samili, 2023). Humanity stands at the

threshold of a transformative era, one where AI promises to revolutionize various aspects of our lives, leading to a multitude of benefits. These include (Abd-Elraheem & Hassanein, 2022; Al Darayseh, 2023; Alfayez et al., 2021; Alsaidi et al., 2023; Ayanwale et al., 2022; Bin Ibrahim, 2021; Celik et al., 2022; Ferikoğlu & Akgün, 2022):

1. Reduced human effort: AI can automate repetitive and time-consuming tasks, freeing up human labor for more creative and strategic endeavors.
2. Time efficiency: AI's ability to process information and perform tasks at an accelerated pace can significantly reduce the time required for various operations.
3. Cost savings: AI can optimize processes and resource allocation, leading to substantial cost reductions across various industries.
4. Enhanced product quality: AI-powered systems can analyze vast amounts of data and identify patterns that humans might miss, enabling the development of higher-quality products and services.
5. Boosted productivity: The combined impact of these factors can lead to a significant increase in overall productivity, driving economic growth and innovation.

This digital revolution has the potential to reshape economic, social, and cultural systems, fundamentally altering behavioral patterns and practices at both the individual and societal levels.

Concept and Nature of AI

The concept of AI emerged in the mid-20th century, driven by advancements in electromechanical computing sciences. At the 1956 Dartmouth College conference, McCarthy defined AI as "the science and engineering of making intelligent machines" (Alfarani & Fatani, 2020, p. 10). This definition of AI was based on the notion of accurately describing and defining human intelligence in a way that could be replicated by a computerized machine (Gherhes, 2018). Safar (2024a, p. 929, 2024b, p. 460) defines AI as "a branch of computer science that enables the creation and design of computer programs that mimic human intelligence, allowing computers to perform tasks that were previously the domain of humans, such as those requiring thinking, understanding, hearing, speaking, and movement in a logical and organized manner".

AI aims to understand the nature of human intelligence by developing computer programs that can mimic intelligent human behavior. This entails enabling computer programs to solve problems or make decisions in various situations by drawing upon a vast repertoire of reasoning processes embedded within the program (Al Hiary, 2023a; Bakr & Taha, 2019). This cutting-edge technology is poised to replace many of the tasks currently performed by humans. It is anticipated to significantly contribute to the advancement of institutional work across various sectors, leading to a reduction in the workforce and enabling operations to continue uninterrupted for extended periods. A key advantage of

machines is their ability to work without requiring breaks, thereby boosting productivity (Al Shaibaniya, 2019; Celik et al., 2022).

Objectives of AI

AI encompasses a broad spectrum of subfields that have become increasingly influential in human life. The core objectives of AI lie in the deployment of intelligent technologies and software. These advancements aim to create machines capable of independent learning, reasoning, comprehension, and decision-making, ideally exceeding human capacity in these areas. These core objectives encompass (Abd-Elraheem & Hassanein, 2022; Abdulsalam, 2021; Alfayez et al., 2021; Al Fifi, 2020; Alghamdi & Alfarani, 2020; Al Hiary, 2023a; Alsaidi et al., 2023; Bin Ibrahim, 2021; Fouad et al., 2012; Safar, 2024a, 2024b; Simhadri & Swamy, 2023):

1. Computer vision: It is essentially giving computers eyes. It uses AI to analyze images and videos, allowing them to "see" and understand the world around them.
2. Pattern recognition: This involves enabling machines to identify and understand patterns in data, such as images, sounds, or text.
3. Expert systems: These are AI systems designed to emulate the expertise of human specialists in a particular domain, providing solutions and guidance based on accumulated knowledge and rules.
4. Knowledge engineering: This field focuses on capturing, representing, and formalizing human knowledge in a way that can be processed and utilized by AI systems.
5. Artificial neural networks (ANNs): These are brain-inspired computer systems that learn from data. Imagine a complex web of connections that can find hidden patterns, making them great for tasks like image recognition and speech understanding.
6. Natural language processing (NLP): This subfield deals with the interaction between computers and human language, enabling machines to understand, interpret, and generate human language.
7. Machine learning: This involves training AI systems to learn from data and improve their performance over time without explicit programming.
8. Deep learning: A leading-edge machine learning technique, employs deep neural networks inspired by the brain to automatically unveil complex patterns from data. This transformative approach enables tasks like image recognition and speech understanding, making it a game-changer for tackling complex problems.
9. Adaptive learning: Tech tailors learning to each student's strengths and weaknesses, letting them learn faster in areas they grasp and get extra help where needed. It leverages algorithms and data analysis to assess students' strengths and weaknesses and then adapts the presentation of material

accordingly. This personalized approach boosts engagement and learning outcomes.

10. Diagnosis, analysis, and prediction: Beyond data storage, AI excels at analysis and prediction. In medicine, for example, AI assists in diagnosing and analyzing diseases, even predicting their progression. Similarly, AI helps in education by analyzing student learning data to identify strengths and weaknesses, allowing for targeted support and improved learning outcomes.
11. Discourse understanding: This focuses on enabling AI systems to comprehend the context and nuances of human communication, including intentions, emotions, and implicit meanings.
12. Human-computer interaction (HCI): It is the field of study that focuses on the design and development of interactive interfaces and systems that allow for a smooth and natural interaction between humans and intelligent systems, such as voice assistants, robots, and AI-powered applications.
13. Problem-solving: AI techniques are employed to solve complex problems by analyzing data, identifying patterns, and applying reasoning strategies.
14. Data mining and analysis: AI algorithms are used to extract meaningful insights from large datasets, enabling better decision-making and understanding of complex phenomena.
15. Bolstering cybersecurity: This objective prioritizes the application of AI in developing and deploying robust security solutions. These solutions aim to safeguard critical infrastructure, networks, devices, applications, and sensitive data from cyberattacks and data breaches.
16. Optimizing business performance: A core objective lies in harnessing AI to streamline and enhance core business functions, encompassing production, service delivery (including support and maintenance), and overall operational efficiency. Through this strategic application, AI aims to drive increased productivity and empower data-driven decision-making, ultimately propelling economic growth.

The core objectives of AI are inherently contextual, adapting to the specific applications within various disciplines. From healthcare and finance to education and transportation, AI serves a distinct set of goals tailored to address the unique challenges and opportunities presented by each domain. This inherent versatility allows AI to permeate a wide array of industries and sectors, fostering continuous advancements in technological capabilities and societal well-being.

Integrating AI in Education: Exploring Roles and Significance

The UNESCO emphasized that the technical and vocational education and training (TVET) sector's interest in AI has not yet translated into widespread institutional practices. While the international TVET community recognizes the potential impacts of AI on both

the labor market and the education and training sector, there is a gap in understanding how these systemic changes will affect the practices of educational institutions (Bin Ibrahim, 2021).

The European Union Summit held in Gothenburg, Sweden in 2017 highlighted the critical role of AI in today's world. The summit launched the second Digital Education Plan, which outlined three key priorities for the educational process (Alsaidi et al., 2023; Tuomi, 2018): (1) Maximizing the use of digital technology in teaching and learning; (2) Emphasizing the development of digital skills and competencies to keep pace with this digital transformation; and (3) Enhancing the educational process by utilizing the analysis and review of the outcomes of educational experiences in European countries. The plan concluded that AI would have a profound impact on teaching and learning in the years to come.

Educational systems are striving to integrate AI into the teaching and learning processes by leveraging modern technologies to create a teaching and learning environment that helps teachers and learners adapt to technological change. Safar (2024a, 2024b) and Alsaidi et al. (2023) have identified three main areas for AI applications in education:

1. Cognitive science applications: These applications involve using AI to understand and model human cognitive processes, such as learning, memory, and problem-solving. This knowledge can then be used to develop more effective teaching methods and learning tools.
2. Intelligent machine applications: These applications involve using AI to create intelligent machines that can assist learners in various ways, such as providing personalized feedback, adapting to individual learning styles, and offering automated tutoring.
3. Natural user interface applications: These applications involve using AI to create natural and intuitive interfaces between teachers/learners and technology. This can make it easier for teachers and learners to access and use educational resources, and it can also make the teaching and learning processes more engaging and enjoyable.

By incorporating these AI applications into the curriculum, educators can create a more personalized, engaging, and effective teaching and learning experience for all students (Alamri, 2023; Alghamdi & Alfarani, 2020; Alshidi & Alsaidi, 2022; Ghanaiem, 2023).

AI applications have gained significant attention in the education sector, particularly with the rapid advancement of AI technologies. Leveraging AI in the educational process has become an integral part of the development of educational systems to transition into the era of the Fourth Industrial Revolution. Digital technological tools enabled by AI can help overcome many structural barriers that hinder effective teacher access to all learners. School systems face numerous challenges, and the significance of AI lies in its ability to assist schools in addressing these challenges while also equipping students with the skills to navigate modern software (Abdulsalam, 2021; Al Darayseh,

2023; Celik et al., 2022; United Nations Educational, Scientific and Cultural Organization [UNESCO], 2021).

AI applications are contributing to a transformation of teacher roles in the educational setting, particularly in the areas of assessment, grading, and question formulation for students. AI also plays a role in better diagnosing and evaluating student problems, identifying learners' psychological states, and providing them with feedback. It can facilitate a shift in the teacher's role from lecturing and direct instruction to fostering active learning (Alamri, 2023; Al Darayseh, 2023; Bin Ibrahim, 2021; Borge, 2016; Celik et al., 2022). AI-based educational programs are designed to meet the learning needs of diverse student groups and cater to a wide range of educational objectives. These programs facilitate student-to-student interaction, enhance access to digital resources, and promote student engagement in the learning process through various methods (Abd-Elraheem & Hassanein, 2022; Alfayez et al., 2021; Al Kanaan, 2022; Alshidi & Alsaidi, 2022; Ayanwale et al., 2022; Woolf et al., 2013).

AI applications are transforming educational management by replacing traditional systems with new AI-powered electronic systems that enhance efficiency and quality. These systems can (Al Habib, 2022; Al-Sobhi, 2020; Mokatel & Hasni, 2021): (1) Distribute courses and schedules to teachers based on their expertise and interests; (2) Identify and support gifted students; (3) Provide individualized support for students with learning difficulties; and (4) Facilitate electronic communication with parents.

The integration of AI applications into educational systems represents a modern approach in response to the technological advancements of the Fourth Industrial Revolution. This integration harnesses the power of modern technologies and communication tools (International Telecommunication Union [ITU], 2020). According to Safar (2024a, 2024b) and Alsaidi et al. (2023), several AI applications can be employed in intelligent education, including: (1) Developing intelligent systems; (2) Knowledge representation; (3) Optimistic experimentation; (4) Machine learning; (5) Deep learning; (6) Handling incomplete information; (7) Problem-solving; (8) Learning ability; (9) Logic and inferencing capabilities; (10) Natural language processing; (11) Dealing with conflicting information; (12) Learning from past experiences; (13) Building models and perception; and (14) Diagnosis, analysis, and prediction.

The Benefits of Using AI in Education

The positive impacts of using AI applications in education are evident in the following aspects (Abd-Elraheem & Hassanein, 2022; Akgun & Greenhow, 2022; Alamri, 2023; Al Darayseh, 2023; Alfayez et al., 2021; Al Habib, 2022; Al Hiary, 2023a; Alsaidi et al., 2023; Alshidi & Alsaidi, 2022; Ayanwale et al., 2022; Bin Ibrahim, 2021; Celik et al., 2022; Kim & Kim, 2022; Safar, 2024a, 2024b; Shaban, 2021; Simhadri & Swamy, 2023):

1. Leveraging human-like intelligence: AI can be harnessed to replicate and model human cognitive functions through the analysis of extensive datasets. This advancement has the potential to revolutionize human-computer interaction.
2. Automating workflows through AI: AI facilitates the autonomous delegation of tasks and functions to robots and other automated digital devices/systems to undertake complex and intricate tasks previously deemed beyond human capabilities, thereby enhancing productivity, and minimizing human error. This transformation of administrative systems into electronic systems can also contribute to informed decision-making and facilitate the identification of gifted students through intelligent analysis of question patterns.
3. Enabling learners to break free from a one-size-fits-all approach to education.
4. Enabling remote operation: AI paves the way for the remote control of machines and digital devices, fostering enhanced efficiency and safety across a multitude of applications.
5. Facilitating continuous learning: AI empowers digital devices and systems to learn autonomously, extract insights from data, and adapt to evolving circumstances with greater intelligence. This capability fosters ongoing development and optimization, surpassing limitations inherent in human cognition.
6. Personalizing the learning journey: AI personalizes and optimizes the educational experience for each learner. By analyzing student performance data, AI-powered systems can curate appropriate learning resources and recommendations, fostering individual growth and achievement.
7. Empowering lifelong learning: AI fosters a paradigm shift towards continuous learning by facilitating educational and professional development opportunities throughout an individual's life. This adaptability equips learners with the necessary skills to navigate the ever-evolving landscape of the modern world.
8. Enhancing assessment and feedback: AI offers the potential for refined learner evaluation through accurate performance assessments and insightful feedback generation. This empowers educators to gain deeper understanding of student strengths and weaknesses, enabling them to tailor instruction and optimize learning outcomes.
9. Identifying potential issues through emotional recognition: AI can assess students' human emotions and analyze their facial expressions, voice patterns, and written communication to flag potential signs of anxiety, fatigue, or stress in students. These insights can help teachers identify students who may be struggling and intervene early on, providing support and resources.
10. Streamlining educational workflows: AI automates numerous teaching, learning, and administrative tasks, thereby enhancing efficiency and reducing time burdens for both educators/teachers and learners.
11. Bridging the educational divide: AI expands access to educational opportunities for individuals in remote or underserved areas. By facilitating online learning

platforms and delivering instruction via AI-powered tools, learners can overcome geographical barriers and engage in educational materials previously unavailable.

12. Empowering educators: AI equips teachers with a comprehensive suite of tools and resources. These tools facilitate the analysis of learner performance and preferences, enabling the identification of knowledge gaps. AI-powered guidance empowers educators to provide targeted support, unlocking each student's full potential.
13. Empowering learner autonomy: AI equips learners with a diverse toolkit to enhance their educational journey. These tools facilitate self-directed learning, enabling students to improve, refine, and sustain their educational pursuits, fostering a sense of ownership over their academic achievements.
14. Identifying and addressing educational challenges: AI can help generate solutions and proposals for educational problems and optimize learning experiences through AI-powered solutions.

AI is a technological revolution impacting all fields, including education. AI enhances both teaching and learning processes, personalizes the learning experience, and assists teachers in the learning process. AI and its applications can simulate the experience of one-on-one human lessons. Intelligent AI-based education systems provide learning activities that cater to students' cognitive needs. They study and analyze the responses of the target audience and make appropriate decisions that benefit the delivery of content aligned with their interests (Abd-Elraheem & Hassanein, 2022; Al Darayseh, 2023; Almalki, 2023; Alsaidi et al., 2023; Ayanwale et al., 2022; Bin Ibrahim, 2021; Celik et al., 2022; Ferikoğlu & Akgün, 2022; Florea & Radu, 2019; Mahmoud, 2020; Mokatel & Hasni, 2021; Safar, 2024a, 2024b; UNESCO, 2021; Zhang et al., 2023).

The Drawbacks of Using AI in Education

The emergence of AI technologies and applications is driving a paradigm shift in educational delivery. These AI-powered tools are fundamentally changing how we teach and learn. These smart technologies hold immense promise to revolutionize the educational landscape by offering significant pedagogical advantages, including the potential to personalize learning experiences, enhance student engagement, and provide immediate feedback, all of which contribute to improved learning outcomes for a diverse student population. However, the integration of AI in education necessitates a critical examination of potential drawbacks, such as (Abdulsalam, 2021; Alghamdi & Alfarani, 2020; Al Hiary, 2023b; Celik et al., 2022; Ghanaiem, 2023):

1. Increased financial investment: The integration of AI technologies and applications within the educational landscape necessitates a significant financial investment.

2. Potential faculty displacement: The automation of certain teaching tasks through AI may lead to workforce reductions and higher unemployment rates among educators.
3. Cybersecurity risks: The implementation of robots, devices, and smart applications in education introduces potential vulnerabilities to hacking and malware attacks.
4. Diminished human interaction: Overreliance on AI-powered systems could diminish opportunities for face-to-face interaction, communication, and social development between educators and learners. This may subsequently hinder the identification of individual student needs and the cultivation of essential social-emotional skills.
5. Student disengagement: Extensive use of automated systems may lead to student boredom and a decline in learning motivation due to an overdependence on technology at the expense of traditional pedagogical methods.
6. Technical proficiency requirements: Effective utilization of automated systems, robots, and AI applications may necessitate the development of new technical competencies and skills among both educators and students.
7. Potential for social isolation: Overreliance on AI could have negative consequences for human behavior by limiting the opportunities for human interaction and social engagement.
8. Technological disruption risks: The educational process may be susceptible to disruption due to technological malfunctions, potentially causing temporary or permanent interruptions in learning.
9. Data privacy and security concerns: The growing use of AI applications in education raises critical concerns regarding the privacy and security of personal student data and educational information collected and stored.
10. Challenges in individualized assessment: AI systems may face limitations in accurately assessing individual student progress and true comprehension of educational materials, potentially hindering the effectiveness of the teaching and learning processes.
11. Broader ethical considerations: The implementation of AI in education necessitates careful consideration of a range of ethical issues, including potential biases based on race and gender, dehumanization, manipulation of information/data, and even existential risks.

The Challenges of Employing AI in Education

The integration of modern technologies and AI in education presents a transformative opportunity for teaching and learning. However, maximizing their effectiveness necessitates a strategic approach that acknowledges and addresses the following key challenges (Abd-Elraheem & Hassanein, 2022; Abdulsalam, 2021; Akgun

& Greenhow, 2022; Al Habib, 2022; Al Kanaan, 2022; Alsaidi et al., 2023; Celik et al., 2022; Luchaninov, 2023; Safar, 2024a, 2024b; Shaban, 2021; Zhang et al., 2023):

1. Digital equity: Bridging the disparity in access to modern technology and infrastructure across educational institutions is crucial to prevent AI integration from exacerbating existing educational inequalities.
2. Upskilling the educational workforce: A comprehensive professional development strategy is necessary to equip educators, learners, and administrators with the necessary skills and competencies to effectively utilize AI tools and integrate them seamlessly throughout various educational stages.
3. Pedagogically sound content development: Creating engaging and impactful AI-powered educational content that aligns with established pedagogical principles remains a core area of focus.
4. Robust data protection measures: Implementing robust safeguards to protect the sensitive data (including Personally Identifiable Information - PII) of students, teachers, and administrators collected and processed through AI applications is paramount.
5. Balancing human interaction with technology: Ensuring a harmonious integration of AI-powered learning with fostering essential human interaction between educators and learners is a critical challenge.
6. Promoting educational equity: Efforts to bridge the digital divide and ensure equitable access to modern technology for all stakeholders are essential to promote educational justice.
7. Developing effective assessment methods: Refining methods to accurately measure the true impact of AI on learning outcomes remains an ongoing challenge in education research and practice.
8. Fostering a culture of innovation: Overcoming potential resistance to change through targeted professional development initiatives and cultivating a school culture that embraces innovation are key to successful AI integration.

The strategic integration of modern learning technologies and AI presents significant opportunities for educational transformation. While acknowledging the implementation challenges, a commitment to continuous improvement and the provision of comprehensive support structures is paramount. By harnessing the potential of these advancements, we can create a dynamic teaching and learning environment that empowers educators, learners, and educational leaders to achieve a new level of knowledge acquisition, skill and competency development, and overall educational efficacy.

Literature Review

Previous Studies

These recent trends indicate that the integration of AI technologies and programs contributes to students' acquisition of various modern technical skills and competencies

aligned with the Fourth Industrial Revolution. Numerous research studies have shed light on the significance of AI technologies and applications; among them are the following:

(1) A study by Mahmoud (2018) that aimed to identify the effectiveness of an AI-based program in teaching social studies to middle school students in terms of developing their productive thinking skills and self-directed learning tendencies. The study's findings revealed the following: (a) A statistically significant difference between the average scores of the research sample students on the pre- and post-critical thinking tests, in favor of the post-test; and (b) A statistically significant difference between the average scores of the research sample students on the pre- and post-creative thinking tests, in favor of the post-test.

(2) A study by Zawacki-Richter et al. (2019) aimed to provide an overview of research on AI solutions and applications in higher education through a systematic review. The study's findings revealed that most disciplines involved in AI research in education are from computer science, and the most commonly used quantitative research methods in this research were experimental methods. The study's results also showed that most of the AI fields used in higher education institutions are limited to supporting social and administrative services such as record keeping, needs assessment, and evaluation, while there is a lack of studies that have focused on practical application experiences and the challenges of using AI in higher education institutions. The results also showed a weak link between educational needs and the need to discover more AI applications in higher education institutions.

(3) Alfarani and Alhujaili's study (2020) aimed to identify the factors influencing teacher acceptance of AI in education in light of the Unified Theory of Acceptance and Use of Technology (UTAUT). To achieve this, the study employed a descriptive approach. The results revealed that teachers have a high level of acceptance for using AI in education, and that all of the following factors (performance expectancy, effort expectancy, social influence, facilitating conditions) positively influence the intention to use AI in education. Additionally, the findings indicated that there are statistically significant differences between the sample's responses in determining the intention to use AI in education attributed to the gender variable, favoring females, and that there are no statistically significant differences between the sample's responses in determining the intention to use AI in education attributed to the variables of age, years of experience, and educational specialization.

(4) Alfarani and Fatani (2020) conducted a study aimed at determining how to integrate AI applications in middle schools from adaptation to adoption. This was achieved by preparing educational content based on the use of the "Calypso" language to interact with the "Cozmo" interactive robot. The study also aimed to determine the extent to which female students master some of the cognitive and skill aspects of the "Calypso" language as one of the AI programming languages, and to present a vision for the proposal to integrate AI applications as one of the academic courses. The study used the descriptive analytical approach. The results showed that about 75.18% of the female students achieved the required level of mastery in the cognitive aspect of the "Calypso" language, while 78%

of the female students were able to achieve the required level of mastery in the skill aspect of the "Calypso" language. The study recommended the integration of AI and its educational applications into the instructional content of academic programs for teachers in universities, as well as the need to benefit from AI applications in teaching and learning.

(5) Alghamdi and Alfarani's study (2020) aimed to identify the reality of the use of AI educational applications by special education teachers and their tendency towards them from the perspective of teachers in Al-Noor Institute in Jeddah Governorate. The study used a descriptive analytical approach to achieve its objectives. The results showed that the domain of the importance of using AI educational applications received a score of "strongly agree" from the participants. The domain of obstacles to using AI educational applications, as well as the domain of the tendency to use AI educational applications, received a score of "agree", while the domain of the level of knowledge and skill associated with using AI educational applications received a score of "neutral".

(6) Mahmoud's study (2020) aimed to identify the AI applications that can be utilized to develop the educational process in light of the challenges of the COVID-19 pandemic. The study employed a descriptive approach. Among its most prominent findings was the identification of several challenges and problems related to the following aspects: the educational process, educational administration, the teacher, the learner, parents, and learner assessment in the context of the COVID-19 crisis. The study also concluded that some AI applications, such as intelligent learning systems, intelligent content, virtual reality (VR) applications, augmented reality (AR) applications, and layers applications, can be employed to address some of these challenges and problems. The study recommended that AI applications have a relationship with the effectiveness of education.

(7) A study conducted by Alfayez et al. (2021) delved into the extent to which AI concepts and applications are embedded within the computer and information technology curricula for middle and secondary school students in the Kingdom of Saudi Arabia. Employing a descriptive-analytical quantitative approach grounded in content analysis methodology, the study meticulously crafted a content analysis card encompassing five dimensions and 35 indicators. This robust instrument yielded a high reliability coefficient of 0.86, paving the way for a comprehensive analysis of computer and information technology textbooks utilized in middle and secondary school general education. The findings of the study unveiled a varying degree of integration of AI concepts and applications within the content of middle school textbooks. The inclusion rates for the first, second, and third middle school grades stand at 3.46%, 6.70%, and 10.00%, respectively. In contrast, the inclusion rates for secondary school computer and information technology textbooks exhibited greater consistency, hovering around 18.00% for Computer 1 and Computer 3 textbooks and 15.00% for Computer 2 textbooks. In light of these findings, the study recommended a thorough review and enhancement of computer and information technology curricula for middle and secondary school, advocating for a more prominent role for AI concepts and applications. This emphasis should extend beyond traditional computing disciplines to encompass the broader realm of information and communication technology.

(8) Bin Ibrahim's study (2021) aimed to identify the extent to which AI applications and ethics are incorporated into high school physics curricula. The study population was secondary school physics textbooks. To achieve the study's objective, the researcher employed a descriptive and analytical approach based on content analysis. The researcher used two content analysis checklists to determine the extent to which physics curricula cover AI applications and ethics. The findings indicated weaknesses in physics curricula in incorporating AI applications and ethics. The researcher recommended presenting a vision for incorporating AI applications and ethics into high school physics curricula.

(9) Abdulsalam's study (2021) investigated the attitudes of faculty members at two Egyptian universities towards the application of AI in education. The study employed a descriptive analytical survey design, utilizing a questionnaire with 58 items categorized into three dimensions: AI applications in education, implementation considerations, and ethical concerns. The findings revealed a generally "high" level of agreement among faculty members regarding the adoption of AI in education and its diverse applications. Notably, the participants' academic ranks did not significantly influence their opinions.

(10) Shaban's study (2021) explored the integration and utilization of AI technologies and applications within higher education. This descriptive study reviewed the theoretical foundation of AI, its characteristics, its potential benefits for education, and its proposed applications in higher education settings. Additionally, the research examined the key challenges hindering its implementation in educational contexts. The findings revealed a "low" level of awareness among faculty and students regarding the significance of AI algorithms, technologies, and applications in higher education. This was further evidenced by a lack of conviction in its importance. Furthermore, the study highlighted the resistance among faculty members to incorporate AI algorithms, technologies, and smart software into their teaching and learning practices.

(11) Aloufe and Alrehaili (2021) conducted a study exploring the potential of AI applications to enhance innovative teaching methods for female high school mathematics students in Al Madinah Al Munawara, Saudi Arabia, from the perspective of female math teachers. The research also investigated correlations between AI application usage and teachers' academic qualifications, experience, ICT course attendance, and technological skills. To meet its objectives, the study utilized a descriptive-analytical survey methodology and gathered data through a 31-item questionnaire distributed among 150 female math teachers, selected via stratified random sampling. Results indicated that teachers had a "moderate" level of knowledge regarding AI's role in fostering innovative capabilities and recognized its importance in teaching. However, the study identified obstacles to effective AI utilization in teaching. Notably, no statistically significant differences were found in teachers' responses based on academic qualifications, experience, or ICT course attendance. However, differences were noted in the level of knowledge and perceived importance of AI, linked to teachers' technological skills, with those possessing higher skills showing greater enthusiasm for AI integration. Based on these findings, the study recommended promoting AI applications in teaching innovation while enhancing teachers' awareness of their significance.

(12) Ramadan's study (2021) investigated how secondary school teachers in Saudi Arabia apply AI applications in education. The study, which employed a descriptive-analytical survey method, gathered data through a questionnaire that assessed 53 skills across five domains. A stratified random sample of 386 teachers participated. The results revealed that teachers applied AI skills "moderately", with the most frequent use observed in teaching strategies, preparing the AI environment, and implementation. Furthermore, the study found no significant variations in AI application based on factors like position, gender, professional experience, city, or participation in AI courses.

(13) A study conducted by Al-Atel et al. (2021) investigated the significance of AI in education and the challenges students face with its use. The study focused on students enrolled in the College of Basic Education in Kuwait and employed a descriptive research approach. The findings revealed statistically significant variations in student perceptions of AI's importance in education based on their academic year. However, no such variations were observed regarding the challenges associated with AI use. The study also identified gender and cumulative grade point average (GPA) as factors influencing students' perspectives on the challenges of using AI in education, while no significant differences were found concerning its importance in the learning process.

(14) The study of Alshidi and Alsaidi (2022) intended to evaluate the level of integration or inclusion of AI concepts and applications in the mathematics curricula at the basic education stage in the Sultanate of Oman. The research employed a quantitative descriptive approach, where an analysis tool consisting of 24 items distributed across five domains was designed. After verifying the validity and reliability of the tool, it was applied to the mathematics curriculum content for grades seven and eight in the Sultanate of Oman, including student's textbooks and activity books. The study results revealed that the level of integration of AI concepts and applications in the mathematics curricula for grades seven and eight was generally "low". The percentages of inclusion rate in the content of seventh-grade mathematics curriculum were as follows: Student's Book for the first semester/term was 3.50%, the Student's Book for the second semester/term reached 0.70%, and the Activity Book for the first semester/term was 1.70%, while the Activity Book for the second semester/term reached 2.40%. While the percentages of inclusion rate in the content of the eighth-grade mathematics curriculum were as follows: the Student's Book for the first semester/term reached 0.70%, the Student's Book for the second semester/term was 8.80%, and the Activity Book for the first semester/term reached 2.00%, while the Activity Book for the second semester/term was 0.30%. The study recommended the importance of updating mathematics curriculum by effectively integrating AI concepts and applications into mathematics curricula, and the necessity of training mathematics teachers on how to use and integrate them into the teaching and learning processes.

(15) Al Kanaan's study (2022) evaluated the awareness of pre-service science teachers at Qassim University, Saudi Arabia, concerning the use of AI applications in science education. The study employed a mixed-methods approach, utilizing a questionnaire distributed to 43 pre-service teachers and interviews conducted with 15 participants. The findings revealed a generally "low" level of overall awareness regarding

AI applications in science education, with responses across different domains of the study falling within the "low" to "very low" range.

(16) Abu Swairah et al. (2022) designed and evaluated an e-learning unit on AI for ninth-grade girls in the Gaza Strip. The study aimed to assess the unit's effectiveness in developing their AI programming skills. It employed a descriptive and a quasi-experimental (one-group) design. A validated programming skills observation card was used as the assessment tool. The study identified relevant AI programming skills and designed the e-learning unit following a six-stage educational design model. The results showed statistically significant improvements in student scores on the observation card after using the unit ($\alpha \leq 0.01$). To measure the effect size, Eta squared ($\eta 2$) was calculated for the observation card, indicating a large effect ($\eta 2 = 0.99$). This suggests the proposed e-learning unit has a significant impact on developing programming skills related to AI among ninth-grade female students.

(17) Al Habib's study (2022) investigated the perspectives of education experts, specifically faculty members in educational fields at Saudi universities, on the use of AI for training academic staff. The study employed a descriptive-analytical quantitative approach, utilizing a questionnaire to gather data from 82 experts across 18 Saudi universities. The findings revealed a "moderate" level of agreement among experts regarding the use of AI in faculty training. Notably, there was significant consensus on the challenges that impede its effective implementation. Based on these results, the study proposed recommendations to facilitate the improved integration of AI in academic staff training programs.

(18) A study by Ferikoğlu and Akgün (2022) investigated the awareness of AI and its integration into education among teachers in Turkish public and private schools. They employed a quantitative descriptive-analytical research methodology and utilized a questionnaire called the "Artificial Intelligence Awareness Level Scale for Teachers" consisting of 51 statements. The study included 561 teachers from major Turkish cities during the 2019/2020 academic year. The findings indicated that Turkish teachers had a "moderate" level of awareness of AI and its educational applications (around 70% based on the scale).

(19) Abd-Elraheem and Hassanein's study (2022) explored the perspectives of Egyptian university faculty members on utilizing AI technologies and applications for digital transformation in higher education. The study employed a descriptive-analytical approach, utilizing a questionnaire with 47 statements regarding the requirements, current use, and challenges associated with AI applications in this context. The sample included 39 faculty experts from various Egyptian universities. The findings revealed a "strong" consensus among experts on the necessity of AI for transforming higher education into a digital environment. However, while acknowledging the challenges that hinder ideal faculty use, the study also found a "moderate" level of current AI use among faculty members. The study concludes by proposing three scenarios for AI-driven digital transformation: extensional/referential, reformist, and innovative/fundamental transformation.

(20) Alamri's study (2023) aimed to assess the integration level of innovation and AI attributes within early childhood education curricula in Saudi Arabia, as perceived by teachers. The study employed a descriptive survey approach. Data were collected using a researcher-designed questionnaire. The study's sample consisted of 905 teachers across various regions of Saudi Arabia, encompassing the Eastern, Western, Northern, Southern, and Riyadh areas. The findings revealed that the integration of innovation and AI characteristics in early childhood curricula was deemed "high" in the realm of activities and learning tools. However, it was clearly "insufficient/weak" in teaching methods/strategies and objectives domains, "very insufficient/very weak" in the domains of assessment and content. Based on the results, the study proposed a vision for enhancing early childhood education curricula in Saudi Arabia, emphasizing the incorporation of innovation and AI attributes.

(21) Samili's study (2023) investigated how AI applications impact the professional performance of secondary science teachers in Samtah Governorate, Saudi Arabia. The study employed a descriptive-analytical quantitative approach, surveying 103 science teachers randomly selected during the 2022/2023 academic year. The findings revealed that a strong majority (80.20%) of science teachers agreed on the positive influence of AI applications on their professional performance, including fostering supportive teaching and learning environments and professional growth. Interestingly, the study found no significant differences in teachers' perceptions based on factors like educational qualification or years of experience.

(22) The study of Zhang et al. (2023) explored the factors influencing pre-service teachers' intentions to use AI-based educational applications at a German university. The study utilized the Technology Acceptance Model (TAM) and surveyed 452 participants. The findings indicated that perceived ease of use and perceived usefulness were the primary factors affecting pre-service teachers' behavioral intentions towards using AI in education. Interestingly, the study also revealed gender differences. Female participants reported higher levels of AI anxiety compared to males, while also showing greater perceived enjoyment of using AI applications. Overall, these findings emphasize the importance of considering pre-service teachers' perceptions and attitudes towards AI technology within educational contexts.

(23) A study conducted by Alsaidi et al. (2023) investigated the prevalence of AI concepts and applications within the social studies curriculum for grades eleven and twelve in Omani basic education schools. The study employed a quantitative descriptive-analytical approach, utilizing a 24-statement data analysis tool that assessed five domains: data analysis and structuring, AI applications, AI programming, physical computing, and deep learning. The findings revealed a "weak/limited" inclusion of AI concepts and applications within the curriculum and textbooks, with low percentages observed across all five domains. Precisely, the analysis revealed that the inclusion reached a maximum of 6.55% in the twelfth-grade geography and modern technologies textbook. Conversely, the eleventh-grade social studies and Islamic civilization textbooks demonstrated minimal inclusion, at 0.86% and 0.24% respectively. In light of these results, the study recommends

incorporating AI concepts and applications more effectively into social studies curricula and providing training programs to enhance social studies teachers' awareness of the pedagogical value of AI applications, as well as to improve their ability to teach and leverage AI technologies and applications in the classroom.

(24) Safar's study (2024a) investigated pre-service teachers' awareness of AI at Kuwait University's College of Education. The study also explored how factors like gender, specialization, ICT certification, AI training experience, and ICT proficiency influence their perceptions of AI. Employing a descriptive-analytical quantitative approach, the researcher collected data through an online questionnaire from 555 pre-service teachers across three semesters (Fall, Winter/Spring, and Summer) in the 2023/2024 academic year. The findings revealed a generally "high" level of AI awareness among participants. However, statistically significant differences were observed based on gender (males showed higher awareness), AI training attendance (those who had prior AI training courses displayed higher awareness), and ICT proficiency (those with higher ICT skills exhibited higher awareness). Based on these results, the study recommends promoting an AI culture among educators, providing ongoing training on AI technologies and applications, integrating AI topics into educational programs, and encouraging collaboration between educational institutions and AI specialists.

(25) Safar's study (2024b) sought to evaluate the level of awareness regarding AI among in-service teachers in Kuwaiti general education schools. The study additionally explored the influence of various factors, including gender, specialization area, ICT qualifications, participation in AI training, ICT proficiency, and professional experience, on teachers' perceptions and awareness of AI. A descriptive-analytical quantitative approach was employed, aligning with the study's objectives. Data collection occurred during the 2023/2024 academic year through a validated online questionnaire containing 36 items. The questionnaire was distributed electronically to a purposive stratified sample of 1,924 in-service teachers. The findings revealed that the overall level of AI awareness and its potential educational applications among teachers was categorized as "high" (M = 3.81, SD = 0.71, RII = 0.76). Notably, the majority of scale items (21 items) indicated a "high" level of awareness, while the remaining items (15 items) demonstrated a "very high" level of awareness. Interestingly, the variable of specialization type (Arts & Humanities/Science) did not yield statistically significant differences in teachers' mean responses across the entire instrument. However, statistically significant differences were identified for variables such as gender, ICT qualifications, participation in AI training programs, ICT proficiency level, and years of professional experience. Female teachers, those possessing international ICT certifications, participants in AI training programs, individuals with higher ICT proficiency, and those with over 20 years of experience exhibited higher levels of AI awareness. The study culminated in several recommendations aimed at promoting AI awareness and utilization in education among teachers. These recommendations included the organization of training sessions and workshops, the development of educational materials introducing AI concepts, the integration of AI topics

into curricula and professional development programs, and the fostering of collaboration between educational institutions and AI-specialized organizations.

Commentary on Previous Studies

It is evident from the results of previous research studies the importance of employing AI in the educational settings. Most studies have confirmed the impact of AI technologies and applications in achieving educational goals and developing learning skills and competencies among students. The current study builds upon previous studies by utilizing their theoretical frameworks, methodologies, and research instruments. Also, it benefited from previous studies' results in preparing the data analysis section. This study aligns with prior studies by focusing on various aspects of AI in education such as awareness, understanding, and integration in educational settings.

However, the current study distinguishes itself by being conducted post-COVID-19 pandemic, highlighting the impact of the pandemic on educational technology adoption, particularly AI technologies and applications. This study also contributes to the existing body of research by employing a robust methodology and offering a comprehensive assessment tool for future studies in this field. It is also unique as a longitudinal study, spanning two consecutive school terms, and focusing specifically on integration degree (i.e., inclusion level) of AI concepts and applications in schools' curricula, which is an underexplored area in existing literature. The researcher noted the scarcity of Kuwaiti research studies in investigating AI applications in education.

In light of the foregoing, the importance of AI as one of the most prominent contemporary technological developments becomes clear. AI plays a pivotal role in the teaching and learning processes in the coming years, in light of the shift towards employing digital technology in the educational process as a primary goal for teaching and learning in the twenty-first century. This study comes to shed light on the extent to which AI concepts and applications are available in computer science curricula in general education in the State of Kuwait.

Problem of the Study

Kuwait's National Development Plan, Vision 2035, also known as New Kuwait, recognizes the power of AI to transform various sectors, including education. This ambitious plan acts as a roadmap for a prosperous and sustainable future. It is built on five key themes and nine focus pillars/areas for investment. Pillar 4, "Empowering Citizens and Institutions", highlights the importance of human capital. By investing in its people's knowledge, skills, and creativity, Kuwait aims to build a competitive workforce for long-term success. One of Vision 2035's goals is to modernize the education system. This involves aligning education with future job market needs, equipping students with essential skills and competencies for a rapidly changing world, and enhancing their competitiveness

in a dynamic economic, social, and technological landscape. The Kuwaiti education philosophy focuses on developing data analysis skills, promoting knowledge and technology production, and fostering awareness of information and networks security (New Kuwait, 2024).

There are various research studies that have focused on AI technologies and applications and their uses for digital transformation in the field of education. They have pointed to the importance of including AI concepts, applications, and ethics into the curriculum (Safar, 2024a, 2024b). However, few studies have actually scrutinized the availability level (i.e., inclusion degree) of AI concepts, applications, and ethics within the curricula for PreK-12 schools and higher education institutions. These studies include Alfayez et al.'s study (2021), Bin Ibrahim's study (2021), Alshidi and Alsaidi's study (2022), Alamri's study (2023), and Alsaidi et al.'s study (2023). There are no Kuwaiti studies that have focused on this topic to the best of the researcher's knowledge.

The researcher, based on his experience in educational supervision, noticed a lack of attention to the inclusion of AI in the Kuwaiti curriculum. This could have a future impact on the preparation of graduates with the knowledge, skills, and competencies needed to adapt to the Fourth Industrial Revolution era. As a result, this study was conducted to delve into the extent to which AI concepts and applications are embedded within the computer science curricula across primary schools in the State of Kuwait.

Research Questions

This current study attempted to answer the following questions:

1. What is the extent to which AI concepts and applications are included in the content of the computer science curriculum for the fourth grade in the State of Kuwait?
2. What is the extent to which AI concepts and applications are included in the content of the computer science curriculum for the fifth grade in the State of Kuwait?

Objectives of the Study

The current study aimed to achieve the following objectives:

1. To identify the extent to which the concepts and applications of AI are integrated into the computer science curricula for the fourth grade in Kuwait.
2. To reveal the extent to which the concepts and applications of AI are integrated into the computer science curricula for the fifth grade in Kuwait.

Significance of the Study

The significance of the study can be summarized as follows:

1. The study's originality stems from its focus on the contemporary topic of AI, a field still in its early stages of research and exploration regarding its significance in educational systems.
2. The study delves into the identification and assessment of AI concepts and applications embedded within computer science curricula, providing valuable insights for curriculum developers to enhance the effectiveness of computer science education in the face of the rapidly evolving technological landscape.
3. The study employs a structured and methodological (systematic) approach to identify and evaluate the incorporation of AI concepts and applications within the computer science curricula.
4. By narrowing the focus to specific grades and textbooks, the study could delve into a more detailed and comprehensive analysis of AI integration, identifying patterns and trends with greater precision.
5. The study's findings offer actionable recommendations for curriculum developers and educators directly involved in designing and implementing computer science curricula to improve them and better prepare students for the demands of the AI-driven future.
6. The study contributes to the expanding body of knowledge on the integration of AI into education and provides practical guidance for enhancing computer science curricula.

Limitations of the Study

The limitations of the study can be categorized as follows:

1. Objective limitations: This is manifested in analyzing the inclusion of AI concepts and applications in computer science textbooks for the fourth and fifth grades.
2. Spatial limitations: The study was confined to the primary general education schools in the State of Kuwait.
3. Temporal limitations: The study was conducted during the first and second semesters/terms of the 2023/2024 school year.
4. Scientific limitations: This challenge stems from the lack of readily available academic research on this critical topic within our region.

Terminologies of the Study

Here are some of the concepts and terms presented in this study, along with detailed definitions and explanations, including:

1. Artificial intelligence (AI): AI involves harnessing computer and digital technologies to explore the creation of machines, devices, robots, or applications capable of emulating certain aspects of human intelligence. These

capabilities include language comprehension, image identification, problem-solving, machine learning, inference, and drawing insights from previous experiences. AI systems are designed and programmed to execute a range of tasks, functions, and operations typically carried out by humans, thereby demonstrating intelligent behavior (Al Hiary, 2023a; Celik et al., 2022; Ghanaiem, 2023; Safar, 2024a, 2024b).

2. AI concepts: These are a broad range of scientific ideas that underpin the development and application of AI systems. This includes well-established concepts such as machine learning, deep learning, natural language processing (NLP), computer vision, robotics, and reasoning/problem-solving paradigms. Additionally, the ethical considerations surrounding AI development are paramount. While these represent the foundational concepts of AI, the field is inherently dynamic, with novel paradigms emerging continuously. Nevertheless, a thorough understanding of these core principles equips learners with a robust foundation for comprehending the intricacies and vast potential of AI (Alfayez et al., 2021; Alshidi & Alsaidi, 2022; Alsaidi et al., 2023; Bin Ibrahim, 2021).
3. AI applications: AI software encompasses a diverse range of tools and platforms that enable the development and deployment of intelligent applications. These tools empower users to harness the power of AI to automate tasks, analyze data, make predictions, and solve complex problems across various industries. Alshidi and Alsaidi (2022) as well as Bin Ibrahim (2021) defined AI applications as educational programs with a remarkable capacity to perform numerous tasks that mimic human behavior, including learning, thinking, teaching, and guiding, with the ability to make decisions in a scientific and organized manner. The researcher practically define it as a set of applications that are incorporated into computer science curricula, imparting digital skills and competencies to students, and are assessed/measured through/by an analysis card.
4. Computer science curricula: The researcher defines them as the fourth and fifth-grade computer science materials/contents for general education, which include student textbooks and activity books used in general education schools in the State of Kuwait.
5. General education schools: These are government and private schools that provide free (for Kuwaitis) and paid (for non-Kuwaitis) compulsory education for students from the first grade through the twelfth grade using government curricula.

Methodology

Research Design

This research adopted a quantitative descriptive methodology, specifically utilizing content analysis technique. Content analysis, as described by Al-Assaf (2012, p. 217), is a systematic approach that involves examining and analyzing recurring units within a particular content source. These units can encompass words, themes/topics/ideas, characters, or any other quantifiable element. This methodology facilitates the objective and systematic extraction of information based on pre-established criteria. Content analysis is particularly valuable for describing and analyzing the current state of a phenomenon, identifying potential problems, and laying the groundwork for further investigation and decision-making (Abou-Allam, 2021; Alamri, 2023; Alfayez et al., 2021; Alsaidi et al., 2023; Alshidi & Alsaidi, 2022; Bin Ibrahim, 2021; Creswell & Creswell, 2018; Fraenkel et al., 2019; Johnson & Christensen, 2020). Given its alignment with the study's objective of evaluating the extent to which AI concepts and applications are incorporated within Kuwaiti primary school computer science curricula, content analysis was deemed the most appropriate methodological approach.

Population and Sample

The study population encompassed all textbooks for the computer science curricula prescribed for students in the general education stages across the State of Kuwait during the 2023/2024 school year. This comprehensive set comprised 18 student textbooks. The study sample was carefully selected to include four computer science textbooks catering to fourth and fifth graders in primary education for the 2023/2024 school year. Table 1 provides detailed information regarding the study sample textbooks.

Table 1. Distribution of computer science textbooks by grade level for the 2023/2024 school year.

Educational Stage	Grade Level	Textbook	School Term	Type	Edition	No. of Units	No. of Pages	No. of Ideas/Topics
Primary	Grade 4	Our digital world - Part 1	First	Student textbook	2nd 2020/2021	2	119	50
		Our digital world - Part 2	Second	Student textbook	2nd 2023/2024	2	151	53

	Grade 5	Our digital world - Part 1	First	Student textbook	2nd 2020/2021	2	136	66
		Our digital world - Part 2	Second	Student textbook	2nd 2023/2024	2	143	56

Instrument

To achieve the study's objectives, the researcher prepared a content analysis card after referring to educational literature and relevant previous studies. The tool was adapted after its development from the study of Touretzky et al. (2019), Alfayez et al. (2021), Alshidi and Alsaidi (2022), as well as Alsaidi et al. (2023). The study tool, in its final form—after verifying its validity and reliability—consisted of 35 phrases (measurement indicators) distributed over five main comprehensive domains that focus on the fundamental dimensions of AI, namely: data analysis and structuring, AI applications, AI programming, physical computing, and machine learning and deep learning. The idea/topic was adopted as the unit of analysis due to its suitability for the nature of the study and its objectives.

Instrument Validity

To ensure the validity of the study tool (content analysis card)—the extent to which it accurately measures what it is intended to measure—the researcher employed expert judgment content validity. This involved presenting the card to a group of experienced and qualified experts in the field to gather their insights, opinions, feedback, guidance, suggestions, and recommendations. The researcher carefully considered all the feedback received and made appropriate modifications, including deletions, edits, and additions. This process led to the finalization and formalization of the study tool (content analysis card).

Instrument Reliability

To assess the reliability of the research tool (content analysis card)—meaning the extent to which it produces consistent results or close readings whenever it is used—the researcher employed the test-retest method. This involved applying the content analysis card twice to the same content, fourth-grade computer science student textbook for the first semester/term, which was randomly selected for analysis, with a specific time interval between applications (20 days). The researcher used the simple linear correlation coefficient, a statistical measure that gauges the strength and direction of the linear relationship between two variables, with values ranging from -1 to 1. Specifically, Pearson's correlation coefficient was used to calculate the correlation between the ratings or scores from the analysts. The correlation coefficient (reliability coefficient) reached a

"very high" value of 0.992. This indicates a strong positive correlation (as one variable increases, the other increases perfectly), meaning the tool exhibits a "very high" degree of internal consistency among its items (indicators). This makes the tool acceptable for research and academic purposes and instills strong confidence in using the tool and initiating the data collection process.

Data Collection

Upon confirming the validity and reliability of the research tool (content analysis card), the study was effectively implemented in the first and second semesters/terms of the 2023/2024 school year. The following procedures were meticulously followed:

1. Identification of applicable computer science curricula: The computer science curricula for the fourth and fifth grades of primary school were selected for analysis using the content analysis card. These curricula encompass four student textbooks.
2. Extraction of ideas/topics from selected textbooks: Each selected computer science curriculum student textbook was thoroughly examined to identify ideas/topics. This comprehensive analysis included: cognitive content (information), images, drawings, figures, tables, activities, exercises/drills, applications, thinking boxes, and guiding prompts. The cover, index, and book key were intentionally excluded to avoid duplication of ideas/topics.
3. Definition of analysis categories: The analysis categories represent the AI concepts and applications embedded within the content analysis card. These categories were meticulously categorized into five distinct domains or dimensions: data analysis and structuring, AI applications, AI programming, physical computing, and machine learning and deep learning.
4. Content analysis of selected textbooks: The selected computer science curriculum textbooks were subjected to rigorous content analysis using the aforementioned analysis tool. This meticulous process aimed to quantify the frequency of repetition of phrases or indicators from the analysis card within the extracted ideas/topics.

Methods of Analysis

After successfully implementing the study and collecting data, the researcher employed a variety of advanced statistical techniques to process and analyze the data statistically. These techniques specifically aimed to answer the research questions and included:

1. Pearson correlation coefficient: This coefficient was utilized to assess the reliability of the study tool by calculating the correlation between the ratings or scores of the analysts across time.
2. Frequency counts: Frequency counts were utilized to determine the total number of occurrences of each phrase (indicator) within the content analysis

card throughout the computer science curriculum student textbooks for the fourth and fifth grades in Kuwait.

3. Percentages: Percentages were calculated to represent the degree of inclusion for all indicators (phrases) incorporated within the content analysis card. The inclusion rate for each phrase (indicator) in the content analysis card relative to the specific student textbook content—the available or included ideas/topics within the textbook content—was calculated using the following statistical formula: Inclusion rate = (Number of occurrences of the indicator or phrase / Total number of ideas/topics in the textbook) * 100.

The statistical criterion (benchmark) explained in Table 2 was used to interpret the inclusion rate percentages.

Table 2. The established statistical benchmark for interpreting inclusion rate percentages.

Range of Inclusion Percentages	Degree of Inclusion
80.0-100.0	Very high
60.0-79.0	High
40.0-59.0	Medium
20.0-39.0	Low
0.0-19.0	Very low

Results and Discussion

The Results for Research Question No. 1

Research question no. 1 was stated as follows: What is the extent to which AI concepts and applications are included in the content of the computer science curriculum for the fourth grade in the State of Kuwait? To address this inquiry, the number of occurrences (repetitions/frequencies) and corresponding inclusion percentages for all domains/dimensions of the content analysis card were extracted, along with the overall inclusion percentage, as detailed in Table 3.

Table 3. Degree of inclusion of AI concepts and applications in primary school fourth grade computer science curricula.

Domain	No.	Phrase/Indicator	G4 Student Textbook - Part 1	G4 Student Textbook - Part 2

			No. of Occurrences	Inclusion Percentage %	No. of Occurrences	Inclusion Percentage %
First: Data Analysis and Structuring	1	The content discusses the processes of storing, searching, retrieving, modifying, and deleting data to feed AI systems.	0	0.00	0	0.00
	2	The content presents data representation and coding systems for feeding AI systems.	0	0.00	0	0.00
	3	The content discusses computational and logical operations in computers for building AI-based applications or intelligent systems.	0	0.00	0	0.00
	4	The content assists in identifying causal relationships between data and predicting outcomes.	0	0.00	0	0.00
	5	The content reviews methods of reorganizing, analyzing, and classifying data using appropriate software and tools to feed AI systems.	0	0.00	0	0.00
	6	The content discusses big data	0	0.00	0	0.00

		and its applications in the field of AI.				
Total Percentage of Inclusion of 1st Domain			0	0.00	0	0.00
Second: AI Applications	1	The content explores real-world applications of AI to solve everyday problems.	0	0.00	0	0.00
	2	The content discusses the foundations and concepts of AI and its relationship to other sciences.	0	0.00	0	0.00
	3	The content explores the privacy implications of using AI applications.	0	0.00	0	0.00
	4	The content provides examples of intelligent tutoring systems that offer learning activities tailored to students' cognitive needs and provide feedback.	0	0.00	0	0.00
	5	The content discusses AI algorithms used in natural language processing (NLP) and semantic modeling.	0	0.00	0	0.00
	6	The content reviews the stages of designing, creating,	0	0.00	0	0.00

		assembling, and operating robots.				
	7	The content discusses machine learning (ML) concepts and applications that aid in decision-making.	0	0.00	0	0.00
	8	The content explores AI-based games.	0	0.00	0	0.00
Total Percentage of Inclusion of 2nd Domain			0	0.00	0	0.00
Third: AI Programming	1	The content discusses the creation of intelligent algorithms (that generate and test other algorithms) to accomplish open-ended tasks.	0	0.00	0	0.00
	2	The content reviews the steps involved in designing and building programs using programming languages to control AI devices.	0	0.00	0	0.00
	3	The content discusses debugging and troubleshooting techniques for AI devices.	0	0.00	0	0.00
	4	The content discusses comparing the performance of	0	0.00	0	0.00

		multiple algorithms used to solve a particular problem.				
	5	The content reviews various models that explain how AI applications work as a system to accomplish tasks.	0	0.00	0	0.00
Total Percentage of Inclusion of 3rd Domain			0	0.00	0	0.00
Fourth: Physical Computing	1	The content simplifies the design and analysis of combinational and sequential digital circuits.	0	0.00	0	0.00
	2	The content explains the physical hardware components of AI devices.	0	0.00	0	0.00
	3	The content provides a functional overview of AI hardware units.	0	0.00	0	0.00
	4	The content explains the principles of interactive systems using software and hardware that can sense the world.	0	0.00	0	0.00
	5	The content explores innovative systems for understanding the relationship between humans	0	0.00	0	0.00

		and the digital world.				
	6	The content discusses sensors and microcontrollers for electromechanical control.	0	0.00	0	0.00
Total Percentage of Inclusion of 4th Domain			0	0.00	0	0.00
Fifth: Machine Learning (ML) and Deep Learning (DL)	1	The content discusses the analogy between the workings of human brain cells (neurons) and electrical networks for information processing.	0	0.00	0	0.00
	2	The content explores machine learning theories and principles.	0	0.00	0	0.00
	3	The content reviews techniques that mimic the way the human brain performs a particular task.	0	0.00	0	0.00
	4	The content discusses neuro-linguistic programming concepts and the application of computational techniques for analyzing and understanding text content.	0	0.00	0	0.00

	5	The content discusses examples of image processing and pattern recognition methods.	0	0.00	0	0.00
	6	The content explores AI systems for knowledge inference and representation.	0	0.00	0	0.00
	7	The content reviews the mathematical model for information processing based on the connectionist approach in computing.	0	0.00	0	0.00
	8	The content explores machine learning techniques and applications, and how to leverage this concept to achieve optimal results.	0	0.00	0	0.00
	9	The content supports the derivation of high-level abstractions by analyzing massive datasets using linear and nonlinear transformations.	0	0.00	0	0.00
	10	The content discusses some	0	0.00	0	0.00

		current scenarios for envisioning the application of machine learning techniques.				
Total Percentage of Inclusion of 5th Domain			0	0.00	0	0.00
Overall Total Percentage of Inclusion of All Domains/Dimensions			0	0.00	0	0.00

Results from Table 3 show that the level of inclusion (integration) of AI concepts and applications in the content of the fourth-grade primary computer science textbooks in the State of Kuwait is "very low" overall. The content of the "Our Digital World - Part 1" student textbook for the fourth grade, first semester/term, scored 0.00%, and the "Our Digital World - Part 2" student textbook for the fourth grade, second semester/term, also scored 0.00%. The detailed study results indicated that the inclusion rate was 0.00% in all domains or dimensions of the content analysis card (without exception). This indicates that the two student textbooks for the fourth-grade computer science curriculum do not contain any AI concepts or applications whatsoever. Consequently, this will hinder the achievement of international standards and trends in AI inclusion. Touretzky et al. (2019) pointed to the importance of integrating AI concepts and applications at all educational stages, from kindergarten to university.

The Results for Research Question No. 2

Research question no. 2 was stated as follows: What is the extent to which AI concepts and applications are included in the content of the computer science curriculum for the fifth grade in the State of Kuwait? To address this inquiry, the number of occurrences (repetitions/frequencies) and corresponding inclusion percentages for all domains/dimensions of the content analysis card were extracted, along with the overall inclusion percentage, as detailed in Table 4.

Table 4. Degree of inclusion of AI concepts and applications in primary school fifth grade computer science curricula.

Domain	No.	Phrase/Indicator	G5 Student Textbook - Part 1		G5 Student Textbook - Part 2	
			No. of Occurrences	Inclusion Percentage %	No. of Occurrences	Inclusion Percentage %

First: Data Analysis and Structuring	1	The content discusses the processes of storing, searching, retrieving, modifying, and deleting data to feed AI systems.	0	0.00	0	0.00
	2	The content presents data representation and coding systems for feeding AI systems.	0	0.00	0	0.00
	3	The content discusses computational and logical operations in computers for building AI-based applications or intelligent systems.	0	0.00	0	0.00
	4	The content assists in identifying causal relationships between data and predicting outcomes.	0	0.00	0	0.00
	5	The content reviews methods of reorganizing, analyzing, and classifying data using appropriate software and tools to feed AI systems.	0	0.00	0	0.00
	6	The content discusses big data and its applications in the field of AI.	0	0.00	0	0.00
Total Percentage of Inclusion of 1st Domain			0	0.00	0	0.00

Second: AI Applications	1	The content explores real-world applications of AI to solve everyday problems.	0	0.00	0	0.00
	2	The content discusses the foundations and concepts of AI and its relationship to other sciences.	0	0.00	0	0.00
	3	The content explores the privacy implications of using AI applications.	0	0.00	0	0.00
	4	The content provides examples of intelligent tutoring systems that offer learning activities tailored to students' cognitive needs and provide feedback.	0	0.00	0	0.00
	5	The content discusses AI algorithms used in natural language processing (NLP) and semantic modeling.	0	0.00	0	0.00
	6	The content reviews the stages of designing, creating, assembling, and operating robots.	0	0.00	0	0.00
	7	The content discusses machine	0	0.00	0	0.00

		learning (ML) concepts and applications that aid in decision-making.				
	8	The content explores AI-based games.	0	0.00	0	0.00
Total Percentage of Inclusion of 2nd Domain			0	0.00	0	0.00
Third: AI Programming	1	The content discusses the creation of intelligent algorithms (that generate and test other algorithms) to accomplish open-ended tasks.	0	0.00	0	0.00
	2	The content reviews the steps involved in designing and building programs using programming languages to control AI devices.	0	0.00	0	0.00
	3	The content discusses debugging and troubleshooting techniques for AI devices.	0	0.00	0	0.00
	4	The content discusses comparing the performance of multiple algorithms used to solve a particular problem.	0	0.00	0	0.00

	5	The content reviews various models that explain how AI applications work as a system to accomplish tasks.	0	0.00	0	0.00
Total Percentage of Inclusion of 3rd Domain			0	0.00	0	0.00
Fourth: Physical Computing	1	The content simplifies the design and analysis of combinational and sequential digital circuits.	0	0.00	0	0.00
	2	The content explains the physical hardware components of AI devices.	0	0.00	0	0.00
	3	The content provides a functional overview of AI hardware units.	0	0.00	0	0.00
	4	The content explains the principles of interactive systems using software and hardware that can sense the world.	0	0.00	0	0.00
	5	The content explores innovative systems for understanding the relationship between humans and the digital world.	0	0.00	0	0.00

	6	The content discusses sensors and microcontrollers for electromechanical control.	0	0.00	0	0.00
Total Percentage of Inclusion of 4th Domain			0	0.00	0	0.00
Fifth: Machine Learning (ML) and Deep Learning (DL)	1	The content discusses the analogy between the workings of human brain cells (neurons) and electrical networks for information processing.	0	0.00	0	0.00
	2	The content explores machine learning theories and principles.	0	0.00	0	0.00
	3	The content reviews techniques that mimic the way the human brain performs a particular task.	0	0.00	0	0.00
	4	The content discusses neuro-linguistic programming concepts and the application of computational techniques for analyzing and understanding text content.	0	0.00	0	0.00
	5	The content discusses examples	0	0.00	0	0.00

		of image processing and pattern recognition methods.				
	6	The content explores AI systems for knowledge inference and representation.	0	0.00	0	0.00
	7	The content reviews the mathematical model for information processing based on the connectionist approach in computing.	0	0.00	0	0.00
	8	The content explores machine learning techniques and applications, and how to leverage this concept to achieve optimal results.	0	0.00	0	0.00
	9	The content supports the derivation of high-level abstractions by analyzing massive datasets using linear and nonlinear transformations.	0	0.00	0	0.00
	10	The content discusses some current scenarios for envisioning the	0	0.00	0	0.00

		application of machine learning techniques.				
Total Percentage of Inclusion of 5th Domain			0	0.00	0	0.00
Overall Total Percentage of Inclusion of All Domains/Dimensions			0	0.00	0	0.00

Results from Table 4 indicate that the degree of inclusion (integration) of AI concepts and applications in the content of the fifth-grade primary computer science textbooks in the State of Kuwait is "very low" overall. The content of the "Our Digital World - Part 1" student textbook for the fifth grade, first semester/term, scored 0.00%, and the "Our Digital World - Part 2" student textbook for the fifth grade, second semester/term, also scored 0.00%. The detailed study results indicated that the inclusion rate was 0.00% in all domains or dimensions of the content analysis card (without exception). This indicates that the two student textbooks for the fifth-grade computer science curriculum do not cover any AI concepts or applications whatsoever. Accordingly, this will impede the attainment of international standards and trends in AI integration. Touretzky et al. (2019) emphasized the importance of incorporating AI concepts and applications across all levels of education, from kindergarten through university.

Discussion of the Results

This study identifies a critical gap in Kuwait's educational system. The current educational philosophy lacks a focus on integrating AI into the curricula (Safar, 2024a, 2024b). Furthermore, computer science curriculum objectives across all grade levels fail to incorporate AI concepts and applications into the subject matter of student textbooks. This omission marginalizes AI education within the broader educational framework. Consequently, the current curriculum content is not aligned with the demands of the 21st century's digital transformation, which emphasizes the development of essential AI-based knowledge, skills, and competencies. Notably, computer science textbooks lack any indicators or references to AI concepts and applications. This is particularly concerning given that computer science curricula, by their very nature, should be at the forefront of introducing emerging technologies like AI to learners. The limited integration of AI across curriculum, particularly within computer science, will hinder the achievement of educational goals, especially in the context of the global transition towards the Fourth Industrial Revolution, where AI plays a pivotal role.

The findings of the current study are somewhat consistent with those of Alsaidi et al. (2023), who revealed a generally "low/weak" level of integration of AI concepts and applications into 11th-grade social studies curricula in Oman. The AI content percentages

were 2.88% for economic geography, 0.86% for social studies, and 0.24% for Islamic civilization textbooks. Similarly, the results of the current study are somewhat in line with those of Alshidi and Alsaidi (2022), who found a "low/weak" degree of inclusion of AI concepts and applications into middle school (grades 7-8) mathematics curricula. The AI inclusion percentages for 7th-grade math textbooks ranged from 0.70% to 3.50%, while the percentages for 8th-grade math textbooks ranged from 0.30% to 8.80%.

In contrast, the findings of this study somewhat differ from those of Alfayez et al. (2021), which indicated that the degree of inclusion of AI concepts and applications into the content of computer science and information technology curricula for middle and high school in Saudi Arabia was generally "low", ranging from 3.46% to 18.00%; where the inclusion rate for middle school textbooks ranged from 3.46% to 10.00%, while the integration rate for high school textbooks was higher than that of middle school, ranging from 15.00% to 18.00%. This is considered a "low" level of integration, but it is significantly higher than the inclusion rate in the current study.

In addition, the findings of the current study somewhat differ from those of Bin Ibrahim (2021), which showed a noticeable weakness in the integration/inclusion of AI concepts, applications, and ethics into high school physics curricula in Saudi Arabia. These topics were not adequately addressed in the analyzed curricula, as they were generally available to a "low" degree, ranging from 8.30% (ethics) to 9.20% (concepts and applications). This is considered a "low" level of integration, but it is at a much higher level when compared to the inclusion rate of the current study. The findings of the current study also somewhat differ from those of Alamri (2023), which showed that the degree of inclusion of innovation and AI characteristics into kindergarten curricula in Saudi Arabia was generally "low/weak", reaching 2.1 on a five-point Likert scale. This is considered a much higher level of inclusion when compared to the integration rate of the current study.

Conclusion and Recommendations

Computer science curricula in general education serve as the foundation for students to grasp the fundamental principles of computer science, information and communication technology, and navigate the intricacies of the digital world that surrounds them. As AI continues to advance at an unprecedented pace and permeates various aspects of our lives, it has become imperative to integrate its concepts, applications, and ethical considerations into the computer science curriculum, specifically, and across all academic disciplines, more generally. This integration aims to enhance learners' skills, competencies, and capabilities while equipping them with the requisite knowledge for the future. Consequently, examining the extent to which AI concepts and applications are incorporated into school curriculum textbooks for diverse subjects, particularly computer science, across all educational stages, is a topic of paramount importance for shaping the future of education (teaching and learning).

The current study's findings reveal a conspicuous absence of AI topics, concepts, and applications within the computer science curricula for the primary stage in the State of Kuwait. This omission can be attributed to a confluence of factors, including: (1) A pervasive lack of awareness and understanding among curriculum developers regarding the paramount importance of AI and its diverse technologies in the contemporary era; (2) The conspicuous absence of clear directives and guidelines from the Ministry of Education pertaining to the integration of AI topics, concepts, and applications into the school curricula; and (3) A prevailing shortage of qualified personnel equipped to effectively teach AI in schools.

In light of the study's results, the following decisive steps are recommended to address the glaring deficiency in integrating these emerging topics into school curricula. These steps are essential to ensure that learners acquire the knowledge, skills, competencies, and capabilities necessary to thrive in a world where AI is rapidly gaining prominence across all domains:

1. Revamp computer science curriculum textbooks across all educational levels/stages to seamlessly integrate comprehensive, structured, and thorough concepts, applications, and ethical considerations of AI.
2. Modernize the content of existing curriculum textbooks for various subjects to align with cutting-edge technological advancements. This includes incorporating a comprehensive definition of AI, its concepts, and applications, while emphasizing the ethical aspects of its utilization.
3. Develop interactive digital (electronic) content leveraging AI technologies.
4. Foster a culture of AI awareness, ethics, and the significance of employing its smart technologies and applications within the teaching and learning domain among faculty members. This will cultivate an informed and cognizant generation.
5. Provide comprehensive training to teachers and school administrators on AI technologies, equipping them with the knowledge and skills to effectively integrate and utilize these technologies in the teaching and learning process.
6. Ensure the availability of necessary resources and unwavering support to facilitate the seamless integration and utilization of AI technologies within the teaching and learning process.
7. Strengthen coordination, collaboration, and partnerships between educational institutions, specialized bodies, and organizations dedicated to AI to promote and enhance AI awareness.
8. The Ministry of Education and the Ministry of Higher Education and Scientific Research, as well as educational settings and institutions, should adopt robust plans and strategies to motivate faculty, administrators, and learners to embrace AI technologies in the education (teaching and learning) field.
9. Conduct additional research studies akin to the current study, employing diverse samples, variables, methodologies, and targeting different communities. Additionally, implement experimental studies to evaluate the

effectiveness (impact) of AI-based teaching and learning programs. Furthermore, conduct descriptive survey and analytical studies to identify the obstacles and challenges that hinder the effective utilization of AI technologies in teaching and learning.

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