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EDU4All: An Intelligent platform Transforming Learning with LMS Powered by Machine Learning

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ABSTRACT

This study investigates how Artificial Intelligence (AI) is integrated into Learning Management Systems (LMS) and aims to propose a new platform called (Edu4ALL), which will enhance traditional education while ensuring that the virtual school's resources are available to all students during crisis periods. The proposed Edu4ALL is a collaborative platform taking the form of an LMS with a new feature-based Smart Education System (SES), having the capacity to deliver live-scheduled online sessions covering the considered area, assess schools, teachers, and students using collected data. The collected data is securely aggregated in a data warehouse, facilitating efficient processing, integration, and analysis for predictive modeling. The data used in this study were sourced from the Iraqi Ministry of Education, based on results from various schools during the 2022-2023 academic year. The learning management system incorporates four AI prediction models: school graduation prediction model, government prediction model, school performance prediction model, and teacher performance prediction model. These models utilize different machine learning methods such as the XGBoost and Random Forest Regressor algorithms to forecast outcomes accurately. The predictive models achieved high accuracy rates: model 1 (99.88%) identifies student performance gaps, supporting targeted interventions to improve instructional content; model 2 (99.5%) highlights top-performing teachers, emphasizing resource alignment and professional development; model 3 (99%) predicts top-performing schools, underscoring the role of institutional strategies and resource optimization; and model 4 (97%) evaluates government performance, ensuring equitable resource allocation and policy improvements. From the results obtained, it is concluded that Edu4ALL serves as an innovative system to improve Iraq's education delivery and resource management.

Keyword: Learning Management Systems (LMSs); Artificial Intelligence (AI); Ed4all, Live Video-Streamed Classes; Online Education.

1.0 INTRODUCTION

During the recent years, technology has changed in several countries across the globe [1]. These changes take place more slowly in developing countries than in developed countries [2] and [3]. Education is a critical factor and plays a vital role in contemporary social institutions. Moreover, the quality of education provided in a country ultimately determines its long-term economic, social, and political development. Many researchers have been interested in the relationship between E-learning and education in Iraq in recent years. E-learning is a viable option for the provision of quality education to wide-ranging student audiences, which is helping the country rebuild its education system and prepare citizens to live in the 21st century.

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Learning Management Systems (LMSs) and other e-learning tools facilitate the creation, distribution, and organization of instructional materials over the Internet [4]. These technologies have revolutionized education by providing students with an easy and adaptable way to access information. However, LMS has faced difficulties due to the quick expansion of education and the global accessibility to online knowledge. The majority of LMS platforms available today allow for the creation of content modules either standalone or through online integration. In both situations, giving all students the same material fails to account for information overload and individual cognitive variations.

Moreover, it overlooks that learners have diverse knowledge requirements and preferences, leading to differing expectations for the learning content and management system. The solution to these challenges is often personalization [5]. With the advent of innovative AI-assisted LMS, AI is revolutionizing the educational scene. These systems, which are referred to as AI-assisted LMSs for short, provide novel designs for existing LMSs and are explored from multiple viewpoints:

1) Automatic personalized content creation using Automatic Natural Language Generation (NLG) and text-to-speech systems;
2) Content translation using statistical machine translation and automatic discrete tone generation; and
3) Adjunctively pedagogically motivated tutoring using a combination of machine learning algorithms and NLG-based automata dialogue systems for adaptive pedagogical processing. Every strategy demonstrates both the expected difficulties and possible advantages of being used in the classroom [6].

According to Ref. [7] LMSs have had few features and capabilities in the past. They were unable to conduct safe tests, had a user interface that was far from intuitive, and lacked analytical skills. This sparked a rush to upgrade LMSs at colleges and institutions in order to fully enable online learning in situations where traditional classroom instruction was not feasible. Because they provide end-to-end solutions with distinctive features and functionalities, LMSs are now widely associated with education. To effectively combat the threat of cheating, online exam software has only been developed up to this point for the Multiple-Choice Questions (MCQ) system of exams [8]. It is not available for other types of exams, such as subjective, theoretical, and numerical-based exams with a variety of guidelines, including open/closed book and internet permissions.

These factors contribute to the academic dissatisfaction of schools, colleges, and universities as well as the dissatisfaction of students and parents with online learning environments and testing methods. Thus Ref. [9], maintain the main causes of this discontent:

i) improper teacher-student interaction during online classes as a result of various internet and electrical outages.
ii) the ease with which students can cheat on online tests and exams by using social media software and other electronic devices or by sitting close to one another outside of the range of detection.
iii) privacy concerns regarding female teachers and students turning on the camera during classes and exams.
iv) students' time management problems with non-MCQ-based subjective exams, particularly when it comes to converting written scripts into an electronic submission format (e.g., scanning the document takes a lot of time during the exam period, and online submission becomes challenging due to load university LMS as traffic spikes suddenly).
v) internet outages, where it makes it easier to provide, monitor, and oversee training programs and courses or LMS, which have become essential to contemporary education. However, conventional LMS platforms frequently lack the sophistication necessary to meet the wide range of student needs [9].

In summary, Ref. [10] , highlight that LMSs bring about significant changes and transformations in education. It helps understand the way education should be organized and managed. It encourages educational institution managers to engage in various activities that necessitate adopting new procedures and exploring

alternative approaches to tackle emerging challenges that extend beyond purely educational matters. LMS is a planned teaching process that can occur in different places other than a regular school. For such a system to be effectively utilized in distance learning, teaching, communication, creation, and management, specific components and processes are essential. It also necessitates specialized techniques such as course design, unique instructional methods, and advanced communication strategies using electronic and other technologies, along with essential organizational and administrative arrangements [9].

Nevertheless, the structure of this paper consists of four sections. The first section provides a background on the LMS highlighting its features, benefits as well as the challenges associated with AI processing. The second section deals with the research methodology. The third section highlights the key findings of the current study. Finally, the last section focuses on the key conclusions drawn.

2.0 LITERATURE REVIEW

The e-learning system theory framework was developed based on the services provided by the three main components of information systems: people, technology, and the technology itself [11]. The proposed framework aims to overcome most of the challenges identified in this research. Furthermore, it will enable decision-makers to effectively assess schools, teachers, and students using data collected from a real interactive system.

Building on this foundation, Ref. [12], delved into the sustainability of e-learning environments facilitated by LMS. They identify the importance of user interface, navigation, and usability in designing these systems, arguing that effective planning and structuring of resources are crucial for fostering interaction and knowledge transfer. This article underscores the necessity of evaluating LMS design to ensure clarity and effectiveness and the role of communication tools in enhancing learner engagement. The findings suggest that while LMS is widely adopted, challenges remain in creating sustainable e-learning experiences that meet the needs of both instructors and students. Expanding the discussion further, Dhiman et al. (2022), present a comprehensive analysis of the technical aspects of LMS development, specifically focusing on customization, manageability, and support [13].

Reference [14] emphasize the importance of integrating features that facilitate payment processing and branding, which are crucial for organizations aiming to implement effective LMS solutions. The study illustrates the advantages of LMS, such as flexibility and improved quality of teaching and learning, reinforcing the notion that these systems are not only tools for content delivery but also vital components of a holistic educational framework.

Other researchers have collected public opinion and comments about online education using data from Twitter. Once more, it was discovered that practical communication tools and various regulatory procedures were significant barriers to guaranteeing the caliber of online education delivery techniques. Reference [15] explored the impact of online learning through video conferencing platforms such as Zoom, WebEx, Meet, and others on vocational education, which requires hands-on training for students. The study revealed significant shortcomings in the students' learning outcomes. A similar study on STEM education in Latin America was conducted by Ref. [16].

Numerous scholars have examined the change in creating efficient online learning resources for educational establishments. For instance, Ref. [17] emphasized the necessity of efficient teacher preparation for online learning resources and the institutions' ongoing monitoring of students' development and satisfaction. Similarly, researchers have thoroughly reviewed the literature on the various tactics and procedures used by various educational institutions and the difficulties that scholars and students encounter when utilizing the new online delivery technique for education.

2.1 Artificial Intelligent Applications in LMS

Integrating artificial intelligence (AI) within learning management systems (LMS) represents a revolutionary change in educational paradigms, emphasizing personalized learning and enhanced instructional support. As

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articulated in several critical studies, the literature reveals a progressive understanding of how AI can be leveraged to optimize educational outcomes [18].

In 2021, [19] explored the role of AI and machine learning as crucial support systems for instructors. They highlighted that AI-driven systems can identify patterns in student engagement, such as common errors or lagging performance, thereby facilitating timely interventions tailored to individual student needs. This proactive approach enhances student learning through automated tutoring and personalized feedback and improves instructor satisfaction by providing continuous support and tracking student progress. However, the authors noted the inflexibility of intelligent tutoring systems (ITS) due to technical constraints, suggesting that while AI can significantly enhance learning environments, challenges still must be addressed in implementing adaptable curricula [19].

Building on these insights, an in-depth review of natural language processing (NLP) techniques and their applications in analyzing educational feedback was carried out as in [20]. They argued that AI's predictive capabilities could revolutionize how educational institutions interpret student feedback, thus personalizing learning experiences. By employing NLP techniques, institutions can analyze vast amounts of textual data to gauge student perceptions and adjust educational infrastructures accordingly. The study emphasized that the automation of administrative tasks through AI streamlines operations and allows educators to concentrate on more meaningful interactions with students, fostering a more engaging learning environment.

The proactive and reactive uses of AI in education were further explored [21]. The scholars underscored the importance of AI in achieving quality education, a key sustainable development goal, particularly in the COVID-19 pandemic, which necessitated rapid adaptations in teaching and learning methods. Their review of recent research highlighted how AI tools can support various facets of education, from student admissions to performance assessment. They also addressed the limitations and challenges faced in the adoption of AI technologies, advocating for a balanced approach that recognizes both the potential benefits and the existing hurdles in the educational landscape. Refer to Table (1), which shows the differences between the platforms.

Table 1: Compares various LMS platforms

The software	Save timing	Create team	Bank of question	Calendar	Grading	Chat or command	Collaboration	Virtual classroom	Artificial intelligent	Lives course	Data analysis and predication
Moodle	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Limited	Limited	Yes	No
Google classroom	No	Yes	Limited	Yes	Limited	Yes	Yes	Limited	Limited	Yes	No
Blackboard	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Limited	Yes	No
Microsoft Team of Education	Yes	Yes	Yes	Yes	Yes	Yes (integrated with Teams chat)	Yes (including document co-authoring)	Yes (integrated with Teams meetings)	Limited (potential for future use)	Yes	No
Canvas	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Edmodo	No	Yes	No	Yes	Yes	Yes	Yes	Limited	Limited	Yes	No
Taaleem	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No

2.2 An Overview of LMS

A learning management system (LMS) is a versatile software platform that simplifies the administration, delivery, and management of educational content, training programs, and development initiatives. Learning management systems have become a central part of modern education, especially in English-speaking countries [22]. They provide tools for recording and tracking student activities, teaching, assessing performance, and encouraging collaboration between teachers, students, and peers. It supports synchronous and asynchronous learning and enables interactive experiences through forums for reflective discussions, chat

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for real-time communication, and web conferencing for multimedia-supported lectures. In addition, learning management platforms often include intelligent algorithms to recommend courses based on user profiles, enhancing personalization and engagement [23].

Learning management systems serve as comprehensive frameworks for managing progressive learning, allowing teachers to track attendance, assign grades, and monitor student progress. They create dynamic learning ecosystems where collaborative learning and knowledge sharing thrive and encourage critical thinking, negotiation, and assessment through online discussions. These discussions, often supervised by teachers, allow students to deeply engage with the content, share different perspectives, and build knowledge together. In addition, learning management system platforms enable flexibility, overcome traditional time and space barriers, and provide students with access to various resources and teaching opportunities [24].

Learning management systems have been criticized for prioritizing administrative tasks over learning innovation despite their benefits. Educators are trying to deconstruct the components of traditional learning management systems to create more flexible and personalized learning experiences by recombining open content and educational tools to meet the needs of future learning practices. By integrating essential communication tools and enhancing collaboration, learning management systems support effective course management and encourage intellectual and emotional engagement among participants, making them a critical role in transforming traditional education into a more flexible, interactive, and learner-centered model [25].

Thus, the use of LMS encourages the interaction of all components of a traditional didactic scenario: teacher, students, and subject matter as shown in the following Figure (1):

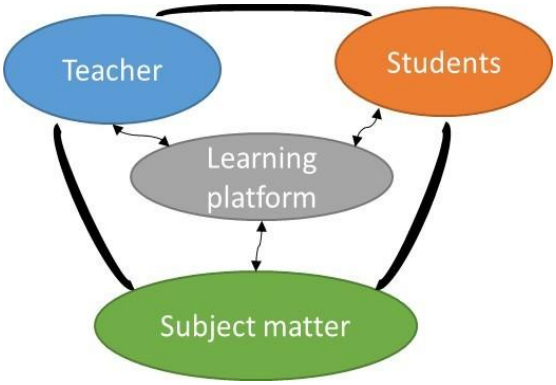

Figure 1: Components of an ICT learning scenario

3.0 The Edu4ALL Solution

3.1 Motivation and challenges

During times of crisis, such as pandemics, wars, or natural disasters, governments are urged, encouraged, and tasked with ensuring that citizens affected by these events remain connected to educational opportunities. The most important challenges:

- How can we provide equal educational opportunities and high-quality materials to all students during times of crisis, while maintaining natural student interactions?
- How can data collected via the LMS be exploited to enhance educational outcomes and content sharing?
- How can educational content be made socially available and accessible to all learners (accessibility issues and technical challenges)?

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- How can AI-features (data intelligence capabilities) be incorporated into SIS to improve decision-making and data management practices in educational institutions?

To address these challenges, we propose: developing a new educational platform called "Edu4ALL", designed to enhance traditional education through seamless integration. It comprises a smart and strategic e-education platform that implements a unified e-solution, functioning as an e-learning institution aimed at meeting and fulfilling national teaching and learning objectives.

The operational core system of the proposed solution functions intelligently within a dedicated business process, integrating the knowledge of both e-teachers and main teachers. It leverages data warehousing and AI techniques to enhance and optimize system performance. Additionally, it boosts student interaction during offline lectures by incorporating randomly selected questions, while also enabling the ranking and monitoring of students, schools, and teachers.

3.2 Edu4ALL as collaborative platform

The Edu4ALL Learning Management System is an innovative learning platform designed to integrate and optimize data from both physical schools and online learning environments. It harnesses the power of artificial intelligence, data mining, and advanced analytics to enhance educational outcomes and improve the overall learning experience. Edu4ALL aims to deliver equitable education and strategic insights to enhance academic outcomes on a national scale. This paper presents the system's architecture, data processing methodologies, and the results achieved using the Edu4ALL Learning Management System. By aligning its operations with government regulations, Edu4ALL addresses key challenges in modern educational systems, such as scalability, resource efficiency, and performance evaluation. The Edu4all platform aims to support students in partner educational institutions by establishing a comprehensive educational unit within each partner institution worldwide, with a particular focus on Iraq. To increase its impact and promote awareness of its values and expected outcomes, the platform is currently being introduced in various schools among students.

3.3 Software Architectural Design

Edu4ALL consists mainly of three software components. Iraqi-NVS, DInte , Data-Lake/warehouse (Figure 2):

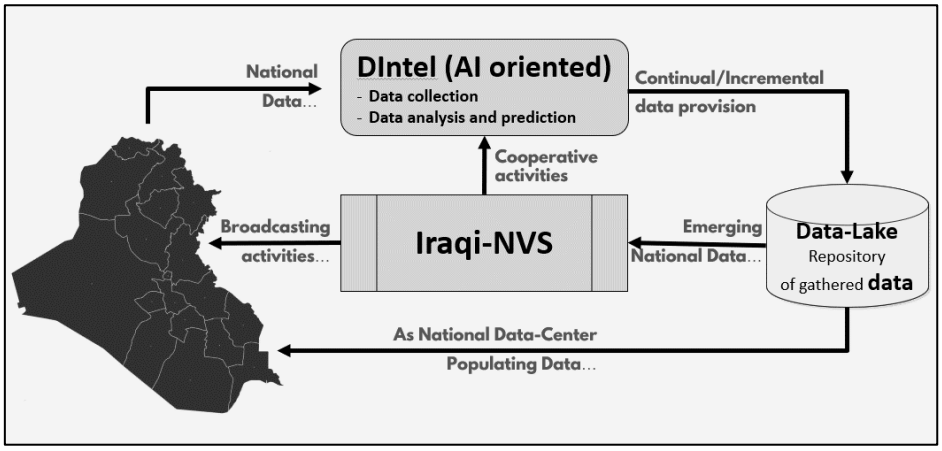

Figure 2 : Architectural design of the proposed solution software

3.4 Iraqi-NVS operational business process

The Edu4ALL that we propose is a collaborative platform taking the form of an LMS with a new feature-based Smart Education System (SES) that will have the capacity to (Figure 3):

- Deliver life-scheduled online sessions covering the considered area.

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- Assess physical schools, teachers, and students using collected data.

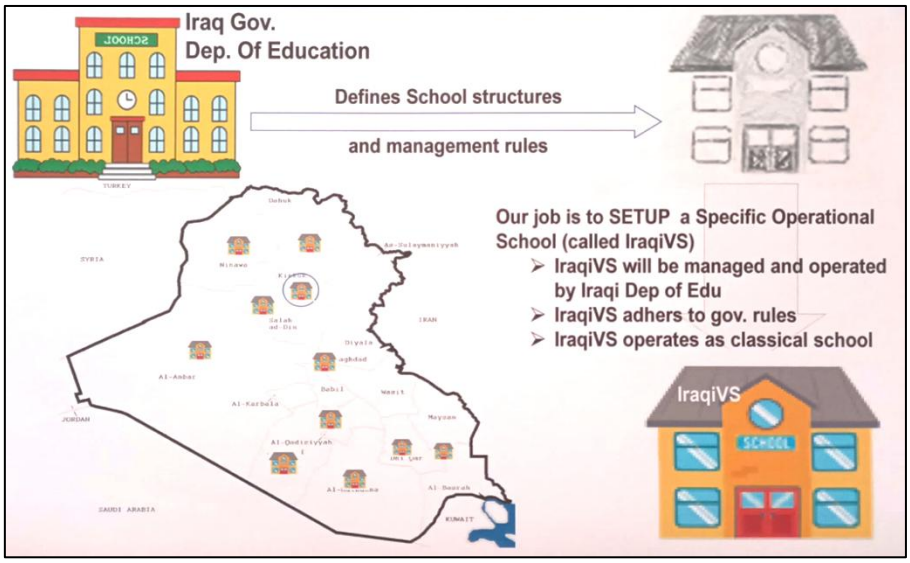

Figure 3: Governmental applied education

This will be achieved by establishing a dedicated operational school called the "Iraqi National Virtual School (Iraqi-NVS)," which will be managed by the Iraqi Department of Education (Figure 4).

- Iraqi-NVS applies government rules and operates as a traditional school (teaching map; schedule, teacher allocations).
- Iraqi-NVS will be activated by the government in periods of wars and crisis throughout the country.
- Iraqi-NVS delivers online learning-sessions to the whole country passing (by replication) through the physical schools' features.

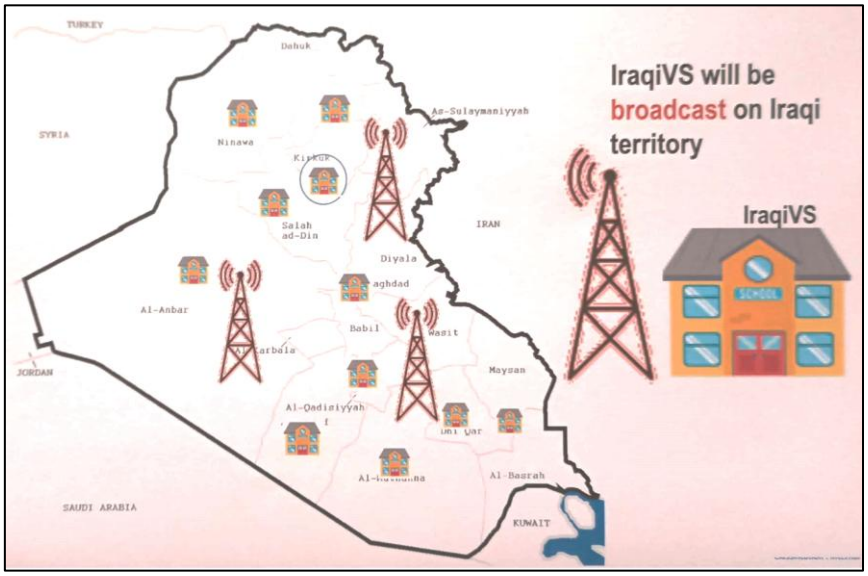

Figure 4 : E-learning Iraqi –NVS broadcast

The Edu4ALL platform within Iraqi-NVS is intended to:

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- Provide real-time learning sessions and live-streaming classes through the establishment of the National Virtual School (NVS).
- Function as a central virtual school model that can be operationally replicated and expanded to cover the entire targeted region.
- Continuously rank and assess the performance of virtual schools, virtual teachers, and virtual students by analyzing incrementally collected data.

The Iraqi National Virtual School serves as a central platform for data transfer and management of educational resources, transforming how education is delivered across Iraq. Like live video streaming, it ensures that content is delivered efficiently and incrementally, enabling teachers, students, and administrators to collaborate and learn in real-time. The platform supports interactive features such as notes, annotations, and discussions, allowing students to improve their understanding and share ideas in a collaborative learning environment. Educators can use these tools for assessments, while features such as metadata tagging, timelines, and task assignments enrich the learning experience by improving interactivity and engagement. The National Virtual System (NVS) integrates live streaming with workflows that include content capture, encoding, conversion, and distribution, ensuring accessibility across devices and varying internet speeds. It promotes personalized learning, skills development, and scalability, meeting the needs of diverse users while supporting Iraq's broader educational goals. Despite its potential, successful implementation depends on adequate funding, infrastructure, and alignment with curricular and policy objectives. Ultimately, Iraq's NVS system is redefining education by integrating technology, teaching methods, and collaboration into an innovative and scalable system, promoting equitable access to resources and collaborative learning opportunities across the country.

Video annotation, conversely, involves adding metadata or annotations—such as text, images, or links—to videos to enrich the learning experience. By combining these technologies, the Edu4ALL Learning Management System creates a dynamic and interactive learning environment. This integrated approach can greatly enhance student engagement, understanding, and learning outcomes.

Additionally, the platform facilitates data collection from various sources nationwide, including schools, universities, and government ministries. This data includes information on student performance, teacher qualifications, resource allocation, and educational policies. The Iraqi NVS (National Virtual School) serves as a national data center, storing and processing the collected data. It enables data sharing, collaboration, and informed decision-making among different stakeholders. It also promotes collaborative activities and data integration across national educational institutions. Additionally, it supports broadcasting activities and ensures the widespread distribution.

3.5 Data Intelligence (DIntel)

Data intelligence (DIntel) is one of a core component of the Edu4ALL platform, enabling robust data collection, integration, and analysis from schools across geographies. Figure 2 illustrates the platform based on collecting diverse datasets to generate actionable insights for students, teachers, schools, and policymakers.

Data intelligence (DIntel) operates as illustrated in Figure 3, with Edu4ALL leveraging comprehensive data collection from schools across various regions. Figure 5 illustrates the structure of (DIntel). The data includes:

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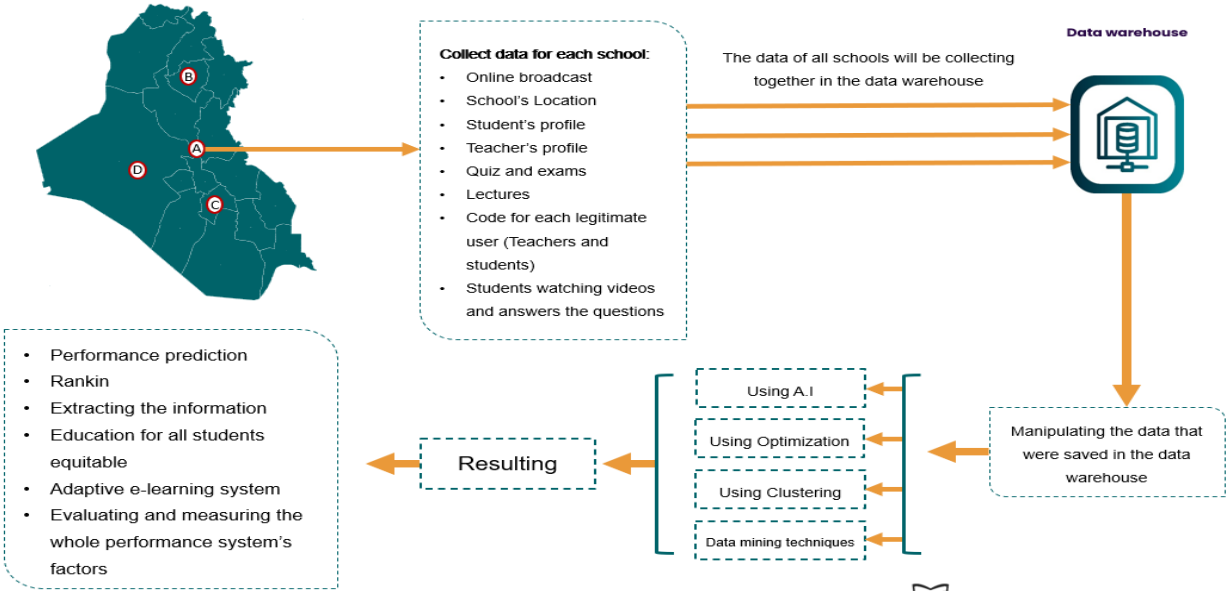

Figure 5 : General structure of the proposed system for data workflow

- ✓ Data workflow:
  - The Edu4ALL platform systematically collects and centralizes school data to ensure comprehensive coverage of education metrics. The following types of data are collected and processed:
- ✓ Online session data
  - Attendance records, including login times and session lengths, are tracked to monitor student engagement.
  - Engagement metrics measure participation in live sessions, such as questions asked, answers given, and frequency of interaction.
  - Submission data captures assignments, homework, and activities submitted during or after live sessions.
- ✓ Student profiles:
  - Measures of academic performance include grades, test scores, and progress trends in each subject.
  - Demographic data includes student age, gender, socioeconomic status, and geographic region.
  - Engagement metrics analyze interaction with learning materials, and time spent watching video, in addition to answering the three-level questions related to the topic of the video itself, which are included in the question bank and recorded in the student's log., engagement rates, and online behavior.
- ✓ Teacher profiles:
  - Qualifications, certifications, and teaching experience are captured to assess subject matter competency and suitability.
  - Teaching effectiveness is measured through student scores, course attendance, and qualitative/quantitative feedback.
  - Feedback includes teacher ratings of students and peers that identify strengths and areas for improvement.
- ✓ Assessments:
  - Results from tests and exams taken through the Edu4ALL platform provide insight into student learning outcomes and achievement gaps.

- Ongoing assessments, tests, and other data are captured to track academic progress.

✓ School locations:
- Geographic data is collected to determine schools' physical location and record accessibility deficits in different regions.
- This information supports targeted interventions in remote or underserved areas to improve educational equity.

✓ Learning content usage:
- Data on student interaction with videos, lecture materials, and digital resources is recorded to analyze the effectiveness of the content.
- Metrics include the number of views, completion rates, and the amount of time spent on specific learning materials.

The data is securely transferred to a central data warehouse for processing and analysis. At the core of the Edu4ALL platform is a central data warehouse designed to manage large amounts of data from diverse sources.

3.6 Data -Lake/warehouse

National educational Data – Lake, refers to the educational system national data (curriculums, data about schools, etc.). All produced data would be provided as national data (could be solicited from any governmental department).

At the heart of the Edu4ALL platform is a centralized data warehouse that acts as an organized and secure repository for managing large amounts of data. A data warehouse integrates information from various sources, including physical schools and online platforms, into a unified database. This enables seamless data analysis, reporting, and predictive modeling.

✓ Data Integration:
- The repository integrates disparate data sets from multiple educational districts and systems, ensuring a single source of truth for all educational data.
- Integrates physical school data (e.g., attendance and assessments) with online school data (e.g., live session attendance and content usage) to provide a comprehensive view of student learning.

✓ Real-time access to analytics tools:
- The system supports real-time data processing, allowing educators, administrators, and policymakers to access up-to-date reports and insights.
- The analytics tools in Edu4ALL leverage the data warehouse to create dashboards, visualizations, and predictive analytics for decision-making.

✓ Scalability:
- The data warehouse is designed to meet the changing needs of the national education system and can handle increasing data loads as more schools, students, and teachers are added to the platform.
- The system ensures reliable performance in processing large amounts of data and provides scalability for future needs.

DIntel, combined with the Edu4ALL platform's central data warehouse, transforms raw educational data into meaningful insights. This integrated approach supports real-time monitoring, predictive analytics, and scalable data management, empowering Iraq's education system to address challenges, promote equity, and improve overall student and institutional performance.

Once collected, the data will be processed and analyzed using sophisticated technologies such as artificial intelligence algorithms to identify patterns, predict performance, and suggest personalized learning strategies and optimization techniques. These methods improve resource allocation, lesson planning, and management

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of educational infrastructure and group schools, students, and teachers based on common characteristics to identify trends, provide targeted interventions, and extract data mining insights to uncover relationships between teaching methods, resources, and academic outcomes.

Thus, the Edu4ALL platform will enable predictive analytics to predict student performance and rank schools, teachers, and students based on KPIs. By analyzing a regional and demographic difference, Edu4ALL ensures that resources and opportunities are distributed relatively, enabling equal access to quality education. Edu4ALL assesses and measures the education system's overall performance and provides actionable insights for policymakers and educators. However, this part focuses on four sections, as described below.

3.7 Dataset

This section focuses on a structured dataset that is systematically organized and stored for analysis or processing. Datasets serve as a fundamental resource in data analytics, data analysis, and machine learning (ML), providing the data for analysts to uncover insights and identify trends. The data of analysis is derived from the Iraqi Ministry of Education based on the degrees of several schools for the academic year 2022-2023. The data is comprised of 65,535 rows and 37 columns. The researcher depends heavily on a combination of four AI predictive models which are: Student Graduation Prediction Model, Government Predictive Model, Schools Performance Prediction Model, and Teachers Performance Prediction Model.

Additionally, the current study delves into the deployment and impact of the Ed4all Learning Management System (LMS), a comprehensive and innovative tool with many functions. These include a comprehensive database for storing all data, scheduling lectures by specifying timings and weekly schedules, e-teacher functionality to assist the actual teacher, various lecture types (such as files, videos, audios, and live sessions), mapping the next step for students based on predictive results or interactive exam performance, and creating a question bank to assess student progress. Moreover, it incorporates interactive lectures with questions that must be answered before proceeding to the following lecture. The system also provides live-streaming monitoring capabilities along with strategic insights into educational operations.

3.8 Preprocessing & Analysis

Once data is stored in the warehouse, it undergoes processing and transformation to make it usable for advanced analytics. The process begins with data cleaning; the process involves removing inconsistencies, errors, and redundancies from the collected data. It then involves converting raw data into structured formats suitable for analysis. Finally, various datasets are merged to provide a comprehensive view of performance at the student, teacher, and school level. Before proceeding with the analysis, it is essential to preprocess the raw data to ensure its quality and readiness for modeling. Key preprocessing steps include:

- **Handling Missing Values:** Remove all null and repeated values. There is one column with missing values: SubName8, which has 65,535 - 65,401 = 134 missing entries.
- **Outlier Detection and Treatment:** Identify and manage outliers using statistical methods or visualization techniques. Consider removing, capping, or imputing outliers based on their impact on the analysis.
- **Data Consistency:** Ensure data consistency across different columns, such as standardizing units of measurement or formatting dates.

Because the data doesn't have the teacher's name and rank and number of downloaded details (we add this by a random value to predict the best teacher).

3.9 AI model

After analysis, the four models applied on this dataset are:

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1- Model 1: Predicting Student Grades based on Grade Level Across Six Subjects

This model predicts a student's future grade by analyzing their performance in seven subjects over previous years, accounting for trends and variations in achievement by grade level. It processes historical academic data to capture patterns like consistent improvement, stagnation, or declines across subjects, using these patterns as predictors for future performance. Random Forest, XGBoost, and CatBoost algorithms are employed to create robust predictive platforms. Random Forest provides a solid baseline by leveraging decision trees for aggregated predictions, while XGBoost and CatBoost optimize the process by incorporating gradient-boosting techniques that handle categorical data and focus on reducing prediction errors. These models are valuable in academic advising, enabling educators to identify students in need of intervention or those with potential for advanced learning opportunities. The datasets were split into 80% for training and 20% for testing, the input from degree1 to degree8 and the output was (failed (راسب), repeated (معيد), passed (ناجح)). The accuracy of Random Forest is 0.9988 and the confusion matrix is shown in Figure (6).

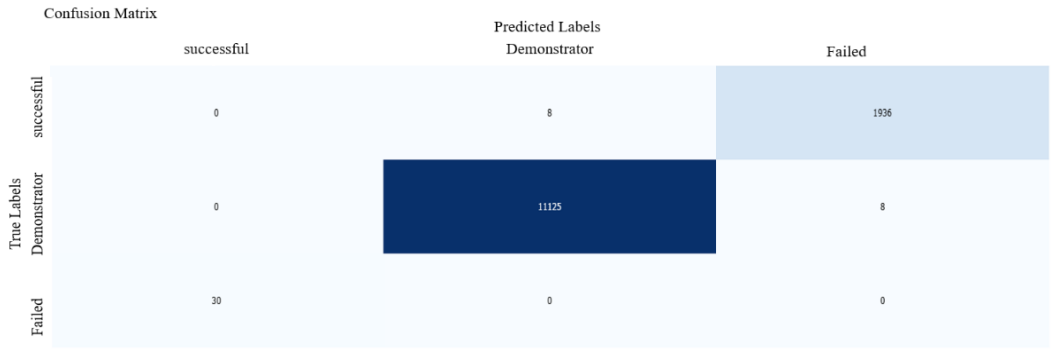

Figure 6: Confusion Matrix for Random Forest Student Grades

While the XGboost and CatBoost had an accuracy of 0.9998 and 0.9994, and the confusion matrix is shown in Figures (7 and 8).

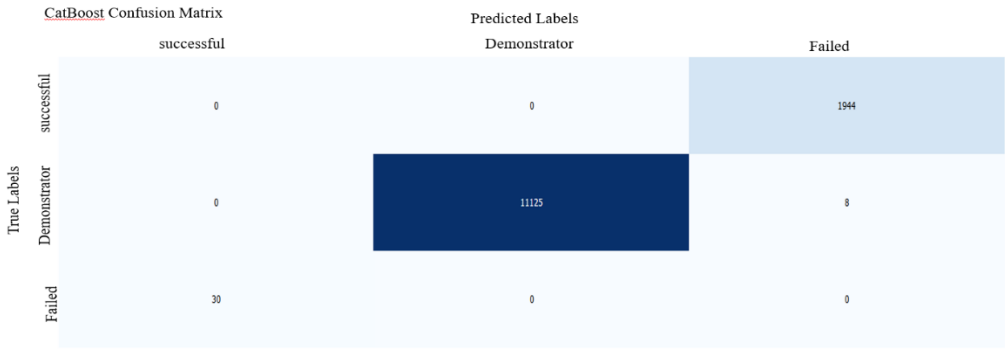

Figure 7: Confusion Matrix for CatBoost Student Grades

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Figure 8: Confusion Matrix for XGBoost Student Grades

2- Model 2: Predicting the Best Teacher based on Teacher Rank, Number of Downloads, and Student Grades

This model identifies the most effective teacher by analyzing three key factors: the teacher's rank, the number of times their materials are downloaded, and their students' average grades. It was added as a random way to the dataset because the data doesn't contain the teacher's name, rank, or number of downloads. These factors reflect a teacher's reputation, resourcefulness, and teaching impact, respectively. Random Forest builds the baseline model by evaluating each feature's importance and further optimizes predictions by managing categorical data like teacher rankings. This model aids school administrators in recognizing and rewarding outstanding educators, fostering a culture of excellence in teaching practices. The datasets were split into 70% for training and 30% for testing, the output of the model (failed (راسب), repeated (معيد), passed (ناجح)) rank, number of downloads, school type, and region where the output was the teacher's name. The accuracy of Random Forest is 0.995 and the confusion matrix is shown in Figure (9).

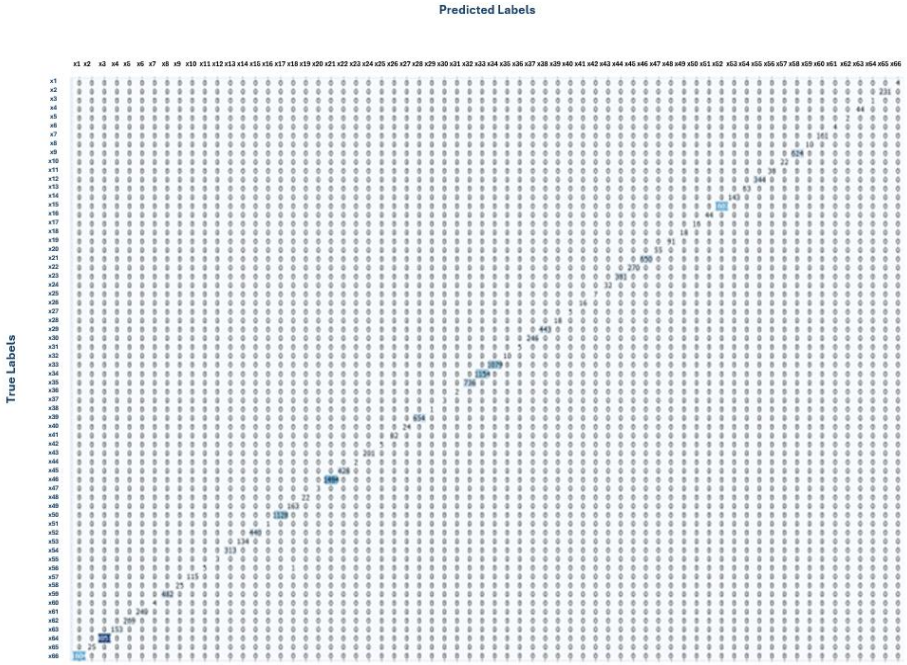

Figure 9 : Confusion Matrix for Random Forest Teacher

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3- Model 3: Predicting the Best School Based on Final Student Grades

This model ranks schools based on their students' final grades, identifying the top-performing institutions. By analyzing aggregated student performance data, it determines schools that consistently achieve higher average scores. Before starting to predict the school, we calculated the success rate and extracted it from the existing data represented by the eight students' grades, where we calculated the average of all students and divided it by the number of successful students, as well as the total downloads and evaluation of all teachers in one school.

Based on that, four categories were added to classified schools: excellent, very good, good, and average. After that, we trained the Random Forest model and the results appeared. Because a very good classification appeared in one school, we increased the number of samples to train the model better. Random Forest captures variability in student grades, providing a baseline ranking for schools the accuracy was 99% and the confusion matrix is shown in Figure (10), while XGBoost improves precision by focusing on relationships between final grades and other variables such as school facilities or teaching resources, and the accuracy was 99% and the confusion matrix shown in Figure (11). This model assists parents in selecting schools and helps school administrators in benchmarking their performance to maintain or improve standards.

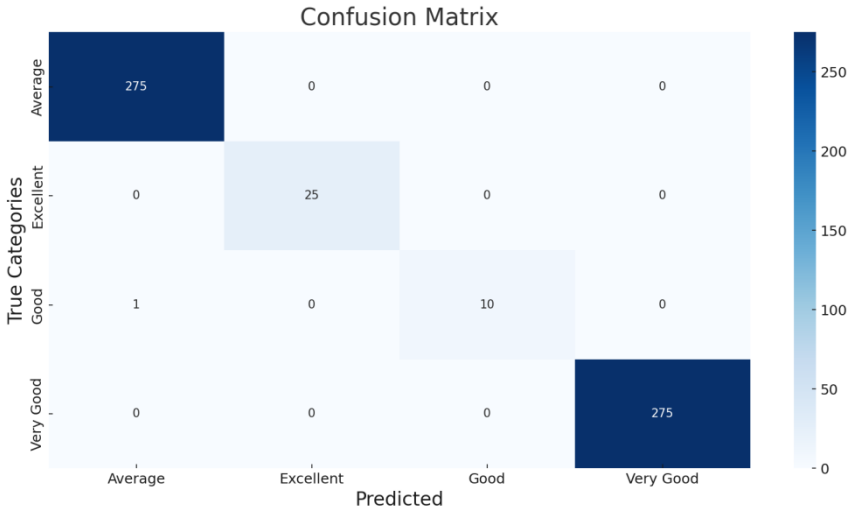

Figure 10 : Confusion Matrix for Random Forest School before over-sampling

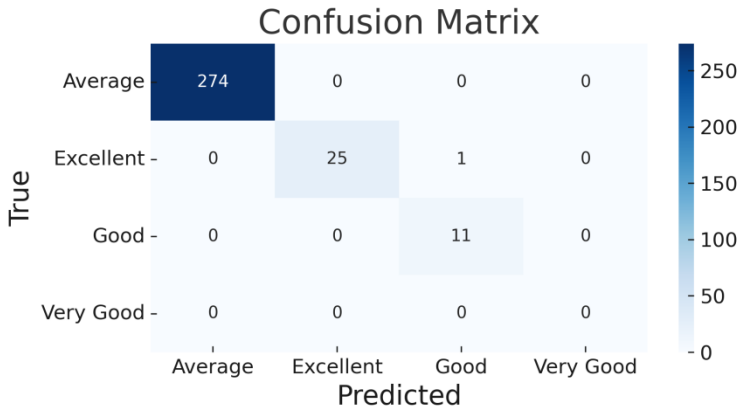

Figure 11: Confusion matrix for XGboost School after over-sampling

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4- Model 4: Predicting the Best Performing Government Based on School Names and Student Grades

This model evaluates government education performance by correlating school names and their students' average grades. By aggregating school-level data under respective governments, the model identifies which government consistently produces the highest-performing schools. The prediction utilizes features such as school reputations and average grades to rank the governments. Random Forest is used for initial feature selection and handling missing data. This model supports policymakers in identifying best practices and allocating resources to replicate successful education policies, with the input of the model STUCASES (راسب, ناجح ,معيد), rank, number of downloads, school type, school name, and the output was the government name. The accuracy of the Random Forecast was 97% and the confusion matrix is provided in Figure (12).

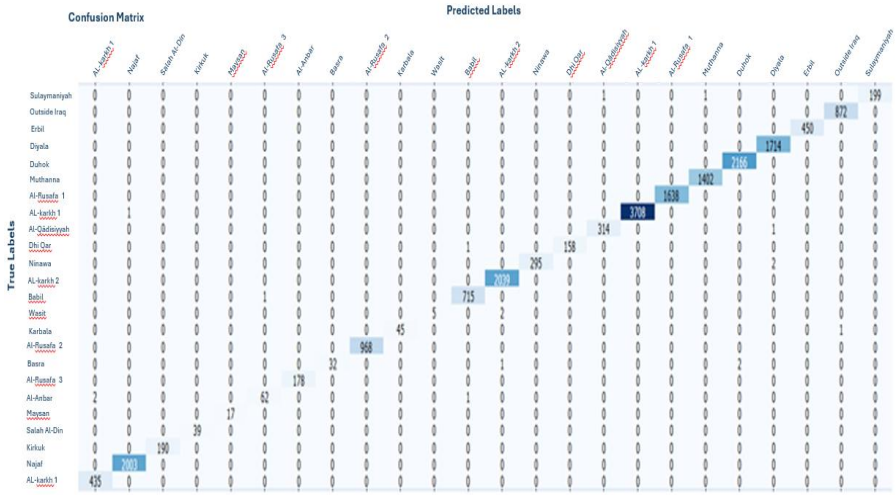

Figure 12 : Confusion Matrix for XGboost Best Performing Government

3.10 Discussion and Results

This study examined the impact of live streaming technologies and Learning Management Systems (LMS) on online learning experiences and student academic performance. It revealed key findings that are consistent with and contradict previous research. The key findings indicate that while LMS tools, such as live video streaming, increased student satisfaction and enjoyment, they had no significant impact on academic performance. This highlights the need to improve content alignment, delivery methods, and learning materials to effectively improve learning outcomes. Students preferred live online lectures due to their flexibility and accessibility, highlighting the importance of self-directed learning as a core skill in modern education. Four predictive models are used in the Edu4ALL platform to provide actionable insights and complement the analysis of broader LMSs. Model 1 (99.88% accuracy) identified student achievement gaps using Random Forest, supporting the argument that learning content needs improvement despite satisfaction with live tools. Model 2 (99.5% accuracy) identified high-performing teachers and emphasized the importance of resource alignment and professional development in improving learning outcomes. Model 3 (99% accuracy) predicted the best-performing schools using XGBoost and explained the role of institutional strategies and resource optimization. Model 4 (97% accuracy) assessed government performance and provided data-driven insights to allocate resources and replicate successful policies equitably.

Compared to other learning management platforms such as Moodle, Google Classroom, Blackboard, Microsoft Teams for Education, Canvas, Edmodo, and Taaleem, Edu4ALL offers significant advantages in AI integration, performance prediction, and resource optimization. Comparisons of tablet features reveal gaps in some widely used platforms: for example, Google Classroom and Edmodo lack comprehensive tools for live classes, collaboration, and virtual classrooms, limiting their potential for interactive and real-time learning. Platforms

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such as Canvas and Microsoft Teams for Education purposes have proven to be strong contenders due to their comprehensive features such as collaboration and assessment tools, chat integration, and AI support (Table 2). However, Edu4ALL leverages AI-powered predictive models and centralizes data collection across a data warehouse, providing unique value for targeted improvements in academic performance, resource allocation, and teacher effectiveness. While platforms like Blackboard and Canvas offer robust grading and virtual classroom capabilities, Edu4ALL extends these capabilities with data-driven insights for performance predictions, grading, and adaptive e-learning systems. Edu4ALL positions itself as a scalable and future-proof platform tailored to address the unique challenges of the Iraqi education system. However, the findings highlight the need to align content quality, delivery methods, and learning outcomes, as more than satisfaction with live tools alone is insufficient to enhance academic performance.

Faculty should improve pedagogical content and use AI models to create constructive and sustainable learning environments that effectively integrate technology, address student needs, and promote long-term educational success.

Table 2 : The most popular LMS's platforms' features compared with EDU4ALL

The software	Save timing	Create team	Bank of question	Calendar	Grading	Chat or command	Collaboration	Virtual classroom	Artificial intelligent	Lives course	Data analysis and predication
Moodle	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Limited	Limited	Yes	No
Google classroom	No	Yes	Limited	Yes	Limited	Yes	Yes	Limited	Limited	Yes	No
Blackboard	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Limited	Yes	No
Microsoft Team of Education	Yes	Yes	Yes	Yes	Yes	Yes (integrated with Teams chat)	Yes (including document co-authoring)	Yes (integrated with Teams meetings)	Limited (potential for future use)	Yes	No
Canvas	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Edmodo	No	Yes	No	Yes	Yes	Yes	Yes	Limited	Limited	Yes	No
Taaleem	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No
EDU4ALL	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

4.0 Conclusions

The Edu4ALL Learning Management System demonstrates the transformative power of AI-driven predictive models and advanced data analytics to improve Iraq's education delivery and resource management. By integrating systems such as the Iraqi National Virtual School (NVS) and Data intelligence (AI-driven), the platform enables the collection, storage, and analysis of comprehensive data to support equitable and effective teaching practices. The study implemented four highly accurate prediction models: Model 1 (99.88% accuracy) predicts student performance and identifies at-risk students for targeted support; Model 2 (99.5% accuracy) identifies top-performing teachers based on rank, student grades, and downloads, improving the replication of effective teaching practices; Model 3 (99% accuracy) highlights top schools based on student outcomes and informs infrastructure and policy decisions; and Model 4 (97% accuracy) identifies top-performing districts to ensure equitable resource distribution and advance education policy. Data collected from schools – including profiles, assessments, attendance, and location – are integrated into a data warehouse where advanced technologies such as aggregation, optimization, and data mining enable performance prediction, adaptive e-learning systems, and delivery of equitable education. NVS also enhances real-time interactive learning through video streaming and collaboration tools, improving student engagement and satisfaction. By seamlessly aligning learning materials and delivering data-driven learning and insights, Edu4ALL serves as an innovative and scalable solution that promotes continuous improvement, equitable outcomes, and alignment with global standards, taking a decisive step toward transforming education into an accessible, interactive, and efficient system, shaping the future of Iraq.

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Declaration of competing interest

The authors declare that they have no known financial or non-financial competing interests in any material discussed in the paper.

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