Research Journal of Agricultural Science, 57 (2), 2025; ISSN: 2668-926X
http://doi.org/10.59463/RJAS.2025.2.11

ARTIFICIAL INTELLIGENCE & UNIVERSITY STUDENTS

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Abstract. *Artificial Intelligence (AI) is transforming modern education by enhancing how students learn, develop, and prepare for their careers. This study reviews recent research to explore how five core AI technologies—machine learning, natural language processing (NLP), robotics, expert systems, and computer vision—support higher education. A qualitative content analysis of academic sources was used to examine practical applications and outcomes for students. Machine learning helps personalise education by predicting student performance, recommending resources, and automating feedback. NLP enhances communication through virtual tutors, instant feedback, and language translation, promoting inclusive learning environments. Robotics enables hands-on experience, supporting technical skills and interdisciplinary learning. Expert systems simulate human decision-making, aiding in diagnostics, planning, and academic advising. Meanwhile, computer vision improves lab-based learning, supports virtual reality applications, and allows remote monitoring. Despite these benefits, challenges such as data privacy, algorithmic fairness, and the need for teacher training remain. NLP stands out as the most impactful technology due to its wide use and adaptability in educational contexts. The study concludes that integrating AI ethically and strategically can create more engaging, personalised, and future-ready education systems. Educators and policymakers are encouraged to focus on scalable AI tools while ensuring that human values remain central to learning. Continued research and collaboration across disciplines will be vital to fully harness AI's potential in education.*

Keywords*: artificial intelligence, university students, natural language processing*

INTRODUCTION

Artificial intelligence has become an integral part of many industries – from healthcare to entertainment – which continue to evolve rapidly, offering new opportunities and challenges. Artificial Intelligence refers to the simulation of human intelligence using machines programmed to think and learn like humans (Qawqzeh, 2024). These intelligent systems can perform a wide range of tasks, such as learning from experience, decision-making, speech recognition, and problem solving (Bearman & Ajjawi, 2023). The main key aspects of Artificial Intelligence are:

- machine learning, which involves training algorithms to learn from data and make predictions or decisions without being explicitly programmed (for example, recommendation systems on platforms like Amazon or Netflix, which use machine learning to suggest content based on user preferences);
- natural language processing, which allow machines to understand and interpret human language (e.g. virtual assistants such as Alexa and Siri and language translation services);
- robotics: robots powered by artificial intelligence can perform tasks ranging from simple repetitive actions to complex activities requiring autonomy and adaptability (e.g. autonomous drones and industrial robots);

- expert systems, designed to mimic the decision-making skills of a human expert and used in areas such as medical diagnosis and financial planning (Qawqzeh, 2024);

- computer vision, which allows machines to interpret and make decisions based on visual data from the world (for example, self-driving cars and technologies such as facial recognition).

As for students, they are generally individuals dedicated to continuing their education and preparing for future careers and lives. Students are individuals enrolled in a higher education institution, usually pursuing an academic degree – bachelor's, master's, doctoral or post-doctoral. The main key aspects regarding students are:

- involvement in research and projects: many students are involved in practical experiences, research projects, and internships that help them apply their theoretical knowledge to real-world situations;

- personal growth: university is a period of significant personal growth and development, in which students often become more independent, learning to manage their time and responsibilities, and exploring their interests and identities (Wang & Li, 2024);

- academic goals: students engage in the study of a particular field of knowledge (e.g., business, arts, engineering, exact sciences, or humanities) with the aim of acquiring specialized knowledge and skills in the chosen field of study (Qawqzeh, 2024);

- career preparation: academic / tertiary / university education prepares students for their future careers (providing them with the necessary qualifications and experiences), which is why they often seek part-time jobs, networking opportunities and internships to increase their skills for a better employment;

- campus life: students often participate in various extracurricular activities (e.g. clubs, social organizations, sports, or volunteering), which helps them develop their social skills, leadership qualities, and well-rounded experience.

MATERIAL AND METHODS

The material used in this study consists of articles about Artificial Intelligence and students, and the research method consists of analyzing the content of the results presented in these researches.

RESULTS AND DISCUSSIONS

In the following, we will identify those key aspects of Artificial Intelligence that can help students continue their education and prepare for career and life (Llerena-Izquierdo et al., 2024; Qawqzeh, 2024).

1. Machine learning Machine learning is a subset of Artificial Intelligence that allows computers to learn and make decisions based on data, without being explicitly programmed for each specific task. Essentially, machine learning means creating systems that learn and adapt from experience, improving their performance over time. Machine learning has several key concepts:

- algorithms, the mathematical models used in machine learning (e.g., decision abilities, support vector machines, and neural networks) for different types of problems;

- the applications, from medical diagnostics, self-driving cars, natural language processing, personalized recommendations (e.g. those used by Amazon or Netflix) to speech recognition;

- data and training: algorithms are trained on data to recognize patterns and make decisions or predictions;

- unsupervised learning: the algorithm receives data without explicit instructions on what to do with it and tries to find hidden patterns or other structures within the data (for example, customer segmentation in marketing, where the algorithm groups customers based on purchasing behavior);

- reinforcement learning, which involves training an algorithm through trial and error, rewarding it for correct actions and penalizing it for wrong ones (for example, in robotics and gaming, where the algorithm learns to navigate environments or play games effectively);

- supervised learning: the algorithm is trained on labeled data (meaning that the input data is associated with the correct output) to predict the outcome from new, unseen data (e.g., email spam detection, where the algorithm learns from examples of spam and non-spam emails).

2. Natural language processing is an area of Artificial Intelligence focused on the interaction between computers and human (natural) languages with the goal of enabling machines to understand, interpret, and generate human language in a meaningful and useful way by combining linguistics, computer science, and machine learning to help machines process and understand human language. It has a wide range of applications, from improving customer service with chatbots to improving accessibility with voice-to-text technology (Chan, 2023; Fuchs, 2023; Tam et al., 2023; Aladini et al., 2024; Almassaad, Alajlan & Alebaikan, 2024; Batista, Mesquita & Carnaz, 2024; Bouchard, 2024; Essien et al. 2024; Khlaif et al., 2024; Llerena-Izquierdo et al., 2024; Qawqzeh, 2024; Salimi & Hajinia, 2024; Singh & Ngai, 2024; Suglo et al., 2024; Vargas et al., 2024; Wang & Li, 2024). Its main components and key applications are:

- feeling analysis, usually used to determine the feeling or emotion expressed in a piece of text in social media monitoring with the aim of assessing public opinion regarding certain events, products or services (Singh & Ngai, 2024);

- text analysis, which involves breaking down and analyzing text data to understand its structure and meaning through techniques such as tokenization (dividing text into words or phrases) and grammatical structure analysis;

- TEXT GENERATION human-like (e.g., chatbot-like applications, automated content creation, and creative writing) (Chan, 2023; Fuchs, 2023; Tam et al., 2023; Aladini et al., 2024; Almassaad, Alajlan & Alebaikan, 2024; Batista, Mesquita & Carnaz, 2024; Bouchard, 2024; Essien et al., 2024; Khlaif et al., 2024; Singh & Ngai, 2024; Vargas et al., 2024).

- recognition of named entities, which involves identifying and classifying key elements in the text (e.g. dates, places, names of people, etc.);

- speech recognition, which allows machines to convert spoken language into text (for example, the virtual assistants Alexa and Siri, which use speech recognition to understand and respond to user commands);

- INFORMATION RECOVERY by searching and retrieving information from large data sets (for example, search engines that use natural language processing to understand and answer user queries more effectively);

- AUTOMATIC TRANSLATION, which allows the translation of a text from one language to another (for example, Google Translate and other translation services that help overcome language barriers) (Salimi & Hajinia, 2024).

3. Robotics is a branch of engineering and science that involves the design, construction, operation, and use of robots – machines capable of performing a range of actions autonomously or semi-autonomously, and that combines multiple disciplines (e.g., computer

http://doi.org/10.59463/RJAS.2025.2.11

science, electrical engineering, mechanical engineering, and artificial intelligence) to create machines that can perform complex tasks, often beyond human capabilities. Here are some key aspects of robotics:

- actuators, components that allow a robot to move (for example, motors, hydraulic systems, or pneumatic systems that control the robot's limbs or wheels by converting energy into motion);

- the applications, from healthcare (e.g., robots that assist in surgeries), exploration (e.g., Mars rovers), industrial production (e.g., robots that assemble products) to everyday tasks (e.g., robotic vacuum cleaners);

- mechanical design (the physical structure of the robot) which includes the design of the parts, joints, and mechanisms that allow the robot to move and interact with its environment, and which can range from simple wheeled robots to complex humanoid robots;

- scheduling, which involves writing code that instructs the robot how to behave and respond to different situations, using different programming languages and software tools;

- sensors, crucial for robots (cameras, microphones, and tactile sensors) to perceive their surroundings, as they provide information about the environment (e.g., distance, light, sound, and temperature);

- control systems, the brain of the robot, which processes sensor data and determines the robot's actions (for example, a simple microcontroller or a complex computer system that uses algorithms and artificial intelligence to make decisions).

4. Expert systems mimic the decision-making skills of a human expert in a specific domain and are used to solve complex problems by reasoning through bodies of knowledge, represented primarily as “if..., than...” rules, rather than conventional procedural code. In general, expert systems are designed to provide consistent and high-quality decisions and advice, raising knowledge and experience embedded in them (Bouchard, 2024). The key components and functions of expert systems are:

- knowledge acquisition, the process of extracting, structuring, and organizing knowledge from human experts or other sources to update and expand the knowledge base;

- knowledge base, which contains domain-specific knowledge (acquired from human experts in the field) and consists of facts and rules about the subject;

- interface, which allows users to interact with the expert system and enter queries or problems, in which case the system provides solutions, explanations or recommendations based on its knowledge base;

- inference engine, which applies logical rules to the knowledge base to infer new information or make decisions, and which mimics the reasoning process of human experts using techniques such as forward chaining and backward chaining;

- the explanation system, which can justify the reasoning process and decisions made by the system, helping users understand how conclusions were reached and have greater confidence in the system's recommendations.

Applications of expert systems:

- customer support(e.g., support, troubleshooting, and automated help desk services);

- medical diagnosis(e.g. systems like MYCIN to diagnose and suggest treatments in bacterial infections);

- output(e.g. in quality control, diagnosing equipment failures, optimizing processes);

- financial services: (e.g. loan approval, investment consultation, credit assessment).

5. Computer vision focuses on enabling computers to interpret and understand visual information in the world, just as humans do, with the goal of replicating and exceeding the

capabilities of human vision, making it a powerful tool in various industries and applications. Main components and key applications:

- movement analysis, which involves tracking and analyzing movement in a sequence of images or video frames, is used in sports analysis, animation, and video surveillance.
- object detection and recognition, that is, identifying and classifying objects in an image or video (for example, detecting pedestrians in self-driving car footage, identifying products in a retail store, or recognizing faces in a photograph);
- feature extraction, which involves identifying important features or patterns in an image (e.g., corners, edges, or textures) used to match and recognize objects from different images;
- image processing, which involves manipulating and enhancing images to extract useful information through techniques such as edge detection, filtering, or noise reduction;
- image segmentation, which involves dividing an image into segments or regions, each representing an object or a different part of an object (e.g., in medical imaging to segment organs or tumors and in autonomous vehicles to understand the road environment);
- three-dimensional vision, by understanding three-dimensional structures from two-dimensional images (for example, in applications such as three-dimensional modeling, augmented reality, and robotics).

Computer vision applications:

- healthcare: medical imaging systems use computer vision to help diagnose diseases, such as X-ray analysis or magnetic resonance scans;
- retail trade(for example, in personalized shopping experiences, inventory management, and automated payment systems);
- entertainment: augmented reality and virtual reality rely on computer vision to create immersive experiences;
- security(e.g. in surveillance systems for monitoring and detecting suspicious activities);
- autonomous vehicles, to detect obstacles, understand traffic signs, and navigate roads.

CONCLUSIONS

Of all the key aspects that can help students continue their education and prepare for their careers and lives, natural language processing seems to be the most useful (as evidenced by the large number of articles on the topic) because it has the potential to help students stay engaged in the course material and feel more connected to their learning experience, can simulate conversations with students to provide feedback, answer questions, and provide support, and uses a large data set to generate answers to student questions, feedback, and requests.

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