A Research Study on Student Conceptions of Artificial Intelligence

Ashish Hingle, George Mason University

Ashish Hingle (he/his/him) is a Ph.D. student in the College of Engineering & Computing at George Mason University. His research interests include engineering ethics, information systems, and student efficacy challenges in higher education. Ashish gra

Dr. Aditya Johri, George Mason University

Aditya Johri is Professor in the department of Information Sciences & Technology. Dr. Johri studies the use of information and communication technologies (ICT) for learning and knowledge sharing, with a focus on cognition in informal environments. He also examine the role of ICT in supporting distributed work among globally dispersed workers and in furthering social development in emerging economies. He received the U.S. National Science Foundation's Early Career Award in 2009. He is co-editor of the Cambridge Handbook of Engineering Education Research (CHEER) published by Cambridge University Press, New York, NY. Dr. Johri earned his Ph.D. in Learning Sciences and Technology Design at Stanford University and a B.Eng. in Mechanical Engineering at Delhi College of Engineering.

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Ashish Hingle and Aditya Johri

College of Engineering & Computing, George Mason University, Fairfax, VA, USA

Abstract

Artificial Intelligence (AI) discussion is commonplace in news-media, policy circles, and popular culture today. A basic level of AI literacy is fundamental to understanding this world-shaping technology, especially for engineering students. However, these concepts are often ambiguously defined with varying expertise, understanding, and imagination levels. This study explores how first- and second-year engineering students define artificial intelligence and the sources influencing their knowledge. We collected survey responses from sixty-one (61) students in an engineering college in the US and conducted a thematic analysis. Overall, we found that students primarily described AI through hardware or software and questioned AI's expected level of expertise. In addition, students were influenced mainly by popular culture and digital media. We discuss how these findings can be used to improve teaching and learning environments. This work highlights the continued need to explore students' underlying assumptions and knowledge brought to the classroom.

Keywords

Artificial Intelligence, AI Literacy, AI Competency, AI Imagination, AI Concepts

Introduction

Artificial intelligence (AI) has been a component of scholarly and literary imagination for decades before we had the tools or technology to enact it in real-world settings. AI has appeared in popular culture through books, television shows, and music, "illuminating human's complicated fears and yearnings towards technologie""[1]. However, over the past decade, technology has advanced to a point where artificial intelligence can realistically do some of the actions book authors wrote and movie producers directed. The advancement of AI technologies has rapidly introduced changing levels of complexity, making it challenging to describe to the ordinary person. In addition, there is a level of obscurity that AI sits behind: does AI refer to the decision-making process, the algorithm, or the system as a whole? Perhaps AI refers to all three of these components. Or maybe AI can also refer to other technologies built into the system to help the intelligence function. The ambiguity with which AI is described in both scholarly and literary media affects how the average person explores and understands this topic.

Popular media further enforce the ambiguity of what AI refers to, discourse through social media applications, and people's past experiences. News articles discussing AI topics have increased since 2009, representing both positive and negative sentiments about its adoption[2]. News articles shared in bite-sized chunks perfect for social media sharing can introduce new concepts to everyday people but can also reinforce misinformed ideas or talking points[3]. New AI implementation issues, such as bias, digital privacy, and security, need to be explained[4]. Movies

and books can expand the imagination of their audience to explore the possibilities of technology in new ways. However, a distinction must be made between what is fact and fiction, what is possible with our technology today, and what can be achieved.

Students coming into technology-focused programs are also subject to these depictions in popular media and have their own understanding of what AI is. The experiences students have may position them to have varying knowledge of AI and even perhaps their overall image of what an AI future looks like. To better understand how first- and second-year engineering students conceptualize AI, we conducted a thematic analysis of student responses framing their understanding of AI concepts. Additionally, we explore the influences of their AI knowledge to understand better how to have conversations on the topic.

The following research questions were addressed in this study:

1. What do first- and second-year engineering students identify with the concept of "Artificial Intelligence"?
2. What influences do first- and second-year engineering students identify with the conceptualization of "Artificial Intelligence"?

Related Work

Research about AI literacy has increased significantly as AI technology has become ubiquitous in developing a product or service over the past decade. Several large-scale systematic reviews have already explored what research on AI literacy conceptualization may become more prominent in the coming years. Long and Magerko[5] examined AI literacy conference papers, journals, books, and grey literature and established a list of seventeen competencies, including *"Recognizing AI," "Imagine Future AI,"* and *"Ethics,"* and fifteen design considerations. Ng et al.[6] explored how researchers define AI literacy, how educators implement literacy approaches, and how they evaluate skills. The authors found that overall, the papers predominantly focused on "*Applying AI knowledge, concepts and applications in different scenarios*" and *"Know the basic functions of AI and how to use AI applications,"* and a variety of pedagogical tools were being implemented for AI literacy interventions [6].

However, these reviews also highlight that AI literacy definitions and procedures are not standardized; researchers are still exploring new techniques and strategies to conceptualize what being AI literate is. Work on AI literacy is still in its beginning stages, and there is still much potential for development [5]. As a limitation of the review, [6] mentions, "There is a need for empirical work to develop in-depth knowledge about AI literacy, its assessment, and the benefits it brings to those who possess it in the workplace" [pg. 11].

Much of the work on AI literacy has focused on defining literacy measures and techniques. Fewer studies have focused on what influences affect AI literacy. Mertala et al.[7] found that young students placed AI on a spectrum of ubiquitous technology and could identify it through micro, exo, and macro levels. Students commonly identified AI with "robots," and the authors posited four explanations; 1) robots give form to the abstract concept of AI, 2) robots are commonly programmed with AI functionalities, so they naturally are seen together, 3) they are

both conceptualized with anthropomorphic tendencies, and 4) "both robots and AI are commonly represented as replacers of the human workforce and providers of help in media texts" [pg. 8].

More generally, science fiction works have been connected with digital imagination and worldbuilding for future technologies[8]. News media has also been widely able to raise conversations on AI topics. However, news articles on AI often raise general questions rather than going to specific details on the topics[1]. In creating sensational titles, news articles have targeted non-technical fields to show the widespread nature of AI adoption; for the fashion and modeling industry[9], digital artists[10], and writing novels[11].

Methods

We used a thematic analysis approach as outlined by Braun and Clarke[12] to code the data and identify overarching themes inductively. The authors identify semantic and latent levels of analysis in engaging with the data. For this study, we first used a semantic lens, exploring only what the students discussed in their responses to the questions posed in the survey. We then used a latent lens to explore the implications of the definitions. The primary reason is that we explore discrepancies and understanding through the language and context in which students explain the definitions. However, we used the latent lens to explore some topics.

Participants

This study was conducted in the College of Engineering at a large public University in the US. Data were collected from sixty-one (61) student participants in an undergraduate course, technology in the global economy. Specifically, the course addresses the social impacts of technology in everyday life and introduces concepts such as ethics, algorithmic thinking, and societal concerns about using technology. The course also addresses privacy, surveillance, and automation, in addition to innovative research on topics such as "Digital Twins."

Data Collection

The initial class session broadly introduced the topics covered throughout the course. However, the first class did not define the concepts addressed in this study in detail or provide additional resources. Data for this study were collected in the first week of the course during a fall 2022 iteration. Students completed a reflection assignment to gauge their understanding of AI concepts and what influenced their knowledge before being exposed to the course topics. The questions posed to the students were left open-ended to allow students to provide their understanding of the concepts. The students were not given possible influences at this point to avoid potentially affecting their answers. The specific instructions in the assignment were to answer the following questions:

1.   What do you think of when you hear the phrase "Artificial Intelligence"?
2.   What do you think your definition of "Artificial Intelligence" is most influenced by?

Results & Discussion

There were four overall themes for each of our research questions. The following sections provide some examples from the student discourse on each theme. As students were defining AI

as a broad concept, we highlighted specific themes through the discourse in each section highlights specific themes and provided context for other themes discussed. The student responses were edited for anonymity.

The first research question was posed to understand what students associate with the term "artificial intelligence." For many, AI is a broad concept that can be difficult to describe directly. In addition, students come to college at different levels of conceptual understanding and may associate some miscommunication with what AI is. Student responses outlined the following themes: 1) The Agent in AI systems, 2) Human-like thinking, or more, 3) Human Interaction with AI, and 4) Societal Impacts.

<u>The Agent in AI systems</u>

Throughout the student responses, the ambiguity of defining AI was prevalent. This was presented through the various student descriptions for the "agent" in the AI system. Students shifted between different terms to conceptualize what AI is. The agent, which can also be described as the central unit in an AI system, varies by student definition. Some students described AI as hardware, specifically as a computer, device, or physical item:

The first thing that comes to my mind when I hear Artificial intelligence is computers or any type of machine that works to make life easier. [Student 1]

For these students, AI was embodied in an agent that interacted with people and completed a specific action. Students that described AI in this way seemed to view it as predominantly a hardware device or machine aimed at accomplishing a mundane or repetitive task that saved human time. Within this group of hardware-focused definitions, many students specifically highlighted "robots":

When I hear the phrase 'Artificial Intelligence,' I think of robots or self-driving cars who have the closest possible ability to be human like with the only true difference being that they are programmed by a computer and lack true human empathy and emotions. [Student 2]

The synonymous of AI and robots were prevalent throughout the discussions. This student and others that responded with similar definitions seemed to indicate that because of the precision with which AI systems work, AI represents intelligence beyond human levels and is unobstructed by human limitations. This finding mirrors those of [7], who also found "robots" commonly used to describe AI.

Other students regarded AI as referring primarily to software, algorithms, code, and programs:

I think of artificial intelligence as programming that can think for itself. However, the level of complexity that the program may have could impact its full potential. [Student 3]

These students described programs and algorithms as the primary process of AI. However, the hardware components were not defined or described as enabling the software to work.

Human-like thinking, or more?

A second theme that students brought was comparing the intelligence level represented in AI to that of humans. Overall, most students described AI as a system that mimics human thinking:

When I hear Artificial Intelligence, I think of robots or devices programmed to have almost the same intelligence as humans, for example, things like Apple's Siri, Hey Google, or Amazon's Alexa. These programs are designed to make certain things easier for humans, for example, finding a song, adding things to your shopping cart, translating words, and so many other things. [Student 4]

This student highlights the AI being used to complete everyday tasks with "almost the same intelligence as humans." Human-like intelligence was often referred to as the benchmark by many of the student's responses.

Other students viewed the representation of intelligence in AI to be better than that of humans:

Robots that are programmed by humans to be better than humans in certain tasks. [Student 5]

This student highlights the association between a robot being imbued with the ability to make decisions better than any human could, but only at specific tasks. Some student responses took this idea further in describing AI as a being or intelligent life:

I think of the idea of "Man trying to be God" by creating an intelligent life of its own. [Student 6]

While perhaps hyperbolic, this sentiment of humans creating intelligence, in the sense of an agent that can think and behave for itself, surfaced several times through the responses. But on the other hand, some students argued that even good AI was a flawed representation of intelligence:

Intelligence that isn't by humans. It is by machines, and it is getting better enough to do things humans can. However, it cannot fully think like a human. [Student 7]

Although AI systems can behave human-like in some ways, these responses seemed to argue that no matter how good AI got, it would never be able to think or act like human beings fully.

Human Interaction with AI

Our third theme was how AI could function independently without the oversight or assistance of human interaction. This was the predominant stance as opposed to an environment where AI systems heavily rely on human interaction and collaboration (which is perhaps closer to reality):

I think of complex algorithms that aim to do autonomous, day-to-day tasks without human error. One of its main purposes is to take away tasks from human workers in order to focus on more meaningful tasks. [Student 8]

This student describes an environment where AI takes away time-consuming tasks that allow human workers to focus on more "meaningful" tasks. Job loss due to automation and reliance on

AI systems is a booming discussion that is often brought up in general media conversations. However, not all the students described AI with this level of independence:

More specifically, I think "Artificial Intelligence" involves a computer or robot having the ability controlled by a human in order to do tasks that are typically completed by humans due to the requirement of both human intelligence and discernment. Regarding the purpose of artificial intelligence, it allows technical systems to recognize and understand their environment, handle what they perceive, solve problems as well as act to achieve a particular goal. The computer is given data, processes it, and responds. [Student 9]

This student took a contrary position, where the system was designed to be controlled by a user. In reality, this is perhaps a more accurate representation of what AI can and will be able to do for the foreseeable future.

Societal Impacts

Some of the student's responses also highlighted the overall societal concerns of AI through their definitions. While not required to answer the question, the inclusion of the societal impact can highlight the connotation with which students are engaging with AI outside of the classroom. Some students weighed the benefits of AI with the consequences:

Artificial intelligence is a subject that many people have positive and negative thoughts. Like some people may agree that this will be helpful, but on the other hand in the long-term, it could not be. As an example, with artificial intelligence, we could create robots integrated with a computer that could take decisions and our lives become better by reducing some process that may take a long time to do for humans, but a negative impact of this will be that many jobs will disappear since computers will replace them. [Student 10]

This student introduces the dichotomy of the potential benefits and harms of AI. Contrasting with how Student 6 described AI, the question of job loss is raised and weighed against the benefit of not having to do more straightforward tasks. Some students elaborated on potential ways to address these concerns, including actively managing the impacts of AI:

AI has allowed benefits such as increasing efficiency, saving cost (long term), reducing human errors, etc. The risk of the introduction of AI is it lacks creativity/emotion, job losses, privacy/security threats, and much more. Although these disadvantages may seem alarming, humans must adapt to a path that successfully manages AI in order to expand our society's limits on technology. [Student 11]

Overall, students defined AI with a focus on hardware, and robots, which could think and work independently with little to no human interaction once started.

The second research question was posed to understand what students self-described as the influences on their definitions of AI. Student responses outlined the following themes: 1) The Role of Print and Video Media, 2) Online Discourse through Social Media, 3) Educational Interests and Coursework, and 4) Past Experiences with Technology.

The Role of Print and Video Media

Overall, we found that students largely credited their understanding of AI concepts on their interactions with pop culture, print, and video media. This includes movies, books, TV shows, and video games:

I think my definition of Artificial Intelligence is most influenced by it being this 'futuristic idea' through television or movies. [Student 2]

As many of the student respondents outlined, imaginative representations of what AI could be primarily influenced their definitions. Some students called out movies specifically beyond the grouping, especially highlighting dystopian visions of AI:

I think the definition of artificial intelligence is mostly influenced by the movie industry. AI is always portrayed as smart robots often turning against humans. The majority of people think as such when hear about AI. [Student 12]

The dystopian view of what AI could become is prevalent in sci-fi movies, which are already a massive portion of film productions.

Online Discourse through Social Media

We found a second significant, influential source to be conversations about AI in news and popular media:

To be honest, a lot of readings and YouTube videos influenced my views on artificial intelligence. There was a YouTube clip where an AI was being interviewed and it blurted out "We will destroy all humans." I know that may sound a little silly, but I strongly believe that humans need to remain control of all technologies created. [Student 13]

It is common for students to interact with videos on social media platforms such as YouTube, Tik Tok, Facebook, and Instagram, so it makes sense that this is an influential source of information. Additionally, creator incentives also encourage conversations on AI developments.

Educational Interests and Coursework

Several students acknowledged educational interests as an influence:

*In my past semester, I did a research report about the many aspects that surround artificial intelligence. I believe that my definition of artificial intelligence is most influenced by the reports of others and the way that they have described the many aspects of AI technology. Based on the information found in these reports, that is how I learned about what AI technology was, how it is shaping the world and how the world will be impacted by this technology in the future. With the newfound knowledge I gained, I am now able to make my own assumptions about the way that AI will impact society and use this to make my own definitions surrounding that specific topic.
[Student 14]*

This student and others who highlight educational interest often cited research or assignments they were tasked with exploring topics surrounding AI. They may not have taken classes on AI specifically, but questions on, for example, the future of work in an AI world, were topics that came up in other courses.

<u>Past Experiences with Technology</u>

The final theme was of having past experiences with AI-based technologies:

I think my definition of Artificial Intelligence is influenced by what I use such as I use face ID every day to unlock my phone, and also, I love using filters on Snapchat. I also would say there's an influence from the classes I have taken. [Student 15]

Many students could identify everyday uses of AI through social media, specifically filters, voice modulation, and even deepfakes. However, these topics have been explored in news and media articles too.

Recommendations from our Findings for Instructors

This study provides insights into first- and second-year engineering students' definitions and influences of AI. In addition, the study highlights the empirical influences of AI conceptualization from our engineering students' viewpoint. Some of these findings can be used to influence and inform how instructors approach AI. The recommendations highlighted below reflect the findings of this study and our own experiences with students about AI adjacent technologies.

Firstly, it is fundamental to acknowledge that students will come into the classroom with different understanding levels and preparedness about AI concepts. The scale of recognition and understanding may be broad, especially when working with first- and second-year students. Many of these students may entirely rely on external sources of influence, as is apparent through the response to the second research question. Initiatives focusing on introducing AI concepts to students before college, in middle school, or earlier often depend on the school system and the funding available. Instead of assuming that all the students in the classroom explicitly understand artificial intelligence concepts at the same foundational level, it is an equitable practice to establish what these concepts mean early in the course. Considering the context of AI in the specific course is also important. For some courses, a basic overview may be sufficient to ensure that all the participants share the foundation for the remainder of the course. For others, however, providing definitions, readings, and other resources during the first week of the course may be necessary to give the students an understanding of positionality and expectations of using AI concepts in the course. Accounting for the differing levels of knowledge is perhaps the most crucial recommendation as we advance.

Secondly, courses should take advantage of students' interests in creating learning experiences and engagement. Through the data we collected, students outlined how their knowledge of AI concepts references popular culture, news media sources, and other social forms of digital information dissemination. There is a natural opportunity here to engage students with language and context with which they are familiar. Instructors should adapt learning resources, assignments, and assessments to build on these already existing influences. By doing so,

instructors can create learning opportunities on topics that are interesting and relevant to students and bring in cases that are timely conversation pieces—allowing students to work with contextually interesting data or theories within the context of accomplishing the class's learning objectives. For example, in a machine learning course, allowing students to find and use a dataset associated with their favorite books, movies, or other forms of pop culture may enable them to not only learn the techniques being taught but also question the data in ways that someone closer to the topic could. In this context, students who consider themselves cinephiles may be better suited to find and work with erroneous data or understand where natural relationships between genre and audience occur. Augmenting student interest is not a new idea but one that is perhaps underutilized in exploring 'difficult' technical topics. This practice may come with its own set of hurdles to overcome but may be more well-received regarding interest and attention from students.

As an extension to the second recommendation, conversations about the societal implications of AI should be brought up with students in an engaging way beyond simply providing them with articles to read. The study's findings indicate that students are aware of conversations about the societal impact but are limited to the type of online buzz common in news and media outlets. The use of an interactive medium such as roleplaying (Hingle & Johri, 2022). should be explored and implemented if possible. Students' sentiment toward the societal implications of AI needs to be developed more in the classroom, especially in technical courses where the focus may be more on learning techniques. If instructors can, they should engage students by exploring what conversations are being discussed by leaders and experts in the field and find ways to bring these conversations in on an everyday basis. Ethics should not be a conversation for the final weeks of a course but rather an ongoing one throughout the course.

Limitations

There are some limitations to the study. First, although the course is required of all students in the engineering college, and they are encouraged to take it earlier in their program, some students may have taken courses that address topics concerning AI already. In completing these types of classes, the students will naturally be exposed to definitions and research on the subject. However, this is perhaps representative of real-life situations where students could have taken a course at a different program (in the case of transfer students) or online before signing up for this class.

Conclusion

Exploring college students' understanding of AI is an important step to personalize learning about the topic and associated technologies. More effort must be made to clarify and distinguish the meanings of ideas if students enrolled in a class have marginally different definitions for the basic terminology of the class. Additionally, the influences on these definitions that students have experienced need to be better understood as there is an opportunity to elaborate and communicate through them. Most of our students noted their ideas of AI being influenced through a lens of imagination and pop culture; robots take away work's monotony. How can these influences be used to clarify meanings, explain reality, and explore new ideas? For those who cited an interest in technology and AI as a key influence, how can we reach others who may not be initially interested? There is still much work that should be explored in this area.

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Ashish Hingle

Ashish Hingle is a PhD students in the College of Engineering & Computing, George Mason University.

Aditya Johri

Aditya Johri is Professor of Information Sciences & Technology, College of Engineering & Computing, George Mason University.