International Journal of Education, Modern Management, Applied Science & Social Science (IJEMMASSS)
ISSN : 2581-9925, Impact Factor: 6.340, Volume 03, No. 01, January - March, 2021, pp. 385-394

STUDY AND DESIGN OF E-LEARNING SYSTEM BASED ON ARTIFICIAL INTELLIGENCE

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ABSTRACT

Systems for e-learning are now an essential component of the educational system. By facilitating efficient and effective content-based learning, technology in the classroom helps students feel more confident. Curriculum is developed in line with learners' ability and background knowledge, with customised learning methods placing a strong focus on learning behaviour and interest. It is a versatile method of instruction that may be modified to meet the needs of each learner. The individualised learning plan meets all of the demands of each student. This study provides an effective way for designing a personalised e-learning system. Artificial intelligence-based systems adjust to the needs of each student individually to increase the efficacy of the online learning system. This is an adjustable e-learning platform that works with the learner's diverse learning needs. Through research that integrates data mining techniques, artificial neural networks, fuzzy logic, and adaptive neurofuzzy systems, an interactive, customised e-learning system is being created.

Keywords: *NeuroFuzzy System, Artificial Neural Network, Fuzzy Logic, e-Learning.*

Introduction

Systems for e-learning are now an essential component of the educational system. By facilitating efficient and effective content-based learning, technology in the classroom helps students feel more confident. Curriculum is developed in line with learners' ability and background knowledge, with customised learning methods placing a strong focus on learning behaviour and interest. It is an adaptable method of instruction that may be modified to meet the needs of each student[1]. An effective educational system must understand students and develop a plan that caters to their specific learning needs and interests. The personalised learning approach maximises each learner's demands. A professional system that monitors students' progress and provides them with individualised instruction is known as an intelligent tutor system. Examples of e-learning applications include computer-based learning, web-based learning, digital collaboration, and virtual classrooms. Artificial intelligence may be used to automate processes related to education, such as creating lesson plans, training programmes, and student evaluation.

Artificial intelligence is the most current e-learning fad in business and higher education[2]. AI helps in the creation of specialised decisions based on data analytics, which enhances education for individualised instruction and accelerates the learning process. As a consequence of the digital revolution, internet use is increasing everyday in India. Rural communities may now have access to

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internet technology on par with urban ones. E-learning is thus in extremely high demand in India. According to a worldwide industry research, the e-learning business will be valued $325 billion by 2025. According to the statistical analysis, several private universities provide online courses for undergraduate and graduate degrees. E-learning is marketed as a crucial tool for cutting-edge education on websites run by the ministry of electronics and information technology. Additionally, the government provides funding for programmes focused on curriculum development, faculty development, resource development, etc. in e-learning research and development. A study on online education in India for 2021 found that there is a growing dependence on the internet for education, opening up a huge market for e-learning and corresponding employment opportunities[3]. The knowledge and skill requirements of learners are constantly changing as a consequence of learning curve advances that surprisingly mirror e-learning methodologies. It allows for teacher and student engagement on a peer-to-peer basis. E-learning is rapidly growing in importance as a part of business training since it allows for professional training of employees without the need of humans[4]. The business supports the development of specialised, custom e-learning solutions for training employees. Time and money are saved, which helps the business. Employees that have access to online learning and can work from home are a better choice for finding a solution[5]. Through the use of e-learning software, electronic content is presented in a number of forms, such as graphs, charts, audio-visual lectures, discussion boards, etc. Numerous e-learning programmes are compatible with Android and iOS devices as well as mobile, laptop, tablet, and other platforms. Big data and AI technologies will be very helpful to learner analytics in 2020 in order to monitor students' behaviours and guarantee their effectiveness. Machine learning algorithms may be utilised for data collection, analysis, and learner performance monitoring to improve the efficacy of the e-learning system. The definition of e-learning technology includes both synchronous and asynchronous learning trends. Real-time learning may take place via online discussions, instant messaging, webinars, video conferencing, and synchronous e-learning. Asynchronous e-learning is exemplified by online lectures, online PowerPoint presentations, discussion forums, message boards, and other means of providing e-learning content[6].

E-learning has the great potential to be radically transformed by artificial intelligence, saving students time and money in the process. Learners won't be troubled by this since the AI-based e-learning platform will automatically provide all instructional content. E-learning promotes learning by promoting knowledge intake, enhancing decision-making skills, and resolving problems in the here and now[7].

The following is a list of popular e-learning tools: Blended learning is a modern method of instructing students that mixes traditional classroom methods with electronic media, e-material, and online resources. It is a hybrid approach to learning that combines online and conventional classroom materials. Students socialise with professors and one another in a collaborative learning setting. Students' interactions with other students may enhance their learning and extend their perspectives[8]. Using instant messaging, forums, chats, message boards, and other interactive learning technologies, a cooperative group of students is encouraged to study and share knowledge and skills. Google Classroom is a free online application that enables educators and learners to produce and distribute electronic study materials, assess work, conduct tests, and offer performance reports for each pupil. It is an online teaching strategy that emphasises the relationship between instructors and students.

Massive Open Online Courses (MOOCS) is a social learning environment that enables online learning. It provides free access to digital information and has a structure that promotes resource reuse[9]. Swayam, NPTL, Coursera, edX, Uadcity, Udemy, FutureLearn, NovoED, Iversity, Canvas, Open2Study, and Open Learning are some of the major MOOCS providers. They encourage students to engage in e-learning and support a modern, uniform educational system. Gamification is an unofficial method of engaging pupils in online learning. This teaching technique system may provide rewards, accomplishment badges or levels, and virtual money to motivate students. The engagement and achievements of the learners may be utilised to measure learning performance[10]. If the gamification strategy is well thought out, it may motivate students to complete a learning journey while still having fun by grabbing and retaining their interest, skill, and problems. According to a survey performed by the e-learning industry, 80% of learners believed that gamification is a more successful method for motivating and engaging learners.

Artificial intelligence is the process of transferring human intelligence to a machine that has been taught to reason like a human being in order to solve problems. Artificial intelligence is a branch of computer science that is used to build intelligent computers that can think and act in order to resolve challenging problems[11]. It also makes use of rule-based systems, machine learning, deep learning, natural language processing, support vector machines, heuristic search, and artificial neural networks. AI

is available in two flavours. A kind of artificial intelligence called as "narrow AI" or "weak AI" replicates human intelligence and only works in certain situations. Narrow AI is continually focused on doing a certain task well and effectively[12]. These robots are intelligent systems that, when confronted with various constraints, outperform even the most basic human intelligence. Strong AI, often referred to as artificial general intelligence, is used in robots, movies, and other uses of artificial intelligence (AGI).

It is a computer with universal intelligence that can operate and think like a human and utilise that intelligence to handle any situation. A range of businesses might benefit from the use of intelligent voice recognition systems like Alexa, Siri, and Cortana, which are smart assistants that can provide information and aid human decision-making.

Every business, including manufacturing, healthcare, e-commerce, and education, needs AI to automate a variety of operations. By delivering students a customised learning experience, artificial intelligence technologies transform education. The true power of artificial intelligence lies in its capacity to store a wealth of student-related data, analyse it, and provide individualised teaching tailored to each student's needs.

Artificial intelligence might fill in the knowledge gaps in the subject areas where teachers lack the specialised expertise needed to recognise the unique skills and interests of each student. Deep learning is a subfield of machine learning. Algorithms developed via machine learning are utilised to explore how the brain functions using an Artificial Neural Network. Deep learning is a brilliant technique for more efficiently digesting a lot of data. It is used to the development of intelligent computer systems that are capable of learning complex function mapping—the transformation of input into output—directly from data and without the aid of specialised human traits. Artificial neural networks and fuzzy rule-based systems are two examples of artificial intelligence-based techniques that may be utilised to build a customised e-learning system.

Research Review

The learner's interest, sentiments, previous domain knowledge, and aptitude for the subject matter all have an impact on learning, which is a dynamic process. The e-learning material is published online in a variety of formats, including audio, video, presentations, text, discussion forums, webinars, and more. Students may acquire knowledge and skills in line with their requirements with the help of e-learning resources. The learner-centric nature of the customised e-learning technique aids in giving pupils the best learning path[13]. There are a tonne of online learning tools available, but it could be challenging for a student to choose the ones that best suit their requirements. Making a customised e-learning environment is a major challenge in the current academic setting. The primary focus of the literature review is the current research, which was carried out in an original e-learning system. Fuzzy inference systems, artificial neural networks, genetic algorithms, and data mining algorithms are some of the methods that researchers have found for developing customised e-learning systems. This evaluation helps to identify the limitations and possibilities of an existing e-learning system.

Felix Castro et al. presented a number of data mining techniques for e-learning improvement in 2007. It is essential to use techniques like neural networks, evolutionary algorithms, clustering, fuzzy logic, inductive learning, and visualisation to optimise e-learning and determine students' educational aptitude and potential. The research found that students' learning results could be categorised and their e-learning problems could be resolved[14] using data mining techniques.

Marc El Alami et al. (2007) have created a proactive e-learning management system using a virtual learning environment. To evaluate user involvement and behaviour in e-learning, this system makes use of a dynamic rule-based expert system. This method allows the user to get information, suggestions, and advice whenever they choose. Additionally, experts recommended using intelligent agents to improve the current web-based system. According to Jinsha, Xinye Li, Qi Luo, and J. Individualized e-learning systems, according to Yuan (2007), assist learners by proposing reading content. The recommended model for a tailored web-based learning system that selects user interest modules based on user traits and instructional materials is suggested in light of its features. A vector matrix is used to create a user interest module[15]. Instructional materials are filtered using the adaptive filtering technique, which is based on the vector space concept, to provide the learner a customised learning experience. Erla M. Morales and colleagues in 2008 presented the object model for e-learning systems, which supports the creation of an interactive learning system. Examples, techniques, practise activities, and assessment activities all apply to the first level of the object hierarchy. In four unique aggregate levels, researchers build object hierarchies[16]. The second level includes the data, concept, method, and processes, content, summary, cognitive level, aim, and overview components. At the third

level, it incorporates a number of educational modules and exercises. The module-level structure of the e-learning system enables a learner-centric approach. Wojciech Kacalak and Maciej Majewski go into great depth on the many intelligent components of the e-learning system, such as voice recognition, biometric authentication, phrase meaning analysis, word and sentence recognition, and user response assessment (2009). Researchers focus on problems with spoken language sentence evaluation. They also suggested employing hybrid neural networks to address problems with intelligent e-learning systems. The abilities of a pupil are assessed by Ahmad Baylari and Gh. A. Montazer (2009) developed a test for them; the exam is adaptive and training materials are provided in accordance with the learner's understanding. Review tests are used to get feedback from students on how to improve the course material. A backpropagation network is used to learn from the dataset using supervised learning. The output of the system is compared to the results of the learning style index method. According to researchers, ANN-based individualised e-learning systems provide pupils a great opportunity to learn at their own pace[17].

According to Norsham Idris et al., soft computing methods are useful for addressing the ambiguity and incompleteness of circumstances (2009). ANN is one of the soft computing techniques used to categorise learning objectives according to concepts. The Adaptive Education Hypermedia System (AEHS) and soft computing techniques provide data prediction, recommendation, filtering, and classification. Three applications for ANN are speech recognition, control, and pattern recognition. In order to provide the learner individualised learning paths, researchers develop frameworks for their models, such as the user model, domain model, and adaptability model. To organise learning materials, unsupervised learning techniques like Self Organizing Maps (SOM) are utilised. A mix of analytical and graphical techniques are used to aggregate data into two-dimensional presentations, which are then projected into clusters.

Backpropagation ANN is used for the concept-based classification of the learning object. The multilayer perceptron network is trained using the conventional backpropagation method. Conjugate Gradient Approach, which makes use of the output Weight Optimization (OWO) method, is used to determine which learning path is optimum for the particular learner. Studies have shown that ANN can help students choose their learning resources and paths in line with those goals[18]. A hybrid neural network-based interactive e-learning system with natural language recognition was proposed by Wojciech Kacalak and Maciej Majewski (2009). Using this technique, the user and the e-learning system may communicate in two ways. To recognise words and phrases, researchers employed a fuzzy neural network. To recognise patterns, they used a hamming neural network technique. A researcher demonstrates a useful method for analysing, measuring, and evaluating learners' knowledge for interactive e-learning systems.

In 2016, Lopa Mandal developed a new architectural framework for the Intelligent Tutoring System. Using Bloom's taxonomy, the tutor may use this approach to develop a domain model and course materials for the student. To construct an adjustable e-learning system, the system merged the learners' static and dynamic learning strategies. By examining their emotions and reactions, the technology helps teachers choose the right learning materials for their students. The researcher developed a java-based system with neuro-fuzzy architecture for customised e-learning. The FSML is used to identify the preferred learning preferences of learners (Federal Silver Model of Learning). The Kort spiral learning model is used to explore how an individual's emotional state affects their capacity to learn[19]. The whole system was created using AI techniques. Beulah C. Christian Latha (2016) proposed a customised e-learning framework to identify learning patterns, objects, learning styles, and learning paths for the learner. Through the use of association rule mining, FSML is utilised to ascertain the learners' preferred learning style.

The Apriori technique is used to ascertain the link between the difficulty level of the learning object and the knowledge of the learners[20]. A genetic algorithm is used to discover the best routes. Content-based filtering, collaborative filtering, and a hybrid approach are used to recommend learning routes. The researcher suggested focusing on learning duration since it is an important aspect in determining how successful e-learning is.

Suggested Model

The planned individualised e-learning system is made up of four parts. This method focuses on identifying learning styles, predicting domain knowledge, analysing learner behaviour, and suggesting e-learning materials along with the learning path. Figure 1 depicts the recommended design for a personalised, AI-based e-learning system.

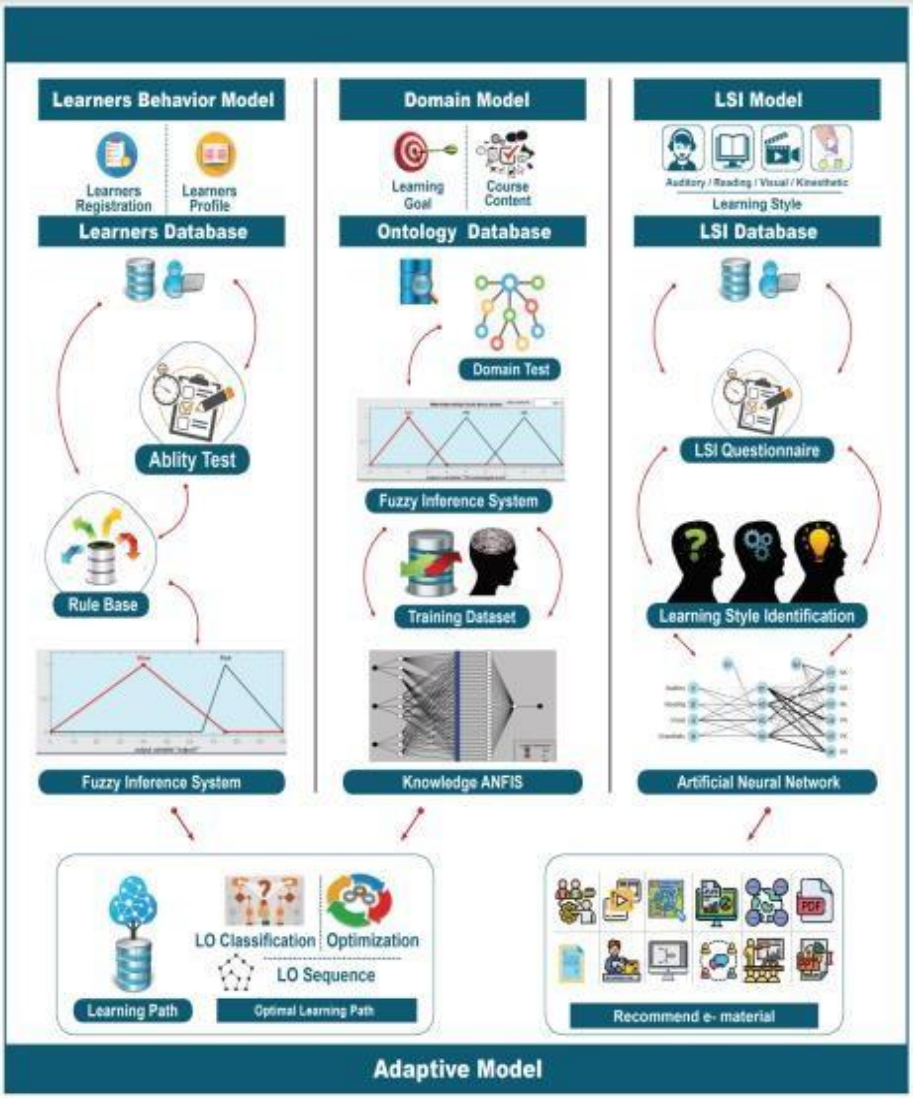

Figure 1: Model of AI based Personalized e-learning System

- **Behavior Approach:** This model aims to identify the distinctive learning preferences of every learner. Here, a learner's dataset is created to track academic knowledge together with details on the learner's aptitude and reading, listening, and skills. A fuzzy rule-based framework is developed to categorise learners into two groups: quick learners and slow learners.
- **Methodology for Identifying Learning Styles:** This model aims to identify each learner's particular learning preferences. In this example, a learning style identification questionnaire is used to gather data on the learner's preferences for the four different learning styles: auditory, reading, visual, and kinesthetic. The bimodal learning preferences of students may be predicted via the use of artificial neural networks.

Modeling the learner's present domain knowledge is the goal of the domain model. In order to collect information on the learners' past knowledge, three separate test types—basic level, intermediate level, and advanced level tests—are employed in this situation. A system based on fuzzy rules is used to analyse data. The Adaptive Neuro-Fuzzy System (ANFIS) approach predicts the learner's domain knowledge level as Unknown, Partially Known, or Completely Known.

- **Adaptive Model:** The objective of this model is to recognise the learner's learning trajectory and to provide suitable online resources for that learner that will promote a better understanding of the concept. The behaviour database and the domain knowledge database are used to compile learner data for analysis. To predict learners' learning trajectories, a rule-based system is developed utilising data from domain databases and their behaviour. The learner's suggested e-content is picked out of the LSI database.

Identification of Learning Style

Every student has a different learning style. A person's preferred manner of assimilating, comprehending, processing, and remembering information is referred to as their learning style. An individual's learning style is influenced by a variety of factors, such as their interests, emotions, physiology, cognitive ability, experience, and environmental factors. The tutor must employ the best teaching techniques while creating the curriculum, giving lessons, and carrying out evaluations. It's critical to recognise your style of learning, according to Kolb, in order to play to your advantages as a student. Additionally, he believed tutors needed to adapt their teaching strategies to each student's preferred learning styles. Learning styles are dynamic and subject to alter based on the situation. Finding one kind of learning style and using it as the basis for all of your training will not result in effective teaching and learning. The trainer should employ a range of learning approaches, or at the very least, a bimodal approach, while imparting knowledge to the pupils since various people may have different learning preferences.

According to Sternberg, there are differences between learning ability and learning style (1999). Learning ability refers to the student's capacity to learn something, while learning style refers to how the learner wants to study something. The majority of educationalists nowadays focus on categorising different learning styles in traditional or classroom instruction, but in the era of the internet and globalisation, e-learning is a crucial part of the educational system. Only a small portion of them focus on the e-learning platform. The majority of learners reject or avoid using the e-learning system since it is unable to identify their skills and chosen learning style before supplying e-material for learning. In order to change the outdated teaching-learning paradigm, a learner-centric approach is now crucial. Individualized online learning makes it possible to use a learner-centric strategy in the educational system. Knowing a student's chosen learning style helps an instructor create e-learning resources that will provide the best learning experience. Identification of learning styles is essential for promoting the adoption of e-learning. The literature review reveals that various educationalists advise various methods for determining learning styles. Based on variables including cognitive ability, attitude, behaviour, psychology, curiosity, and the capacity to understand and process information, they classified learning styles into several groups. Students may learn in four distinct ways, according to Kolb (1984). The sensitive divergent learner finds it more enjoyable to envision, observe, or see events unfold than to actually carry them out. Assimilating pupils are rational thinkers who are more likely to fully understand the material. Students that are convergent adopt a practical approach and are more inclined to try out a solution themselves. Students that are accommodating have intuitive learning methods, like trying new things, and are willing to face challenges. Gordon Pask (1976) recommended two learning methods for students. In a serialist system, students choose a structured, sequential learning approach. When using the Wholist method, the student prefers analogy-based learning and draws a generalisation rather than delving into details. According to the Honey & Mumford Model, there are four distinct learning styles. A campaigner Action is how a student gets knowledge. They like learning via brainstorming, role-playing, group debates, and puzzles. Students that study theory like articulating the premises behind the exercises and gaining information in this manner. Pragmatic learners prefer a hands-on approach to education. They have gained more knowledge via case studies, discussion, and problem-solving. Reflector learners gain knowledge by seeing, observing, and planning the action. In the Felder Silverman Model, the learner's learning styles are represented by eight different dimensions. The intuitive learner prioritises facts and processes and favours a radical style of thinking. The focus of intuitive learners is on concepts and theories, and they like fresh techniques. An individual who learns best visually prefers to comprehend concepts via the use of diagrams, flowcharts, and other visual aids.

Language learners prefer written and verbal explanations. The active learner acquires greater information by doing and working with others. Reflective students like working alone and value in-depth investigation.

Sequential learners favour a step-by-step approach to learning. Global learners prioritise quick learning above procedural knowledge and opt for an all-encompassing technique. The Myers-Briggs

Type Indicator suggests four characteristics of the learner (MBTI). Based on their capacity for concentration, the learner may be categorised as either an extravert or an introvert. Depending on their method of information processing, learners may either be intuitive or sensing. According to the interaction method of learning, the learner is either assessing or perceiving. Depending on their ability to make decisions, learners are either feeling or thinking. The Ridings Cognitive Style Analysis paradigm states that there are four main learning styles. Verbal learners like to express their information orally and focus on participating in the activities. Picture-based learning helps students recall knowledge. A wholistic learner is more likely to take a wide view of the situation and draw generalisations. Since they like to analyse things in sections, analyst learners often focus on one component at a time while using the sequential technique. Herman Witkin offered two choices for the learner's cognitive learning in 1962. For field dependence learners to learn more effectively, direct discussion and debate are recommended. Field independent learners get information by adhering to their own principles and criteria. They may be able to learn more on their own by reading, analysing, and thinking. According to Vermunt's Inventory of Learning Styles, the learner has four distinct learning preferences (ILS). The learner who employs a meaning-directed learning strategy has a personal interest in a specific subject. They like gaining a solid foundation in knowledge by studying subjects in-depth. Recalling memories, practising information, and evaluating previously acquired material are all activities that reproduction-directed learners like. Learners that prefer an application-oriented learning style choose a practical processing, vocational learning approach. Ambivalent kids who are undirected learners need stimulus in the classroom. The VARK model was first presented by educationalist Dr. Neil Fleming in 1987. According to his theory, learners preferred their preferred learning style, which has a significant influence on how they behave and learn. According to Neil Fleming, there are four different types of learning. For those who learn best visually, charts, graphs, and photographs are common teaching aids. Participants in lectures and group discussions want to learn. The kinesthetic learner assimilates material via practical application, case studies, and firsthand knowledge. The student who enjoys reading and writing enjoys reading assignments, notes, and directions. As was already established, several models for defining learning styles have been put forward by different education experts and are shown in Figure.

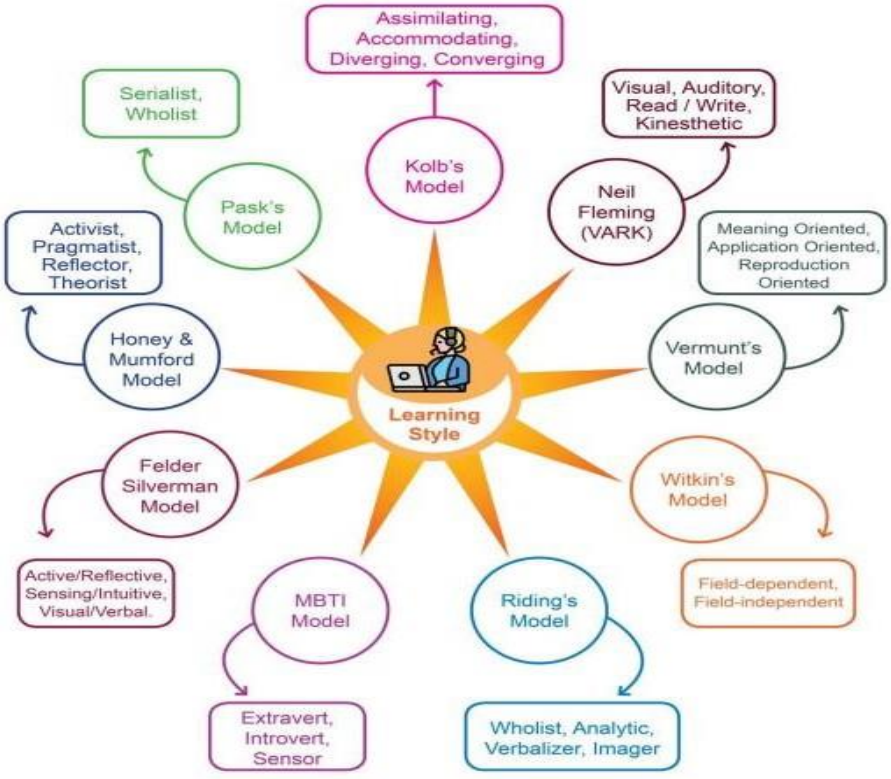

Figure 2: Learning Style Identification

According to the research study, there are several methods for figuring out learning styles. Identify The many learning styles of students help to promote learning interest and make it easy to provide learning resources to each student so they may choose the most effective learning method for better learning outcomes. According to their chosen learning styles, students have access to educational resources, which improves their level of knowledge, metacognition, self-assurance, and motivation. In a customised learning environment, every student learns differently. Each learner processes, comprehends, and retains knowledge in a different manner. When teaching programme coding, for instance, some pupils get straight in and like the debugging and testing processes. Other students learn by seeing their peers at work, some students follow along with video lectures, and some students use a hybrid approach to learning. Neil Fleming claims that learning better when information is presented in a certain way has nothing to do with intellect. Four different learning styles—auditory, reading, visual, and kinesthetic—are the focus of research.

Domain-Specific Prediction

Knowledge identification is necessary for assigning students to certain online learning resources in the e-learning environment. Each pupil have a different level of competence. Each student may have different learning goals and approaches. The ability to provide e-material specifically suited to their requirements is made possible by the detection of learners' existing knowledge levels using domain knowledge prediction. This gives the best learning environment, helps the learner understand a subject fast, and saves time. The researcher in this study categorised the learner's domain knowledge into three groups: completely Unknown, somewhat dimly known, and well known. It is challenging to predict learners' future domain knowledge since it cannot be fully measured. In order to solve this problem, the fuzzy rule foundation system was developed to predict the learner's knowledge. When building a fuzzy system, the knowledge of the relevant domain expert is taken into consideration.order to build a rule basis. According to the literature study, the fuzzy rules obtained from human experts were inadequate, therefore eventually, the Adaptive Neuro-Fuzzy System (ANFIS) technique is utilised to increase the accuracy of domain knowledge level prediction for each learner.

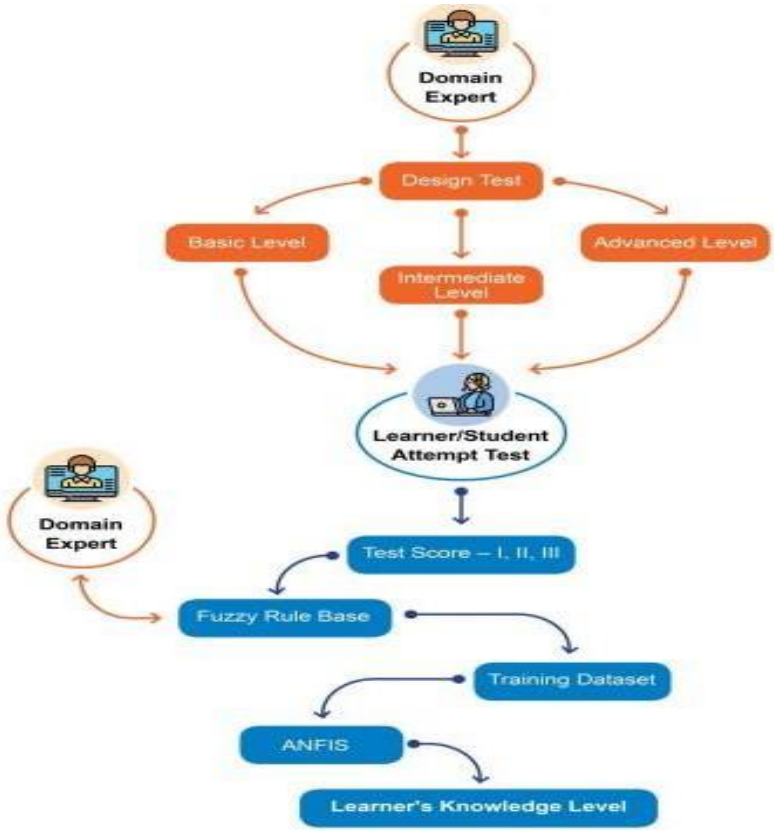

Figure 3: Stepwise Approach for Domain knowledge Identification of Learner

Here, the relevant domain specialists created the exams for domain knowledge. With a maximum of 10 marks for each exam, three distinct MCQ tests were created for topics at the basic, intermediate, and advanced levels. Three levels of MCQ tests—Level I on database ideas, Level II on SQL concepts, and Level III on advanced SQL concepts—were created. 1225 BCA/BSc final year students used the Moodle online web interface to take the domain knowledge exam. Each test result is kept in its own individual.csv file before being aggregated into a single.csv file known as a Score dataset. The Fuzzy rule-based system was used to assess score datasets and classify learners according to their degree of domain knowledge as Unknown, Partially Known, and Completely Known. The Adaptive Neuro-Fuzzy System (ANFIS) is used to improve forecasting accuracy. Each learner's knowledge level is predicted using a score dataset, making it possible to provide each student more learning materials based on their specific needs.

Conclusion

In order to increase student performance, earlier researchers provide a theoretical framework for a tailored e-learning system. Techniques based on expert systems are utilised to provide individualised instruction. In order to determine a learner's aptitude, machine learning algorithms are used; however, no interactive system has been established to educate students in accordance with their aptitude and interests. The development of an adaptive e-learning system with average accuracy uses data mining methods. The literature evaluation indicates that AI systems are capable of adapting to each student's unique needs in terms of learning. It may aid in creating a system that offers students relevant educational experiences. Intelligent tutoring programmes can recognise the knowledge level and learning preferences of students in an online learning environment. An essential component of a tailored learning system for a better learning experience is learner behaviour analysis. The Mamdani technique is used to create a fuzzy rule-based system for learning behaviour analysis of learners. An expert knowledge base and the K- means clustering technique are used to create a rule basis that forecasts the system's output. Feed-forward with two layers The suggested fuzzified system's accuracy is tested using neural networks and conjugate gradient algorithms. The majority of educationalists concentrate on identifying learners' learning styles in conventional or classroom instruction. Very few people concentrate on the e-learning platform. Identification of learning styles is crucial to a customised e-learning system. These models, FSLM and VARK, encourage identifying the learner's learning behaviour. The learner's static and dynamic elements influence their preferred learning method.

According to the research that is currently available, it is important to take into account a learner's aptitude, academic achievement, interests, skills, and learning attitude when determining their learning behaviour. It is advantageous to create a customised e-learning system that functions in accordance with the learner's style of learning, degree of knowledge, and capacity for learning. By offering the student the best learning route and suggesting appropriate e-learning materials, the performance and accuracy of the e-learning system may be enhanced. To create an adaptive elearning system, learner performance assessment is required.

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