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Artificial Intelligence (AI) in Education: Unlocking the Perfect Synergy for Learning

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Research Article

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Abstract

Background/purpose. Exploring intelligent agents in digital learning raises questions about the essence of Artificial Intelligence (AI) and its potential impact on education. This article provides insights into these inquiries and outlines outcomes from various experimental implementations, emphasizing the pivotal role of intelligent agents and conversational bots. These technologies have the power to revolutionize education by nurturing adaptive learning and problem-solving skills among university students. This work builds on existing research, aiming to articulate a conceptual understanding of AI as a strategic tool for learning.

Materials/methods. The study systematically collected data from Colombian universities and underwent thorough analysis through a systematic review process. Findings were meticulously organized according to themes and categories, enriched by contemporary perspectives in learning theories and artificial intelligence, ensuring a comprehensive exploration within the context of Colombian higher education.

Results. The synergy between repositories and artificial intelligence significantly enhances the capability to discover, analyze, and manage academic information. This amalgamation holds great promise as a strategy to enhance efficiency and precision in the university research process.

Conclusion. The exploration of AI in education reveals a promising future. The integration of technology within teaching improves learning, making AI a valuable ally for progress and evolution in higher education.

1. Introduction

Recent trends suggest that the complexity of technological advancements will lead to structural changes in the field of education. This has been evidenced by the global pandemic caused by the COVID-19 virus, where technology played a strategic and decisive role in global education.

Therefore, the role of Artificial Intelligence (AI) as an integrative field of technology will continue to grow exponentially, and among the options that it allows us in education, particularly in learning strategies, is that it requires the agent to not only respond to information requests, but also to anticipate, adapt, and actively seek ways to support students.

This interaction between student and agent responds to requirements of adaptation and comprehension, how educational communities facing an intelligent system can develop, reason, and cooperate. Intelligent agents not only provide us with information but also contribute to making the right decisions. They enjoy some degree of autonomy and can perform routine tasks and actions on our behalf, thereby saving time and effort to engage in other activities. All this is meant to enhance learning and provide timely assistance to students in situations where the academic environment, university, family, or classmates are insufficient, leaving aside time and space limitations.

Given this innovation in educational and pedagogical processes, reflecting on changes from traditional and routine forms of higher education allows for transformation and challenges in new scenarios, rethinking current educational purposes.

Considering the above, the commitments in higher education regarding these technologies allow for enabling conditions in different educational contexts, leveraging the potential of these digital tools that reach and allow for the socialization of information. In the case of intelligent agents, they strengthen the process of communication in students by guiding them toward change and building established relationships between mental structures, interfaces, and intelligent agents.

Therefore, the contribution of these interfaces in the future and the current trend in technological evolution for educational purposes (without face-to-face teaching) has been assumed by the interface itself, with some form of AI configured as intelligent agents, avatars, virtual tutors, or conversational bots. These are based on the combination of technological concepts of identification of complex patterns and natural language processing (Mamlok, 2021).

1.1. Intelligent Agents

In the academic environment of higher education, an intelligent agent can significantly contribute by performing tasks ranging from reducing repetitive tasks to facilitating understanding and learning from its own experience, transforming education into a self-correcting activity. The incorporation of feedback systems allows the teacher to improve courses incrementally through engagement with the intelligent agent and by constantly reviewing teaching quality. Additionally, these systems offer an appropriate framework to facilitate interactions between students and mutual feedback, allowing education to become a collaborative process of knowledge construction. In conclusion, an intelligent agent in the academic environment of higher education has the potential to improve the quality of teaching, promote interaction between students and teachers, and transform the learning process into a collaborative knowledge-building activity, while also providing opportunities and challenges in the implementation and observation of how these technologies can improve the quality of teaching and learning (Verma & Singh, 2021).

Concepts have been developed considering current realities and complementing them with the fields of psychology and social environment. Starting with the purpose at hand regarding the definition of an intelligent agent, it is a tool for knowledge exchange for a training system in higher

education, allowing for the management of each user/student, storing, and incrementing their database. Thus, an intelligent agent aids in academic management, including the improvement, storage, and retrieval of experience, and access to the experience of others to improve their response.

1.2. Roots of the Agent

John McCarthy introduced the idea of an agent in the mid-1950s, and the term was later coined by Oliver G. Selfridge a few years after when they were both at the Massachusetts Institute of Technology (MIT). They envisioned a system that, when given a goal, could carry out appropriate computing operations details and could ask for and receive human-like responses when stuck. An agent would be a "'soft robot' living and doing its business within the world of computers" (Wu et al., 2023), able to divide agent research through roots that mainly lie in artificial intelligence (AI), and is "mainly focused on deliberative agents with symbolic internal models" (Nwana, 1996).

These works have contributed to the understanding of topics surrounding agent interaction and communication, task composition, and distribution. On the other hand, the rapid growth of technology studies has seen a much wider range of agent type appear, where moderately intelligent agents can also be found. As "agents" of many varieties have proliferated, there has been an explosion in the use of the term without corresponding consensus on its meaning, ranging from machines that can be pre-programmed to perform tasks to forms of performing low-level computer tasks while being instructed in a higher-level programming or scripting language (Farhadi & Jennings, 2021).

Other meanings have been based on the implementation of a primitive or aggregated "cognitive function" (Gligorea et al., 2023); some because they exhibit characteristics of distributed intelligence (Pellas, 2023); some because they fulfill a mediating function between people and programs, because they perform the function of an "intelligent assistant" (Han, 2021); and some because they are seen by users as manifestations of intentionality and other aspects of the "State of Mind" where AI models must adapt accordingly (Montag et al., 2024).

From the literature, the definition of an agent can be indicated as the notion of an ascription, which is to make an inscription, add something, incorporate someone into an entity, in this case, an agent, made by some person, or may be based on a description of attributes that intelligent agents must possess. These perspectives complement by indicating that an agent: Simplifies the complexities of current computing and offers a way to overcome the limitations of current machine-human communication approaches, which aptly describes an overview of what an agent is.

Intelligent agents are characterized by various attributes that give them a high degree of flexibility and autonomy in carrying out tasks. Among these attributes, are their reactive ability to perceive and act in the environment, their autonomy in defining and achieving goals, their ability to collaborate with other agents in achieving common goals, their ability to infer and abstract to work with explicit models of themselves, their ability to maintain their identity and usability over time, their adaptability through learning from experience, and their mobility to migrate between different platforms. These attributes are fundamental to the development of intelligent agents in educational environments, as they allow for the creation of more efficient and personalized learning solutions.

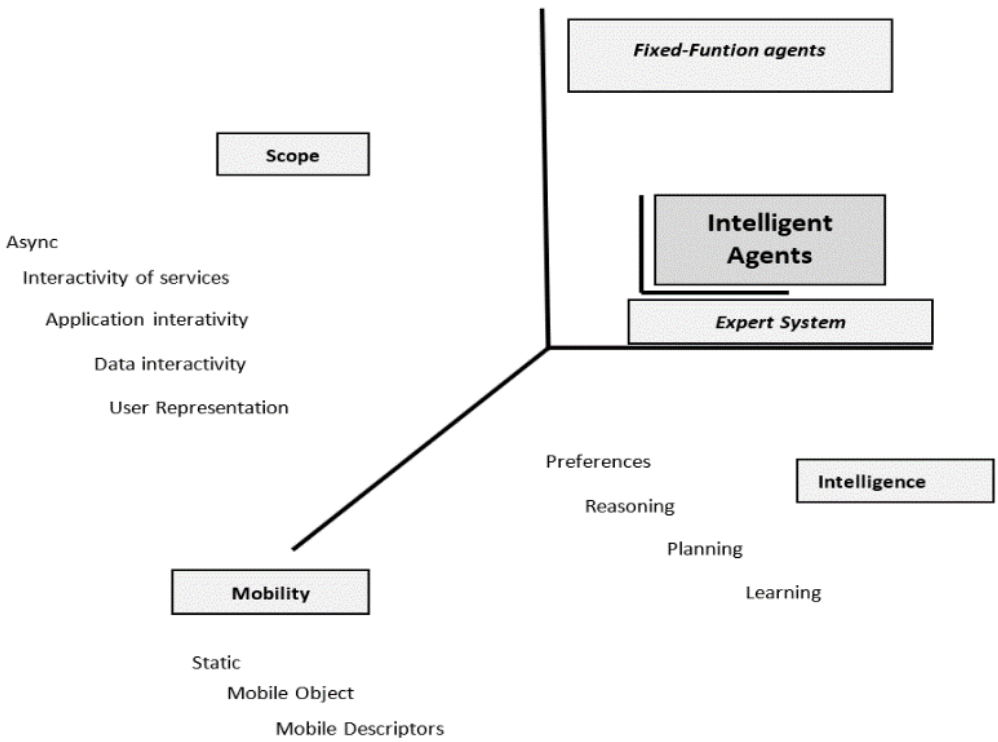

Figure 1. *Adaptation of the Intelligent Agent*

Likewise, they can be characterized by providing a simple type of agent, for example, characterized by the ability to solve problems and an agent that responds to changes in its environment or messages with the ability to reason and create action plans and execute them.

Schmidt et al. (2020) described intelligent agents in terms of three dimensions: scope, intelligence, and mobility. Scope refers to the degree of autonomy and authority that an agent has and can be measured qualitatively through the nature of the interactions it maintains with other entities in the system (see Figure 1). These agents function asynchronously, meaning that they can perform tasks without the need for constant supervision.

The scope dimension is critical for evaluating an agent's effectiveness in each task, as it affects its ability to make decisions and act autonomously. In summary, the scope dimension is a key characteristic of intelligent agents that can be measured through the nature of their interactions with other entities and that is essential for evaluating their autonomy and authority in a system. This was also proposed by Shi and Zhang (2021), who examined the concept of autonomous intelligent agents within digital environments, and delved into three pivotal dimensions essential to the meticulous design of such intelligent agents: autonomy, intelligence, and mobility, which also aligns with Schmidt et al.'s (2020) proposal.

In the field of artificial intelligence, reasoning is associated with the ability of agents to access and achieve goals defined by the user. Through user preferences, agents can adapt to different levels of intelligence and learn autonomously, adjusting their environment and resources based on user needs. In this sense, mobility refers to the movement of agents in the network, carrying with them accumulated data and states from their previous experiences. At higher levels of mobility, agents can interact with other agents and resources in real time, allowing for even greater adaptation and personalization based on user goals. In summary, the combination of reasoning, intelligence, and mobility in intelligent agents enables a personalized and adaptive learning experience to manifest in the educational environment.

Luckin et al. (2022) demonstrated that artificial intelligence has the potential to transform education and explained how intelligent agents can adapt to individual student needs to improve their knowledge acquisition through adaptive learning, virtual tutoring, and automated assessment.

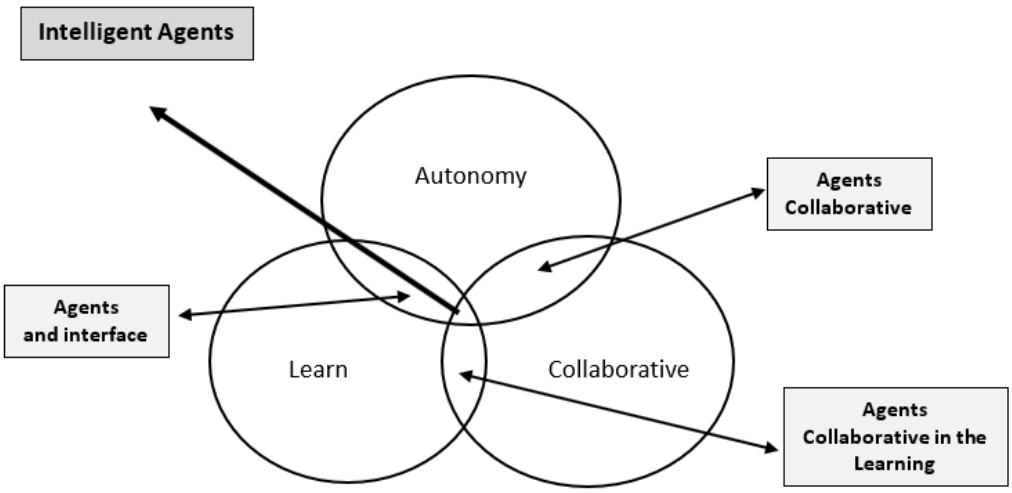

Figure 2. *Primary Attribute Dimension of the Intelligent Agent*

From a typology based on the primary attribute dimension of the intelligent agent, Nwana (1996) presented a classification of intelligent agents based on their autonomy, learning ability, and collaboration (as cited in Drawel et al., 2022). This typology is divided into various categories, such as mobility, which can be static or dynamic, and the model of symbolic reasoning, described as reactive. Agents are also classified based on attributes such as autonomy and collaboration in learning. From this, Nwana (1996) derived four types of agents: collaborative, collaborative learning, interface, and intelligent (see Figure 2). Additionally describes seven categories of intelligent agents: collaborative, interface, mobile, information/Internet, reactive, hybrid, and intelligent.

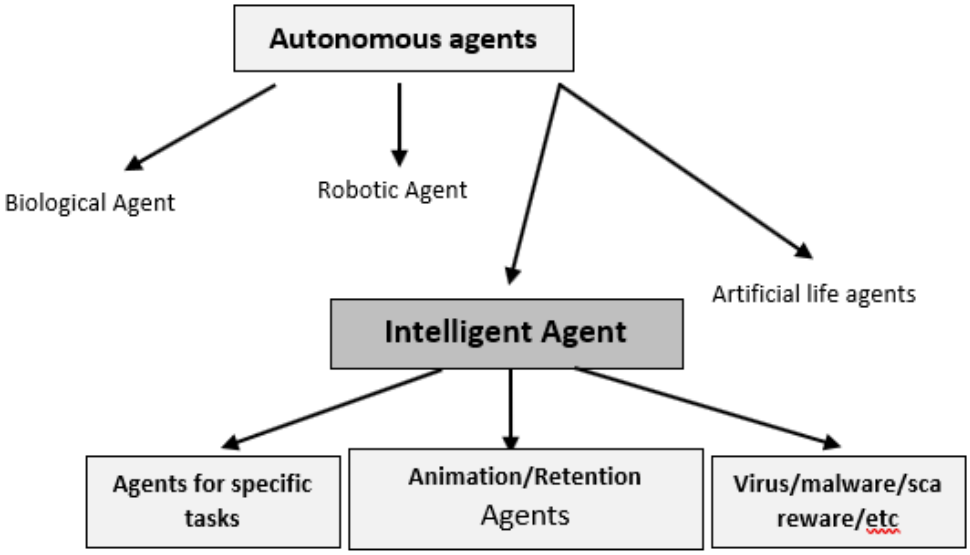

Figure 3. *Multi-agent system and Taxonomy of Intelligent Agent*

Based on Nwana's (1996) work, Drawel et al. (2022) implemented a multi-agent system that uses artificial intelligence techniques to provide students with a personalized and adaptive learning pathway. This system uses intelligent agents to collect information about student performance and preferences and then generates personalized learning recommendations based on this information.

Furthermore, Red'ko and Sokhova (2022) asserted that an autonomous agent is a system situated within an environment, perceiving, and acting upon it over time in pursuit of its objectives. By applying this definition, agents can be contemplated within the control structures of various environments, such as databases, file systems, networks, and the Internet, as well as within written languages and applications.

The term "agent" started as the idea of carrying out appropriate computer operations and achieving bidirectional communication which, like many other commonly used computer terms such as "desktop," "mouse," and "window," have become concretized as widely used software-related terms. As technological developments continue, the agent term will become more commonplace among the user community and recognized worldwide. The motivation to autonomize everything concerning human life will continue to drive the development of intelligent agents.

Intelligent agents already occupy a place in today's education, based on a conceived computational structure that guarantees that everything is "under control" technically and ensures that everything works according to the established norms. However, in order to ensure that everything works as intended, it is crucial to realize a specific and adequate level of information concerning the intentions and actions of the student population. It is also important to accurately convey the capabilities and limitations of intelligent agents so as to prevent users' expectations from exceeding the system's actual capabilities. In this regard, it is essential to carefully describe both the capabilities and limitations of the agents and to ensure that the accompanying instructions are integrated naturally and effectively into the agent's interface. Such a move would facilitate greater use of the system and improve the end-user's experience. "Designing Effective Personalization and Recommender Systems for Learning" complements this by highlighting the importance of designing effective personalization and recommendation systems for learning, which includes providing clear and precise information about the capabilities and limitations of intelligent agents to its student users (Zawacki-Richter et al., 2019).

Moreover, security and privacy are valid concerns regarding intelligent agents, from data protection to the nondeliberate accessing of personal data, so it is important to formulate agents that adequately address these issues. The way in which agents interact with users is by programming them in such a way do that they do what most students want. Identifying both the positive and negative aspects of agents is inevitable, but as Negroponte pointed out, "the best metaphor I can think of for a human-computer interface is that of a well-trained English butler" (Negroponte, 2021,). Negroponte continued by stating that the

> 'agent' answers the phone, recognizes callers, bothers you when it is appropriate, and may even tell a white lie in your name. The same agent is well-trained in timing and is respectful of idiosyncrasy. People who know the butler enjoy a considerable advantage over a total stranger. That's okay. (Negroponte, 2021)

To create intelligent agents and carry out these tasks to the satisfaction of end-users in learning environments and according to established learning strategies, we first need to readdress certain fundamental questions. With regards to intelligence agents and learning, the AI literature's focus has been on decentralized approaches to intelligence, with interface designs driven more by personalized intelligence than agents. Ultimately, the key emphasis being the knowledge of each individual person.

1.3. Agents for Learning and Information Adaptability

Developing intelligent agents capable of solving complex problems autonomously fosters flexibility and adaptability of the people using them. When developing systems that facilitate information and reasoning processes, the information provided by the agents must be appropriate, useful, and easy to understand for the users. Additionally, it is important to provide adaptability mechanisms that allow agent content to adapt to users' evolving information needs, including dynamic simulations that help understand complex situations that cannot be adequately represented. This combination of flexibility, adaptability, and ease of use makes intelligent agents a valuable tool for improving learning and decision making in a variety of contexts. Bhatia et al. (2022) employed systems with dynamic simulations to help students understand complex concepts, demonstrating the efficacy of personalized learning systems based on agents and the importance of adaptability in delivering information and designing educational content (Jiang et al., 2022).

The term "intelligent agent" often evokes images of humanoid robots performing tasks by instruction. However, in the context of education and learning, intelligent agents play a somewhat different role. These agents aim to ensure that people still feel in control while being provided with accurate information and options for learning. Additionally, they should provide an adequate form of interaction between the agent and the person, which includes agent feedback to the person and presentation of the agent's conceptual model of operation and activities. The way in which the agent presents information and responds to the person should simplify their access to knowledge. In summary, intelligent agents in learning should hide complexity and reveal the options people want to learn while developing effective forms of interaction that facilitate learning (Vikas & Mathur, 2022), and to show how intelligent agents can significantly enhance learning and teaching by providing personalized feedback, adapting to individual student's needs, and supporting peer collaboration (Panagiotis et al., 2015).

In a study by Li (2019), it was demonstrated that the use of intelligent agents in language learning can significantly improve students' performance when compared to traditional teaching methods. The study noted that the agents' ability to personalize and adapt learning to students' individual needs is one of the main reasons for their effectiveness. These findings support the idea that agents can be a valuable tool for the enhancement of human intelligence in different areas of learning and cognitive performance. Agents offer the possibility of contributing to human intelligence, adding one more tool to the domain of cognitive artifacts that effectively make people smarter.

1.4. Artificial Intelligence – Intelligent Agents – Learning

The current complexity in technology use and educational trends in virtual environments, along with new ways of accessing knowledge from digital didactic strategies, suggest a significant increase in technology usage behavior in the coming decades. AI environments must respond to information requests, adapt, and actively seek ways to support students with specific tasks in learning strategies, fostering connectivity between students and content and coordinating tasks among students in collaborative work. This symbiotic relationship between intelligent agents and AI facilitates the management of interactions among students, content, and strategy in the process of knowledge acquisition. Furthermore, the intersection of AI fields, exemplified by intelligent agents, has significantly advanced our comprehension of how academic communities can evolve, reason, and collaborate (Yazdanpanah et al., 2021).

According to Rasouli et al. (2022), the combination of intelligent agents and 5G technology can significantly improve the learning process by facilitating access to information and customizing learning based on individual student needs. Intelligent agents can provide real-time assistance and present information in an understandable and accessible way, which can improve the efficiency and

effectiveness of the learning process. Furthermore, 5G technology provides a high-speed and low-latency network, enabling the transfer of large amounts of data in real time, resulting in better information management and a more interactive learning experience.

1.5. Evolution of Technology to Intelligent Agents and their Relationship with Learning

In the past, technology in learning focused primarily on individualized instruction with independent tutors. However, over time, it has evolved into more collaborative and integrative approaches that combine doing, knowing, and learning. In this regard, intelligent system applications have been developed that allow for the training of both students and teachers, leading to improvements in traditional education. An example of this is computer applications that allow for inquiry and collaboration among participants (Svenningsson & Faraon, 2019).

However, there are also interactive learning systems that allow learners to manipulate cognitive artifacts (Ramirez, 2020) from various perspectives or points of view. Perspectives can be superficial (interface level) or deep (interaction level). For example, an aerial artifact can be viewed from several different perspectives:

- From an image or text that explains how it should be used (user perspective).
- From its construction (motor perspective).
- From its economic value in its construction (financial perspective).

Therefore, intelligent learning systems must be social, active, and constructive processes that yield knowledge that is easy to acquire, represent, and recontextualize in order for them to be adaptable to the university system, and should:

- Be highly interactive and networking;
- Employ designs and virtual environments that are complementary to a university's content;
- Allow students to explore, understand, and participate in metacognitive processes when faced with difficult learning situations.

Thus, intelligent agents and learning must allow for the motivation of individuals and that the knowledge gained must be considered important for everyday life, including problem-solving situations, where learning occurs through the ability to adapt to the environment determined by the institution.

1.6. General Characteristics of Platforms and Intelligent Agents

Platforms and intelligent agents represent a paradigm shift in computational systems, harnessing advanced artificial intelligence methodologies to execute intricate tasks and render decisions predicated upon predetermined rules and data. This technological innovation has precipitated a transformative impact on human task execution and decision-making processes. Within the overarching framework of these systems, machine learning assumes a pivotal role, enabling intelligent agents to interactively assimilate information and refine their performance over temporal epochs (Russell & Norvig, 2016).

Moreover, these intelligent agents are meticulously engineered to engage with human users through sophisticated user interfaces, exemplified by entities such as chatbots (e.g., Ageintic) or virtual assistants. This nuanced design facilitates their integration into domains such as customer service and technical support, thereby enhancing the efficiency and efficacy of these critical domains (Raghavachary & Miller, 2019). The synergistic amalgamation of machine learning capabilities and user-centric interfaces underscores the multifaceted utility and pertinence of platforms and intelligent agents in contemporary computational landscapes.

Other important characteristics of these technologies include process automation, which serves to automate repetitive tasks to increase efficiency and reduce response time (Yang et al., 2023), and decision making, which allows for responding to dynamic situations in real time. In general, these characteristics make platforms and intelligent agents valuable tools in a variety of applications, from customer service to supply chain management. Among other characteristics, we find usability, interactivity, accessibility, didactics, intelligence, adaptability, and personalization to be the most relevant:

Usability refers to the ease of use and accessibility of a product, system, or device, i.e., its ability to be effectively, efficiently, and satisfactorily understood, learned, used, and valued by users. Usability is a key aspect in the design of digital products and is a critical factor in determining the success or failure of a product.

Interactivity refers to the ability of a system or device to respond to user actions and inputs, allowing them to actively participate in the experience. Interactivity can include various forms of interaction, such as the use of a mouse, keyboard, touchscreen, or voice input, and is a key element in creating intuitive and easy-to-use digital products. Interactivity is also important for maintaining user attention and interest and improving the overall user experience.

Accessibility refers to the ability of a product, system, or device to be effectively used by all people, including those with disabilities. This includes aspects such as usability, compatibility with assistive technologies, and the ability to customize the product to meet individual needs. Accessibility can also include a product's ability to be used in different contexts, such as in low-light environments or with various languages. Improving accessibility is important not only to ensure the inclusion of all users, but also to improve the overall user experience and increase satisfaction with the product.

Didactics is a discipline that deals with the study and application of effective methods for teaching and learning. Didactics addresses questions about how to improve the effectiveness of teaching and how to foster meaningful and lasting learning in students. Didactics encompasses a wide variety of topics, including lesson planning, learning assessment, the selection of teaching materials, student motivation, and incorporating technology in the classroom. Didactics is relevant to anyone who plays a role in the teaching and learning process, including teachers, instructors, tutors, and educational program designers.

Intelligence is a key characteristic of platforms and intelligent agents, referring to their ability to perform complex tasks and make decisions based on programmed rules and data. Artificial intelligence is a branch of computer science that deals with the development of systems capable of performing tasks that require human intelligence, such as speech recognition, decision making, and machine learning. Artificial intelligence relies on algorithms and mathematical models to process and analyze large amounts of data and improve performance over time.

Adaptability refers to a system or device's ability to adjust to different situations and environments. Platforms and intelligent agents must be adaptable to function in a wide variety of situations and contexts. Adaptability also refers to a system's ability to learn and improve over time, allowing for greater efficiency and effectiveness in performing tasks.

Personalization refers to a system or device's ability to adapt to the individual needs and preferences of the user. Platforms and intelligent agents can personalize the user experience by collecting and analyzing data on their preferences, behaviors, and usage habits. Personalization can improve the efficiency and effectiveness of the platform or agent and increase user satisfaction by providing a more relevant and meaningful experience.

In summary, platforms and intelligent agents are software systems that use artificial intelligence techniques to perform complex tasks and make decisions based on programmed data and rules. These technologies have important features such as machine learning, process automation, interactivity, usability, accessibility, adaptability, personalization, and the ability to make real-time decisions. These features make platforms and intelligent agents valuable tools in a variety of applications, from customer service to supply chain management.

1.7. General Characteristics of the Intelligent Agent-User Relationship

Similar to the previous section, the following are considered the most relevant characteristics of the intelligent agent-user relationship:

Flexibility in an intelligent agent refers to its ability to adapt and respond effectively to a wide variety of situations and tasks. A flexible agent can perform a wide range of actions and make appropriate decisions in an uncertain or changing environment. This implies the ability to learn from experience, adapt to new situations, and change behavior based on the needs of the environment. Flexibility is important for intelligent agents in many fields, such as robotics, systems control, artificial intelligence, and automation, as it allows the agent to perform more complex tasks and adapt to a wide variety of situations.

Scalability in an intelligent agent refers to its ability to grow and improve effectively as demands increase in terms of complexity, speed, and number of tasks. Scalability refers to an intelligent agent's ability to function effectively in a wide range of situations and tasks, from small and simple to large and complex. This can include the ability to integrate with other systems and technologies, efficient use of resources, and the ability to process large amounts of information. Scalability is important for intelligent agents in many fields, such as robotics, artificial intelligence, machine learning, and automation, as it allows the agent to perform more complex tasks and handle a greater amount of data and situations.

Ubiquity in an intelligent agent refers to its ability to be available anywhere and at any time. A ubiquitous agent is capable of functioning in any context or environment, whether online or offline, and interacting with other systems and devices. Ubiquity is important for intelligent agents in many fields, such as robotics, artificial intelligence, automation, and information technology, as it allows the agent to be always available to perform tasks in any place in response to the user's needs. Ubiquity is also important for improving the efficiency and effectiveness of intelligent agents, since it enables them to work autonomously and perform tasks without the need for human intervention.

Functionality in an intelligent agent refers to its ability to effectively perform a task or set of tasks. A functional agent can carry out a wide range of actions and make appropriate decisions in an uncertain or changing environment. Functionality refers to an intelligent agent's ability to perform specific tasks and meet defined objectives. This may include tasks such as collecting and processing information, making decisions, executing actions, and interacting with other systems and users. Functionality is important for intelligent agents in many fields, such as robotics, artificial intelligence, automation, and machine learning, as it allows the agent to perform specific tasks effectively and to meet defined objectives.

1.8. Knowledge Networks

Knowledge networks are created and adapted through practice, and knowledge is gradually modified to fit contextual requirements. This process is essential because context is gradually constructed and added to current knowledge, which presents the challenge of adequately representing context. Context includes the conditions and variables surrounding the intelligent agent and must be considered when making decisions and taking actions. Therefore, it is fundamental to understand how to represent context to achieve optimal performance in decision

making. According to Nonaka and Takeuchi (2019), Japanese companies create new knowledge and innovation through collaboration and the creation of knowledge networks demonstrating the importance of knowledge networks in the business environment and knowledge management.

2. Methodology

As a methodology, the repository called @geintic employs a feedback process to contain essential information about learning content, featuring two sets tailored for distinct learning styles. These contribute to the generation of personalized and pertinent content delivered to the student. The primary function of the intelligent agent is to gather and store data, along with corresponding metadata, in a knowledge set crucial for the learner's educational needs. This set represents customized variables that the student will observe during the final stage of the agent's automated disposition, ranging from a concise summary to a comprehensive analysis of the student's learning style. Moreover, the agent thread generates supplementary information to address knowledge gaps that may arise from exposed content, facilitating the presentation of a sequence of learning objects to the student.

3. Results

Based on the findings and documentary research, it can be concluded that the utilization of intelligent systems in education holds a broad scope. Beyond merely defining and utilizing the elements and support offered by these systems, they have the potential to instigate transformative changes in the learning process through logical and automated sequences within the systems.

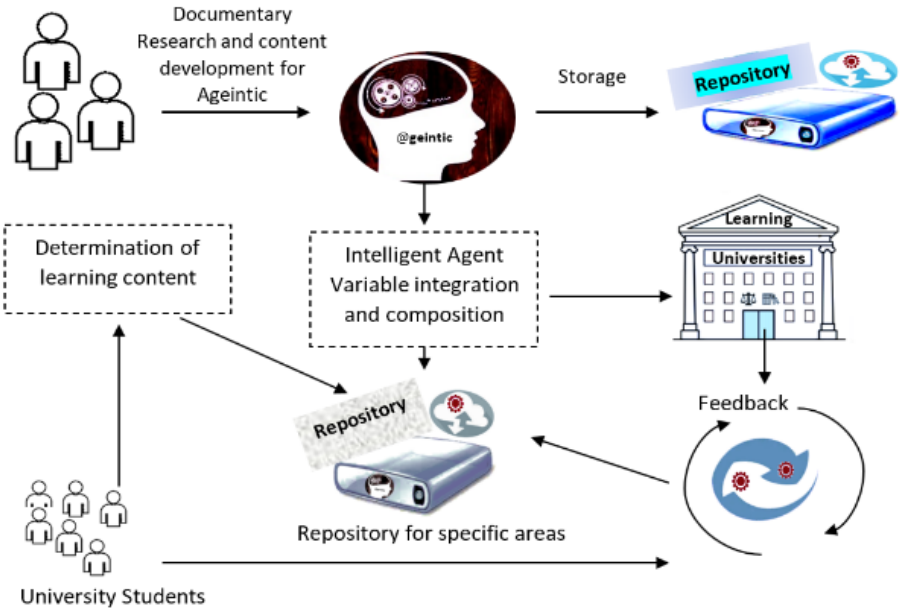

Figure 4. *Development of the Achievement of the Intelligent Agent's Contents*

Drawel et al. (2022) implemented a multi-agent system that uses artificial intelligence techniques to provide students with a personalized and adaptive learning pathway, based on Nwana's (1996) work. This system uses intelligent agents to collect information about student performance and preferences and then generates personalized learning recommendations based on this information.

However, these intelligent systems cannot be limited to simple sequencing or ordering of content. They must be supported on platforms that contemplate the changes that take place both in the local scope of universities and in the global areas around education (see Figure 4). The

development of the intelligent agent from authorship to the feedback delivered to students in their academic processes is particularized as follows:

In the university context, students receive information and share their particularities in the learning process. In this sense, the intelligent agent @geintic plays a fundamental role, as it is responsible for selecting and delivering personalized information. This agent performs processes of selection and personalized delivery of the information stored in its repository.

Repository A is where all the information covered and extracted from the research is housed. All relevant processes and contents for the agent @geintic are stored here. Additionally, this repository contains primary information on learning styles, described according to research results.

Repository B is responsible for determining the results in each of the processes and sub-processes carried out in the @geintic platform. This repository contains information on specific tasks and allows for searching and content recovery according to research results.

Learning – University is the physical space where students can access the system.

Feedback: The process is developed automatically from the set of active contents present in the platform, along with the metadata that describes it. It provides personalized learning alternatives to students and determines their learning styles through evaluation. This intelligent system of feedback distributes learning content to students and tracks their progress.

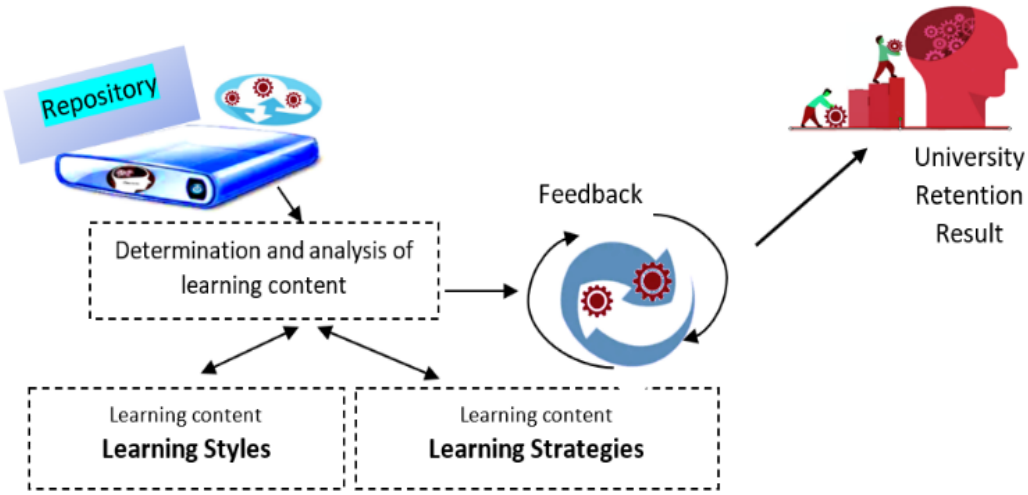

Figure 5. *Intelligent Agent Feedback Processes*

The intelligent agent combines information with the system's functionality, deploying personalized learning options and storing them in the @geintic repository. This enables students to recognize and rethink their learning processes. Once the contents are stored, the agent integrates its variables with the students to generate specific adaptations. The agent also evaluates the learning and provides feedback to the student automatically.

Regarding the Achievement of the Integration Process and Composition of the Intelligent Agent Variable

Figure 5 presents the model for achieving @geintic contents, which illustrate the agent's input for its operation at the time of delivering the results to students.

4. Discussion

The complexity of computers and their connection with people can be overcome by delegating complex tasks to intelligent agents, allowing even greater abstraction of the details of the person-program interface, this agent technology can provide specific and viable solutions to improve the effectiveness of online education, especially in emergencies such as the COVID-19 pandemic. Agents can address multiple problems at the same time, considering the particularities of each student and providing an unprecedented level of functionality.

In summary, the intelligent agent is a valuable tool for addressing complex challenges in the educational field, as well as in other fields of modern-day life, simplifying the interface between computers and people, and delegating to agents the details of specifying and carrying out complex tasks.

Thus, specific solutions in the educational environment to achieve viable alternatives in research on learning strategies in reducing dropout rates as a problem require agents with specific and pointed questions. This agent technology possesses the capability to simultaneously address diverse challenges, considering the individual intricacies of human characteristics. It affords an unparalleled degree of functionality to individuals, as elucidated by Wooldridge (2020).

Likewise, this connection is made online, incorporating resource managers, performing safe planning of tasks, assigning strategies, supervision, and possibly, the intelligent agent could function as a global manager of academic resources.

4.1. Intelligent Agent Structure

Based on developments carried out in the elaboration of learning style and university dropout instruments, the different areas that correspond to the current study are related. The proposal's contribution is based on intelligent agents and learning strategies, and in the significant variables found in the correlation between university dropout and learning.

The study revolves around the conception and implementation of an intelligent agent tasked with executing an automated content sequencing procedure. This process is informed by way of an investigation into learning styles and the phenomenon of university dropouts. The intelligent agent tailors the learning experience of students by considering their learning styles, drawing insights from a comparative analysis of learning strategies within the university milieu, as discussed by Ramirez (2020).

An example of this approach can be found in the work of Vega et al. (2022), who designed an intelligent agent that adapts the teaching-learning process according to students' profiles, significantly improving their academic performance. This approach has the potential to improve the effectiveness of education and reduce university dropout rates by personalizing the learning experience of each student and adapting it to their individual needs.

In the context of intelligent agents in learning processes, a design is presented that includes a comparative analysis and a study of the results as a continuation of the research project. The agent starts with personalized input for each student, showing a general understanding of the process and its development. Then, an automatic structure is established that presents options within the system, considering all the sub-processes that make up the agent and all the variables employed.

An example of this approach can be found in the work of Morrison et al. (2023), who designed an intelligent agent that personalizes the teaching-learning process for students with visual disabilities, improving their academic performance and reducing the inequality gap. This strategy has the potential to improve accessibility and inclusion in education by personalizing the learning experience for each student and adapting it to their individual needs.

5. Conclusion

To effectively integrate intelligent agents into the university educational system and prevent dropout, it is essential to begin by improving access to knowledge and fostering a culture of knowledge transfer. In addition, digital skills, autonomy, and self-directed learning must be developed so that students can operate without human intervention. The COVID-19 pandemic changed the way in which we learn, so it is important to understand this "new normal." In summary, barriers such as distance and time must be eliminated, and the educational system must be opened globally, considering the needs and challenges of higher education institutions concerning dropout.

However, some questions arise regarding this integration, such as: Would computer-mediated intelligent agents lead to a new world? What would this world look like? What would be the role of teachers and institutions in this world? Bearing this in mind, the existing digital divide will victimize education if universities do not assimilate or integrate intelligent agents properly and promptly, considering that the use of intelligent agents leads to the creation of new applications daily, enabling knowledge management.

Interdisciplinary education research has significantly contributed to our understanding of learning processes and the nature of teaching practices that support these processes. Therefore, it is essential to incorporate this understanding into the design of AI technology used in education and training. This understanding can come from both learning sciences researchers and educators in teaching practice.

The increasing adoption of artificial intelligence (AI) in education and training underscores the urgent need for interdisciplinary collaboration among stakeholders. It is crucial that educators and trainers help AI developers better understand teaching and learning, and that, in turn, AI developers help educators and trainers better understand AI and its application in education, facilitating academic synergies through open digital resources.

The framework proposed in this study is a structured approach to achieving three central objectives for AI in education and training: Prioritizing intelligence, addressing educational challenges, and educating everyone about AI. In summary, the application of AI in education must be approached with caution, and there must be diverse and varied collaboration among universities, AI developers, educators, and trainers to ensure effective and equitable solutions for quality education and training.

Declarations

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References

Drawel, N., Laarej, A., Bentahar, J., & El Menshawy, M. (2022). Transformation-based model checking temporal trust in multi-agent systems. *Journal of Systems and Software*, *192*, Article 111383. https://doi.org/10.1016/j.jss.2022.111383

Farhadi, F., & Jennings, N. R. (2021). A faithful mechanism for incremental multi-agent agreement problems with self-interested and privacy-preserving agents. *SN Computer Science*, *2*(4), Article 272. https://doi.org/10.1007/s42979-021-00650-4

Gligorea, I., Cioca, M., Oancea, R., Gorski, A. T., Gorski, H., & Tudorache, P. (2023). Adaptive Learning Using Artificial Intelligence in e-Learning: A Literature Review. *Education Sciences*, *13*(12), Article 1216. https://doi.org/10.3390/educsci13121216

Jiang, B., Li, X., Yang, S., Kong, Y., Cheng, W., Hao, C., & Lin, Q. (2022). Data-driven personalized learning path planning based on cognitive diagnostic assessments in MOOCs. *Applied Sciences*, *12*(8), Article 3982.https://doi.org/10.3390/app12083982

Li, T. J. J. (2019). End-user programming of intelligent agents using demonstrations and natural language instructions. In *Proceedings of the 24th International Conference on Intelligent User Interfaces: Companion* (pp. 143-144). ACM. https://dl.acm.org/doi/10.1145/3308557.3308724

Luckin, R., Cukurova, M., Kent, C., & du Boulay, B. (2022). Empowering educators to be AI-ready. *Computers and Education: Artificial Intelligence*, *3*, Article 100076. https://doi.org/10.1016/j.caeai.2022.100076

Mamlok, D. (2021).*The Great Promise of Educational Technology: Citizenship and Education in a Globalized World*. Palgrave MacMillan

Montag, C., Ali, R., Al-Thani, D., & Hall, B. J. (2024). On artificial intelligence and global mental health. *Asian Journal of Psychiatry*, *91*, Article 103855. https://doi.org/10.1016/j.ajp.2023.103855

Morrison, C., Grayson, M., Marques, R. F., Massiceti, D., Longden, C., Wen, L., & Cutrell, E. (2023). Understanding Personalized Accessibility through Teachable AI: Designing and Evaluating Find My Things for People who are Blind or Low Vision. In *Proceedings of the 25th International ACM SIGACCESS Conference on Computers and Accessibility* (Article 31). https://doi.org/10.1145/3597638.3608395

Negroponte, N. (2021, April 23). Machines in Residence. *The Architecture Machine*. https://mitp-arch.mitpress.mit.edu/pub/oo9x1yoz/release/1

Nonaka, I., & Takeuchi, H. (2019). *The wise company: How companies create continuous innovation*. Oxford University Press.

Nwana, H. S. (1996). Software agents: an overview (1996). *The Knowledge Engineering Review, 11*(3), 205-244. https://doi.org/10.1017/S026988890000789X

Panagiotis, S., Panagiotopoulos, I., Goumopoulos, C., & Kameas, A. (2015). Combining agents and ontologies for building an intelligent tutoring system. In M. Helfert, M. T. Restivo, S. Zvacek, & J. Uhomoibhi (Eds.), *International Conference on Computer Supported Education* (Vol. 2, pp. 15-24). SCITEPRESS. https://doi.org/10.5220/0005422900150024

Pellas, N. (2023). The Effects of Generative AI Platforms on Undergraduates' Narrative Intelligence and Writing Self-Efficacy. *Education Sciences*, *13*(11), Article 1155. https://doi.org/10.3390/educsci13111155

Raghavachary, S., & Miller, J. (2019). Introduction to cloud-based machine learning. *Journal of Computing Sciences in Colleges*, *34*(4), 100-100. https://dl.acm.org/doi/abs/10.5555/3344013.3344025

Ramirez, E. A. B. (2020). Analysis of learning styles through intelligent systems. *Etic@net. Electronic Scientific Journal of Education and Communication in the Knowledge Society, 20*(1), 1-17. https://doi.org/10.30827/eticanet.v20i1.15519

Rasouli, S., Ghafurian, M., & Dautenhahn, K. (2022). Students Views on Intelligent Agents as Assistive Tools for Dealing with Stress and Anxiety in Social Situations. In C. Bartneck, T. Kanda, M. Obaid, & W. Johal (Eds.), *Proceedings of the 10th International Conference on Human-Agent Interaction* (pp. 23-31). ACM. https://doi.org/10.1145/3527188.3561932

Red'ko, V. G., & Sokhova, Z. B. (2022). Model of an autonomous agent forming its own simple knowledge base. *Procedia Computer Science*, *213*, 477-485. https://doi.org/10.1016/j.procs.2022.11.094

Russell, S., & Norvig, P. (2016). *Artificial Intelligence: A Modern Approach.* Pearson.

Schmidt, S., Ariza, O., & Steinicke, F. (2020). Intelligent blended agents: Reality–virtuality interaction with artificially intelligent embodied virtual humans. *Multimodal Technologies and Interaction, 4*(4), Article 85. http://dx.doi.org/10.3390/mti4040085.

Shi, Y., & Zhang, K. (2021). Advanced model predictive control framework for autonomous intelligent mechatronic systems: A tutorial overview and perspectives. *Annual Reviews in Control*, *52*, 170-196. https://doi.org/10.1016/j.arcontrol.2021.10.008

Svenningsson, N., & Faraon, M. (2019). Artificial intelligence in conversational agents: A study of factors related to perceived humanness in chatbots. In *Proceedings of the 2019 2nd Artificial Intelligence and Cloud Computing Conference* (pp. 151-161). ACM. https://doi.org/10.1145/3375959.3375973

Vega, H., Sanez, E., De La Cruz, P., Moquillaza, S., & Pretell, J. (2022). Intelligent System to Predict University Students Dropout. *International Journal of Online & Biomedical Engineering*, *18*(7), 27-43. https://doi.org/10.3991/ijoe.v18i07.30195

Verma, A., & Singh, A. (2021). A new era of technology-empowered education: education 4.0 a systematic review. In *2021 9th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO)* (pp. 1-7). IEEE. https://doi.org/10.1109/icrito51393.2021.9596245

Vikas, S., & Mathur, A. (2022). An empirical study of student perception towards pedagogy, teaching style and effectiveness of online classes. *Education and Information Technologies, 27*, 589-610. https://doi.org/10.1007/s10639-021-10793-9

Wooldridge, M. (2020). Artificial Intelligence requires more than deep learning what, exactly? *Artificial Intelligence*, *289*, Article 103386. https://doi.org/10.1016/j.artint.2020.103386

Wu, Y., Xu, X., Xue, J., & Hu, P. (2023). A cross-group comparison study of the effect of interaction on satisfaction in online learning: The parallel mediating role of academic emotions and self-regulated learning. *Computers & Education*, *199*, Article 104776. https://doi.org/10.1016/j.compedu.2023.104776

Yang, J., Chen, Y.-L., Por, L. Y., & Ku, C. S. (2023). A systematic literature review of information security in chatbots. *Applied Sciences*, *13*(11), Article 6355. https://doi.org/10.3390/app13116355

Yazdanpanah, V., Gerding, E. H., Stein, S., Cirstea, C., Norman, T. J., & Jennings, N. R. (2021, June 29-30). *Collective responsibility in multiagent settings* [Virtual conference presentation]. ACM Collective Intelligence Conference 2021. Copenhagen, Denmark. https://www.dropbox.com/s/d00qz3knb7tz72l/Collective%20Responsibility%20in%20Multiagent%20Settings.pdf?dl=0

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). A systematic review of research on artificial intelligence applications in higher education–where are the educators? *International Journal of Educational Technology in Higher Education*, *16*(1), Article 39. https://doi.org/10.1186/s41239-019-0171-0

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