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Development Of An E-Learning System Based On Artificial Intelligence

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Abstract:
E-learning systems are now a crucial part of the educational system. Utilizing technology in the classroom increases students' confidence by enabling efficient and effective content-based instruction. The emphasis of personalised learning systems is on learning behaviour and interest, and curriculum is created in accordance with learners' aptitude and foundational knowledge. It is a flexible teaching approach that can be tailored to each student's requirements. The tailored learning strategy maximises each learner's needs. This research project offers a useful methodology for creating a customised e-learning system. In order to enhance the effectiveness of the online learning system, artificial intelligence-based systems adapt to the demands of each student individually. This is an adaptable e-learning system that operates in accordance with the learner's many learning aspects. An interactive, customised e-learning system is being developed via research that combines data mining methods, artificial neural networks, fuzzy logic, and adaptive neurofuzzy systems.

Keywords: e-learning, Artificial Neural Network, Fuzzy logic, NeuroFuzzy System.

I. Introduction

E-learning systems are now a crucial part of the educational system. Utilizing technology in the classroom increases students' confidence by enabling efficient and effective content-based instruction. The emphasis of personalised learning systems is on learning behaviour and interest, and curriculum is created in accordance with learners' aptitude and foundational knowledge. It is a flexible teaching approach that can be tailored to each student's requirements[1]. The tailored learning strategy maximises each learner's needs. Understanding students and creating a strategy that meets their unique learning requirements and interests are essential for an efficient educational system. An intelligent tutor system is a professional system that keeps track of the students' progress and offers them individualised tutoring. Computer-based learning, web-based learning, digital collaboration, and virtual classrooms are all examples of e-learning applications. Artificial intelligence may be used to automate learning tasks including developing lesson plans, training programmes, assessing student

performance, and implementing cutting-edge teaching techniques. The most recent e-learning craze in business and higher education is artificial intelligence[2]. AI assists in making customised judgments based on data analytics, which improves education for individualised teaching and speeds up the educational process. India is seeing a daily rise in internet users as a result of the digital revolution. Rural areas may now get internet technologies as well as metropolitan areas. As a result, e-learning is in very high demand in India. The global industry analysis predicts that by 2025, the e-learning market would be worth $325 billion. Several private colleges provide e-learning courses for their undergraduate and graduate degrees, according to the statistics study. Websites from the ministry of electronics and information technology promote e-learning as a vital resource for innovative education. Additionally, the government offers support for e-learning research and development initiatives that concentrate on curriculum development, faculty development, resource development, etc. According to a research on online education in India for 2021, there is an increasing reliance on the internet for education, creating a colossal market opportunity for e-learning and commensurate job prospects[3]. Learning curve developments that unexpectedly reflect e-learning techniques result in constant changes in the knowledge and skill needs of learners. It enables peer-to-peer interaction between the instructor and the student. In order to give workers with professional training without involving humans, e-learning is becoming a crucial component of corporate training[4]. To teach personnel, the company encourages the creation of specialised bespoke e-learning tools. The company benefits from time and money savings. Employees that are able to work from home and use online learning are a better option for finding a solution[5]. Electronic material is presented in a variety of ways via e-learning software, including graphs, charts, audio-video lectures, discussion boards, etc. Numerous e-learning programmes are compatible with mobile, laptop, tablet, and Android and iOS devices. In 2020, learner analytics will greatly benefit from big data and AI technologies in order to track students' actions and ensure their efficacy. To increase the effectiveness of the e-learning system, machine learning algorithms may be used for the data collecting, analysis, and monitoring of learner performance. Both synchronous and asynchronous learning trends are included in the classification of e-learning technology. Online chats, instant messaging, webinars, video conferencing, and synchronous e-learning are all forms of real-time learning. Online lectures, online PowerPoint presentations, discussion forums, message boards, and other methods of delivering e-learning content are all examples of asynchronous e-learning[6].

Artificial intelligence has the enormous potential to completely transform e-learning while also saving students money and time. Because the AI-based e-learning platform will automatically give all educational material, learners won't be burdened by this. E-learning encourages learning through encouraging information acquisition, improving decision-making abilities, and problem-solving in the present[7]. Several well-known e-learning technologies are listed below: Blended learning is a contemporary approach of educating pupils that combines conventional classroom techniques with electronic media, e-material, and internet resources. It is a hybrid learning strategy that incorporates both online and traditional classroom resources. In a collaborative learning environment, students socially connect with one other and with instructors. Interacting with other students may help pupils learn more and broaden their horizons[8]. A collaborative group of learners is encouraged to gain and share information and skills using instant messaging, forums, chats, message boards, and other interactive learning tools. Google Classroom is a free online tool that allows teachers and students to create and share electronic study materials, grade assignments, administer examinations, and provide performance summaries for each

student. It is an online teaching method that emphasises instructor connection with students.

MOOCS: Massive Open Online Courses is a platform for social learning that allows users to study through the internet. It offers free access to electronic information with a framework that encourages resource reuse[9]. The main MOOCS providers include Swayam, NPTL, Coursera, edX, Uadcity, Udemy, FutureLearn, NovoED, Iversity, Canvas, Open2Study, and Open Learning. They encourage students to pursue e-learning and contribute to a contemporary, standardised educational system. Gamification is an unofficial e-learning strategy to keep students interested. To encourage learners, this teaching method system might provide incentives, achievement badges or levels, and virtual cash. The involvement and accomplishments of the learners may be used to assess learning performance[10]. If the gamification approach is properly designed, it may be used to inspire students to finish a learning trip while having fun by capturing and holding their attention, skill, and difficulties. 80% of learners felt that gamification is a more effective strategy for learner engagement and motivation, according to a poll conducted by the e-learning sector.

Artificial Intelligence: The process of mimicking human intellect into a computer that has been trained to think like a human being in order to solve issues is known as artificial intelligence. A field of computer science called artificial intelligence is used to create intelligent machines that can reason and act in order to solve complicated issues[11]. It uses artificial neural networks, support vector machines, natural language processing, heuristic search, rule-based systems, machine learning, and deep learning, among other technologies. AI comes in two flavours. An artificial intelligence method known as "narrow AI" or "weak AI" functions only under certain circumstances and simulates human intellect. Narrow AI is constantly focused on carrying out a particular job well and successfully[12]. These robots are intelligent systems that perform even better than rudimentary human intelligence when faced with several limits. Robotics, movies, and other artificial intelligence applications employ strong AI, often known as artificial general intelligence (AGI). It is a computer with universal intelligence that can function and think like a person and use that intelligence to address any issue. Intelligent speech recognition systems like Alexa, Siri, and Cortana, which are smart assistants, may be utilised in a variety of industries to improve human capacity for decision-making and to give information.

AI is crucial to the automation of many tasks in every industry, including manufacturing, healthcare, e-commerce, and education. Artificial intelligence tools change education by giving pupils a tailored experience. The actual strength of artificial intelligence is its ability to retain a lot of data about students, evaluate it, and give individualised instruction based on each student's requirements.

Artificial intelligence may fill in the gaps in the subject areas where instructors lack the specialised knowledge necessary to comprehend the talents and interests of each individual student. Machine learning has a branch called deep learning. An Artificial Neural Network is used to examine the function of the brain using algorithms created via machine learning. Deep learning is a clever method for processing a large quantity of data more effectively. It is used to create intelligent computer systems that can learn intricate function mapping—the conversion of input into output—directly from data, independent of specially designed human characteristics. Fuzzy rule-based systems and artificial neural networks are two examples of artificial intelligence-based approaches that may be used to create a tailored e-learning system.

2. Literature Survey

Learning is a dynamic process that is influenced by the learner's interest, feelings, prior domain

knowledge, and aptitude for the subject matter. Online publications of the e-learning content include audio, video, presentations, text, discussion forums, webinars, and more. E-learning materials assist students in acquiring information and skills in accordance with their needs. Because the tailored e-learning strategy is learner-centric, it helps to provide students the right learning route[13]. The internet is full with e-learning resources, but it may be difficult for a student to choose the ones that would best meet their needs. A significant problem in today's academic climate is creating a tailored e-learning environment. The present study conducted in a unique e-learning system is the main topic of the literature review. Researchers have identified a number of techniques for creating customised e-learning systems, including fuzzy inference systems, artificial neural networks, genetic algorithms, and data mining algorithms. This analysis aids in pinpointing the drawbacks and potential of a current e-learning system. A variety of data mining strategies are shown for e-learning optimization by Felix Castro et al. in 2007. For the purpose of optimising e-learning and identifying students' educational aptitude and capability, approaches such as neural networks, genetic algorithms, clustering, fuzzy logic, inductive learning, and visualisation are crucial. According to the study, data mining methods may be used to classify students' learning outcomes and solve their e-learning challenges[14]. Using a virtual learning environment, Marc El Alami et al. (2007) have developed a proactive e-learning management system. This system uses a dynamic rule-based expert system to assess user engagement and behaviour in e-learning. The user may use this system at any time to get information, recommendations, and tips. Researchers also suggested using intelligent agents to enhance the present web-based system. According to Xinye Li, Qi Luo, Jinsha, and J. Yuan (2007), individualised e-learning systems support learners by suggesting instructional materials. According to its features, the suggested model for a customised web-based learning system that chooses user interest modules based on user attributes and teaching resources is advised. A user interest module is made using a vector matrix[15]. In order to provide the student a tailored learning experience, instructional materials are filtered using the adaptive filtering method, which is based on the vector space model. The object model for e-learning systems, which aids in the development of an interactive learning system, was described by Erla M. Morales et al. in 2008. The first level of the object hierarchy is covered by examples, strategies, practise activities, and evaluation activities. Researchers construct object hierarchy in four distinct aggregate levels[16]. The data, idea, technique, and procedures, content, summary, cognitive level, goal, and overview items are all included in the second level. It integrates several learning modules and activities at the third level. A learner-centric approach is made possible by the e-learning system's module-level structure. The e-learning system's multiple intelligent components, including voice recognition, biometric authentication, phrase meaning analysis, word and sentence recognition, and user response evaluation, are discussed in detail by Wojciech Kacalak and Maciej Majewski (2009). Researchers concentrate on issues with sentence assessment in spoken language. In addition, they recommended using hybrid neural networks to solve issues in intelligent e-learning systems. In order to determine a learner's skills, Ahmad Baylari and Gh. A. Montazer (2009) created a test for them; based on the learner's knowledge, training materials are given, and the exam is adaptive. Review exams are used to get suggestions from students for further modifying the learning content. Using supervised learning, a backpropagation network is utilised to learn from the dataset. The system's output is contrasted with the outcome of the learning style index technique. Researchers claim that ANN-based individualised e-learning systems are an excellent way for students to study at their own pace[17]. Soft computing approaches are beneficial for resolving situations' ambiguity

and incompleteness, according to Norsham Idris et al. (2009). ANN is one of the soft computing approaches used to classify learning goals on the basis of concepts. Data prediction, recommendation, filtering, and categorization are supported by the Adaptive Education Hypermedia System (AEHS) and soft computing approaches. Speech recognition, control, and pattern recognition are three areas where ANN is useful. Researchers create frameworks for their models like the user model, domain model, and adaptation model to provide the learner individualised learning routes. Unsupervised learning methods such as SelfOrganizing Map (SOM) are used to group learning items. Data is grouped into two-dimensional presentations using a combination of analytics and graphical methods, and is then arranged into clusters using these projections. For the concept-based categorization of the learning object, backpropagation ANN is used. In order to train the multilayer perceptron network, a traditional backpropagation technique is used. Conjugate Gradient Approach is used to choose the best learning route for the specific learner utilising the output Weight Optimization (OWO) technique. According to studies, ANN may choose learning materials and routes for students in accordance with their expectations for their learning[18]. Wojciech Kacalak and Maciej Majewski (2009) suggested a hybrid neural network-based interactive e-learning system with natural language recognition. The user and the e-learning system may speak to each other in two directions using this method. Researchers used a fuzzy neural network to recognise words and sentences, and a hamming neural network approach to recognise patterns. For interactive e-learning systems, a researcher shows an effective technique for evaluating, analysing, and assessing learners' knowledge.

A new architectural foundation for the Intelligent Tutoring System was created by Lopa Mandal in 2016. Through this method, the tutor may create a domain model and course materials for the student using Bloom's taxonomy. The system combined the learner's static and dynamic learning methods to create an adaptable e-learning system. The technology assists in selecting learning material for learners by analysing their emotions and responses. For tailored e-learning, the researcher created a java-based system based on neuro-fuzzy architecture. Learners' preferred learning styles are determined using the FSML (Federal Silver Model of Learning). Researchers claim that a learner's ability to learn relies on their emotional state, which is examined using the Kort spiral learning model[19]. AI approaches are used to create the entire system. Beulah C. In order to discover learning patterns, objects, learning styles, and learning routes for the learner, Christian Latha (2016) suggested a customised e-learning framework. To determine the learners' preferred learning style, association rule mining is used to execute FSML. To determine the relationship between learners' knowledge and learning object complexity level, the Apriori method is used[20]. For learning route optimization, a genetic algorithm is applied. Recommendations for learning paths are made using content-based filtering, collaborative filtering, and a hybrid technique. The researcher recommended concentrating on learning length since it is a crucial factor in assessing the effectiveness of e-learning.

3. Proposed Model

Four components make up the designed individualised e-learning system. This approach focuses on learning style identification, domain knowledge prediction, learner behaviour analysis, and e-learning material suggestions together with learning route. The suggested concept for an AI-based, personalised e-learning system is shown in Figure 1.

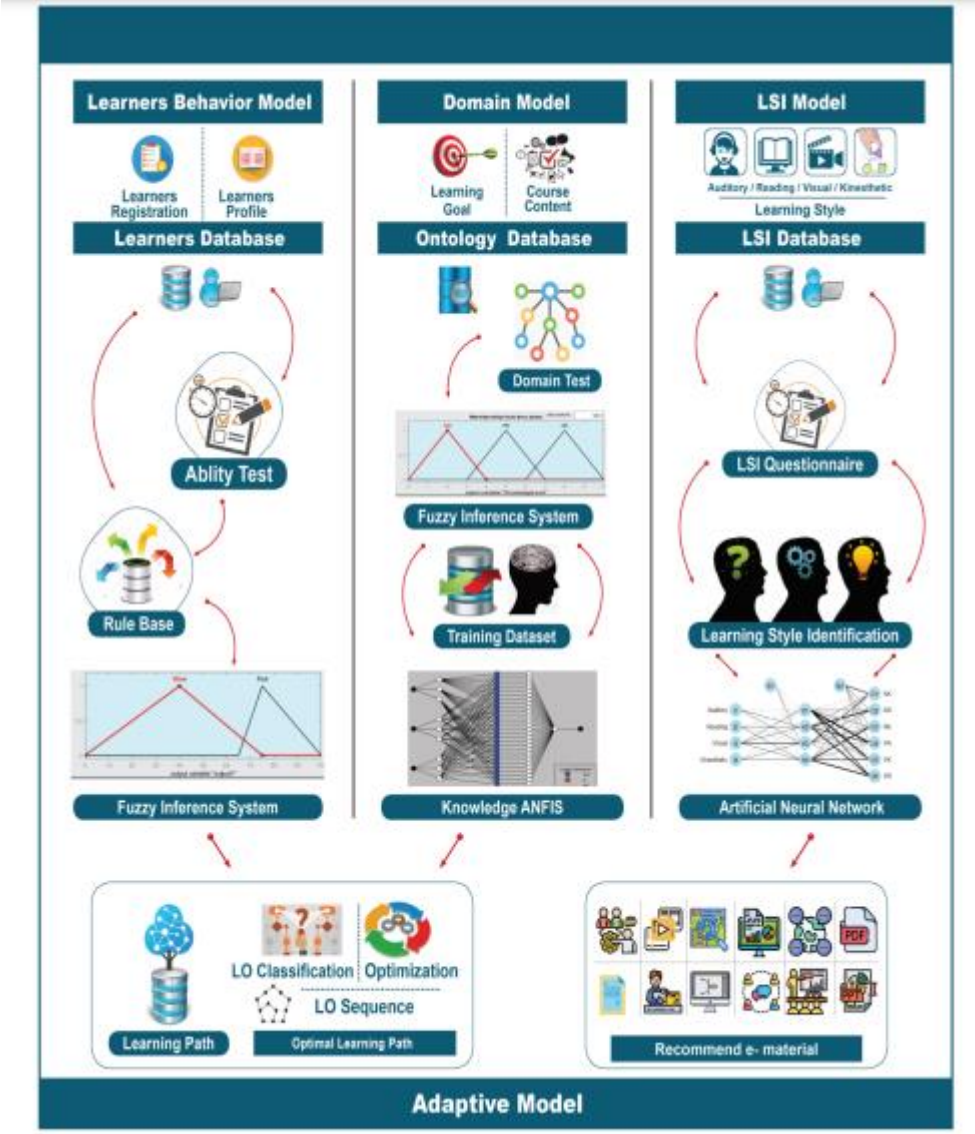

Figure.1. Model of AI based Personalized e-learning System

Behavior Model: This model's goal is to pinpoint each learner's unique style of learning. Here, a learner's dataset is generated to record academic knowledge as well as information about the learner's reading, listening, and aptitude. In order to divide learners into two groups—fast learners and slow learners—a fuzzy rule-based framework is created.

Learning Style Identification Model: This model's goal is to pinpoint each learner's unique learning preferences. The learner's information on the four distinct learning styles—auditory, reading, visual, and kinesthetic—is collected via a learning style identification questionnaire in this case. The use of artificial neural networks allows for the prediction of learners' bimodal learning preferences.

Domain Model: This model aims to forecast the learner's current domain knowledge. Three different test types—basic level, middle level, and advanced level tests—are used in this instance to gather data on the learners' prior knowledge. Data analysis is done using a system based on fuzzy rules. The learner's domain knowledge level is predicted using the Adaptive Neuro-Fuzzy System (ANFIS) technique as Unknown, Partially Known, or Completely Known.

Adaptive Model: This model's goal is to identify the learner's learning path and suggest appropriate online resources for that learner that will aid in a deeper comprehension of the idea. Data about learners is gathered for analysis from the behaviour database and the domain knowledge database. A rule-based system is created to forecast learners' learning paths using behaviour and domain database information. The learner's recommended e-material is chosen from the LSI database.

4. Learning Style Identification

Each learner has a unique learning style. The chosen method of assimilation, comprehension, processing, and retention of information to learn anything well is referred to as learning style. The learning style of an individual relies on a number of variables, including their interests, emotions, physiology, cognitive capacity, experience, and contextual circumstances. The finest teaching strategies must be used by the tutor while developing the curriculum, delivering instruction, and conducting assessments. To play to your strengths as a student, it is important to understand what sort of learner you are, says Kolb. Additionally, he thought tutors should modify their approaches to instruction to fit the learning preferences of each student. A dynamic component of learning, learning style will change depending on the circumstances. Effective teaching and learning do not result from identifying learning styles and delivering instruction based on just one kind. Individuals may have different learning preferences, thus the trainer should use a variety of learning techniques, or at the at least, a bimodal approach, while delivering instruction to the students.

Learning capacity and learning style are distinct, according to Sternberg (1999). While learning style relates to how the learner prefers to study something, learning ability refers to how the student can learn something. The majority of educationalists nowadays concentrate on learning type identification in conventional or classroom teaching, but e-learning is a significant component of the educational system in the age of the internet and globalisation. Few of them concentrate on the e-learning platform. Because the system is unable to recognise the learner's talents and preferred learning style before delivering e-material for learning, the majority of learners refuse to use or avoid the e-learning system. A learner-centric strategy is now essential to the teacher-centric process of changing the old teaching-learning paradigm. It is feasible to apply a learner-centric approach in the educational system via individualised online learning. Identification of a learner's preferred learning style aids a teacher in providing e-learning materials that will allow for the greatest possible learning experience. To encourage the use of e-learning, it is vital to identify learning styles. The literature study indicates that different educationalists recommend diverse techniques for identifying learning styles. They divided learning styles into categories based on factors such as cognitive capacity, attitude, behaviour, psychology, interest, and the ability to comprehend and process knowledge. Kolb (1984) identified four different learning styles for students. The sensitive divergent learner prefers to imagine, observe, or watch things happen than than actually doing them. Assimilating students are logical thinkers who are likely to grasp the subject completely. Converging students take a practical approach, and they are likely to test out a solution by doing it themselves. Learning styles of accommodating students are intuitive, they like trying new things, and they are open to taking on difficulties. Two learning techniques are suggested by Gordon Pask (1976) for learners. In a serialist system, learners choose an organised, step-by-step learning strategy. The learner who uses the Wholist approach favours analogy-based instruction and comes to a conclusion without getting into specifics. The Honey & Mumford Model states that there are four different learning styles. An activist

learner gains knowledge via action. They like learning via group discussions, role-playing, puzzle-solving, and brainstorming. Theory-based students like learning things in this way and formulating the assumptions behind the exercises. Learners who are pragmatic favour a hands-on approach to education. Through case studies, problem-solving, and debate, they have learned more. By looking, observing, and anticipating the activity, reflector learners learn. The learner's learning styles are represented by eight distinct dimensions in the Felder Silverman Model. The intuitive learner favours a radical way of thinking and is concerned with processes and facts. Intuitive learners like novel approaches and concentrate on ideas and theories. A visual learner likes to understand topics with the use of visual aids like charts, graphs, and flowcharts.

Verbal learners choose explanations that are both written and spoken. By taking action and cooperating with others, the active learner gains superior knowledge. Reflective learners appreciate in-depth analysis and like working alone. A step-by-step method to learning is preferred by sequential learners. Global learners choose an all-encompassing strategy and rapid learning above procedural knowledge. Four aspects of the learner are suggested by the Myers-Briggs Type Indicator (MBTI). The learner may be classified as either an extravert or an introvert based on their ability for attention. The learner might be either intuitive or sensing, depending on how they process information. The learner is either evaluating or perceiving, in accordance with the interaction mode of learning. Learners are either feeling or thinking, depending on their capacity for decision-making. There are four different learning styles for learners, according to the Ridings Cognitive Style Analysis paradigm. Verbal learners like to vocally communicate knowledge and concentrate on engaging the activities. Imager learners like to remember information via pictures. A wholistic learner tends to take a broad picture of the issue and make general conclusions. In the sequential approach, analyst learners often concentrate on one component at a time since they like to examine situations in pieces. In 1962, Herman Witkin proposed two cognitive learning preferences for the learner. Direct dialogue and debate are preferred for improved learning by field dependency learners. Field autonomous learners acquire knowledge using their own standards and ideals. By themselves, they may learn more by reading, thinking, and analysing. The learner has four different learning styles, according to Vermunt's Inventory of Learning Styles (ILS). A particular topic is of personal interest to the learner who uses a meaning-directed learning approach. They like building a knowledge foundation by learning topics in-depth. Reproduction-directed learners like recalling memories, practising material, and assessing previously learned material. A tangible processing, vocational learning method is preferred by learners with an application-oriented learning style. Undirected learners are ambivalent students who need stimulation in the classroom. In 1987, Dr. Neil Fleming, an educationalist, introduced the VARK model. His hypothesis holds that learners favoured the learning style, which has a big impact on how they behave and learn. There are four distinct learning styles, according to Neil Fleming. Graphical representations, charts, graphs, and pictures are popular teaching tools for visual learners. Participants in group discussions and lectures desire to learn. The kinesthetic learner absorbs information via hands-on practise, case studies, and personal experience. The learner who likes to read and write loves to read instructions, notes, and homework. As mentioned above, many models for identifying learning styles were proposed by various education professionals and are shown in the Figure. 2.

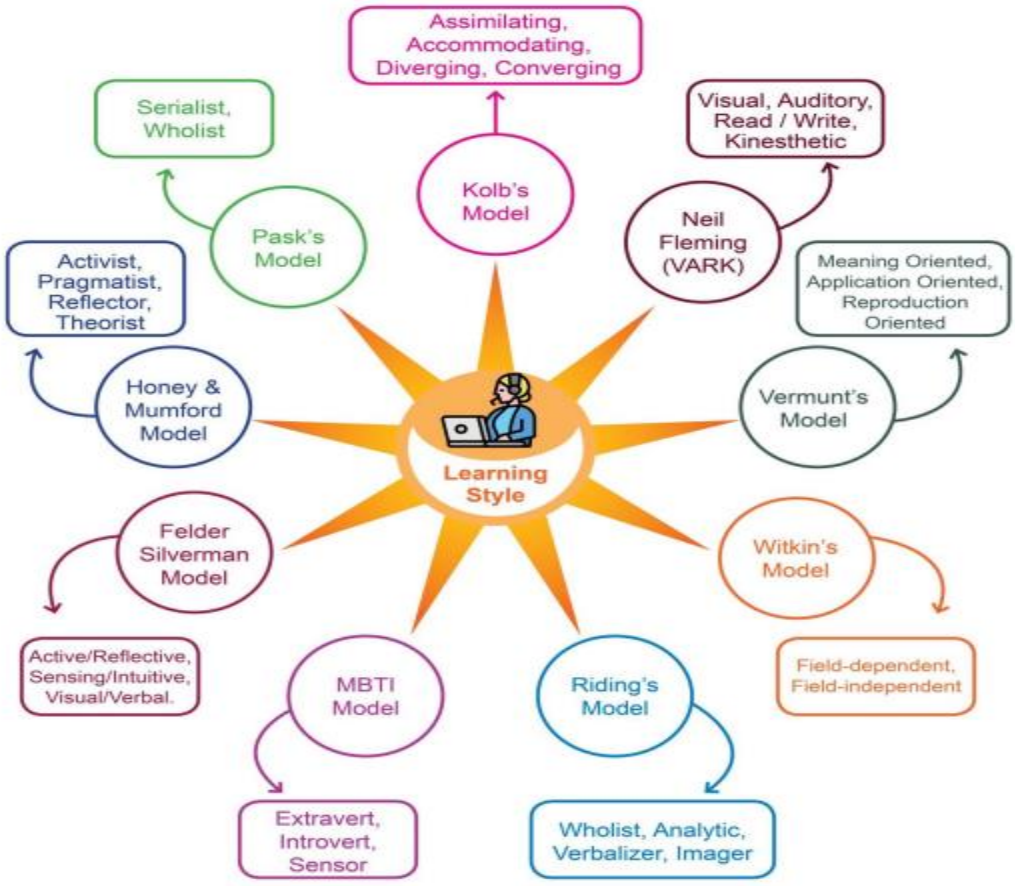

Figure.2. Learning Style Identification

A variety of techniques exist for identifying learning styles, according to the research study. Identify The different learning preferences of students assist to increase learning interest and make it simple to suggest learning materials to each student so they may choose the best learning strategy for improved learning results. Students have access to instructional materials based on their preferred methods of learning, which raises their level of knowledge, metacognition, self-assurance, and motivation. Each student learns differently in a tailored learning environment. Each learner has a unique way of ingesting, processing, comprehending, and retaining information. As an example, when teaching programme coding, some students get right in and like debugging and testing procedures. Other students study by following along with video lectures, some students learn by watching their friends work, and some students take a hybrid method to learning. Neil Fleming asserts that intelligence has nothing to do with learning better when knowledge is given in a certain manner. Researchers concentrate on four types of learning, including auditory, reading, visual, and kinesthetic.

5. Domain Knowledge Prediction

The assignment of learners to specific pieces of online learning material in the e-learning space depends on knowledge identification. Each student has a varied degree of expertise. Learning expectations and learning routes might vary from learner to learner. The identification of learners' current knowledge levels via domain knowledge prediction enables the provision of e-material tailored to their needs. This helps the student comprehend a topic quickly, saves time, and provides the greatest learning environment. In this study, the researcher divided the learner's domain knowledge into three categories: completely

unknown, somewhat known, and known. The present domain knowledge of learners cannot be quantified with complete precision and is thus difficult to forecast. The Fuzzy Rule basis system is created to forecast the learner's knowledge in order to address this issue. The expertise of the relevant domain expert is taken into account while designing a fuzzy system in 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.

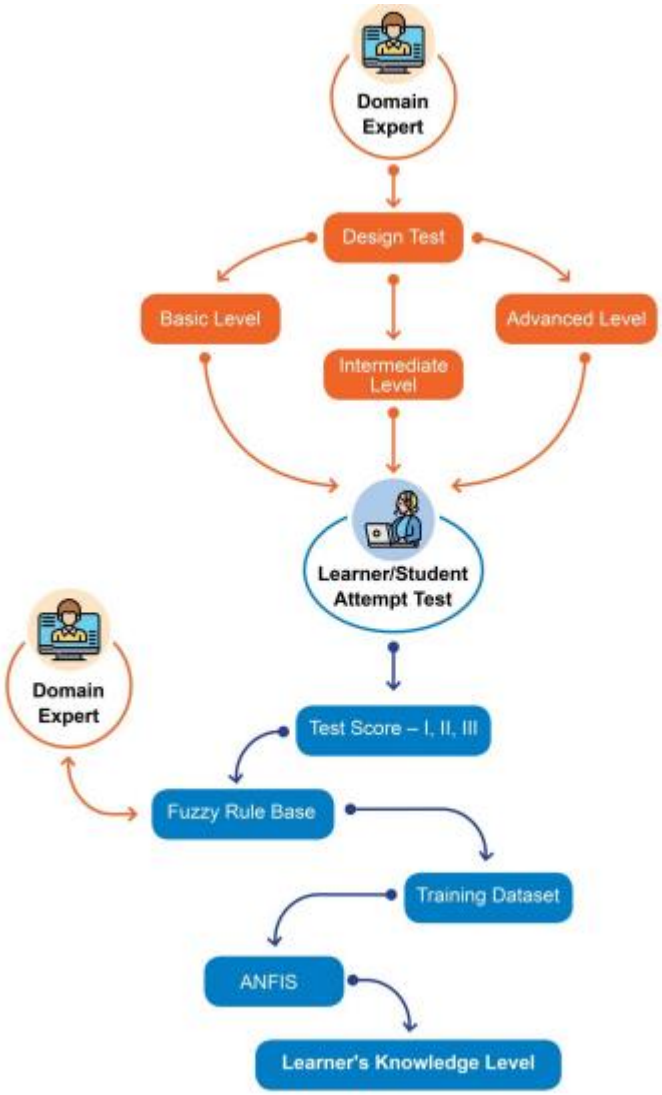

Figure.3. Stepwise approach for domain knowledge identification of learner

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.

6. 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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