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Innovative Integration of Computer Network Technology in Modern Educational Systems

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ABSTRACT

A novel educational system has been developed using the Radial Basis Function (RBF) algorithm to address the limitations of traditional classroom environments, which often rely on standardized material and fixed teaching methods. This research assesses recent advancements in interactive intelligent education systems by combining Artificial Intelligence (AI) with interactive teaching methods. A model based on cognitive functions is constructed using the RBF algorithm to personalize instructional approaches and foster a self-directed learning platform. The research methodology involves a comprehensive literature review, developing an Education Intelligent System (EIS) using AI-driven cognitive modelling, and the implementation of the RBF algorithm within a neural network architecture. The system's effectiveness is evaluated through empirical methods, including extensive data analysis and continuous refinement based on student performance feedback. Additionally, a network topology model is designed to enhance the system's adaptability for different roles within the educational framework. The results show significant improvements in instructional effectiveness, learner engagement, and personalized learning experiences. This research demonstrates that AI and interactive technologies can revolutionize conventional educational methods, enhance learner proficiency, and cultivate a more dynamic and engaging learning environment. Future work aims to improve the system's user interface and analyze larger datasets to refine the AI algorithms further.

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1. INTRODUCTION

With the advancement of the information age, computers have become much more pervasive in individuals' daily routines. Data transfer via networks has seen significant advancements, expanding beyond basic textual information to include multimedia elements such as photographs, audio, and video. The increasing frequency of data transit has led to a constant expansion in the data files, hence exerting more pressure on computer networks. The expansion of computer network capacity has led to a substantial growth in network streaming media technologies. Two crucial aspects that have significantly driven this advancement are data compression coding technology and network media transmission technology. The emergence of streaming media technology has greatly aided the extensive implementation of online education, resulting in substantial changes in both individuals' lives and the education sector [17]. The increasingly widespread use of online education may be attributed to advancements in science and technology. The use of multimedia technologies in online education has been notably observed

within the education sector. The integration of multimedia technology in online education has resulted in significant changes in the methodologies used for educational delivery. Several academics have proposed that the effective utilisation of different forms of media may enhance the comprehensibility, engagement, and practicality of information compared to conventional techniques. Allowing students to engage in discussions indicates that multimedia technology can stimulate students' learning and enhance the clarity of courses [8].

Consequently, multimedia technology as a pedagogical approach to online education is rising, enhancing the visual appeal and variety of online learning experiences [4]. In today's rapidly advancing information technology era, educational institutions increasingly implement extensive digitalisation efforts, particularly schools. Among these efforts, the establishment of network education is of utmost importance. Network education offers numerous advantages over traditional education, including sharing existing educational resources and providing enhanced services to a broader audience. Additionally, it can generate more significant economic benefits for the school.

This study delves into the constraints of conventional educational institutions and the transformative potential of artificial intelligence (AI) and interactive technology. Traditional educational settings are typically bound by standardised resources and rigid instructional approaches, which often fail to cater to the diverse needs of individual learners. The limitations of these methods impede the implementation of personalised learning paths, thereby restricting students' ability to study at their preferred pace or in accordance with their individual preferences. This results in less engaging and less efficient learning scenarios [4]. The advent of the information age has led to a transition towards digitalisation in education, propelled by progress in network and multimedia technologies. The advent of online education has become a potent alternative, enabling the dissemination of instructional material via many digital channels. This transition has facilitated the incorporation of multimedia components such as photographs, audio, and video, enhancing the comprehensiveness and user engagement of learning compared to conventional text-based approaches [17]. The incorporation of streaming media technology, which entails the immediate transmission of media via the internet, has significantly transformed how educational material is consumed, resulting in the widespread acceptance of online education and a more comprehensive range of visually captivating learning opportunities [8]. Incorporating the fast advances in artificial intelligence (AI) and mobile technology into educational settings poses considerable difficulties. Currently, existing systems typically face challenges in efficiently harnessing AI to customise learning experiences according to the specific requirements of each student [12]. Furthermore, the varying levels of accessibility and competence in mobile technology among students and teachers add complexity to implementing mobile-based learning solutions [11]. These challenges create a gap in using artificial intelligence and mobile technology to improve educational results.

Another significant challenge in the integration of AI in education is the ethical use and privacy issues. AI systems often require the collection and analysis of large amounts of personal data to tailor learning experiences, raising serious concerns about privacy and ethics [8]. Ensuring the accessibility, ethical integrity, and effectiveness of these systems is crucial for the future of education. An urgent need exists for an innovative methodology that integrates artificial intelligence capabilities with interactive and mobile learning techniques. This project aims to identify the existing gap in the successful integration of artificial intelligence (AI) and interactive technologies to develop learning environments that are more personalised and efficient [1]. The proposed approach uses the Radial Basis Function (RBF) algorithm to create an intelligent education system that offers a self-directed and customised learning platform designed to meet the specific requirements of each student [14]. The objective is to augment student involvement, amplify instructional efficacy, and provide a more vibrant learning milieu [3].

1.1. Statement of the Problem

Although artificial intelligence (AI) and mobile technologies have made fast progress, incorporating these breakthroughs into educational institutions typically encounters substantial obstacles. Existing educational systems have challenges successfully using AI to customise learning experiences according to individual requirements. This is further exacerbated by the inconsistency in the availability and proficiency of mobile technology among students and educators, which might impede the acceptance of mobile-based learning solutions. Furthermore, using AI systems to collect and analyse substantial quantities of personal data for customising learning raises ethical problems and data privacy issues. This study addresses the gap in effectively incorporating artificial intelligence and mobile technologies into educational settings. The primary objectives are to ensure accessibility, promote ethical use, and enhance learning outcomes. Resolving this challenge is crucial since the future of education depends more and more on technology to address the requirements of different learners and enhance educational fairness and effectiveness.

1.2. Literature Review

1.2.1 Advancing Mobile Education with AI and Interactive Tech

[12] presents the study findings on the use of mobile technology in education in this particular domain. Their project aims to facilitate a community educational experience by allowing simultaneous access to instructional information via shared playlists and network coverage [12]. The paper presents the "Malleable Mobile Education System," created by [13], that utilises

localisation and peer-to-peer networking to offer education [13]. [6] presents Sequencer404, a VoIP-based system that uses a voice sequencer to enable multiple users to engage and manage instructional material over telephone and Internet Protocol [6]. In a study conducted by Onwubiko, S. G., the focus is on investigating the potential of mobile devices such as iPhones or iPads in creating social and electronic art. This study aims to overcome conventional mobile education approaches, such as using ringtones. MoPhO's research uses advanced mobile technologies to create an interactive and collaborative learning environment, including multi-touch screens, built-in sensors like accelerometers and gyroscopes, cameras, microphones, GPS, and 2G/3G data networks. This approach combines powerful computational capabilities with the flexibility of mobile devices, transforming them into educational tools [5]. The primary objective of this study is to explore the integration of artificial intelligence into the development of interactive online educational systems.

1.2.2 AI's Impact on Education

The academic investigation into using artificial intelligence in education has garnered significant interest due to its ability to provide personalised learning experiences. In their 2022 publication, [8] delve into artificial intelligence's ethical implications and transformative potential within education. The authors underscore the capacity of artificial intelligence to tailor educational resources based on the individual needs of learners, leading to heightened engagement and efficacy. The research undertaken by [17] thoroughly examines AI technologies, including machine learning algorithms and data analytics, in the context of predicting student performance and customising learning pathways. The primary objective of this AI application is to enhance educational outcomes.

1.2.3 Impact of Mobile Technology on Education

Integrating mobile technology into education has significantly expanded the range and accessibility of educational resources. This research examines the effective integration of mobile collaborative learning in engineering education via a comprehensive investigation. The authors describe the incorporation of mobile applications and platforms that provide immediate communication and the exchange of resources between students and instructors, hence enhancing the accessibility and adaptability of education [12]. [2] examine the trends in artificial intelligence for online tests and demonstrate how mobile technology aids in both learning and the development of safe and scalable examination systems [2].

2. RESEARCH METHODOLOGY

Based on the shared information in the research article, the research methodology focuses on developing and evaluating an intelligent education system using artificial intelligence (AI) techniques, specifically the Radial Basis Function (RBF) algorithm. Here is a detailed explanation of the research methods used. The research adopts a multi-step methodology to explore the integration of AI and interactive technologies into educational systems to create more personalized and effective learning environments. The methods can be broadly categorized into the following stages:

Literature Review and Theoretical Framework Development:

The research begins with a comprehensive literature review to understand the existing advancements and challenges in incorporating AI and mobile technologies into educational systems. The literature review focuses on several key areas, such as the use of AI in education, its ethical implications and transformative potential, and the integration of mobile collaborative learning in various educational contexts [8, 12]. This stage helps identify the gaps and limitations in current educational practices and the potential for AI to provide personalized and compelling learning experiences.

AI and Cognitive Function Modelling:

Much of the research involves developing a cognitive framework based on AI principles to enhance online education. The study utilizes concepts from cognitive sciences and machine learning to model human mental functions, such as consciousness, psychology, integrity, cognition, affect, and self-awareness, as proposed by Marvin Minsky and further explored by Professor Picard at MIT Media Lab [1, 15]. This framework is designed to simulate human-like thinking, learning, and interaction in educational systems, leveraging AI to provide real-time, personalized feedback to students.

Development of the Education Intelligent System (EIS) Using the RBF Algorithm:

The core of the research involves the development of an Education Intelligent System (EIS) using the Radial Basis Function (RBF) algorithm. The RBF algorithm is implemented as a neural network with five layers, each serving distinct purposes in processing educational data and facilitating interactive learning [14]. The methodology for developing the EIS involves several steps:

The first layer comprises distinct educational data chunks that are input into the neural network architecture.

The second layer deals with the membership concept and its mathematical representation, guiding how the algorithm interprets and groups data.

The third layer interprets rules and generalizations based on the analysis of extreme cases to determine the output.

The fourth layer normalizes the nodes by aligning them with fuzzy rule nodes.

The fifth layer generates outputs through the TS fuzzy model, representing the equilibrium of the product weights [7, 9].

Integration and Interface Development:

The developed RBF-based intelligent system is integrated into a design platform to facilitate interactive learning. The platform allows educators and students to interact with the system in real time, providing an interface for dynamic educational experiences. The interface's design ensures that users can simultaneously observe the RBF algorithm's operations throughout the coding process, making the learning process more transparent and engaging [3].

Empirical Evaluation and System Validation:

The effectiveness of the proposed intelligent education system is evaluated through empirical methods. The research uses big data from online educational platforms to train and test the RBF model. The system's performance is assessed by continuously refining the knowledge and software platform adjustments based on student achievements. The evaluation metrics focus on learner engagement, instructional effectiveness, and overall system usability, comparing the results with traditional education methods [14].

Network Topology Model and System Infrastructure:

The research also involves developing a network topology model to support the interactive online education system. This model adapts a distribution strategy to accommodate the different membership levels of teachers, students, and administrators, providing tailored courses and roles for each group. The system infrastructure includes a backend database supported by SQL Server, a server environment with specific hardware configurations, and backup solutions to ensure system reliability and scalability [3].

Future Enhancements:

Based on the empirical findings, the research outlines future directions for enhancing the system's user interface design, improving the reliability and accuracy of the intelligent education system, and analyzing more extensive datasets to refine the AI algorithms further. These recommendations aim to make the system more user-friendly and effective for a broader range of learners [14].

The research methods used in this study include a comprehensive literature review, AI and cognitive modelling, development of an AI-driven Education Intelligent System using the RBF algorithm, integration and interface development, empirical evaluation for system validation, and network topology design. This multi-faceted approach ensures a thorough exploration and implementation of AI in interactive and personalized education settings.

2.1. Progress of Artificial Intelligence (AI)

Imagination is a distinct cognitive ability in humans that is used to create intellectual challenges, especially in the context of educational instruction. This entails the complex processing skills of a "cognitive machine," specifically engineered to integrate concepts from cognitive-forming gadgets. Marvin Minsky, a prominent figure in Artificial Intelligence, classified cognitive function into six primary dimensions: consciousness, psychology, integrity, cognition, affect, and self-awareness [15]. The features above facilitate the interpretation of the complex systems operated by the human brain, emphasising the significance of machine learning in online education. Professor Picard, a prominent figure at the MIT Media Lab, is credited with pioneering the conceptualisation of social media as a cognitive theory. This included incorporating emotional intelligence into robots, allowing them to imitate human-like observations, thoughts, and emotions [1]. Interaction theory, a dynamic branch of study in artificial intelligence, aims to enhance the interactions between people and computing systems. Within online education, this entails using a virtual assistant similar to Siri to aid students by identifying and resolving mistakes and promoting learning, as shown in **Figure 1**.

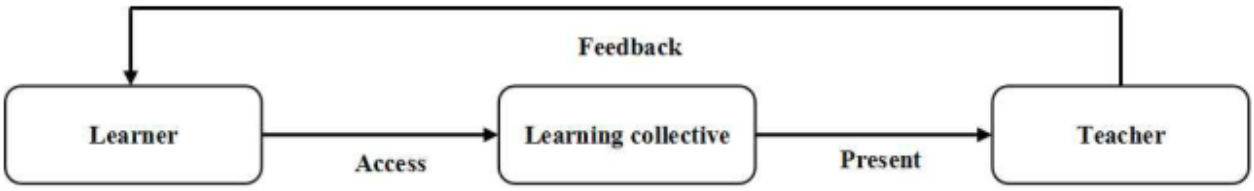

Figure 1: Framework of Cognitive Functions in AI-Enhanced Online Education
Source: Fengchun Zhang et al. / Procedia Computer Science (2023)

One common approach for students to begin their integrated learning experience is accessing the learning platform, allowing them to showcase the educational advantages to instructors with expertise in human-computer interactions [10]. Educators may use the feedback they get to improve their teaching methods and develop student understanding and abilities. This is mainly achieved by analysing constructive criticism, which helps create a more efficient feedback system. This cognitive-based strategy utilises developmental insights to enhance educational evaluations, resulting in improved educational results for learners in contrast to conventional techniques.

2.2. Evaluation and Application of Education Intelligent System (EIS)

The Machine Intelligent Algorithm-RBF algorithm was created for interactive education learning. The radial basis function method, often known as the RBF algorithm, is commonly implemented as a neural network composed of local neurones organised in a network architecture with five layers [14]. The first layer comprises distinct data, which may be partitioned into different educational chunks and fed into the neural network architecture. The second layer of the framework concerns the concept of membership and its mathematical representation, which is represented by formula:

$$\mu_i(x_i) = \exp\left[\frac{-(x_i - c_i)^2}{2\sigma_i^2}\right] \tag{1}$$

i = 1, 2, …, r; j = 1, 2, …, u the citation [16] is provided. The third approach involves interpreting the rules and deriving generalisations based on analysing the most minor and significant cases. Determine the result of the jth rule, as shown by Equation:

$$\phi_i = \exp\left[-\frac{\|X - C_i\|^2}{2\sigma_i^2}\right], \tag{2}$$

where cj = (c1i, ….., cri) The j-th RBF unit's centre is denoted as the representation [7]. The RBF neural network has a property where the activity level increases when the neurons are positioned closer in space. This trait is consistent with the manifestation of elements that impact the dissemination of conversational sound training. The normalisation layer, including the fourth layer, is responsible for aligning the nodes with the output of the fuzzy rule node and its j-th node Ni, as specified by formula:

$$\Psi_i = \frac{\phi_i}{\sum_{k=1}^{N} \phi_k} \tag{3}$$

j = 1, 2, …, u [9]. The fifth layer of the RBF algorithm constitutes a generator that conducts diverse musical assessments using the TS fuzzy model. The resulting output is represented by Equation:

$$y(x) = \frac{\sum_{i=1}^{u}\left[(a_{i0} + a_{i1}x_1 + \cdots + a_{1r}x_r)\exp\left(-\frac{\|x - c_i\|^2}{2\sigma_i^2}\right)\right]}{\sum_{i=1}^{u}\exp\left(-\frac{\|x - c_i\|^2}{2\sigma_i^2}\right)} \tag{4}$$

w_k is the relationship in question pertains to the kth rule, which precisely depicts the equilibrium of the product of the weight of the product, as shown in Equation:

$$y(x) = \sum_{k=1}^{u} w_k \cdot \Psi_k \tag{5}$$

The interactive learning methodology employs the Radial Basis Function (RBF) algorithm and integrates the suggested algorithm into the design platform. The software concurrently presents the whole method throughout the coding process and utilises the interface feature provided by the platform. This methodology has similarities to an interactive learning mode [3],[9]. Among the variables under consideration, X is the ratio of study time allocated towards enhancing educational competencies among students who achieved high scores on their scientific research papers. The variable X also indicates the distribution of latent layers inside online educational software specifically tailored to optimise student achievement. The training above models possess balanced latent layers. The variable Y denotes the maximum score attained in each course. A consolidation of the second, third, and fourth layers into the hidden layer is implemented to enhance the efficiency of the RBF algorithm. In contrast, the first and fifth levels serve as the input and output layers, respectively. The first training utilises the first m of schooling data in big data. Subsequently, the RBF model enhances its assessment by refining knowledge and software platform adjustments to measure students' achievement continuously. The building schematic is seen in **Figure 2**.

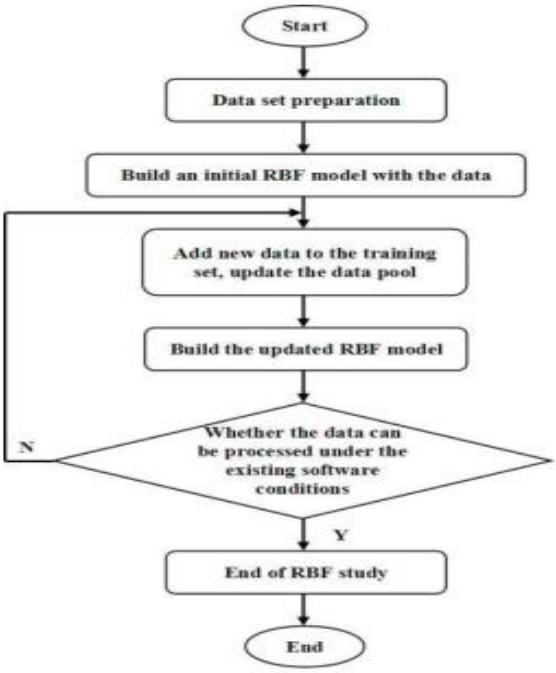

Figure 2: Simplified RBF Algorithm Structure for Education

3. RESEARCH DISCUSSION

The research demonstrates that the network topology model used in interactive online education effectively adapts a distribution strategy to accommodate the varying membership levels of teachers, students, and administrators. This includes providing different courses and roles to each group. This methodology streamlines the use of sophisticated systems in academic management, improving the organisation and incorporation of many educational disciplines via efficient teaching and learning assessments. Interactive online education cultivates various skills and abilities, including further learning, fundamental topics, vocational training, and other educational benchmarks [3]. **Figure 3** depicts a schematic of this concept.

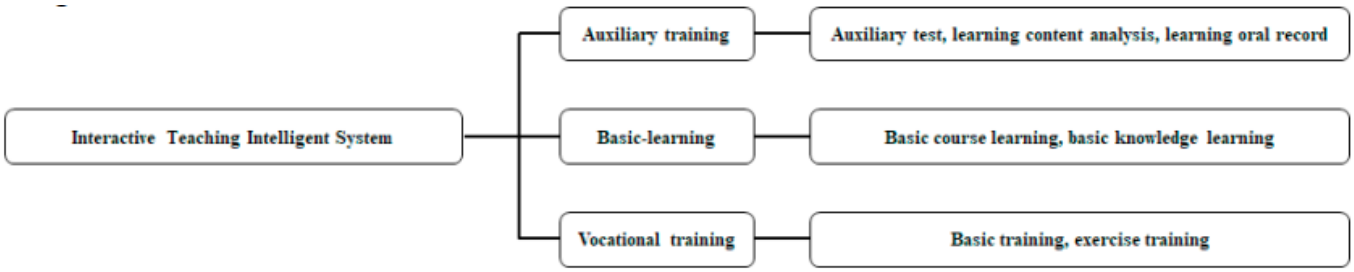

Figure 3: Model of Network Topology for Interactive Online Education

Each system model relies on a backend database supported by SQL Server and encompasses all project management and data functionality. As previously indicated, the network architecture of the intelligent education system incorporates componentry from both software and hardware domains. This configuration comprises a database server environment with a system specification of 4G RAM, a 500G solid-state disc, and a twin CPU Xeon processing system. The Veritas Backup program backs up the system and application software. The application server operates on MS Windows 2007 Enterprise Edition, with WinCC as the software system. The research results presented in this study demonstrate the effectiveness and transformative potential of the developed Education Intelligent System (EIS) based on the Radial Basis Function (RBF) algorithm in creating a more personalized, efficient, and interactive learning environment. The discussion highlights several key findings from the research:

The research demonstrates that the intelligent education system, powered by the RBF algorithm, is adept at adapting to the student's diverse learning needs of students. It provides personalized and self-directed learning experiences, effectively overcoming the limitations of traditional educational methods. This adaptability, as evidenced by the system's adaptive learning model, allows for tailored educational pathways, improving engagement and learning outcomes by accommodating individual learning preferences and paces [3, 14]. Additionally, the research results suggest that the network topology model employed

within the intelligent education system effectively manages different roles and courses for teachers, students, and administrators. The model uses a distribution strategy that aligns with the varying membership levels, providing a more organized and efficient approach to academic management. This approach streamlines the integration of various educational disciplines and allows for comprehensive teaching and learning assessments, thereby enhancing the overall effectiveness of the educational process [3]. The system's empirical evaluation, which involved extensive data analysis and continuous refinement of the RBF model, shows significant improvements in instructional effectiveness as learners progress through their educational journey. The feedback mechanism embedded in the system helps educators adjust their teaching methods based on real-time data, leading to enhanced student understanding and performance [14]. The research findings underscore the importance of utilizing AI-driven feedback loops to support continuous improvement in educational settings, which contrasts with traditional systems' often static and generalized feedback [10].

The study also finds that integrating interactive technologies, including multimedia and streaming media, within the intelligent education system greatly enhances the user experience by making learning more engaging and visually appealing. These technologies support dynamic learning activities that stimulate student interest and participation, contributing to more vibrant and effective learning environments [8, 12]. The research underscores the system's capacity to foster a range of skills and competencies, including foundational subjects, advanced learning, and vocational training. Through its adaptive learning pathways, the AI-driven system promotes lifelong learning and skill development by offering diverse educational benchmarks and personalized learning routes, ensuring that students receive the education most relevant to their individual goals and needs [4, 7]. This capacity of the system is a promising step towards promoting lifelong learning. The research results validate the transformative potential of the proposed intelligent education system based on the RBF algorithm. The findings indicate that the system enhances learner proficiency, increases instructional effectiveness, and creates a more engaging and adaptive learning environment. The results support the potential of AI and interactive technologies to transform education by making it more accessible, personalized, and effective for diverse learners [1, 3, 14]. This potential is inspiring and paves the way for a revolution in education.

4. CONCLUSION

An interactive online education system improves the learning experience and boosts the material quality for students. This study begins by delineating critical components of online education and scrutinising local and foreign research advancements, emphasising the advantages of online learning platforms. This text explores the neural network model, explicitly highlighting the use of the Radial Basis Function (RBF) algorithm to enhance intelligent teaching approaches. This strategy uses learner situations to enhance the effectiveness of educational interactions intelligently. Future research endeavours to enhance these systems by using more user-friendly interface designs and improving the reliability and accuracy of intelligent education systems by analysing more extensive data sets.

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