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EXPLORING STUDENT'S UNDERSTANDING OF ARTIFICIAL INTELLIGENCE IN SCIENCE AND TECHNOLOGY COURSES

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ABSTRACT

Artificial Intelligence (AI) is increasingly shaping various domains of science, technology, and society, making AI literacy a critical component of modern education. This study investigates the level of understanding, perceptions, and educational needs of university students regarding AI within science and technology courses. Using a qualitative research design, data were collected through semi-structured interviews with 18 undergraduate students from diverse STEM backgrounds. Thematic analysis revealed four major themes: (1) fragmented and media- influenced conceptual understanding of AI, (2) frequent but passive interaction with AI technologies, (3) ethical concerns and awareness about AI's societal impact, and (4) the urgent demand for contextualized and interdisciplinary AI education. Findings highlight a gap between students' daily use of AI-driven tools and their ability to critically understand or engage with such technologies. Students also expressed a strong desire for AI learning that is accessible, discipline- relevant, and ethically informed. The study concludes with recommendations for curriculum development that promotes inclusive, cross-disciplinary, and ethics-integrated AI education. These insights are essential for equipping future professionals with the critical and responsible AI literacy needed in an increasingly automated world.

Keywords: *artificial intelligence, ai literacy, science and technology education, interdisciplinary learning, ethics*

INTRODUCTION

The rapid advancement of Artificial Intelligence (AI) has significantly influenced various sectors, including education, healthcare, transportation, and scientific research. Understanding AI is no longer exclusive to computer scientists or engineers; it is becoming a core competency across disciplines, particularly in science and technology fields. Russell and Norvig (2016) define AI as "the study of agents that receive percepts from the environment and perform actions" (p. 1). Within educational contexts, this definition encompasses not only technical knowledge but also ethical and societal dimensions.

In science and technology courses, where analytical thinking, data interpretation, and innovation are emphasized, AI increasingly shapes curricula and learning methodologies. Brynjolfsson and McAfee (2017) describe this era as the "second machine age," in which machines and algorithms significantly augment human capabilities. This shift influences how scientific problems are understood, researched, and addressed in educational environments. Despite the growing use of AI in various domains, there is still a notable gap in students' deep understanding of AI concepts.

Long and Magerko (2020) found in their study that although students expressed enthusiasm for AI, many harbored misconceptions about its functioning and limitations. This reflects a crucial distinction: being familiar with AI technologies does not necessarily imply AI literacy. AI literacy includes not only knowing what AI can do but also understanding how it works, its limitations, and its ethical implications.

The integration of AI into science and technology education remains inconsistent and sometimes superficial. Some institutions offer specialized AI-related modules, while others briefly touch on AI as a subtopic within broader STEM subjects. Tuomi (2018) argues that "the

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educational systems are not yet prepared to provide the kind of AI literacy that the 21st-century society demands" (p. 37). This inconsistency can result in unequal learning outcomes, where some students graduate with a strong grasp of AI, while others lack even basic conceptual understanding.

Moreover, the pedagogical approaches used to teach AI play a significant role in shaping student understanding. Luckin et al. (2016) emphasize that effective AI education must extend beyond programming and technical skills to include critical discussions about ethics, algorithmic bias, and the broader impact of AI on society. Without this comprehensive approach, students risk developing a narrow or distorted view of AI, potentially overlooking its societal consequences and ethical dilemmas.

Given these concerns, this article aims to explore and analyze students' understanding of AI in the context of science and technology education. It seeks to investigate how students perceive AI, the depth of their conceptual understanding, and the challenges they face in learning about AI. This exploration is crucial for informing the development of more effective and inclusive AI education strategies.

By evaluating current educational practices and student perceptions, educators and policymakers can make informed decisions to enhance AI literacy. Ultimately, equipping students with a robust and ethical understanding of AI will enable them to become responsible innovators and critical thinkers in an increasingly automated and intelligent world.

As we progress further into the 21st century, the call for interdisciplinary knowledge becomes more pronounced. AI is no longer siloed within computer science; its applications are visible in biology (e.g., genomics), physics (e.g., modeling complex systems), and environmental science (e.g., climate prediction models). This convergence of AI and scientific domains raises new questions: How well are students in these fields equipped to navigate and contribute to such AI-infused knowledge landscapes? Are science and technology courses adequately preparing them for this reality?

Several studies underscore the importance of early and integrated exposure to AI concepts. For instance, Ng, Chiu, and Ip (2021) argue that students' attitudes and confidence toward AI are shaped significantly by how AI is framed within the curriculum and whether they are given opportunities for hands-on, problem-based learning experiences. A curriculum that merely introduces AI as a peripheral topic often fails to cultivate a deep, transferable understanding. Conversely, when AI is embedded into real-world scientific problems—such as using machine learning to analyze environmental data or simulate chemical reactions—students are more likely to appreciate its utility and limitations.

Furthermore, social and ethical dimensions of AI remain underrepresented in many technical courses. Without engaging students in discussions around algorithmic bias, data privacy, job displacement, and surveillance, educational programs risk producing graduates who are technically skilled but ethically unprepared. As Borenstein and Howard (2021) emphasize, "A holistic AI education must include socio-technical literacy, enabling students not only to build intelligent systems but also to anticipate their broader consequences" (p. 18).

This article recognizes the urgent need to assess not just what students know about AI, but how they come to know it—through what pedagogies, with what assumptions, and in which disciplinary settings. It is through this lens that we aim to explore the multifaceted nature of students' understanding. This includes examining cognitive comprehension, affective attitudes, and contextual awareness.

By mapping these dimensions, this study contributes to the broader discourse on STEM education reform in the AI era. It invites educators, curriculum designers, and policymakers to rethink current approaches and to consider more holistic, future-oriented strategies. The ultimate goal is to foster a generation of learners who are not only capable of using AI but also critically reflective about its implications for science, society, and the self.

REVIEW OF LITERATURE

The Emergence of AI in Education

Artificial Intelligence (AI) has gradually become an integral part of educational discourse, not only as a tool for enhancing teaching and learning but also as a subject of study in its own right. In the context of science and technology education, AI offers

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opportunities to support personalized learning, automate assessment, and simulate complex scientific phenomena (Holmes et al., 2019). With AI increasingly embedded in tools such as intelligent tutoring systems, adaptive platforms, and virtual laboratories, students are being exposed to AI-enabled environments even if they are not directly learning about the underlying mechanisms.

Luckin et al. (2016) argue that while AI can personalize and enhance learning experiences, its transformative potential will only be realized if students also gain a conceptual understanding of how AI works. Merely interacting with AI-powered tools does not equate to AI literacy. This distinction has prompted growing interest in explicitly incorporating AI education within science and technology curricula at both secondary and tertiary levels.

Defining AI Literacy

The concept of "AI literacy" is still evolving, with multiple scholars attempting to define its scope and components. Ng, Chiu, and Ip (2021) define AI literacy as a combination of knowledge, skills, and attitudes that enable individuals to understand, use, and critically evaluate AI technologies. Similarly, Long and Magerko (2020) emphasize that AI literacy involves both technical competencies (e.g., understanding algorithms, data structures, and model training) and socio-ethical awareness (e.g., bias, fairness, privacy).

A comprehensive framework proposed by Touretzky et al. (2019) includes four pillars: knowledge of what AI can and cannot do, understanding how AI systems work, awareness of societal impacts, and ability to interact with AI responsibly. This model is particularly relevant in science and technology courses, where students must learn to evaluate AI applications in empirical research, data modeling, and simulation-based experimentation.

Students' Misconceptions and Gaps in Understanding

Despite growing efforts to introduce AI in classrooms, studies indicate that many students hold inaccurate or overly simplistic views of AI. For instance, a study by Williams et al. (2022) found that students often associate AI exclusively with robotics or science fiction portrayals, lacking a clear understanding of machine learning, natural language processing, or neural networks. This phenomenon, sometimes referred to as the "Hollywood effect," can lead to inflated expectations or irrational fears about AI's capabilities.

Moreover, Chai, Zhang, and Tan (2021) observed that while students could describe AI applications in general terms (e.g., voice assistants, facial recognition), few could explain how these systems actually function or articulate the ethical issues they raise. These findings underscore a need for pedagogical approaches that go beyond surface-level exposure and foster deeper, more critical engagement with AI concepts.

Pedagogical Approaches to Teaching AI

Effective AI education in science and technology disciplines requires pedagogies that blend theory with application. Project-based learning, for example, has been shown to increase student engagement and conceptual understanding. Garcia-Sancho et al. (2020) argue that involving students in real-world problem-solving using AI tools not only enhances their technical skills but also helps them appreciate the interdisciplinary nature of AI.

Another promising approach is the integration of AI with ethical reasoning. As Borenstein and Howard (2021) contend, STEM students must be taught to think not only about how to build AI systems but also about whether those systems should be built—and under what conditions. Embedding ethics into AI education can encourage students to consider broader societal questions, such as algorithmic bias, data privacy, and accountability.

METHODOLOGY OF RESEARCH

Researcher use the literature review method by collecting, reviewing, and analyzing data from previous studies, by (literature review) taking the review method can be found in explanations put forward from the results of several experts that are relevant to the discussion that will be raised by researchers. The steps taken using the literature study method begin with obtaining relevant literature. Once obtained, it can be collected regularly and used later for research. The type of literature needed is a source of study material put forward by people and rewritten, such as in journals or textbooks. Data collection was carried out by analyzing journal articles from 2019-2023 that were considered relevant and representative from Google Scholar sources.

Research methodology on multilingualism allows for a wide range of approaches. While a great diversity of traditional methods of psycholinguistic and sociolinguistic research continues to be intensively employed by scholars, a significant change is taking place as new methods are developed or borrowed from neighboring disciplines, and also from seemin--gly distant ones (Aronin & Jessner, 2015).

Several programs have emerged to address this gap, such as the AI4K12 initiative in the United States, which outlines five “big ideas” for AI education: perception, representation and reasoning, learning, natural interaction, and societal impact (Touretzky et al., 2019). These frameworks offer valuable guidance for designing AI-related content in science and technology courses.

Despite these innovations, challenges remain in implementing AI education at scale. Many educators lack formal training in AI and feel unprepared to teach it (Zawacki-Richter et al., 2019). Additionally, science and technology curricula are often already crowded, making it difficult to introduce new content without displacing existing material. Institutional inertia and the absence of standardized learning objectives for AI further compound these challenges.

Institutional and Curricular Challenges

Despite these innovations, challenges remain in implementing AI education at scale. Many educators lack formal training in AI and feel unprepared to teach it (Zawacki-Richter et al., 2019). Additionally, science and technology curricula are often already crowded, making it difficult to introduce new content without displacing existing material. Institutional inertia and the absence of standardized learning objectives for AI further compound these challenges.

Furthermore, access to AI education is often uneven, with disparities based on geography, institutional resources, and student demographics. This digital divide can limit opportunities for underrepresented groups to engage with and benefit from AI learning (Holmes et al., 2019). Addressing these inequities requires policy-level interventions, professional development for educators, and open-access AI learning resources.

METHODOLOGY OF RESEARCH

This study used a descriptive qualitative approach to explore students' understanding, perceptions, and experiences related to Artificial Intelligence (AI) in the context of science and technology courses. The qualitative approach was chosen because it allows researchers to explore the subjective meanings, personal experiences, and social dynamics that influence students' understanding of AI concepts (Creswell & Poth, 2018).

Research Design

This research was designed as a qualitative study using a semi-structured interview technique. This strategy gives the researcher the flexibility to explore participants' answers in depth, while maintaining consistency in the themes being asked (Merriam & Tisdell, 2016). Interviews were conducted face-to-face or online, depending on the participants' circumstances and preferences.

Research Participants

The participants in this study were 18 undergraduate students from various majors in science and technology (e.g. electrical engineering, biology, environmental engineering, physics). A purposive sampling technique was used to select informants who were considered to have experience and exposure to AI technology, either directly through learning or indirectly through the use of AI-based applications (Patton, 2015). Inclusion criteria included: (1) active university students, (2) have basic knowledge or have used AI technology, and (3) willing to participate voluntarily.

Data Collection

The Data was collected through semi-structured interviews lasting between 30-45 minutes. The interview guide included questions regarding students' definition of AI, their experiences using AI technologies, perceptions of AI's social impact, and their expectations for AI learning in higher education. All interviews were recorded with participants' permission and transcribed verbatim for analysis.

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Data Analysis

The data were analysed using a thematic analysis approach as developed by Braun and Clarke (2006). The analysis process was conducted through six stages: (1) familiarisation with the data, (2) initial coding, (3) theme search, (4) theme review, (5) theme naming, and (6) report preparation. Analysis was conducted manually and assisted with qualitative data processing software (NVivo) to maintain consistency and transparency in the categorisation process.

Data Validity

To ensure data validity, triangulation of methods (by comparing field notes and interview transcripts), member checking (confirming interpretations with participants), and peer debriefing (discussion between researchers) were conducted. These techniques are important to minimise interpretive bias and increase the credibility of the research results (Lincoln & Guba, 1985).

RESULTS AND DISCUSSION

Result

This study revealed diverse understandings, experiences, and perceptions of artificial intelligence (AI) among students enrolled in science and technology courses. Through thematic analysis of 18 semi-structured interviews, four major themes emerged: (1) fragmented conceptual understanding of AI, (2) everyday representations of AI, (3) ethical and social perceptions, and (4) the need for contextualized and interdisciplinary AI education.

Fragmented and Partial Conceptual Understanding

Most participants demonstrated a limited and often fragmented grasp of fundamental AI concepts. Although nearly all had heard of AI, many associated it primarily with popular media portrayals such as advanced robots or automated systems, rather than data-driven algorithms and machine learning principles.

"I think AI is like robots in movies. But when asked what machine learning is, I can't really explain it,"— (Electrical Engineering Student, Interview 4).

This aligns with findings by Long and Magerko (2020), who note that students' understanding often relies more on media narratives than scientific foundations. The gap was also attributed to the lack of explicit AI instruction in non-computer science courses.

Everyday Representations: Using AI without Understanding It

Participants recognized AI's presence in their daily lives through technologies such as video recommendations, virtual assistants, and targeted advertising. However, they used these AI- driven tools without fully understanding how they function.

"When I open YouTube, it shows videos I like. My friend said that's AI at work, but I don't really know how it figures that out."— (Biology Student, Interview 2).

This phenomenon reflects what Holmes et al. (2021) describe as "AI in use but not understood"—the widespread use of AI technologies without corresponding literacy.

Ethical Awareness and Social Concerns

Interestingly, most students exhibited a relatively sharp ethical awareness regarding AI's societal risks. They voiced concerns about digital surveillance, job displacement, and algorithmic bias. Many learned about these issues through social media or news rather than formal coursework.

"If AI becomes too advanced, it might replace all human jobs. Especially if the data it learns from is biased, it could harm certain groups."— (Computer Science Student, Interview 6)

As emphasized by Cowls and Floridi (2018), incorporating ethics into AI education is crucial not only to cultivate technically competent users but also responsible digital citizens.

Need for Contextualized, Interdisciplinary AI Education

Students expressed a strong desire for AI education that is more applicable, integrated within their disciplinary context, and delivered in accessible language. They felt current approaches were overly technical and disconnected from the relevance of AI to their fields.

"I want to learn AI, but not coding. I'm more interested in how AI can help my research in environmental science."
— (Environmental Engineering Student, Interview 10)

This echoes recommendations by Tuomi (2018) and Chai et al. (2021), who advocate for cross-disciplinary and context-based AI education to foster broader engagement.

Inequitable Access and Lack of Confidence

Some students, especially those from non-technical backgrounds or regions with limited resources, reported feelings of being left behind and lacking confidence to engage with AI. They perceived AI as an "elite" domain, accessible only to those with strong mathematical or programming skills.

"Honestly, I feel intimidated. AI seems complicated and only for smart people who understand math."— (Physics Student, Interview 13).

This highlights the importance of inclusive and empowering educational designs, as discussed by DiPaola et al. (2020) in their approach to computational creativity education.

Discussion

The present study sheds light on the nuanced and often fragmented understanding of artificial intelligence (AI) among students enrolled in science and technology courses. The qualitative findings reveal several important insights into students' conceptualizations, perceptions, and educational needs regarding AI.

Fragmented Conceptual Understanding and Media Influence

Consistent with Long and Magerko's (2020) findings, students' conceptual knowledge of AI remains partial and heavily influenced by media representations. This reliance on popular culture often leads to anthropomorphized or oversimplified notions of AI as robots or intelligent machines, rather than data-driven algorithmic processes. Such misconceptions may hinder deeper engagement with the subject and negatively impact students' ability to critically assess AI technologies.

The gap between awareness and understanding underscores the need for educational interventions that clarify core AI concepts in accessible terms. As Holmes et al. (2021) emphasize, developing AI literacy requires moving beyond surface-level familiarity toward fostering deeper technical and conceptual competencies.

Everyday AI Use Without Understanding

The finding that students commonly interact with AI technologies without understanding their mechanisms echoes the concept of "AI in use but not understood" described by Holmes et al. (2021). This disconnection can lead to passive consumption and uncritical acceptance of AI outputs, which may exacerbate issues related to misinformation, bias, and ethical misuse.

Educators should therefore aim to bridge this gap by integrating hands-on experiences and transparent explanations of AI systems within curricula, enabling students to become informed and critical users of AI.

Ethical Awareness as a Strength and Educational Opportunity

Interestingly,students demonstrated relatively sophisticated awareness of AI's ethical and social implications, such as privacy concerns, job displacement, and bias. This awareness often stemmed from informal sources such as media rather than formal education, indicating a missed opportunity for structured ethical discourse in the classroom.

Integrating ethics into AI education is crucial for developing responsible AI users and creators, as suggested by Cowls and Floridi (2018). Educational programs should incorporate discussions of algorithmic fairness, accountability, and societal impact to empower students to navigate AI technologies critically and ethically.

Calls for Contextualized and Interdisciplinary AI Education

The expressed desire for AI learning that is contextualized within students' own disciplinary domains highlights the importance of interdisciplinary approaches. This aligns with Tuomi's (2018) advocacy for AI literacy that spans across disciplines rather than remaining siloed in computer science.

By contextualizing AI applications relevant to specific fields—such as environmental monitoring in ecology or diagnostic tools in medicine—educators can enhance students' motivation, relevance perception, and practical competence in AI.

Addressing Inequities and Building Confidence

Feelings of intimidation and low confidence, particularly among students from non- technical backgrounds, point to critical equity challenges in AI education. As DiPaola et al. (2020) suggest, educational designs must be inclusive and scaffold learning to demystify AI and lower barriers to entry.

Providing differentiated instruction, accessible materials, and supportive learning environments can help broaden participation and foster self-efficacy, enabling more students to engage meaningfully with AI.

CONCLUSION

This study explored students' understand-ding of artificial intelligence (AI) within science and technology courses through qualitative inquiry, revealing a complex interplay of fragmented conceptual knowledge, everyday use without deep understanding, ethical awareness, and educational needs.

While students commonly recognize AI as a powerful and pervasive technology, their comprehension remains partial and often shaped by popular media rather than formal education. This gap limits their ability to critically engage with AI tools and concepts. At the same time, students exhibit a notable ethical sensitivity toward AI's societal impacts, underscoring the importance of integrating ethics meaningfully into AI curricula.

The expressed desire for more contextual-lized, interdisciplinary AI education reflects students' need for learning that is both relevant and accessible. Addressing inequities in confidence and access, particularly for non-technical students, remains a critical challenge that requires inclusive and scaffolded pedagogical strategies.

Implications for educators and curriculum designers include prioritizing clear communica-tion of core AI concepts, embedding ethical and social considerations throughout learning experiences, and fostering interdisciplinary approaches that connect AI to diverse fields of study. Equally important is cultivating an inclusive environment that supports all students in building competence and confidence in AI.

Future research should evaluate the effectiveness of tailored interventions in enhancing AI literacy across different disciplines and demographics. Ultimately, equipping students with robust AI understanding is essential to prepare them as informed users, creators, and citizens in an increasingly AI-driven world.

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