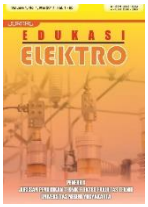
Volume 8, No. 2, November 2024, pages 198 - 207

JEE

Jurnal Edukasi Elektro

https://dx.doi.org/10.21831/jee.v8i2.78448



Perception of Electrical Engineering Students in Aceh towards the Application of Artificial Intelligence in the Digital Era

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Abstract— The goal of artificial intelligence is to build robots that can learn, reason, and adapt to carry out complicated tasks. The research aims to provide essential guidance to enhance students' knowledge related to artificial intelligence devices. The highlights of the need for Indonesian engineering students to align their competencies with the 4.0 industrial revolution by developing knowledge in adopting artificial intelligence to improve Indonesia's technological standing in fields such as power electronics. The respondent of the study involved 125 electrical engineering students in Aceh. The questionnaire is the chosen instrument aimed at obtaining perceptions from electrical engineering students regarding their knowledge of artificial intelligence devices. The research revealed that electrical engineering students in Aceh struggle with understanding artificial intelligence applications due to limited exposure, a lack of expert guidance, unfamiliarity with programming elements, and insufficient explanation of AI concepts in their curriculum.

Keywords: artificial intelligence, knowledge, electrical engineering

Article submitted 2024-10-20. Resubmitted 2024-11-12. Final acceptance 2024-11-14. Final version published as submitted by the authors.

1 Introduction

1.1 Artificial Intelligence Definition

Artificial intelligence (AI) is a machine programmed to follow a set of instructions and operate according to the programmed settings. AI is an effort aimed at designing computer systems that think like the human brain. Artificial intelligence is a technological advancement with the potential to significantly transform the way we teach and learn [1]. These systems are capable of learning, reasoning, and adapting to new information, allowing them to perform complex tasks such as decision-making, problem-solving, and pattern recognition with minimal human intervention. The integration of these capabilities enables AI systems to operate autonomously in various fields, including education, where they can optimize processes, enhance efficiency, and provide innovative solutions to challenging problems [2], [3].

AI is divided into three stages [4]. The first stage is artificial narrow intelligence (ANI). At this stage, AI can perform tasks easily. The next stage is artificial general intelligence

(AGI). At this stage, AI systems are capable of thinking like the human brain. Though they lack true consciousness or self-awareness. Instead, AI mimics cognitive functions such as learning, reasoning, and pattern recognition by processing vast amounts of data and identifying patterns at a speed far beyond human capability Machines/technologies at this stage can work faster than humans because they can perform detailed numerical calculations. The final stage is artificial superintelligence (ASI), where AI has surpassed human thinking and is widely used in various aspects, such as smart robots. At this stage, ASI possesses the capability to independently solve complex problems, make decisions, and innovate beyond human limitations, leading to transformative changes in industries, economies, and society.

AI Based on Intelligence Level, divided into, Narrow AI, which designed to perform specific tasks well, such as facial recognition, virtual assistants and recommendation systems. Superintelligent AI which aims in a theoretical concept and there is no real implementation at the moment. However, AI based on its methods, separate into machine learning, natural language processing and computer vision. Machine learning is a subfield of AI that focuses on developing algorithms that enable systems to learn from data and improve their performance over time without explicit programming. Then, Natural Language Processing (NLP) is a branch of AI that deals with the interaction between computers and humans through natural language. Last, Computer Vision which enables computers to understand and process visual information from the world, such as image and video recognition [4].

Using AI techniques like machine learning, computer vision, and natural language processing to analyze data can help address instructional and administrative inquiries, uncover hidden relationships and patterns, forecast learning outcomes, and automate routine decision-making processes [5]. AI in schools provides numerous opportunities for administrators, teachers, and students. For instance, ChatGPT, specifically the latest version GPT-4, is incorporated into tools like Microsoft Office, Edge, and Bing, helping streamline various educational activities [6]. ChatGPT enables interactive learning by providing real-time answers to student questions, while Canva helps create visual representations of concepts in a creative way [7]. Together, these tools enhance the educational experience by promoting engagement and fostering a deeper understanding of the material, ultimately equipping students with the skills necessary for success in a digital age.

The results of this research are expected to serve as a foundational guideline for the learning aspects and curriculum of electrical engineering, aimed at enhancing the knowledge of electrical engineering students regarding artificial intelligence. Thus, the research findings can determine the extent of knowledge about AI devices. Together, these tools enhance the educational experience by promoting engagement and fostering a deeper understanding of the material, ultimately equipping students with the skills necessary for success in a digital age. To improve AI literacy and make people more equipped to handle and make use of AI technologies in both their personal and professional life, this understanding can guide educational strategies and policies.

In general, college students will experience a period of unemployment due to a lack of knowledge in AI tools that are needed in the workforce. a lack of clear understanding of how AI-powered tools would function [8]. Students often find it difficult to keep up with the latest developments, especially when the technology they are learning does not yet meet

industry needs. Otherwise, some universities do not have adequate laboratory facilities to support the exploration of the latest technologies, such as robotics, renewable energy system simulations, or modern communication networks. The lack of lecturers specializing in the latest technologies, such as artificial intelligence, smart grids, or quantum computing, causes the learning process to be less in-depth and relevant to current trends. Currently, the industry requires expertise in electrical engineering accompanied by skills in programming, data analysis, and project management. Many students lack education on technology entrepreneurship or how to commercialize their technical ideas, which makes them less interested in becoming future innovators. Impact of these problems, students faced struggle to have the practical applications of their technical skills in the classroom.

According to research by Chen (2020), In this study, the AI algorithm is designed to adjust the learning materials and methods according to the abilities and learning styles of each student [9]. On another, stated that AI (virtual assistants) can help answer general programming questions, provide personalized solutions, and enhance learning effectiveness [10]. From lecturer's perception, AI-based analysis can provide insights for lecturers about student engagement and help in delivering more targeted support [11]. It can be concluded that the application of AI in education can provide significant benefits to the learning and teaching process. AI can adjust the material and teaching methods according to the abilities and learning styles of students and engage students in programming questions personally.

This gap in knowledge can hinder their competitiveness in the job market, making it crucial for educational institutions to integrate AI training into their curricula and provide students with hands-on experience using these essential tools. Therefore, this research is conducted to determine the level of knowledge of AI tools among electrical engineering students. The findings of this research will provide insights into the gaps in AI-related their knowledge, allowing educators to design more effective curricula that equip students with the necessary competencies to meet the demands of the modern workforce.

1.2 Theory of AI

AI is typically described as the replication of human intelligence in machines. Intelligence itself is a broad and intricate concept that includes various abilities [12]. These abilities encompass learning from experience, adapting to new situations, understanding and applying knowledge, reasoning, and solving problems, all of which are key components of what we consider intelligence [13].

Connectivism theory is referred to as a theory that influences technology learning. Connectivism is the integration of principles explored by networks, complexity, and self-organization theory. It emphasizes the role of technology and social connections in the learning process, suggesting that knowledge is distributed across a network of connections and that learning consists of the ability to navigate and draw from these networks effectively.

Constructivist theory provides students with the opportunity to try new things that will become their new experiences in learning [14]. Students will be encouraged to express creative new ideas based on those experiences. The theory of constructivism in learning posits that the teacher is not the sole source of knowledge; students (learners) are more active and creative because they have the freedom to learn, making the learning process more

meaningful. Students can interpret multiple realities, which helps them become better equipped to face real-life situations. Understanding different points of view develops critical thinking, sharpens problem-solving techniques, and equips students to function more adaptably and empathetically in challenging social and professional contexts [15], [16].

The term "Diffusion" refers to the meaning of dissemination. In a social context, it means spreading new ideas within society, while the word "innovation" signifies a form of idea, concept, or recent discovery by an individual or a group in society. Diffusion is a useful tool for the deliberate diffusion of innovations [17]. It makes it easier for innovative concepts, methods, and technologies to proliferate throughout diverse groups or communities, facilitating the quicker acceptance and modification of innovations to satisfy the demands of diverse stakeholders.

Besides those theory, there were another theory which support AI. Intelligent Agent Theory in one of theory which perceive an environment and take actions to achieve the goals. The Virtual assistants like Siri and Google Assistant are kind of intelligent agents that respond to user commands. Another theory is Machine Learning Theory. It is a subfield of AI that focuses on the development of algorithms that enable systems to learn from data without being explicitly programmed. The example of Machine Learning Theory, the algorithm used by Netflix or YouTube recommendation systems.

Theory of Artificial Neural Networks (ANN) is computational models inspired by the biological neural networks in the human brain. ANNs consist of several layers of artificial neurons that process information in a manner like the brain. The example of ANN is Deep learning is a form of neural network that has many layers (deep networks). Further AI theory is Symbolic Processing Theory (Symbolic AI). This theory uses symbolic representations (symbols and logical rules) to solve problems and perform tasks. Rule-based systems and expert systems are the example of Symbolic AI which used for medical diagnosis in the 1980s. Next, Fuzzy Logic Theory, that AI systems to operate with uncertainty and imprecise or ambiguous information. In fuzzy logic, values are not just "true" or "false" as in binary logic, but can be somewhere in between, such as "somewhat true" or "somewhat false." Furthermore, Theory of Genetic Algorithm Evolution, which inspired by the process of natural selection in biology. In this algorithm, solutions to a problem are represented as "chromosomes" and improved through evolutionary processes such as mutation, selection, and reproduction. This algorithm is used to find optimal solutions in complex problems.

Expert Systems Theory is AI Theory that based on a computer program that mimics the decision-making ability of a human expert in a specific domain. This system uses a vast knowledge base and rules to analyze data and generate decisions. The Expert systems are used in the medical field to assist with diagnosis and treatment recommendations. Then, Natural Language Processing (NLP) Theory, which enables computers to understand, interpret, and generate human language. It is a branch of AI that focuses on the interaction between computers and humans through natural language. Example of NLP are Chatbot, Google Translate, and text-based search systems like search engines. Further, Computer Vision Theory, is a branch of AI that enables computers to understand and analyze images and videos from the real world. This includes object recognition, motion tracking, and image analysis. Last, Automated Problem-Solving Theory which designed to solve problems

that require reasoning, decision-making, and solution searching. Some popular approaches include backtracking, heuristics, and search algorithms.

1.3 The AI Development in Indonesia

The development of AI in Indonesia has made significant progress in recent years. Several studies indicate that Indonesia ranks low in adopting technology compared to other countries in the Asia-Pacific region [18], [19], [20]. Technology and scientific development encompass the implementation of AI across various fields, including power electronics. Many sectors in Indonesia are beginning to adopt AI technology to enhance efficiency and productivity. For example, the banking and finance sector uses AI for risk analysis, fraud detection, and customer service through chatbots. The Indonesian government has launched various initiatives to support the development of AI. One major initiative is the "AI Roadmap 2020-2045," which aims to position Indonesia as one of the leading countries in the field of AI in Asia. Otherwise, the collaboration between technology companies and academic institutions is increasingly developing to conduct research and development in the field of AI. This partnership helps produce more relevant and innovative solutions to local challenges.

This integration allows for smarter systems, enabling enhanced control, optimization, and efficiency in power electronics applications, such as renewable energy management, electric vehicles, and grid stability. Additionally, these advancements contribute to reducing energy losses, improving system reliability, and supporting the transition to more sustainable, paving the way for future innovations in power systems [16],[21].

The competencies of students as future human resources must adapt to a situation that utilizes technology comprehensively [22]. In the field of electrical engineering, applications of AI include predictive maintenance and smart grid optimization, which have raised issues related to data privacy, algorithmic bias, and potential job displacement [23]. Therefore, students, especially in the engineering field, need to align their competencies with the conditions of the 4.0 industrial revolution, including skills in using, applying, and developing the latest technologies. Despite the progress, Indonesia still faces several challenges in AI development, such as the lack of adequate technological infrastructure, a shortage of AI experts, and ethical and privacy issues that need to be addressed as technology advances. Addressing these challenges will require concerted efforts from the government, educational institutions, include university to foster an environment conducive to innovation, enhance workforce capabilities, and establish clear regulations that ensure ethical use of AI technologies.

Driven by technology breakthroughs and industry needs, Electrical Engineering has developed rapidly in Indonesia in the last few decades. Energy demand in Indonesia continues to increase. Electrical Engineering plays a crucial role in the development of power plants, energy distribution, and energy management, especially in large projects such as Steam Power Plants (PLTU), Hydroelectric Power Plants (PLTA), and Solar Power Plants. (PLTS). Electrical Engineering contributes to the design and implementation of renewable energy systems, such as solar panels, wind turbines, and energy storage systems. Electrical Engineering plays a key role in the implementation of automation and control in the industrial sector. Technologies such as smart sensors, IoT (Internet of Things), and smart

networks are increasingly becoming an integral part of modern industrial systems. With the rapid development of AI and IoT, Electrical Engineering in Indonesia has great opportunities to grow further, especially in terms of industrial automation, smart transportation, and smart electrical grids.

2 Method

To address the research problem, a questionnaire was used as a research instrument to be distributed to respondents. A questionnaire is a tool used to collect data from respondents through a series of written questions. Questionnaires are often used in social research, education, marketing, and other fields to obtain information about the opinions, behaviors, experiences, or demographic characteristics of individuals or groups. The respondent of the study involved 125 electrical engineering students in Aceh. The sample was chosen to obtain representative data regarding students' understanding and perception of AI devices in the field of electrical engineering. Several universities in Aceh offer this program, including Universitas Syiah Kuala (USK), Universitas Malikussaleh, and Universitas Islam Negeri Ar-Raniry. There are a total of 1,530 students, but only students in semesters 5-7 are selected because, in this semester, students have already started studying AI.

The questionnaire is the chosen instrument aimed at obtaining perceptions from electrical engineering students regarding their knowledge of AI devices. By utilizing this instrument, the research aims to identify gaps in knowledge, assess attitudes towards AI applications, and gather insights that can inform educational strategies to better prepare students for the demands of the modern workforce.

The questionnaire is designed using a Likert scale with five categories. The Likert scale is a measurement tool used to assess respondents' attitudes, opinions, or perceptions towards a statement or item. The Likert scale is used to facilitate respondents in answering the questionnaire items. The five categories were Strongly Agree, Agree, Uncertain, Disagree, and Strongly Disagree. The data obtained will be analyzed using Statistical Package for Social Science (SPSS) version 20. This research will employ descriptive analysis, namely frequency (f), percentage (%), and mean (m). Descriptive statistics is a branch of statistics that aims to present and summarize data in a more understandable form. Descriptive statistics help summarize information from large and complex data into simple numbers or summaries. By using tables, graphs, or diagrams, descriptive statistics facilitate the visualization of data for further analysis. Descriptive statistics provide an overview of patterns, trends, and distributions in the data.

3 Result

A total of 5 students believe they have a very good level of knowledge (4%). Many students believe they have a good level of knowledge about artificial intelligence, with a frequency of 50 or 40%. Most respondents indicated that their level of knowledge about artificial intelligence is weak, with a total of 62 or 49.6%. This finding highlights the need for enhanced educational initiatives and training programs to improve understanding and proficiency in artificial intelligence among the respondents. Finally, 8 respondents (6.4%)

reported having a very weak level of knowledge. In general, it can be said that the respondents' level of knowledge about artificial intelligence is at a good and weak level.

The next questions about artificial intelligence devices. The answers are categorized into smartphones and online applications, robotics, automatic smart drive, drones, Siri, virtual reality, and Alexa (smart home). The first theme that dominates is smartphones and online applications with a frequency of 63 (50.4%). This suggests that respondents heavily rely on mobile technology and digital tools, indicating a significant trend towards the integration of smartphones and applications in their daily lives and potentially in their learning processes. The second category is occupied by robotics with a frequency of 20 (16%). This indicates that while robotics is a noteworthy area of interest among the respondents, it is still less prevalent compared to smartphones and online applications, suggesting opportunities for further exploration and education in this emerging field.

The third position is taken by automatic smart drive at 10.4% (f=13). This finding underscores a growing awareness of automated technologies, although it remains significantly lower than the other categories, highlighting potential areas for development and education in smart driving systems among the respondents. Drone answers are positioned in the 4th category with a frequency of 7 (7.2%). This low frequency suggests that while there is some interest in drone technology, it is not as widely recognized or utilized among respondents compared to other categories, indicating a need for increased awareness and educational resources in this area. The following categories are Siri (5th), virtual reality (6th), and Alexa "smart home" (7th). It can be concluded that, in general, students are aware of AI devices with varied responses. However, the varying levels of familiarity with these specific AI technologies suggest that there is an opportunity for educational institutions to enhance their curriculum and provide targeted training to deepen students' understanding and practical experience with these innovations.

Tabel 1. Respondents' knowledge level regarding artificial intelligence (n=125)

Item	Category	Freq	%
Mark your level of knowledge about artificial intelligence (AI)	1. Very Good	5	4%
	2. Good	50	40%
	3. Weak	62	49.6%
	4. Very Weak	8	6.4%
Total		125	100
Provide one example of artificial intelligence (AI) that you know.	Smartphone	63	50.4%
	Robotic	20	16&
	Smart drive	13	10.4%
	Drone	9	7.2%
	Sirri	7	5.6%
	VR	7	5.6%
	Alexa (smart home)	6	4.8%
Total		125	100

4 Discussion

This research was conducted to assess the level of knowledge and skills regarding artificial intelligence among electrical engineering students in Aceh. The research aims to assess the gaps in understanding of students' familiarity with AI technologies. A total of 125 students participated in this research sample, originating from three universities that offer Electrical Engineering programs: Syiah Kuala University, Malikussaleh University, and

UIN Ar-Raniry Banda Aceh. The reason of choosing three universities was based on their prominent Electrical Engineering programs. These institutions were representing a diverse electrical engineering student population in Aceh, with different levels of exposure to AI technologies. However, the diversity of universities provides a more comprehensive overview of the AI's knowledge among students. Nonetheless, the variety of universities offers students a more comprehensive understanding of IA. This outcome aligns with the research conducted by Melvinda etal., (2024) which engaged students in AI-related studies [15].

In the aspect of AI knowledge, students struggle to understand applications that are rarely used, there is a lack of specialized experts who can solve AI problems, the introduction of letters and characters in programming that they have never encountered before, and the material does not adequately explain AI. As a result, students may struggle to grasp key concepts, leading to confusion and a lack of confidence when trying to apply AI techniques or understand its practical applications in real-world scenarios.

It is recommended that students be more diligent in studying artificial intelligence systems, both in lectures and practical activities, as well as receiving direct guidance from AI practitioners. This approach will not only enhance their understanding of AI but also help them develop critical skills needed to solve complex problems, innovate, and stay competitive in an increasingly AI-driven world. When asked about the factors that influence the mastery of AI knowledge, most respondents mentioned theory and practice, as well as the learning environment, as the main influencing factors. Other factors that affect AI knowledge include technology, hobbies, interests, motivation, and actively participating in seminars or training. By engaging with these factors, students can broaden their exposure to AI concepts, stay updated on the latest advancements, and gain hands-on experience, all of which contribute to a deeper and more practical understanding of artificial intelligence. It similar with the finding from Ulimaz, et al, that stated electrical students gain understanding AI by hands on practical [16]. Graduating in electrical engineering greatly enables the creation of AI evolution that will continue to advance computers and communication systems.

5 Conclusion

Based on the result, it can conclude that students demonstrate a fairly good level of awareness regarding the importance of AI and its potential to transform various sectors; however, there are still gaps in technical knowledge related to AI tools and applications. There is a strong interest among students to learn more about AI, with many realizing that skills in AI will be an asset in the job market. However, students face several challenges in the implementation of AI, including a lack of access to resources and practical training, as well as a lack of understanding of how AI can be integrated into their studies. This research emphasizes the importance of UIN Ar-Raniry Aceh, Syiah Kuala University, and Malikussaleh University in providing a more comprehensive curriculum on AI, including workshops, seminars, and collaborations with industry to prepare students for the challenges and opportunities in the digital era. Thus, students believe that the application of AI can enhance efficiency and effectiveness in the field of electrical engineering and related industries, as well as create new opportunities in the job market.

6 Acknowledgment

I would like to express my sincere gratitude to all those who contributed to the successful completion of this research. First and foremost, I would like to thank UIN Ar-Raniry specifically LP2M for financial support throughout this study. Additionally, I am grateful to my fellow students and friends who offered their assistance and shared their insights during the research process. Finally, I extend my heartfelt thanks to my family for their unwavering support and understanding during my academic journey. I am deeply grateful for their encouragement, which has given me the strength and motivation to face the challenges and stay focused on achieving my goals.

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