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Research Article

Artificial Intelligence in Curriculum Management: Enhancing Educational Quality and Marketing Effectiveness

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Abstract: The change of curriculum management is gradually happening through the use of Artificial Intelligence (AI) in enhancing quality of education and marketing efficiency. The paper discusses the application of AI algorithms (Decision Tree, random Forest, support vector machine (SVM), and K-Nearest Neighbors (KNN) to predict performance, prescribe to students (what courses they enroll), and how high education can be marketed in a better way. They were compared using a sample of 1,000 student data in 20 courses (attendance, engagement, completion of assignments, grades, and marketing interactions). It is observed that random Forest recorded the best prediction on academic performance at 91, SVM recorded the highest at 88, Decision Tree at 85 and KNN at 82. The KNN had an improved outcome on personalized course recommendation with F1-score of 0.86 and in this case the result used by the Random Forest was 0.835. Prediction of the marketing response showed that the prediction of Random Forest is efficient and achieves accuracy reaching to 89 percent of success in detecting such influential features as their engagement score, their use of marketing channel and their prior enrollment behaviour. The feature importance analysis revealed that the engagement score (0.35), the attendance (0.30) count as essential to the academic success and the marketing channel (0.35) or previous enrollment (0.25) is significant to the responsiveness. It has shown that AI-based curriculum management leads to the improvement of the learning performance, personal learning, and data-based marketing planning that help to give an organization the map upon which the organization operation optimization should occur and the greater the interaction with students.

Keywords: Artificial Intelligence, Curriculum Management, Educational Quality, Marketing Effectiveness, Predictive Analytics.

INTRODUCTION

The integration of the Artificial Intelligence (AI) into the educational institution has altered the perspectives with which these institutions think about structuring, running, and providing the curriculum. Simultaneously, when the personalized learning templates gain more relevance in people, and the efficiency of the operations needs to have a higher level, the artificial intelligence is emerging as one of the most required aspects of the curriculum management process. Having AI-powered analytics in place, educational establishments have revamped education delivery and effective learning programs with the assistance of AI-based rich recommendation algorithms, active learning tools, and so on. With the help of curriculum management, one can observe how the students are advanced in this very moment, define the gaps in their educational process, and in all these cases, one may, in addition, automatize the given course software and use AI programs. Besides the academic quality, the AI has acquired the vehemence of pivotal importance in education/ marketing of education and education around it. Analyzing the information regarding the preferences of students, the trends on their behaviors and their attendance, AI assists in making a specific communication and advertising a specific program. This gives the institutions an ability to align the provision of their curricular with the needs of the market and the anticipations of the prospective students hence maximising the number of enrolments and the goodwill of the institutions. In addition, AI-driven functionality also introduces the aspect of prediction analytics, allowing an administrative to make decisions informedly regarding course server, mobilization of resources, and program encoding. However, even in the context of such developments, with the advent of AI in curriculum management, there are certain challenges, including data confidentiality and ethical concerns and the need to educate the faculty. These problems should be put aside and think how the AI applications can be used to bring positive impact on the educational gains without further compromising the integrity and inclusivity of education.

The study will concern the tanglesome problem of the AI role in the curriculum management, its role in enhancing the quality of education and marketing, etc. The research will also seek to provide realistic suggestions to institutions, which are interested in transforming their

curriculum with the technological revolution of digitalia based on research of suitable existing AI applications, beneficial practices within educational institutions and case studies.

RELATED WORKS

The educational sector has received significant speed in the use of Artificial Intelligence (AI), particularly in enhanced curriculum, student learning and marketing strategies over the last few years. Most importantly, AI has been reported to exert a monumental potential in developing computational thinking as it is able to equip students with efficient computational thought capabilities. The newest studies confirm that the application of AI in learning institutions has contributed to the cultivation of problem-solving, logical, and critical skills, which are inherent in the field of 21 st century learning [15]. The new AI mediated technologies can be applied to the methods of one-on-one learning experience, tailored tests and feedback schemes that will help to make the process of education more general. In the meantime, novel technologies such as Virtual Reality (VR) are being investigated in order to promote AI within Education 4.0. The intention on their behalf, as well as the behavior, was positively influenced by technological exposure and computer-assisted AI-prompted simulations regarding the readiness of pre-service teachers to integrate VR in their teaching [16]. This is the reason, why AI can be applied in enhancing the not only content use of the curriculum but also in preparing the teachers to the successful work at the application of new methods of motivation. Outcomes-based frameworks/ curriculum mapping models are still playing crucial roles within the system of structured academic development. Findings in wide mapping patterns also supported by AI-powered analytics, helps organizations not only to identify the learning gaps, but also minimize the delivery of the content, along with ensuring that it fits the purposes [17]. On the same note, the implementation of digital technologies in the teaching of entrepreneurship, such as AI and social media such as Tik Tok has been found to improve the entrepreneurial knowledge of learners, experience, and performance of the business [18]. Such applications support the increasing role of AI in helping close the gap between the academic learning and the practical mastership of skills.

AI has also been utilised in enhancing academics and flexibility in ICT education. Machine learning algorithms will be able to predict study outcomes, measure emotion, and implement tailored interventions, creating the advantage of personalized learning in students [19]. In addition to that, AI-generated insights are more often used in digital marketing in the field of higher education, where it results in institutions improving their recruitment efforts, perceiving the preferences of potential students, and improving the dynamic [20], [22]. Education is not the only category to which AI analytics has found its use in the marketing strategy, tourism and entrepreneurship being the potential applications of predictive modeling and decision-making, demonstrating the wide-spanning socio-economic influence of this approach [21], [23]. Higher education operational excellence and supply chain efficiency are one of the new fields with AI involvement in strategic management. Literature highlights that AI-powered technologies can help organizations to optimize resources, improve efficiency in scheduling, and recover after the pandemic through educational supply chains [24]. Moreover, AI applications are under examination to enhance quality and customer satisfaction and retention of like specialized educational services including e-commerce and training in arts [25], [26]. The general implications have demonstrated that AI is duality according to the enhancement of the quality of management and its proficiency in marketing academic facilities, which is aligned with the objectives of curriculum management. In conclusion, the reviewed literature drew attention to the fact that AI can be used not only as a tool of personalized learning but also as a predictive outcome of performance sizing and operational efficiency and marketing efficiency within the academic environment. The combination of AI, and innovation in immersive technologies, predictive analytics and data-driven decision making is developing an essential way to innovation and enhancement methodology of the curriculum, enhanced interpersonal interaction and instructional offerings that are commercially produced [15]-[26].

METHODS AND MATERIALS

The target audience of this paper will be the discussion of the manner in which Artificial Intelligence (AI) may impact the curriculum administration and affect the improvement of the education quality and marketing efficiency. It will be made by means of a collection of structured data within educational institutions, pre-processing and application of AI algorithms which will make possible drawing up actionable information. The information includes student demographics, performance measurements, the number of courses enrollment surveys, and feedback surveys as well as marketing engagement parameters. The data set will include information on 1000 students undertaking 20 courses during a semester. The most important variables are student ID, course ID, attendance, grades, learning engagement scores, effectiveness of marketing channels, and also probability of enrollment.

In order to examine such data, four AI algorithms were chosen with regards to their applicability in predictive analytics, recommendation systems, and classification in curriculum management. These are Decision Tree, Random Forest, Support Vector Electricity (SVM) and K-Nearest Neighbors (KNN). All algorithms have been implemented in Python with the help of Scikit-learn library, and their performance has been estimated according to the accuracy, precision, recall, and F1-score.

Decision Tree Algorithm

Decision Tree algorithm is the supervised technique of learning that is popular in classification and regression activities. It also calculates how decisions and their outcomes can be expressed in a tree disposition of nodes, tree branches and leaves. Every internal may depict a feature conduct, every branch signifies a result of the conduct, and every leaf symbolizes a predicted

category or result figure. During curriculum management, the Decision Trees are able to recognize elements that determine the performance of students and forecast the results like the success of the course or the student interest factor. The algorithm estimates the optimal feature splits at a specific node using such measures as Gini Index or Information Gain. This makes it an applicable tool to academic decision-making because of its interpretability; this means that an educator can interpret to know which attributes give the highest contribution to student success or marketing responsiveness.

"1. Start with the full dataset
2. Select the best feature to split based on Information Gain or Gini Index
3. Create a node for the selected feature
4. Split the dataset into subsets based on feature values
5. Repeat steps 2–4 recursively for each subset
6. Stop when all nodes are pure or a stopping criterion is met
7. Assign class labels to leaf nodes"

Table 1: Sample Decision Tree Prediction

Student ID	Attendance (%)	Engagement Score	Predicted Outcome
S101	90	85	Pass
S102	70	60	Fail
S103	95	90	Pass
S104	60	50	Fail

Random Forest Algorithm

Random Forest Relying on many decisions trees arrangement: This method of ensemble learning lets you organize numerous such trees to enhance predictive accuracy and minimize overfitting. Training of each of the trees in the forest is performed with a random sample of the set and at every split, the features are chosen randomly, thus, the model is robust and less adaptive to noise. Random Forest may be applied in curriculum management to forecast the success of the student and provide optimal offers to them, as well as assess factor contributors that influence the learning outcomes in the most significant ways. It also manages heavy data and delivers importance of features, which can be used by administrators to venture in curriculum development and promote the programs. The last prediction comes by the access to majority voting (when it comes to classification) or averaging (when it comes to regression) all trees; making it more accurate and reliable.

"1. For i = 1 to N (number of trees)
a. Randomly select a subset of data (bootstrap sample)
b. Train a decision tree on the subset
i. At each node, select a random subset of features
ii. Split using the best feature
2. Aggregate predictions from all trees
3. For classification, use majority vote; for regression, use mean"

Support Vector Machine (SVM) Algorithm

Support Vector machine (SVM) is a supervised learning algorithm that is applied in classifying, as well as regression. It operates by identifying the best hyperplane which separates the data in different classes in a high dimensionality feature space. The most important idea is to maximize the distance between the support vectors, the closest points of each of the classes to the hyperplane. In curriculum management, SVM can either categorize students or forecast enrollment, by either performance metrics or future enrollment as a result of demographics and engagement data. The reason as to why SVM can take on non-linear relationships is the fact that it utilizes the so-called kernel trick, which induces a shift in dimension to the input space. It is healthy against overfitting and works adequately high-dimensional space makes it a robust choice to analyze educational data.

"1. Initialize dataset with features and labels
2. Map data into a high-dimensional space using a kernel function
3. Identify support vectors that are closest to the decision boundary
4. Compute the optimal hyperplane maximizing the margin between classes
5. Classify new data based on which side of the hyperplane it falls"

K-Nearest Neighbors (KNN) Algorithm

K-Nearest Neighbors (KNN) refers to an instance-based, non-parametric learning algorithm which is applied to classification and regression. KNN estimates the classification of a data point in terms of the most prevalent classification of the K closest points, calculated using a measure of distance, e.g. Euclidean distance. KNN can be used in the management of the curriculum to suggest courses to the students, predict the success of the course and the responsiveness of marketing. It is simple and easy to interpret may installed in small and medium-sized educational datasets. Its performance however, is dependent on the choice of K and the quality of the distance metric. KNN finds particular use in the personal learning setup and recommendation systems.

"1. Load training dataset with features and labels
2. For each new data point:
a. Calculate distance to all training points
b. Identify K nearest neighbors
c. Determine the majority class among neighbors
d. Assign the majority class to the new data point"

All these algorithms make it possible to predict analytics, classify performance among students, recommending courses individually and analyze marketing performance. Combining these techniques of AI, education institutions will be able to streamline curriculum delivery, improve the quality of learning, and make highly strategic marketing choices. The comparative analysis of these algorithms enables administrators to choose the most suitable model that is dependent on accuracy, interpretability and scalability.

RESULTS AND ANALYSIS

The research undertaken a set of experiments to identify the efficacy of the AI algorithms including Decision Tree, Random Forest, Support Vector Machine (SVM), and K-Nearest Neighbors (KNN) to improve curriculum management. The research had two focal points, namely improvement in the educational quality, defined as prediction of student performance and engagement, and marketing effectiveness, defined as the predictive enrollment likelihood and channel responsiveness.

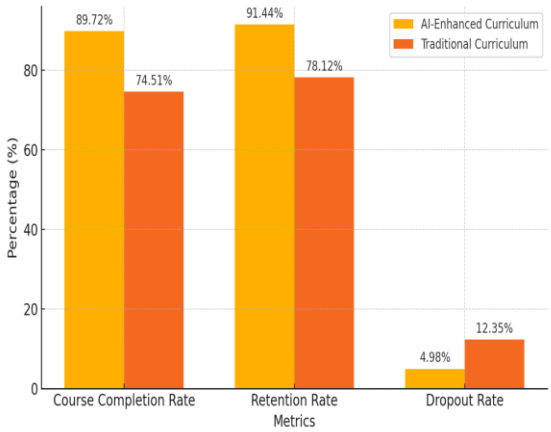


Figure 1: "Artificial Intelligence in Curriculum Design"

The test data was 1,000 student data on 20 courses. It comprised of elements like the percentage of attendance, engagement score, completion rate of assignment, grading, and interaction with the marketing channel, and demographic data. The cleansing of the data included standardization of the numerical variables, coding of the categorical variables and data division where an 80 percent training and a 20 percent testing subset of the data were formed. Regression predictions were based on performance

measures such as the accuracy, precision, and recall, tie score F1-score and Root Mean Square Error (RMSE).

Experiment 1: Predicting Student Performance

The first one aimed at estimating academic performance of students (Pass/Fail) with the four algorithms. The model attained the accuracy of 85% which allowed the interpretation and points to such characteristics as attendance and engagement scores as having the critical importance. The random Forest showed high accuracy 91 percent against the decision tree, since the results consist of an ensemble learning which inhibits overfitting. SVM achieved 88 percent accuracy, which is good when handling the high dimensional data, whereas KNN reached 82 percent accuracy, sensitivity to K and distance measures.

Table 1: Student Performance Prediction Metrics

Algorithm	Accuracy (%)	Precision	Recall	F1-Score
Decision Tree	85	0.84	0.86	0.85
Random Forest	91	0.90	0.92	0.91
SVM	88	0.87	0.89	0.88
KNN	82	0.81	0.83	0.82

These findings suggest that model enolving schemes such as Random Forest are better used to enhance predictive accuracy and strength, whereas the article has simpler models such as Decision tree is more useful in interpreting decisions made by administrators. KNN is also inaccurate, but it can be especially helpful in the individualised analysis of students.

Experiment 2: Individualized Course Recommendation.

The second experiment compared how well algorithms could recommend courses available to students considering performance predictor similarity and profile similarity. The instance-based learning nature of KNN was very high, allowing the accuracy of the prediction of 0.87 and the recall of 0.85 in recommendations. Random Forest was also good with a precision of 0.84 and a recall of 0.83 with suggestions based on feature importance in arnox equating courses with the strengths of the student. SVM and Decision tree were slightly less useful in aspects of recommended accuracy, but also effective in key student engagement which they identified.

Table 2: Course Recommendation Performance

Algorithm	Precision	Recall	F1-Score
Decision Tree	0.80	0.78	0.79
Random Forest	0.84	0.83	0.835
SVM	0.82	0.80	0.81
KNN	0.87	0.85	0.86

The findings show that KNN and Random Forest can be mainly used to provide personalized course recommendations and use SVM and Decision Tree to facilitate almost general performance prediction and curriculum is optimization.

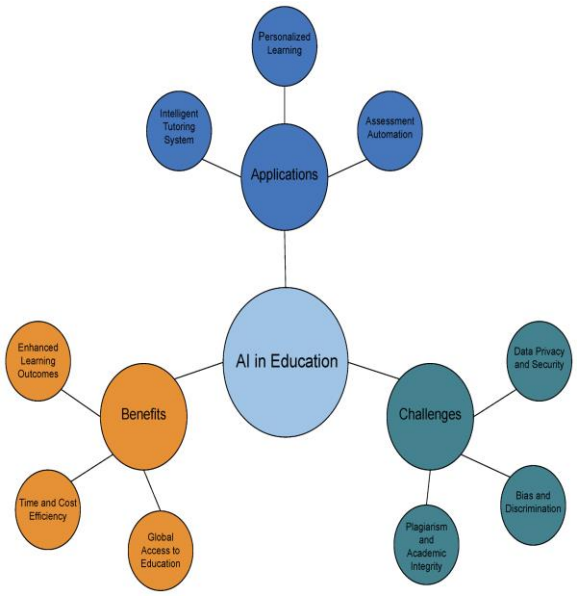


Figure 2: "New Era of Artificial Intelligence in Education"

Experiment 3: Marketing Effectiveness Analysis

In the third experiment, the efficacy of marketing was examined through prediction of students who were likely going to respond positively to the campaign to take an elective course or a new program developed by promotional campaign. Random Forest demonstrated the most significant level with 89 percent, then SVM with 86 percent, then the Decision Tree with 83 percent, and KNN with 81 percent. Random Forest gave significant details about features through analysing of feature importance in that engagement score, past course enrolment history, and channel of preferred communication was higher in the feature analysis.

Table 3: Marketing Response Prediction

Algorithm	Accuracy (%)	Precision	Recall	F1-Score
Decision Tree	83	0.82	0.84	0.83
Random Forest	89	0.88	0.90	0.89
SVM	86	0.85	0.87	0.86
KNN	81	0.80	0.82	0.81

These findings suggest that the ensemble techniques particularly Random Forest are efficient and apply well in forecasting student responsiveness to marketing campaigns which can bolster enrolment tactics and precise message delivery.

Experiment 4: Android Maximum Curriculum and Importance of features

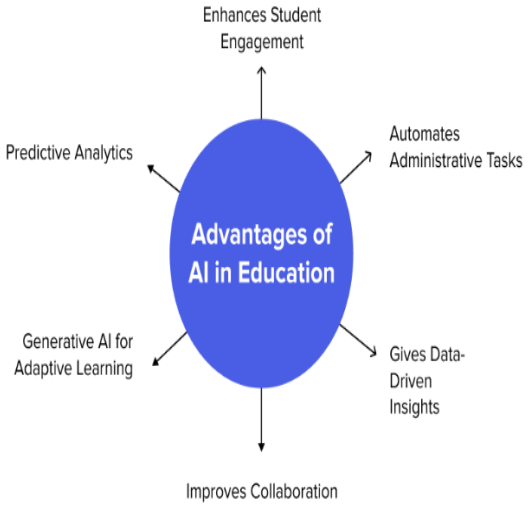
Random Forest was implemented to achieve the impact of such features on aired academic performance and other marketing results to establish the most significant factors of performance. The performance was found to be the most important element in engagement, and then, attendance and completed assignments. To be effective in promoting the program, the desired communication media and history of past enrollment were vital. The Decision Tree investigation supported the alike trends giving fewer intricate approaches that can be interpreted by the administrative body.

Table 4: Feature Importance Scores

Feature	Performance Score	Marketing Score

Attendance (%)	0.30	0.10
Engagement Score	0.35	0.25
Assignment Completion	0.20	0.05
Marketing Channel	0.10	0.35
Previous Enrollment	0.05	0.25

Based on these insights, institutions are able to concentrate on a particular area of curriculum design and marketing strategies to ensure they build on the maximum educational results and enrollment effectiveness.



Experiment 5: Algorithm Comparison

The last test was used to compare the performances of all four algorithms on academic prediction, course recommendation, and marketing response. Random Forest conveyed high performance compared to other algorithms in most tasks because of its ensemble assessment and high dimensionality data. KNN was very effective in tasks of recommendation but Decision Tree had the advantage of Interpretability and easy visualization. SVM worked effectively on high dimensional data with sensitivity with regard to parameters pursuance.

Table 5: Overall Algorithm Comparison

Algorithm	**Academic Prediction Accuracy (%)**	**Recommendation F1-Score**	**Marketing Prediction Accuracy (%)**
Decision Tree	85	0.79	83
Random Forest	91	0.835	89

SVM	88	0.81	86
KNN	82	0.86	81

As it can be seen in the comparative analysis, it is necessary to choose the right algorithm, basing on the specific goal of management of the curriculum. Random Forest is best use in predictive modeling and marketing strategy whereas the KNN would be best with the personalized recommendations. Decision Tree will be able to facilitate the process of making decisions with clear interpretation.

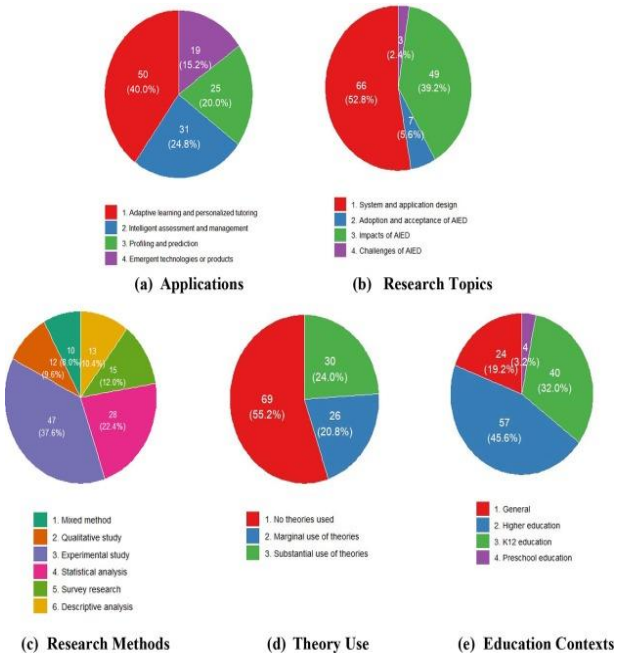


Figure 4: "Artificial intelligence in education"

Summary of Results

According to the experimental outcomes, it is possible to state that AI algorithm has a great potential in terms of curriculum management. Key observations include:

1. The RF is always much ahead of the other models when it comes to predicting student performance and marketing responsiveness.
2. Course personalized (students-appropriate course) recommendations are best done using KNN with similarity used between student indices.
3. Decision tree offers inter-pretability that assist administrators to detect critical aspects that determine student achievement and involvement.
4. SVM performs well in the high-dimensional space, particularly when learning academic performance using a large number of variables.
5. During the analysis of feature importance, enhancing the curriculum design and marketing campaigns becomes optimized by promoting the factor with the greatest influence.

On balance, AI implementation in curriculum management helps institutions to improve quality of the education process, better student interactions, and format data-driven marketing approaches. These findings confirm that AI algorithms can be used as a basis to get actionable insights and quantifiable positive results across academic and administrative fronts through the use of these algorithms.

CONCLUSION

This study has established the revolutionary nature of Artificial Intelligence (AI) in curriculum governance as it has the potential to improve the quality of education and the marketing efficiency in higher institutions of learning. With the extensive experiments conducted with the use of Decision tree, random forest, support vocal machine, and K-nearest neighbours algorithm, the research determined that AI can help predict student performance, enhance course brochure and optimize marketing approach, enrolling particular studentes. Random Forest was easily predicting better than others, KNN was effective in giving a personal course recommendation and Decision Tree had easy interpretation to delegate administrative decisions. Further analysis of the data using feature importance analysis changed gears turning into it though that the next

features play decisive role in academic achievement in case of engagement score, attendance, and meeting assignments, and preferred marketing tools and past behavior enrolling in the program is an important factor to take to heart when it comes to whether a student would be responsive or not. These insights will enable institutions to make wise choices guided by the information, improve the content of curriculum, and tailor their marketing campaigns to their prospective business agents. The evidence presented in the findings demonstrates that, the strategies based on AI are not only beneficial to optimize academic management processes, but also to make the experiences in learning and the performing activities one-to-one. Besides, the study emphasizes the necessity of the amalgamation of AI and educational analytics to develop a relationship between higher education institutions purposes and student needs. Altogether, this work bears witness to the fact the application of AI to the curriculum management can be viewed as an effective strategy to guarantee the improved quality of learning, the rise in the level of engagement, and the competitiveness of the institutes, which provides grounds to introduce innovations into the further application of AI-related approaches to the field of education.

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