Leveraging Knowledge Discovery in Databases for Enhanced Student Support: Development and Implementation of an Automated Response System

Uchenna Venatius Maduabuchi[1], Moses Okechukwu Onyesolu[2], Vivian Chinyere Mbamala[3]
[1]*Lecturer, Department of Computer Education, Federal College of Education (Technical) Umunze, Anambra State Nigeria*
[2]*Professor of Computer Science, Department of Computer Science Nnamdi Azikiwe University, Awka, Anambra State, Nigeria*
[3]*Lecturer, Department of Information Technology, Federal University of Technology, Owerri, Imo State, Nigeria*
Corresponding Author: uchenna.maduabuchi@fcetumunze.edu.ng

***Abstract*: This paper utilizes knowledge discovery in databases to improve student support, focusing on the development and implementation of an automated response system. This document outlines a web-based help desk system aimed at enhancing communication between students and academic staff within higher education institutions in Nigeria. Students frequently encounter obstacles like registration complications, absent results, and ambiguous course requirements, which can be intensified by distance and accessibility concerns. This study presents an application grounded in KDD principles that enables students to submit support tickets, which are then prioritized and automatically allocated to designated staff for timely responses. The system utilizes KDD algorithms to categories and address enquiries by leveraging historical data, leading to notable enhancements in response times. By employing Object-Oriented Design Methodology (OODM) alongside a PHP-MySQL framework and JavaScript, the system demonstrated an outstanding average ticket response time of merely 2 minutes, significantly enhancing the efficiency compared to conventional email-based support systems, which often require hours for a response.**

***Keywords*: Knowledge Discovery, Student Support, Automated Response, Ticketing, Web-Based Application.**

1. Introduction

A complex process, Knowledge Discovery in Databases (KDD) seeks to discover valid, new, and valuable patterns in enormous datasets in order to extract relevant information from them [1]. Data from the Internet of Things (IoT), cybersecurity, and social media are just a few examples of the many forms of information that are abundant in today's digital world, which is characterised by the Fourth Industrial Revolution (4IR) [2]. This multi-stage process makes use of database approaches, decision-making systems, statistics, and machine learning (ML) [1]. Finding useful information in massive datasets is the job of data mining, which is closely related to KDD [1][3]. The need for sophisticated computational tools for data analysis via KDD has grown in response to the explosion in the amount of available information. Methods from high-performance computing, pattern recognition, databases, and statistics are all brought together in this area. When it comes to extracting valuable patterns and making sure they are understandable, KDD tackles scalability difficulties [4]. In order to turn raw data into useful insights, data mining is an important part of KDD [1].

Interest in data mining's potential educational applications has grown rapidly in recent years. The term "data mining" (DM) refers to the practice of extracting previously unknown valuable insights from massive databases [5]. Finding patterns and trends using different categorization techniques is its main emphasis [6]. The goal of Educational Data Mining (EDM), a subfield of this scheme, is to unearth recurring patterns in student knowledge analysis and learning behavior as well as other areas of education [7]. Opportunities for student-centered, technology-enhanced learning systems have been identified thanks to EDM's substantial impact on the education industry [8]. When it comes to educational issues, EDM uses classic DM approaches to handle them [9]. In order to improve learning settings, EDM examines student data including attendance and academic records; it has also been useful in predicting academic success and enhancing the learning experience as a whole [10]. The goal of analysing educational data using machine learning and statistical methods is to find patterns that improve both student comprehension and the efficiency of educational institutions [8]. When it comes to predicting academic performance and discovering connections in educational data, EDM is a potent tool [10]. Any service that helps bring people together to study is considered a support service in the field of education. The research highlights learner support services, especially in open and distant education, because of the physical and temporal distance between students, teachers, and schools [11]. In contrast to more conventional educational models, this split calls for supplementary aid for students. A key component in ensuring the quality of education is the availability of effective student support services, which are vital for improving both the student experience and academic

achievement. They encourage pupils to stay in school and help lower the dropout rate [12]. Students may decide to stop pursuing their education if they do not get sufficient assistance. Graduates who are well-rounded are the result of a well-structured support system.

Registration problems, missing results, and login difficulties are common problems that students have while taking distant courses in Nigeria. Students often have trouble figuring out how to properly handle these issues, which might impede their academic development. The absence of direct engagement with institution administration in present web portals makes these difficulties even more challenging to handle. A planned ticketing system for student support services aims to address these concerns. This approach would help schools communicate more effectively and increase efficiency by keeping track of student requests and interactions over time [13]. Due to the urgent nature of many student concerns, the ticketing system facilitates prompt replies to service requests. Missed chances to resolve academic issues might result from delays in receiving prompt help. Furthermore, the technology would assist with ticket prioritisation, guaranteeing that critical problems are addressed promptly. The effective identification of previously answered tickets to reduce repetition remains an issue, nevertheless.

We recommend an intelligent agent-based strategy to improve the student support experience. In order to improve the effectiveness of student support services at Nigerian institutions, the framework places an emphasis on KDD-based approaches. A virtual assistance framework for student support is introduced in this paper. This framework allows the support staff to reply quickly to student requests. The technology improves response times and strengthens the student-staff interaction by automatically prioritising requests and assigning them to the right staff members [14]. Students, particularly those juggling school and employment, would feel more connected to the community as a whole, thanks to the proposed system's streamlined request-handling process and lightning-fast response times. In response to user input, the system learns from past requests and, using KDD approaches, provides appropriate responses.

Emerging new perspectives and methods to teaching and learning, such e-learning, have been prompted by the rapid development of technology, the trend towards internationalisation in universities, and the removal of obstacles among students [15]. Despite the enormous challenges, such as students' shyness, the high cost of internal transport, problems with attitudes among classmates, and distance between departments or enquiry decks, students also face difficulties in accessing guidance and counselling units. The difficulties motivate the suggestion of an automated responder-embedded, KDD-based student assistance system.

2. Related Literature

Using a variety of cutting-edge technologies, several research have concentrated on improving open and remote education student support systems. When comparing both works, it is clear that they both deal with comparable issues but use different processes and approaches to implementing their solutions. Helpdesk systems, academic performance prediction, and user-centric apps are just a few of the topics that the reviewed research concentrate on as ways to improve student support systems via technology.

Research studies [16], [17], and [18] discuss the importance of having effective helpdesk systems. Incorporating comprehensive ticket information into a central help desk that uses machine learning for ticket categorisation significantly improves accuracy, as shown in [16]. Complementing [16]'s emphasis on client satisfaction and rapid resolution times, [17] also implemented a microservices architecture for its IT helpdesk, which improved scalability and automated classification. A common aim across this research was to automate and optimise ticket administration; for example, [18] used random forest techniques to achieve 82% accuracy in human categorisation.

Both [19] and [20] stress the significance of students making well-informed decisions when choosing their courses of study. The recommender system in [19] uses data mining methods to help students choose their classes, with the hope of increasing graduation rates and decreasing the likelihood that students would quit their studies. Similarly, with an accuracy of 86.72%, the work of [20] uses data mining to direct learners. While [19] looks at the effects on institutions more generally, [20] takes a more personalised approach, yet both studies stress the need of individualised tutoring in the classroom.

Two sources that cover the evolution of academic information systems that are web-based are [21] and [22]. The online course registration system developed by [21] is component-based, which makes it more manageable and reusable. On the other hand, WeBAIS, developed by [22], increases operational efficiency at institutions in Nigeria. Although both systems strive to simplify academic procedures, [21]'s work does not address the unique Student Evaluation of Teaching element that is included in [22]'s system.

A Mobile Student Information System (MSIS) that prioritises the requirements of users by using context-aware apps was introduced in [23]. This is in line with previous research that has focused on mobile solutions; for example, [24] created a web-based integrated information system for mobile devices. Accessibility and user engagement are the main focuses of both studies. However, [23] goes into further detail on the importance of location-aware services, which might make the information that students get more relevant.

Using predictive analytics to evaluate student progress is the subject of three separate studies [25], [26], and [27]. An accuracy of 85.188% was achieved by [25] in their analysis of academic achievement-affecting variables using decision trees and neural networks. Using an emphasis on socio-economic characteristics, [26] achieved an F1-score of 86% using a support vector machine classifier, specialising in advanced

learning analytics. On the other hand, [27] looked at early prediction using data from mid-semester exams and found a number of demographic and personal characteristics that impact success. Although all three studies make use of machine learning methods, they vary in the attributes that are studied and the particular settings in which they are used.

Support personnel may not always read their emails, which causes delays in answers, according to the studied literature, which mostly uses email alerts for ticketing systems. To fill this need, this paper uses KDD algorithms to categorise tickets, incorporates automated SMS answers, and provides self-help services via chatbots. It also takes into account the fact that people have different ways of expressing themselves, such as the fact that student support service messages tend to be lengthier and more detailed than those on platforms like Airbnb.

3. Software and Tools for Development

Strategic integration of multiple technologies and techniques is required for the creation of a Knowledge Discovery Database (KDD) for an autonomous responder student assistance system.

Python, PHP, ASP.NET, JavaServer Pages (JSP), and other back-end programming platforms provide for server-side scripting and dynamic web page production. The system's ability to handle user interactions successfully is ensured by these languages, which permit robust application development [28].

If you want to save and retrieve student information effectively, you need a database management system. Reliable options include Oracle Database, Microsoft SQL Server, and open-source MySQL, which supports several programming languages.

By allowing decentralised data integration and semantic querying, semantic web technologies enhance the KDD. By facilitating ontology construction and facilitating improved navigation across instructional resources, the Semantic Web Architecture paves the way for the personalisation of learning experiences according to each student's requirements [29].

Encoding student enquiries and replies requires knowledge representation methods like frames, semantic networks, and production rules. These methods improve the automated responder's data understanding and management capabilities, which in turn guarantees more relevant and accurate interactions with learners.

4. Data Mining and Knowledge Discovery

Statistics, database administration, pattern identification, machine learning, and AI are all facets of data mining, a relatively new area of study. It combines methods from different domains to unearth patterns in massive datasets housed in various repositories, including databases and data warehouses. [4] describes data mining as the act of discovering new insights hidden in large datasets, while [5] places an emphasis on discovering hidden but potentially valuable information. According to [7], finding genuine, unique, and interpretable patterns in data is what Knowledge Discovery and Data Mining (KDD) is all about.

As a kind of secondary data analysis, data mining usually makes use of already-collected observational data. The results of this procedure may be represented in a number of ways, including rules, clusters, or graphs. An example of a "data rich but information poor" situation is the proliferation of data gathering techniques, which has produced massive volumes of data that are often not put to good use [10]. In order to improve decision-making in many areas, including business and medical research, robust data analysis tools are required to draw useful conclusions from the data.

Data Mining Techniques: The two main uses of data mining are in descriptive and predictive modelling. While descriptive tasks show patterns that people may readily understand, predictive tasks infer outcomes from existing data [7]. Using past data to train a model, predictive modelling creates relationships between dependent and independent variables [19]. A few examples of common tasks include time series analysis, categorisation, regression, and prediction.

Techniques for Classification: Decision trees, ANNs, and Bayesian classifiers are just a few examples of the classification algorithms that use machine learning to find patterns in student data and provide performance predictions [19].

Decision Tree: The structure that classifies records at the leaf nodes of a decision tree is a decision tree, which uses a set of decision rules to divide data into smaller groupings. They are easy to use and don't need any prior understanding of the subject matter when built [5].

Artificial Neural Networks: Models trained using artificial neural networks (ANNs) mimic the way the human brain works; however, ANNs are less interpretable than decision trees and take more time to train [16]. Despite this, ANNs are very good at pattern recognition and classification.

Bayesian Classifiers: Class membership probabilities may be predicted using Bayesian classifiers using Bayes' theorem. According to [9], the naïve Bayesian classifier is useful for big datasets since it performs similarly to decision trees and ANNs.

Techniques for Clustering: Data compression is made possible by clustering, which entails classifying things into groups based on their similarities, and then handling each cluster independently. An unsupervised approach, clustering makes use of a number of methodologies, including hierarchical methods and k-means clustering [17]. The massive amounts of data produced by several disciplines, such as statistics and machine learning, have made it an important topic in data mining studies.

5. AI Agents

Research in artificial intelligence mostly focuses on intelligent agents, which are creatures that can sense their surroundings using sensors and manipulate it using actuators [20]. Based on their past experiences, rational actors strive to maximise their predicted performance. The capacity of a system

to understand data, gain knowledge from it, and adjust to meet defined objectives is defined as artificial intelligence [10]. In order to achieve their objectives and adapt to their surroundings, intelligent agents must take the initiative [11].

With a systematic way to evaluate programs against predetermined "goal functions," researchers in the field of artificial intelligence may compare and contrast various approaches. If an agent is able to maximise its goal function, we will consider it intelligent. Reinforcement learning is one method that uses a "reward function" to direct behaviour [18]. Goals may also be inferred via other means. While other systems, such as nearest-neighbor algorithms, may not have clear objectives, their effectiveness in classification tasks may still be measured [16].

Simple Reflex Agents: These agents rely only on their immediate surroundings and condition-action rules to guide their actions [27]. In completely visible settings, they work well, but in partly viewable ones, they may become stuck in endless cycles.

Model-Based Reflex Agents: Agents that keep an internal model of the world and are able to manage partly visible settings are called model-based reflex agents. When making decisions, they use perceptual history [12].

Goal-Based Agents: Going beyond the scope of model-based agents, goal-based agents make use of goal information to choose behaviours that result in desired results. With the use of search and planning strategies, they are able to accomplish their objectives [3].

Utility-Focused Agents: In order to maximise the predicted benefit from their activities, utility-based agents use a utility function to evaluate the attractiveness of distinct states. To function properly, they need to represent their surroundings with great complexity [4].

Learning Agents: By incorporating environmental input, learning agents gradually enhance their performance. An element for learning takes this input into account and makes adjustments to the performance element accordingly; another element serves as a problem generator, suggesting further learning activities [4].

Machine learning entails training classifiers to generalise from specific examples [8]. Training a classifier model with the available data and then verifying its accuracy are the two main components of the procedure. Classification accuracy is heavily dependent on the machine learning techniques used, with different algorithms being applied to different areas of knowledge.

6. Methodology

The Knowledge Discovery Database (KDD) for the automated responder student support system was built using a mix of web development technologies such as JavaScript, HTML, PHP, MySQL, and CSS. PHP is the principal server-side scripting language that allows for the dynamic production of content, with HTML providing the structural base. Student information is conveniently stored and retrieved using MySQL, a relational database management system. By introducing features on the client side, JavaScript improves interaction and the user experience. Dreamweaver and Fireworks were among the tools used to create user interfaces, guaranteeing a layout that was both aesthetically pleasing and easy to understand.

We chose for an Object-Oriented Analysis and Design Methodology (OOADM) as it works well with complicated web apps that need a lot of data. The suggested system relies on this method since it enables the easy integration of navigation with multimedia data management. By eschewing the conventional separation of data and processes, OOADM places an emphasis on their interdependence.

The three main steps of Object-Oriented Analysis (OOA) are object identification, object organisation, and behaviour and interaction definition. The system's main items and their connections were described in depth using common modelling methods including use cases and object models, which also mapped out possible user interactions.

The automated responder's capabilities are further enhanced by integrating AI and machine learning approaches. In order to provide individualised assistance, the system uses algorithms to examine student data, forecast replies, and adjust to user interactions. By ensuring that the KDD is in line with modern educational demands, this methodological framework helps to maximise the usefulness and accessibility of information for students while also supporting successful system design.

7. Implementation

The KDD-based student support system with an automatic responder is structured into several interconnected modules that collectively address the challenges faced by students.

The Login Module serves as the initial point of access, where users authenticate themselves using a username and password. If the authentication criteria are not met, access to the system is denied, ensuring secure entry.

Next, the Student Registration Module allows students to create profiles by submitting their details, including a chosen username and password. This module facilitates the onboarding of students onto the platform.

Similarly, the Users Registration Module is designated for administrative use, enabling the admin to register new users within the system. This ensures that all necessary personnel can access the platform to provide support.

To manage user oversight, the View Users Module enables the admin to display a comprehensive list of all users currently active on the platform. This feature aids in monitoring and managing user engagement effectively.

The system also includes an SMS Module, which is responsible for sending SMS notifications to both students and support team members. This module enhances communication by keeping users informed about important updates.

Students can generate and submit support requests through the Ticket Module. When a ticket is created, the system

automatically sends an SMS to the support team member assigned to that specific ticket category, ensuring timely intervention.

To facilitate efficient support, the Ticket Respond Module allows support team staff to view and respond to the tickets raised by students. This module is crucial for addressing student concerns promptly.

Additionally, the Notification Module empowers the admin to send SMS notifications to registered students, keeping them updated on relevant information and alerts.

Lastly, the View Ticket Module provides a comprehensive display of the dataset containing all tickets generated. This module is essential for tracking student inquiries and monitoring the overall effectiveness of the support system.

Together, these modules create a cohesive framework for enhancing student support services through automated responses and efficient communication.

8. Input / Output Format

The KDD based student support system with automatic responder has some input and output forms. The input / output specification and design in the new system are structured to allow users to fill forms and submit the data to the database. Below are some of the inputs / output forms.

A. Staff/Admin Registration Form

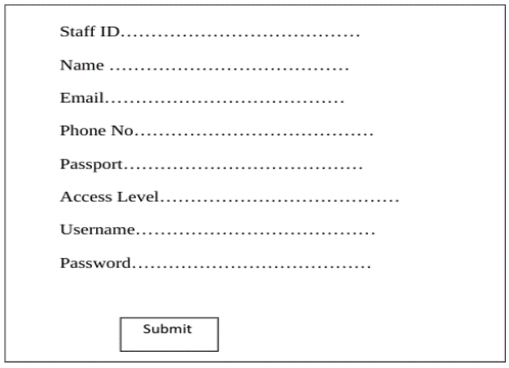

Fig. 1. User registration form

B. Student Registration Form

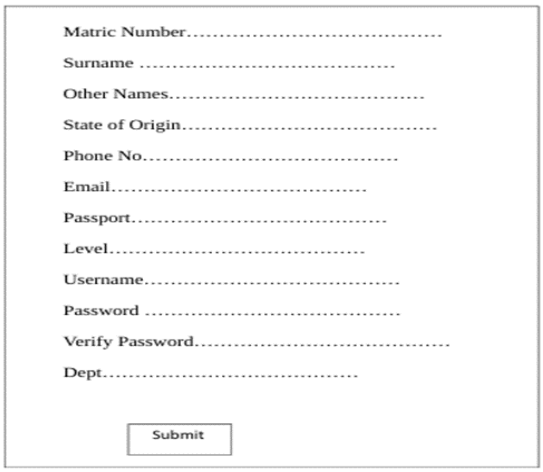

Fig. 2. Student registration form

Figure 2 is used for registering students to the database. During the registration, the student obtains a password for accessing the new system.

C. Staff/Admin Login Form

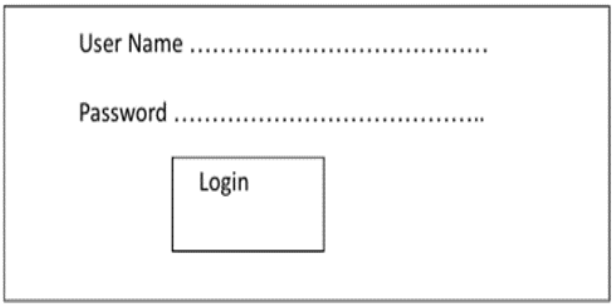

Fig. 3. Admin / Support team login form

Figure 3 is the login form and is used to authenticate staff users on the platform.

D. Student Login Form

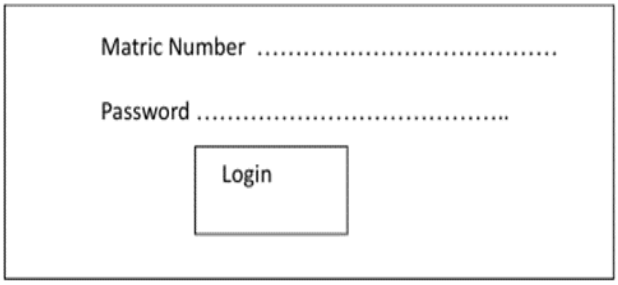

Fig. 4. Student login form

Figure 4 is the login form and is used to authenticate students on the platform.

E. Create Ticket Type Form

Fig. 5. Create ticket type form

Figure 5 is the form used by admin to create ticket types on the platform and assign priority to the different ticket types.

F. Assign Ticket Form

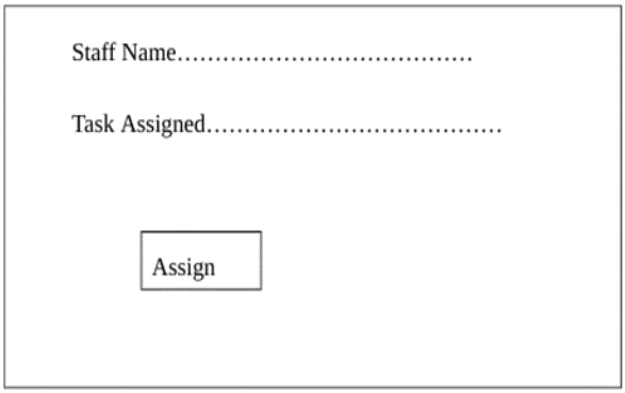

Fig. 6. Assign ticket form

Figure 6 is the form used by admin to assign task to members of the support team.

G. Ticket Form

Ticket ID.....

Ticket Type .....

Ticket Class.....

Complaint .....

Date Submitted .....

Time.....

Student Matric Number.....

Student phone Number.....

Check Staff Assigned the Ticket ----------

Check Ticket priority ----------

Submit

Fig. 7. Ticket form

Figure 7 is the ticket form. Students use this form to generate tickets and send to support team. Once the ticket is raised, the KDD algorithm will check if there are similar question that has been answered before. If yes, the system automatically responds to the question otherwise the system will prioritize the ticket and send it to the support team staff in-charge of the ticket class. The system sends the question to the support team staff through SMS.

H. Ticket Response Form

Ticket ID.....

Ticket Type .....

Ticket Class.....

Question .....

Date Submitted .....

Time.....

Response.....

Date Responded.....

Time Responded ----------

Name of support Team Staff ----------

Submit

Fig. 8. Ticket respond form

Figure 8 is used by the support team staff to respond to issues raised by students in a ticket.

I. Ticket KDD Response

Ticket KDD Response

Ticket ID Question Existing Responses

Auto Generated Response to Ticket

.....

Fig. 9. KDD Generated response to ticket

Figure 9 shows the format of response generated automatically from the system using KDD algorithm.

J. Response Time

Response Time

Ticket ID Question Date Sent Time Date Responded No of Hrs

Fig. 10. Support team ticket response time report

Figure 10 shows the report on ticket response time so as to know how timely a support team staff responded to a ticket.

K. Algorithm

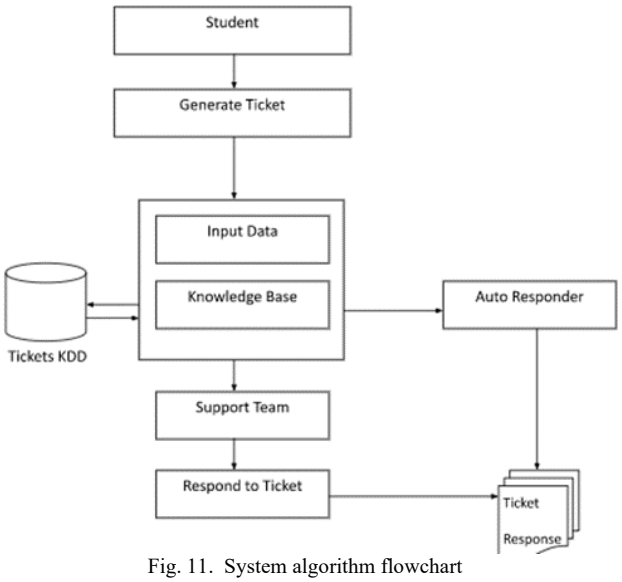

Fig. 11. System algorithm flowchart

L. Results

From Table, the response statistics for support tickets raised by students are as follows: 425 tickets related to admission requirements, 148 regarding semester results, 15 concerning transcripts, 57 about exam issues, 25 for payment issues, 450 on course registration, and 130 for semester registration were all addressed.

This KPI is used to find the average tickets response time

during a selected period. Table 2 shows the average ticket response time to various categories of tickets raised by students and the overall view shows a very low response time when compared to email-based student support system.

Table 1
The total number of tickets responded to during the selected period

Ticket Category	Tickets Responded
Semester Registration	130
Course Registration	450
Payment Issue	25
Exam Issue	57
Transcript	15
Semester Result	148
Admission Requirement	425
Total	1250

Table 2
Average responded ticket time

Ticket Category	Average Tickets Response Time(mins)
Semester Registration	2
Course Registration	4
Payment Issue	2
Exam Issue	6
Transcript	10
Semester Result	3
Admission Requirement	2

9. Conclusion

The student support system addresses a critical issue in universities in developing countries by ensuring timely access to information and data security. This project developed an intelligent agent-based platform that allows students to generate tickets for complaints and receive real-time responses. When a ticket is raised, it is stored in the database, and an SMS is sent to the appropriate support team member. Each ticket is categorized for efficient handling. Once the ticket is responded to, another SMS notifies the student of the response. This system effectively creates an automated response mechanism that utilizes a knowledge base of previously answered questions to assist in addressing student complaints.

10. Recommendations

The intelligent agent-based student support system will be improved by these suggestions based on project development insights.

First, the institution should work with the ICT Directorate to modernise servers and boost RAM to better control user congestion. This change will improve user experience and accessibility.

Campus computer centres should also be scalable to accommodate the rising student population. Students without phone internet access might create complaint tickets at these centres, making help simpler.

References

[1] Palacios, C. A. Reyes-Suarez, J. A., Bearzotti, L. A., Leiva, V. and Marchant, C. (2021) Knowledge Discovery for Higher Education Student Retention Based on DataMining: Machine Learning Algorithms and Case Study in Chile. *Entropy*, 23(1) 485.

[2] Iqbal, H. S. (2021). Machine Learning: Algorithms, RealWorld Applications, and Research Directions. *SN Computer Science* 2(160), 2-21.

[3] Shu, X., and Ye, Y. (2023). Knowledge Discovery: Methods from data mining and machine learning. *Social Science Research*, 110, 102817.

[4] Shivali, J. and Birla, G. (2015). Knowledge Discovery in Data Mining. International *Journal of Engineering Research & Technology (IJERT)* ISSN: 2278-0181, Published by, www.ijert.orgNCETEMS-2015 Conference Proceedings.

[5] Witten, I. H. and Frank, E. (2015). *Data Mining: Practical Machine Learning Tools and Techniques*, 2rd ed. Amsterdam: Morgan Kaufmann.

[6] Baker, R. S., and Yacef, K. (2009). The state of educational data mining in 2009: A review and future visions. *Journal of Educational Data Mining*,1(1), 3–17.

[7] Zhang, Y., Yun, Y., An, R., Cui, J., Dai, H. and Shang, X. (2021) Educational Data Mining Techniques for Student Performance Prediction: Method Review and Comparison Analysis. *Frontiers of Psychology*. 12: 698490.

[8] Albreiki, B., Zaki, N., and Alashwal, H. (2021). A systematic literature review of student'performance prediction using machine learning techniques. *Education Sciences*, 11(9), 552.

[9] Fernandes, E., Holanda, M., Victorino, M., Borges, V., Carvalho, R., and Van Erven, G. (2019). Educational data mining: Predictive analysis of academic performance of public-school students in the capital of Brazil. *Journal of Business Research*, 94, 335-343.

[10] Yağcı, M. (2022). Educational data mining: prediction of students' academic performance using machine learning algorithms. *Smart Learning Environ.* 9, 11.

[11] Kumtepe, E. G., Toprak, E., Ozturk, A., Tuna, G. B., Kilinc, H., and Aydin, İ. M. (2019) Support Services in Open and Distance Education: An Integrated Model of Open Universities. *ResearcGate Conference Paper, May 2019.*

[12] Albreiki, A., and Alzahrani, M. (2021). "Enhancing Student Support Services through Intelligent Systems." *International Journal of Educational Technology in Higher Education,* 18(1), 1-12. DOI: 10.1186/s41239-021-00256-1.

[13] Kharbach, M. (2022). "The Role of Ticketing Systems in Higher Education Support." *Journal of Educational Administration*, 60(3), 345-360.

[14] Yuen, K. S., and Wong, G. K. (2023). "Challenges and Solutions in Distance Learning: A Focus on Student Engagement." *Online Learning Journal*, 27(2), 22-38.

[15] Muftahu, M., Qun, W., and Ting, W. (2023). Globalization of Higher Education: A Review of Emerging Distance Internationalization. *Academic Mobility through the Lens of Language and Identity, Global Pandemics, and Distance Internationalization*, 193-204.

[16] Feras, A., and Hala, B. (2021) A machine learning based help desk system for IT service management. *Journal of King Saud University – Computer and Information Sciences* 33(2021) 702–718.

[17] Ratthida, W. and Limpiyakorn Y. (2019) Development of IT Helpdesk with Microservices.
Department of Computer Engineering Chulalongkorn University Ban gkokl033~ Thailand.

[18] Albert, M., Ignatius, S., Krisananda, P. K., Riyanto, J., and Tuga, M. (2020). Machine Learning-based Automated Problem Categorization in a Helpdesk Ticketing Application. *Information Systems Management Department, BINUS Graduate Program* – Master of Information System Management, Jakarta, Indonesia.

[19] Antonio, J. F., Roberto, R., Juan, C. P., José, M. C. M. and Fernando, S. (2020). Creating a Recommender System to Support Higher Education Students in the Subject Enrollment Decision.

[20] Kapil, S., Varun, J. and Mohd, D. A. (2019). Machine Learning Based Support System for Students to Select Stream (Subject). *School of Electrical and Computer Science*, Shoolini University of Biotechnology and Management Sciences, Solan, Himachal Pradesh, India.

[21] Pharaoh, C. (2013). An Implementation of an Online Based Registration System in Tertiary Institutions in Zimbabwe. *International Journal of Engineering Research & Technology (IJERT),* 2(10).

[22] Muktar, M. A. (2015). Design and Implementation of Web-Based Academic Information System for Nigerian Universities. *A thesis submitted to the school of postgraduate studies,* Ahmadu Bello University, Zaria.
[23] Muhammad, A. and John, K. (2010. Mobile student information system. *Department of Computer and Information Science*, Norwegian University of Science Technology, Trondheim, Norway.
[24] Maria, C. G. C., Lorena, W. R., and Bartlome, T. T. (2015). Mobile Web-Based Student Integrated Information System. *International Journal of Machine Learning and Computing,* 5(5).
[25] Affendey, L. S., Paris, I.H.M., Mustapha, N., Nasir Sulaiman, M.D. and Muda, Z. (2015). Ranking of Influencing Factors in Predicting Students' Academic Performance. *International Technology Journ*al, 9(6), 832-837.
[26] Aljohani, N. R. and Davis, H. C. (2012). Learning analytics in mobile and ubiquitous learning environments. *in 11th World Conference on Mobile and Contextual Learning.*
[27] Acharya, A., and Sinha, D., (2014). Application of Feature Selection Methods in Educational Data Mining, *International Journal of Computer Application*s 103(2): 34-38.
[28] Zhiming, L, (2010). Object-Oriented Software Development with UML. Retrieved July 16th 2010.
[29] Avison, D. and Fitzgerald, G. (2013). *Information systems Development Methodologies, Techniques and Tools* .3rd Edition. McGraw-Hill Education Limited Bershire.
[30] Juan, M. M. P. (2010) Information systems development methodologies for Data-driven Decision Support Systems.
[31] ERP (2014) What is Enterprise Resource Planning Webopedia.