A COMPREHENSIVE REVIEW OF EXPERT SYSTEMS IN PROFESSIONAL EDUCATION: CURRENT TRENDS AND FUTURE DIRECTIONS

Abstract

Expert systems, an inventive branch of artificial intelligence, have gained awareness in the field of professional education due to their prospective to enhance learning outcomes & decision-making processes. This research paper aims to provide a comprehensive review of expert systems into professional education, focusing on current trends and future directions. Through an analysis of recent literature and research studies, we explore the applications, benefits, challenges, and emerging trends of expert systems within the context of professional education. The findings of this review shed light on the present state of expert systems into professional education and offer insight into their potential for future advancements. Furthermore, the papers do ahead future advancements had driven by expert system and data, emphasizing potential benefits for learner engagement and lifelong learning. This research offers valuable insights for educators and policymakers into the current landscape and future opportunities of expert systems in professional education.

Keywords: Expert system, artificial intelligence, Professional education.

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I. INTRODUCTION

The utilization of an expert system in the teaching and learning process within professional educational systems is greatly popular as it will make easy the teaching and learning process. An expert system is a familiar area of artificial intelligence intended to improve the accessibility of knowledge essential in the professional education system. In developing countries, an expert system is very useful in professional courses such as engineering, law, management, medical, and related. Expert system has a lot of benefits, especially for students, teachers, & professional institutions.

1. What is an Expert System?

An expert system is a computer program specifically intended to break difficult problems and to give decision-making capability like a mortal expert. It performs this by rooting knowledge from its knowledge base via the logic and inference rules according to the user queries. It solves the nearly all difficult problems as an specialist by extracting the knowledge stored in its knowledge base. [4] The system helps in decision-making for difficult problems using both data and heuristics like a mortal expert**.**

2. Why We Need an Expert System in Professional Education?

An expert system is a type of computer software designed to take off the decision-making abilities of a mortal expert, specifically in the field of education. The system relies on knowledge base comprised of human expertise to solve problems and address uncertainties that would typically require consultation with one or more human experts. By utilizing human knowledge, expert systems are capable of tackling complex issues that usually necessitate human intelligence. In today's information age, integrating expert systems into educational institutions has the potential to significantly enhance knowledge delivery and acquisition, thereby positively impacting teaching and learning processes (Ngene Chigozie Chidinma 2001) [20]."

To assess the effectiveness of expert systems in education across different levels and aspects, a comprehensive analysis is conducted. This involves exploring academic repositories for conference papers and articles related to expert systems in education. By doing so, it becomes possible to identify the stages of education & specific characteristic that receive significant attention in promoting effective teaching & learning through utilize of expert systems. Additionally, literature available in these databases aids in gauging the concentration of research focused on expert systems in education, providing valuable insights into the direction and emphasis of current studies. Notably, Inusah & Amponsah (2018) [15] highlight the capacity of expert system to enhance management efficiency by facilitating faster, more accurate and simple decision-making for human experts.

According to iMarkham H. C. (i2001), expert systems offer important benefits as educational tools due to their single features to facilitate users toward inquire about "How?," "Why?," and "What?" layouts. When executed in the classroom environment, these systems can provide some aids to students, as they can get answers without trusting

only on the trainer. Besides, expert systems have the ability to make available descriptions for the specified answers, improving students' knowledge and confidence in the reactions they receive. An additional important feature of expert systems, as emphasized by Zorica i Nedic, Vladimir Nedici, and Jan Machotka (2002), is their adaptive training ability, which permits adapting the learning skill to each student's specific pace of learning. This feature has been efficiently used for teaching engineering students and consist of the capability to display students' development and make informed decisions concerning the next stages into their education (Susmita Mohapatra 2019)[23].

3. **Working of Expert System:** Expert systems are specifically designed to tackle complex problems across various domains. Unlike humans, these systems do not possess inherent capabilities; rather, they rely on a knowledge base to obtain information relevant to a specific situation. Through a user interface, individuals can pose inquiries to an expert system, and an inference engine, which applies logical rules, is responsible for retrieving answers from the knowledge base. The I knowledge base itself be a repository of facts & rules, containing information gathered from human experts specified by Shilpi Singh, Meenu gupta, Vijaya jyoti, Anamika Rai, and Smriti Jha (2018) [22].

   In essence, an expert system operates as a knowledge-based system, enabling users to seek expert answers by interacting with the system user interface. The processing of the inference engine facilitates the extraction of pertinent information that matches the user's query.

4. **Development of Expert System:** The process of development expert systems be commonly referred to as "knowledge engineering." An I expert system can be broken down in two main components: the knowledge base & the inference I engine. The knowledge base holds specialized information related to a particular subject, which is derived from the expertise of human professionals in that field. This knowledge is collected from the mortal expert and afterward encoded into the knowledge base utilizing various knowledge representation methods, ensuring that the system possesses expertise in the subject matter. The inference engine is automatic analysis systems that evaluates the present knowledge-base & add on the fresh knowledge to the knowledge-base it is done by applying various rules including forward and backward chaining specified by Shilpi Singh, Meenu gupta, Vijaya jyoti, Anamika Rai, and Smriti Jha (2018)[22].

   Sartori and Melen (2017) point out that for the accurate management of the expert system, validation, verification and excellence of the system must to be done first. Yemelyanov, Nedelkin and Olenev (2019) in their findings indicated that professionals responsible for expert system development are more concern with the validation and verification termed ‘V&V’ but hardly if any of them is concern with the system quality assurance. Moreno et al. (2020) stated that various expert system developers ignores one of the most important aspect of the system which determined credibility, that is the aspect which answered the question of how credible is the system to the user? Credence can a user be able to put to the system if the quality assurance is not in place? (Milad et al. 2021)

II. OBJECTIVES

1. Identify and analyze the various applications of expert system in professional education.
2. Identify the current trends and emerging technologies in the development of expert system in professional education.
3. Highlight the potential benefits of expert system into educational practices.

III. SCOPE AND METHODOLOGIES

The scope of this review research paper is to examine the utilization of "I Expert Systems" within the context of professional education. The paper will delve into the definition, conceptualization of expert systems and their applications in various professional disciplines. It will assess the benefits and limitations of these systems, analyze their effects on student performance and learning outcomes, and discuss the ethical considerations involved. The paper will also explore pedagogical approaches for integrating expert systems effectively and provide insights into future prospects and emerging trends in this field.

Systematic literature review conduct a comprehensive search and analysis of relevant research articles, academic papers, and conference proceedings related to expert systems in professional education to ensure a rigorous and unbiased review.

IV. APPLICATIONS OF I EXPERT SYSTEM IN PROFESSIONAL EDUCATION

Expert systems have found applications into various professional educational fields, spanning computer animation I, computer science, I engineering, I language teaching, and commerce studies. Victor Yec (1995) explored the utilize of expert systems into computer animation, where they served as guides for developers in designing 2D and 3D modeling packages. Heather Christine Markham (2001) focused on their implementation in computer science education. In the field of engineering, Zoricai Nedici, Vladimir Nedici, and Jan Machotkai (2002i) investigated the utilization of expert systems. Additionally, in language teaching, expert systems have been employed in the direction of education.

Moreover, expert systems have been applied as valuable tools into teaching mathematics and associated subjects, as evidenced by the work of iKristopeit. This paper aims to present the use of expert systems in teaching initial data structures, followed by their potential applications into engineering, business, medical, technology, & space science education.

1. **Expert System used for teaching Introductory Data Structure:** The expert system in question utilizes Information technology as its standard for accessing information. It was developed by employing CLIP (C I Language Integrated Production System i) as the inference engine and HTML programming for its front-end interface. According to Markhami (2001) i, this expert system offers an outstanding alternative to private tutorials. Furthermore, due to its utilization of Java technology, the system is rendered interoperable and platform-independent.

2. **Expert System used for Engineering:** This expert system operates by the fuzzy logic method like its engine, enabling it toward function adaptively. Its primary objective is to

assist first-year engineering students in developing a thorough understanding of fundamental concepts, preparing them for new issues in the engineering field. The system achieves adaptability by dynamically adjusting the training approach based on each student's space of learning. Through continuous monitoring of the student's progress, the expert system can make informed decisions regarding the next steps in their training. To guide its behavior, the expert system relies on a fuzzy rule-based decision-making system. This approach allows the system to draw information on each student's performance by comparing it against membership functions for different topics, difficulty levels, and importance levels. In essence, the expert system tailors its instructional strategy to suit the unique learning needs of each individual student.

3. **Expert System used for Learning Internet:** According to (Jim Prentzasi, Loannisi Hatzilygeroudis, C. Koutsojannisi, 2001), hybrid expert system had been developed to assist teacher in learning new technologies such as Internet. They had developed net based Intelligent Tutoring System (ITS) for teaching innovative technologies to teacher.

4. **Expert System used for Mineral Identification:** The development of this expert system aims to provide support used for teaching mineral properties at the institute level, with the ultimate goal of facilitating efficient and significant learning of exact study in earth science. The target users of this system are college students, regardless of whether they possess in-depth computer skills or not. To build this expert system, an expert system building tool called EXSYS (EXSYS Inc. 1994) was utilized. This tool is specifically designed to be easily maintained by individuals without a background in computer science. Notably, EXSYS has been a well-established business expert system building tool available into the marketplace for a number of years.

5. **MYCIN:** The first and oldest expert system is MYCIN, which is designed to address specific bacterial infections and provide acne control, along with other acne treatments. Moreover, MYCIN serves to prevent infection in individuals with a history of stiff disease, inborn heart conditions, or else other acquired heart conditions, particularly those who are allergic to penicillin antibiotics.

6. **DENDRAL:** An expert system designed to decide the structure of the element using its spectrographic data. Its main aim was to analyze hypothesis formation and innovation into science.

7. **R1/XCON:** An Expert System so as to had the ability to choose the best-suited software to do a particular job assigned by the user.

8. **PXDES:** Pneumoconiosis X-Ray Diagnosis Expert System (PXDES) is an expert system which is used to diagnose in which stage a patient of lung cancer.

9. **DXplain:** This was an expert system so as to diagnosing a number of diseases into a patient based on the input provided

V. BENEFITS OF EXPERT SYSTEM

Expert systems recommend surroundings where the excellent capabilities of mortals & the power of computers can be included to defeat a lot of of limitations. Expert system has lots of benefits like:

- Improving the probability frequency, and consistency of decision-making.
- Facilitating the dissemination of mortal expertise.
- Enabling real-time, cost-effective expert-level decisions even for non-experts.
- Enhancing the utilization of vast amounts of available data.
- Allowing objectivity by evaluating evidence impartially, free from personal and emotional biases.
- Enabling adaptability through a modular structure.
- Liberating the human expert's mind and time to focus on more creative endeavors.
- Encouraging exploration of intricate problem areas.
- Tailoring the learning experience to individual students by tracking their progress and learning pace.
- Providing a user-friendly environment to ask questions, seek solutions, and query information.
- Identifying errors and assisting in their resolution in a supportive manner.

1. **Benefits to the Students:** Expert systems significantly enhance simulations & assist in teaching practices from the educational perspective. Although expert systems primarily support new learning and teaching actions, such as problem-based learning (PBL), they play a crucial role in reinforcing concepts for students. Through repeated use, students gain a deeper understanding, making it easier for even slow learners to visualize and comprehend the material effectively. One of the key advantages of expert systems is their reproducibility, ensuring their availability for students to consult at any stage. This accessibility enables students to interrogate and analyze the reasoning process, promoting a deeper level of learning.

   Furthermore, expert systems offer various resources, including worked examples and guidelines, readily accessible to students for review purposes. By utilizing the expert system, students have extra time to focus on the topic matter, facilitated by an interactive interface that enables seamless communication with the system. Students can make queries, seek assistance from the system's tutor, and access additional materials conveniently.

2. **Benefits to the Teacher:** According to Lucy C.S., Obert M. and Lemias Z (2010), the expert system assumes the task of a teacher, delivering a sequence of informative screens, test questions, and providing feedback to students. Moreover, expert systems excel in various areas, including instructional design, decision making, planning, control, and association with both students & trainers. They prove particularly valuable in situations where trainers may face challenges in explaining complex concepts. Many of the teacher's responsibilities can be efficiently handled with the expert system, such as offering expert advice and making decisions during lectures [16].

3. **Benefits to the Professional Institutes:** In professional education, semi-professional staff can effectively deliver professional material to students without compromising academic standards. As a result, institutes and universities can fight with other local institutions operating in regular financial conditions with sufficient resources specified by Fisseha (2011) [3].Although the development of expert systems might be costly, they offer the advantage of reducing the number of human experts needed for teaching responsibilities. However, it is essential for expert systems to assess students' computer skills and background, as these factors could potentially hinder the learning process indicated by Ngene Chigozie Chidinma, et. Al (2021)[20].

VI. CURRENT TRENDS OF EXPERT SYSTEM IN PROFESSIONAL EDUCATION:

Expert systems in professional education were already showing promising trends. However, as technology and educational practices continue to evolve, it is essential to consider that new developments may have occurred beyond that time. Here are some potential current trends of expert systems in professional education:

1. **Personalized Learning:** Personalization remains a significant trend in education, including professional education. Expert systems are being utilized to form personalized learning experiences so as to cater to individual learners' requirements, preferences, & skill levels. These systems can adapt content, pace, and learning pathways to optimize learning outcomes for each professional.

2. **Data-Driven Insights:** The use of data analytics and learning analytics in expert systems is gaining momentum. Educational institutions and organizations are leveraging data to gain insights into learners' performance, behavior, and engagement patterns. This data-driven approach helps in refining course content, identifying areas of improvement, and enhancing the overall learning experience.

3. **Micro learning and Just-In-Time Training:** Expert systems are being employed to deliver bite-sized, easily accessible content, making it convenient for professionals to access relevant information when they need it. This trend aligns with the increasing demand for just-in-time training to support continuous learning on the job.

4. **Simulation and Virtual Reality (VR):** Expert systems are integrating more sophisticated simulation and VR technologies to offer immersive learning experiences. These technologies are especially valuable in fields where hands-on practice is essential, such as healthcare, engineering, and manufacturing.

5. **AI-Powered Adaptive Assessments:** Expert systems are providing adaptive assessments that dynamically adjust the difficulty and content of tests based on the individual's performance. This approach ensures a more accurate evaluation of a professional's knowledge and skills.

6. **Natural Language Processing (NLP) Advancements:** Improvements in NLP are enhancing the capabilities of expert systems to understand and generate human-like language. This progress allows for more effective communication between learners and the system, making the learning process smoother and more intuitive.

7. **Collaborative and Social Learning:** Expert systems are increasingly incorporating collaborative learning features, encouraging professionals to learn from and interact with their peers. These systems facilitate knowledge sharing and networking, creating communities of practice within professional education.

8. **Mobile Learning and Apps:** As mobile technology becomes more prevalent, expert systems are embracing mobile learning approaches. Professionals can access learning materials, assessments, and resources through dedicated apps, making learning more accessible and flexible.

9. **AI-Based Career Guidance:** Expert systems are being used to provide personalized career guidance to professionals, helping them identify suitable career paths, relevant skills to develop, and opportunities for growth.

10. **Ethical AI and Bias Mitigation:** With increased reliance on AI in education, there's a growing focus on addressing ethical concerns and mitigating algorithmic biases. Researchers and developers are working to ensure that expert systems in professional education promote fairness, inclusivity, and transparency.

11. **Cohort-Based Learning:** The cohort-based learning approach is an educational strategy where a set of students advance collectively through a course. In online cohort-based classes, a combination of synchronous and asynchronous learning methods is commonly employed. This approach fosters teamwork among students via shared projects and interactions during class sessions.[3]

12. **Cloud Computing:** A learning cloud refers to a cloud computing innovation within the domain of e-learning, signifying a prospective infrastructure for e-learning that encompasses both hardware and software computing assets tailored for e-learning purposes. Beyond virtualized computing resources, it encompasses provisions for leasing computational resources to educational institutions, students, and enterprises.

13. **Internet of Things (IOT):** As per Faith, the term IoT (Internet of Things) denotes a network that links various objects to the Internet through specified protocols. This is achieved via information-sensing devices that facilitate the exchange and communication of data, enabling capabilities like intelligent identification, positioning, monitoring, and administration. The emergence of IoT has expanded Internet connectivity to encompass physical entities beyond traditional computers, serving multifaceted functions.

14. **Technology-Powered Assessment Tools:** Assessment tools driven by technology are poised to shape the future of evaluation. These tools offer instant feedback, streamline processes, alleviate the burden on educators, and merge formative and summative assessments (Oldfield et al., 2012). Furthermore, AI can aid business students in devising captivating business name concept. Moreover, the ascent of intelligent systems supported by AI and machine learning is anticipated. These systems will engage in ongoing, inconspicuous assessments and provide tailored instruction based on students' learning readiness (Ferrara, 2019).[11]

15. **Big Data:** The driving force reshaping education is data, a direct result of technology integration within online educational settings. The rapid production of substantial data volumes from digital platforms, textbooks, and applications holds significant implications. This data furnishes insights into student interactions, factors that foster engagement, setbacks, and attrition rates. Its utility lies in facilitating real-time content adjustments, timely support for struggling learners, and overall performance enhancement. Furthermore, universities employ data to refine programs and policies, as demonstrated by successes like Oral Roberts University's surge in retention from 61% to 81% and Nazareth College's elevated graduation rates through comprehensive student assessments. Nonetheless, challenges are evident, encompassing concerns about privacy and the management of outdated data repositories. While cloud services contribute to advancement, limitations in resources hinder the full exploitation of data's potential. Conquering these barriers holds paramount importance in leveraging data's transformative capacity within the realm of education.

17. **Blockchain-Led-Education:** Recent developments in online education point towards a growing adoption of Blockchain technology within the EdTech sector. The transition of Blockchain from theoretical concepts to practical applications has become evident, particularly in the field of EdTech. Observations in online education trends underscore the potential of Blockchain's immutability in archiving student records. Simultaneously, professionals can be motivated to engage in learning through the distribution of tokens, scholarships, and similar incentives.[8]

18. **Metered Learning:** Every individual possesses distinct learning paces. As traditional teaching approaches recede, the potential for increased faculty-to-student interaction becomes apparent, potentially altering the existing ratios. Artificial Intelligence (AI) and machine learning can play a pivotal role in achieving this. This collective endeavor is commonly known as Adaptive Learning, a paradigm where learners access content through intelligent devices. These devices or applications monitor and communicate the progress of learning to educators, coupled with suggestions on tailoring the curriculum for more efficient comprehension. Recognizing the limitations in providing individual attention to every student due to time constraints, teachers can effectively align students' understanding by employing diverse learning paths. [8]

These trends indicate how expert systems continue to evolve to meet the changing needs of professional learners and offer more effective, engaging, and efficient educational experiences. As the technology landscape evolves, further advancements and innovations in expert systems for professional education are expected to emerge.

VII. LIMITATIONS OF EXPERT SYSTEM

1. The accuracy of the expert system's responses may be compromised if its knowledge base contains incorrect information.
2. Similar to humans, expert systems are limited in their ability to generate creative solutions for diverse scenarios.
3. The maintenance and development expenses associated with expert systems are significantly high.
4. Acquiring knowledge to design the system is a challenging task

5. Each domain requires a dedicated expert system, which presents a major limitation.
6. Expert systems lack the capability to learn autonomously, necessitating manual updates.

VIII. RESEARCH AREAS OF AN EXPERT SYSTEM IN PROFESSIONAL EDUCATION

Expert systems in professional education have significant potential to enhance training, skill development, and decision-making in various fields. Some research areas of expert systems in professional education include:

1. **Skill Assessment and Gap Analysis:** Developing expert systems that can accurately assess the skills and knowledge of professionals in specific domains and identify areas where they need further training or improvement.

2. **Personalized Learning Paths:** Designing intelligent systems that can create personalized learning paths for professionals, considering their existing knowledge, experience, and career goals.

3. **Performance Support:** Building expert systems that offer real-time support to professionals during their work, providing them with relevant information and guidance to make informed decisions and solve complex problems.

4. **Competency-Based Education:** Researching and implementing expert systems that aligns with competency-based education models, which focus on demonstrating practical skills and abilities rather than traditional knowledge-based assessments.

5. **Adaptive Training and Simulation:** Creating expert systems that can adapt training and simulation experiences based on the learner's performance and progress, providing tailored feedback and challenges.

6. **Expertise Sharing Platforms:** Developing platforms that allow experts in a field to share their knowledge and experiences, creating a repository of valuable insights that can benefit professionals seeking to improve their expertise.

7. **Decision Support Systems:** Designing intelligent decision support systems that assist professionals in making critical decisions, considering relevant data, best practices, and expert knowledge.

8. **Continuous Professional Development (CPD):** Researching ways to integrate expert systems into continuous professional development programs, ensuring that professionals stay updated with the latest developments and best practices in their field.

9. **Collaborative Learning and Communities of Practice:** Exploring how expert systems can foster collaborative learning environments and support the development of communities of practice, where professionals can learn from each other.

10. **Ethical and Legal Considerations:** Addressing ethical concerns related to the use of expert systems in professional education, such as data privacy, security, and potential biases.

11. **Domain-Specific Expert Systems:** Tailoring expert systems to specific professional domains, such as healthcare, law, engineering, finance, etc., to meet the unique requirements and challenges of each field.

12. **Human-Machine Collaboration:** Investigating the optimal balance between human expertise and the capabilities of expert systems, promoting effective collaboration between professionals and AI-powered tools.

These research areas aim to leverage the potential of expert systems to create more efficient, effective, and learner-centric approaches to professional education. As technology advances and more data becomes available, the scope for innovation and impact in this field continues to grow.

IX. CONCLUSION

The research paper emphasizes the significance of expert systems in the field of professional education. After a thorough review of 14 literature, it becomes evident that the incorporation of expert systems in professional education proves to be highly beneficial, effectively addressing educational challenges across various domains, including input, process, output, and outcome. To foster further advancements, it is recommended to integrate educational methodologies with other fields, as expert systems form a multidisciplinary research topic. Consequently, it is anticipated that scientists will develop even more refined expert systems to tackle future educational issues and challenges.

In recent times, expert systems have been increasingly employed in conjunction with artificial neural networks, fuzzy logic, genetic algorithms, and other Artificial Intelligence methods. This integration allows for leveraging the advantages of these approaches, leading to the development of more potent systems capable of providing prompt, accurate, and reliable results for a wide array of tasks.

The application of expert systems has expanded beyond engineering education and has gained acceptance in courses such as accounting, medical and management as an effective teaching tool. With only a limited number of expert systems currently available in the market, students who seek enhanced learning experiences and more personalized attention can benefit significantly from these systems. The interactive and user-friendly interface of expert systems motivates students and encourages a more practical approach to learning. The study indicates that expert systems can serve as both assistants and substitutes for teachers. They cater to individual student needs and monitor their learning progress, with teachers acting as mentors. Additionally, students can assess their own performance. Expert systems not only benefit students but also aid teachers in providing superior guidance. As a result, expert systems offer several advantages over traditional teaching methods and are poised to replace them in the near future.

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