A Review on Artificial Intelligence Based E-Learning System

U. Arun Kumar, G. Mahendran, and S. Gobhinath

Abstract Today, the e-learning system is vital to the educational system. Technology integration in the classroom aids in the effective and efficient delivery of content-based education, hence increasing student confidence. Personalized educational systems concentrate on learning behaviour, interest, and course design based on learners' aptitude and fundamental knowledge. It is a versatile teaching style that may be tailored to match the needs of individual pupils. The individualised learning strategy caters to the specific demands of each student. Understanding learners and developing a strategy that meets individual learning requirements and student interests is required for an efficient education system. An smart Tutor system is an expertise way to monitor the performance of the pupils in order to deliver tailored tutoring. Computer-based education, web-based acquiring knowledge, crowdsourcing, and virtual classrooms are examples of e-learning applications. AI may be used to automate learning processes such as building teaching materials, curriculum, training, evaluating student performance, and employing current teaching technique. Artificial intelligence is the most recent e-learning trend in higher education and business. AI aids in the provision of individual decisions through data analytics, which leads to improved education for tailored teaching and the streamlining of the educational process.

Keywords Artificial intelligence (AI) · E-Learning · MOOC · Genetic algorithm (GA) · Artificial Neural Network (ANN)

1 Introduction

Education is a continuous process that is influenced by the learner's interest, attitudes, prior subject knowledge, and ability to learn. The e-learning content is sent through

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the internet in the form of audio, video, presentations, text, forum discussions, webinars, and so on. E-learning materials assist learners in gaining information and skills that are relevant to their needs. The tailored e-learning strategy is learner-centric, which aids in providing learners with a suitable learning route. Although there is a wealth of e-learning content available on the internet, it can be difficult for the student to choose appropriate e-material that meets his or her learning objectives. In today's academic world, creating a tailored e-learning environment is a major difficulty. The review of literature highlights some of the key studies conducted in a tailored e-learning system. Researchers present a variety of ways for creating and developing personalised e-learning systems, such as Case-Based reasoning, Fuzzy logic—based systems, Artificial Neural Network, Genetic Algorithm, Data mining algorithms, and so on. This review aids in identifying the issues and future prospects of a current e-learning system.

2 Literature Review

Using a case-based reasoning (CBR) and genetic algorithm, Huang and Chen [1] suggested an e-learning system to build an appropriate learning route for individual learners (GA). Personalized curricular sequencing, final assessment, and assessment analysis are all possible with these tools. In a web-based setting, a researcher employs scientific investigation to generate relevant course content for learners based on their needs and learn more successfully.

Villaverde et al. [2] described the operation of a feed-forward neural network for recognising individuals' styles of learning. Felder and Silverman's approach is used to categorise pupils based on their vision & skill development. Backpropagation Artificial Neural Network (ANN) architecture uses Felder & Silverman modeling techniques to learn the relationship between students' activities in an educational environment.

Data mining techniques for e-learning optimization are depicted by Castro et al. [3]. E-learning optimization requires the use of neural networks, genetic algorithms, clustering, probabilistic reasoning, inductive learning, and visualisation techniques. E-learning concerns and pupil categorisation learning—based effectiveness can be solved using data mining techniques, according to the researcher.

Alami et al. [4] developed a proactive e-learning monitoring system which makes use of a virtual learning environment. This model employs a dynamic rule-based expert system to assess user engagement and behaviour in e-learning. The user may get information, recommendations, and tips through this system at any time. Additionally, the researchers advised that the present web-based system be enhanced by including intelligent agents.

According to Li et al. [5], tailored e-learning systems aid in the recommendation of educational materials for the student. The proposed model for a personalised web-based learning system is recommended based on its features for selecting user interest modules based on user characteristics and teaching resources. The Vector matrix is

used in the development of a user interest module. The adaptive filtering algorithm, which is based on the vector space model, is used to filter teaching resources in order to provide the learner with a personalised learning experience.

Erla Morales et al. [6] proposed an object model for an e-learning system, which aids in the development of an interactive learning system. The object hierarchy is elaborated by researchers in four distinct aggregate levels; the first level includes objects such as example, strategy, practise activity, and evaluation activity. The second level contains data, concepts, procedures, and processes, as well as content, summaries, cognitive levels, and objective and overview objects. It integrates several learning modules and activities at the third level. The e-learning system's module-level structure contributes to a learner-centric approach.

Kacalak and Majewski [7] discuss the many intelligent components of an e-learning system in detail, including voice recognition, biometric authentication, phrase meaning analysis, word and sentence recognition, and user response evaluation. The researchers are particularly interested in issues relating to the assessment of spoken language phrases. Additionally, they recommended including a hybrid neural network for problem solving in an intelligent e-learning system.

Baylari and Montazer [8] has developed a test for learners to determine their capacities; training material is produced based on the learners' knowledge, and the adaptive exam is administered. Learners' recommendations for further adaptation of learning material are gathered from review tests. A backpropagation network is used to perform supervised learning on the dataset. The system's output is compared to the outcome of the learning style index technique. According to the study, a tailored e-learning system based on ANNs is an excellent technique for learners to learn according to their abilities.

Kacalak and Majewski [7] suggested an interactive e-learning system based on natural language recognition. In this system, the user and the e-learning system may communicate verbally. Researchers used a fuzzy neural network to recognise words and sentences and a hamming neural network to recognise patterns. An effective approach for assessing learners' knowledge for interactive e-learning systems.

The Intelligent Tutoring System (ITS) was introduced by Pipatsarun and Jiracha [9]. It is an expert system that monitors learner performance and tailors teachings to the learner's learning style. For computer-based instructions, both ITS and Adaptive Hypermedia System (AH) are employed. Researchers present component-based models that incorporate expert, instructional, and learner systems for improving learner performance.

Susnea [10] expanded on the significance of ANN in improving the performance of the elearning system. The results of the online questionnaire are used to categorise the student dataset. For data analysis, ANN approaches such as Radical Based Function (RBF) and Multilevel Perceptron (MLP) are applied. The error rate for raw and processed data is computed, and a comparison analysis is done for the output produced by the RBF and MLP networks. The study discovered that the RBF network has a lower error rate than the MLP network, and the error rate is higher owing to the large number of classes. The researcher has proposed the use of ANN to overcome this issue.

Tung-Cheng et al. [11] used e-learning to construct a fuzzy inference system for learner profile analysis and selecting appropriate English language articles based on learner needs, interest, and learning capacity. The adaptive learning strategy proposed in this research aids in the improvement of learners' English learning abilities as well as their learning interest. Item response theory's recursive method is used to calculate learners' current English vocabulary. Fuzzy logic and memory cycle theories were used to choose relevant articles from the article's vast datasets for each learner. The trapezoid membership function is used to display a learner's article difficulty levels for each linguistic term, namely low, medium, and high. Membership functions are used to express the degree of membership function. In four phases, researchers construct a fuzzy inference method to determine the optimal difficulty level of an article for the learner. The linguistic characteristics of each report are specified in the first phase. The degree of membership for the linguistic quality is then calculated using a trapezoid membership function in the following step. In the Inference stage, use the AND/OR operator to create a fuzzy inference rule using three linguistic words and five fuzzy input variables [42]. The researcher use the discrete Center of Area (COA) computing approach in the defuzzifier stage to determine how appropriate an article is for a certain learner based on a quantized value between 0 and 1. The greater the value, the more relevant the topic for the learner. The Analytic Hierarchy Process is used to analyse a matrix for three criteria for each learner's performance based on the experimental and control groups. The pre-test and post-test findings for both groups are generated for assessment using the statistical t-test and z-test methods.

Judy et al. [12] describe the several goals of Massive Open Online Courses (MOOC): to offer open learning resources, cohesive learning content, and a formative learning environment. MOOCs have the significant advantage of increasing social interaction among learners by encouraging online discussions and assessing work based on peer reviews. MOOC WG12 technologies deliver dynamically composed tailored lessons for each individual student. It emphasises on video lectures, quizzes, and providing learners with quick feedback. Researchers provide information on the scalability of MOOCs in teaching, learning, and model evaluation. It works on Artificial Intelligence in Education to solve this problem (AIED). This system aids in the integration of pedagogical interfaces in order to improve the performance of e-learning systems [41].

Yathongchai et al. [13] used the K-means clustering technique to predict individuals' learning behaviour based on their profiles. Using log files in the "Modular Object-Oriented Dynamic Learning Environment" (Moodle) Learning Management System, the data mining approach is applied to extract the implicit pattern and develop the model for learner categorization (LMS). The C4.5 decision tree technique is used to classify students based on their use of e-resources in the LMS. Using free source Waikato Environment for Knowledge Analysis (WEKA) data mining tools, data is preprocessed and algorithms are applied. The learners' classification model is evaluated using a tenfold cross-validation model. According to the researcher, the proposed model assists teachers in determining student performance in LMS.

Richa [14] employs adaptive content sequencing strategies to address challenges in adaptive e-learning. The knowledge-based framework was created to address

concerns with social e-learning. The research process is separated into many stages: During the Socialization phase, the Nave Bayes classifier is utilised to categorise people based on their expertise. To handle the user's suggestions, the hierarchical analysis and fuzzy modelling approach are employed during the externalisation step. During the combination phase, the researcher created a Stigmergy-based framework to analyse the behaviour of learners. The ant-based algorithm is used to create personalised econtent for the learner. During the internalisation phase, a Context-aware Multi-agent Knowledge Sharing System based on Mobile Ad Hoc Network (MANET) was employed to share learners' knowledge. The study work is given to highlight the significance and possible advantages of incorporating social opinion into e-content creation. The goal of the research is to assist e-learners embrace e-learning approaches and to raise social awareness among e-learners.

Jain et al. [15] created an artificial intelligence-based technique for assessing students' comprehension via the use of a concept map. They used an eXtensible Markup Language (XML)-based parsing approach to evaluate student learning. The idea map method is used to assess students' understanding of a certain subject. The data is analysed by researchers by comparing the expert's knowledge domain to the students' comprehension. According to research, the customised learning system promotes adaptive learning and assists in identifying students' knowledge gaps. Researchers devised a step-by-step method in which experts/instructors constructed idea maps that were then used as a reference for assessing concept maps made by students. This map is then transformed into XML-based documents. The idea and relations are retrieved from the XML file using an XML parser. The Markov Chain decision-making model is used to forecast a student's concept map based on their degree of comprehension. This tool (AISLE) was created using Java and an XML parser to extract the necessary information from the idea map.

Salami et al. [16] proposes an intelligent fuzzy evaluation system for a successful e-learning system. This approach aids in the development of a learning profile for each student. The triangular membership function is used to categorise questions based on their level of difficulty. The Gaussian membership function is used to categorise replies based on the outcome. Six fuzzy sets were created to organise students' learning levels. Using the various operators, fuzzy rules are employed to link the fuzzy input variable to the output variable. These guidelines are used to measure learner knowledge. Defuziffication works by determining the centre of gravity in order to translate information into numerical magnitude. Fuzzy-based evaluation, according to researchers, is an effective method for determining students' knowledge level and performance in e-learning.

According to Chrysafiadi and Virvou [17], supplying e-material depending on student characteristics is a big difficulty in a web-based e-learning system. Researchers shed light on the issues with web-based e-learning systems. In an adaptive learning system, they propose employing student models to recognise learners' knowledge and attributes. To accommodate uncertainty in students' models, the researcher created a nonlinear-fuzzy Knowledge State Definer system for learning computer programming technologies. The Fuzzy Cognitive Map technique is used to determine the relationship between domain concepts and the domain knowledge

of learners. Researchers created various stereotypes based on their knowledge of specific concepts. Data was gathered for each stereotype from the learner. Because this data is imprecise, fuzzy membership functions are used. Understanding fuzzy sets combined with users' stereotypes and overlay models from remote adaptively and personalising web-based e-learning applications is described in this paper.

Limongelli and Sciarrone [18] suggested developing a fine-grained student model for the adaptive educational Hypermedia system. During e-learning, fuzzy logic is used to detect ambiguity in student behaviours, cognitive capacities, and knowledge. The Felder-Silverman Model was suggested by the researchers as a method for identifying learning styles. In this study, researchers created concept/topic graphs and questionnaires to assess participants' prior knowledge of certain ideas. The system offers a collection of topics that the particular learner should study based on the test result. The researchers compared student performance to that of a standard e-learning system. It has been discovered that this technique is effective in informing teachers about how many students comprehend a subject and in providing students with suitable comments during e-learning, resulting in student happiness.

Abeer and Thakaa [19] created an online learning method for slow learners. Researchers used the WEKA data mining technique to categorise pupils based on their learning habits. The REP (Reduced Error Pruning) tree is used for classification, utilising a tenfold cross-validation approach. A researcher-created approach for teaching English grammar to delayed learners is shown here. The outcomes of traditional learning were compared to those of e-learning, and it was discovered that e-learning is a superior teaching style for slow learners to absorb topics in a more participatory way.

Mata-Garcaa et al. [20] discuss the difficulties of customising the learning process to meet the specific needs, circumstances, and characteristics of individual students in an e-learning environment. A fuzzy logic framework has been created by the researcher to address these e-learning challenges. The fuzzy inference system is utilised in a collaborative learning environment to examine student behaviour. Fuzzy rules of association are used to delineate the ties between various forms of learning activity. Students' learning scores are predicted using Fuzzy Inductive Reasoning.

Students' knowledge and cognitive abilities were assessed using fuzzy logic, which was developed by Priya and Keerthy [21]. For the classification of pupils based on their attributes, a fixed weight neural network is utilised. Neuro-fuzzy models are utilised to gather input from students and the Information Technology Services department (ITS). Using the student's knowledge and skills, the word "fuzzification" was created. There are four steps to the model's development: fuzzifier, fuzzy relational system, fuzzy aggregation network, and finally fuzzified. Students' knowledge levels are classified using a back propagation neural network.

Learning style, attitude toward e-learning technology, and their behaviour while using an e-learning system were evaluated by Afzaal H. Seyal, Mohd Noah, and a number of other researchers [22]. They used VAKT models (visual, auditory, kinesthetic, and tactile) to figure out the best way to teach each individual student's strengths and weaknesses. Data was analysed using SPSS, a statistical software package.

An adaptive learning system for a customised elearning system is shown by Bernard et al. [23] for a personalised e-learning system. The learner's learning styles are classified using ANN in this case. The Felder-Silverman learning style model was used to produce four ANN dimensions: Active/Reflective, Sensing/Intuitive, Visual/Verbal, and Sequencing/Global. The learning rate is calculated after the neural network result is mapped with Index Learning Style questionnaires. To boost the growth of ANN, the stratification approach is applied. Finally, findings are separated into an independent dataset using a tenfold cross-validation procedure.

Pandey and Singh [24] created a multi-agent recommender system for a tailored e-learning system using fuzzy logic. The researcher suggested a multi-agent system with several components in this paper. The student and the e-learning content communicate via the interface agent. Task Agent is in charge of handling user requests and resolving conflicts amongst them. A task agent asks the information Agent questions, and the information Agent responds with learning material. Recommender Agent suggests fresh learning materials based on the comments and requirements of the user. Database Management Agent is a database that stores course materials, user account information, feedback reports, and other information. Fuzzy logic is employed to create recommender agents in this case. Defuzzification strategies include Center of Area, Center of Maxima, and Center of Minima. The Neuro-Fuzzy system was also used to offer a Fuzzy cognitive mapping approach for guided learning.

Sarasu and Thyagharajan [25] describe how they used an adaptive Neuro-Fuzzy inference system to provide e-learning material tailored to the learner's knowledge and learning needs. They employed an ontology-based e-learning system to generate ideas and apply a Fuzzy Cognitive Map approach to detect relationships between concepts. The researcher used the ANFIS model to create a fuzzy decision tree that classified data according to the learner's knowledge. Learners' knowledge levels are determined using fuzzy inference methods. Linguistic characteristics are used to categorise learners based on their degree of expertise. When fuzzifying input, a trapezoidal membership function is used to determine the student's knowledge level. For parameter calculation, ANFIS employs back propagation methods. In a fuzzy system, the Gradient Descent Function is used to change parameters.

A fuzzy rule-based individualised e-learning system was proposed by Priya and Keerthy [21]. The researcher hypothesised that a fuzzy Rule-based system can offer a course to a student based on their competence and domain knowledge. The study reveals that adaptive e-learning increases learners' performance.

In South Africa, Jugoo and Mudaly [26] depicted students' difficulties in learning computer programming. Through action research, they are investigating the interaction between students and teachers in order to understand the blended learning environment. For qualitative analysis, the researcher creates a dynamic action research model.

Permphan and Nicha [27] utilised RBF, MLP, SVM, and PNN approaches for constructing learning algorithm. Predictive modelling using data mining, decision trees, and regression. This algorithm measures medical students' learning performance. The results of ANN and regression are compared for accuracy. Researchers

say ANN is utilised to find predictor factors and implicit relationships between predictor variables and target variables.

The researchers Bhattacharya et al. [28] suggested an ANN-based intelligent recognizer to detect the learner's learning status based on test results. For the categorization of a multidimensional pattern vector, a multilayer feed-forward network is utilised. The algorithm's output is used to identify learner performance and is represented as a confusion matrix. This system is used to determine the gap between the learning aim and the cognitive state of the learner.

For the Intelligent Tutoring System, Mandal [29], designed a new architectural framework. Use of Bloom's taxonomy may help the tutor create a domain model and course material for the student. Static and dynamic learning methods of the learner were combined to create an adaptive learning system. Learners' feelings and comments are taken into account by the system, which then recommends appropriate learning material. A java-based system for individualised e-learning was built by the researcher utilising neuro-fuzzy architecture. Learners' learning styles may be assessed using the FSML (Federal Silver Model of Learning). The Kort spiral learning model is used by researchers to determine the amount of learning of a learner based on their emotions. Artificial Intelligence (AI) is used to build the whole system.

In Beulah's case [30], A customised e-learning framework presented by aims to detect a learner's learning patterns, objects, styles, and pathways. Learners' learning styles are identified through association rule mining in FSML. The difficulty of the learning object and the degree of knowledge of the learners are both identified using a prior algorithm. Learning paths may be optimised using the genetic algorithm approach. Recommending a learning route makes use of a variety of techniques, including content-based filtering, collaborative filtering, and a hybrid method. The study's author argued that e-learning performance can be assessed by focusing on the amount of time students spend learning.

Artificial Intelligence (AI) has the potential to revolutionise e-learning, according to Kothari [31]. As an aid to knowledge provision, Artificial Intelligence in e-learning allows for real-time querying. Gamification-based e-learning relies heavily on artificial intelligence (AI) to pique students' attention and keep them engaged. Artificial intelligence (AI) is good enough at mimicking emotion to make learning more enjoyable.

The Dragonfly Neural Network method, developed by Veera et al. [32], may be used to identify students' progress in a tailored e-learning system. From the dataset, this model predicts students' mark scoring tendencies.

Math instruction for slow learners may benefit from an e-learning technique, according to Shivannathan [33]. Synchronous, asynchronous, and web-based e-learning are all terms used by the researcher to describe distinct e-learning approaches. When it comes to teaching slow learners arithmetic, the study found that e-learning strategies were more successful than conventional classroom techniques.

A hybrid fuzzy-based mapping and recommendation system developed by Appalla et al. [34], was used to examine student profiles and learning activities. Using a collaborative sequential map filtering technique for sequential mapping, students with similar learning interests may be identified and collaborative filtering

can be applied. Using a matching algorithm, e-learning content may be recommended to students based on their specific needs. Each learner's behaviour, study time, and knowledge level are stored in a cloud-based database. Learning activities were organised into a tree-structured fuzzy-based learning activity model based on the learner's profile. Learning resources such as pdf, audio, video and text may be used with the suggested technique and the fuzzy model provides better results than a knowledge-based proposed system.

This system was developed by Karthika et al. [35]. It provides e-content, the topic's sequence based on the knowledge of each learner. Intelligent tutoring systems employ the Fuzzy Cognitive Map (FCM) approach to describe and reason about knowledge in an intelligent manner (ITS). For C programming students, a mechanism has been built to dynamically detect a student's expertise level. E-learning content may benefit from the usage of FCM to find the connections between topics. The suggested system monitors e-learning performance and offers e-learners with adaptive training.

Learning Object Management (LOM) standard metadata is described by the researcher in an ontology-based eLearning paradigm that allows adaptive content management. Teacher-centeredness is the hallmark of conventional educational practise. Adaptive learning relies heavily on an inductive method. Student domain knowledge and task ontology are shown in models. Ontology-based models for the teaching domain are provided by these models [36].

In an e-learning system, data mining on the web is critical. Online use mining is a data mining approach used to uncover patterns in web data in order to meet the needs of websites and web-based applications. E-learning aids in the development of a culture of self-directed learning among students as well as the acquisition of new skills. Learning techniques may be used in any location and at any time thanks to web service-enabled technology that provides a wide range of options. A service-oriented architecture for a tailored e-learning system was proposed by the researcher. Service-oriented protocols make it simple to customise the user interface to suit the preferences of the individual. Learning materials are suggested, and students are given assistance in adapting to the teaching model and its suggestions thanks to the system under consideration. Categorization, preprocessing web information and determining what actions are required for tailored systems are all part of this approach. The HITS (Hyperlink Induced Topic Search) technique was used by the researcher to identify online communities. K-means, Suffix Tree, and LINGO clustering algorithms are utilised to improve the search engine's performance. Web use and web content mining may be used to customise e-learning courses, according to an academic study [37].

In classroom teaching, it is difficult for the instructor to adapt instructional methods to the specific requirements and interests of each student. Images, charts, graphs, audio, video, and text are just a few of the many forms in which e-learning materials may be found. It might be difficult to determine which e-material is most suited for each student [39]. VARK is a methodology for identifying a learner's preferred method of learning. Four categories are used to classify learning methods, such as visual and auditory, read/write, and kinesthetic. Learning styles may be identified using VARK online surveys [40]. Data mining methods, such as Naive Bayes

Table 1 Different algorithms and techniques for adaptive education system

S.no	Technique used	Usage
1	Genetic algorithm, case based reasoning [1]	Create optimal learning path
2	Feed forward neural network [2]	Identify learning style of learner
3	Back propagation ANN [3]	Handle association in learning environment, provide learning recommendation
4	Inductive learning, clustering [4]	E-learning optimization
5	Adaptive filtering algorithm [5]	To provide teaching resources
6	Hybrid neural network [7]	Develop intelligent e-learning system
7	Fuzzy inference system [20, 25]	Students behavior in collaborative learning environment
8	Fold cross validation technique [13]	Separate result into independent datasets
9	Hamming neural network [7]	Pattern recognition
10	Gradient descent function [25]	To adjust parameters in fuzzy inference system
11	Analytic hierarchy process [11]	Learner performance evaluation
12	Markov chain model [15]	Decision making
13	Dragonfly neural network algorithm [32]	Student progress identification

and decision trees, are used in this investigation. VARK-based adaptive eLearning and mentoring systems were suggested by the researcher utilising the data mining method [38]. According to literature review researchers suggested different algorithms and techniques for adaptive education system is listed in Table 1.

3 Recommended Approach of E-Learning

Figure 1 shows the suggested personalized E-Learning approach to overcome the research gap mentioned below. Table 2 shows the approach and functions of the recommended personalized E-learning System.

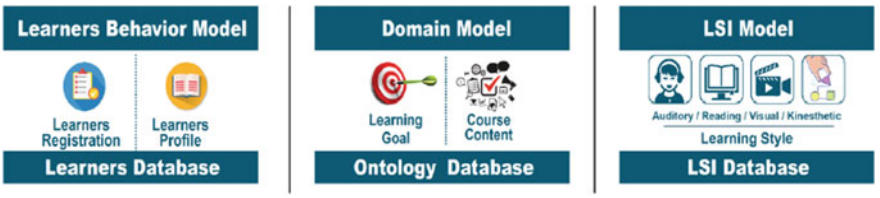

Fig. 1 Suggested AI based personalized e-learning system to overcome the research gap

Table 2 Recommended personalized e-learning approach

S.no	Technique used	Usage
1	Behavior model	To identify the learning behavior of the individual learner
2	Learning style identification (LSI) model	To identify the learning style of the individual learner
3	Domain model	To predict existing domain knowledge of learner
4	Adaptive model	To determine the learning path and recommendation of suitable E-material to the individual learner

4 Conclusion and Research Gap

Theoretically, a customised e-learning system may help students enhance their performance. Use of expert systems for individualised instruction is common. There is no interactive system established to educate students according to their abilities and interests, despite the fact that machine learning algorithms are used to determine a learner's aptitude. The development of an adaptive e-learning system relies on data mining techniques, which provide an average level of accuracy. A study of the literature shows that an AI system is capable of adapting to the specific learning needs of a pupil. It can help to develop a system that provides meaningful learning experiences to the students. Intelligent tutoring systems in the e-learning environment are capable of determining the learning style and knowledge level of students.

In conventional or classroom instruction, most educationalists concentrate on identifying students' preferred learning styles. Only a small percentage of students pay attention to the online course. E-learning systems that are tailored to each student's unique learning style are critical to their success. These models, FSLM and VARK, encourage the identification of the learner's learning behaviour. The learner's static and dynamic characteristics influence their preferred learning method. To determine a student's learning behaviour, it is important to take into account the student's aptitude, academic achievement, interest, skill, and learning attitude. There are several advantages to creating an e-learning system that is tailored to each student's learning style, degree of knowledge, and capacity for new information intake and retention. It is possible to increase the effectiveness and accuracy of an e-learning system by offering an ideal learning route and proposing appropriate e-learning materials for the learner, The development of an adaptive e-learning system necessitates the assessment of student performance.

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