Role of Data Mining in Redesigning the Existing Curriculum: A Survey Based Literature Review

[1]Ritika Awasthi, Research Scholar, Dr. C. V. Raman University, Bilaspur, CG

(ritikaawasthi1612@gmail.com)

[2]Dr. Arvind Tiwari, Asso. Professor, Dr. C.V. Raman University, Bilaspur, CG

(arvindtiwari@cvru.ac.in)

Abstract: Considering the rapid rate with which educational paradigms change, the curriculum must be continually enhanced to adapt to students varied and ever-changing requirements. Within the context of this transformative management, data mining emerged as an essential resource due to its tremendous capacity for analysis. This comprehensive literature review examines the role that data mining performs in redesigning existing educational curricula, emphasizing its application to understanding patterns of learning, predicting academic achievement, and personalizing educational experiences. The study offers an amalgamation of findings from a wide variety of studies, demonstrating that data-driven insights can be utilized to influence curriculum development, encourage responsive learning environments, and enhance educational outcomes. This study also examines the difficulties that arise when attempting to incorporate data mining approaches into educational practices. These challenges include issues around data privacy and the need for collaboration across academic lines. With the provision of empirical evidence that could help educational stakeholders make informed choices, the findings highlight the potential for data mining to influence the process of curriculum design. This review delivers improvements to the existing body of understanding by extending on the intersecting fields of data mining and the development of curriculum. It provides an in-depth assessment of the behaviors, trends, and prospective paths currently are at present being explored in this area of study.

Keywords: Data mining, Python, Machine Learning, Revamping curriculum, Data-driven technologies.

1 Introduction

Data mining is the methodical study and examination of enormous amounts of data in search of meaningful relationships and patterns. It combines approaches from machine learning, statistics,

and database systems. The ability to make informed decisions and predictions has gained significant importance in many domains including business, medical care, and science research. Data mining techniques have demonstrated their efficacy in discovering concealed trends and patterns within data that may not be apparent through traditional statistical strategies. Corresponding to data a researcher, data mining is involved with analyzing large amounts of data to discover patterns and insights. This field utilizes techniques from statistics, artificial intelligence, and database systems. With the experience of data scientists, the development of curriculum in higher education can be substantially developed. By utilizing methods of data mining, the curriculum may be customized to better meet the requirements of the industry and what is expected of the students. Just like a data scientist, curricula have historically been influenced by educational committees and accreditation standards, at times falling in front of current technological developments and consumer demands. It is becoming increasingly clear that curriculum development requires an evolving and data-driven approach[2]. Utilizing methods of data mining for curriculum revamping includes evaluating pupil performance to identify key factors for success, aligning academic programs with current job market trends, and utilizing course evaluations to identify areas that may be improved. Using different methods, valuable insights may be extracted from data related to education by revealing hidden patterns[3]. Through these insights, institutions can fine-tune their curricula to ensure that graduates develop the skills and knowledge they require. With the assistance of machine learning, we can anticipate future developments in the labor and educational markets, enabling us to adjust our curriculum in beforehand.

Nevertheless, certain obstacles are specific obstacles that need to be successfully overcome, including ensuring data quality, tackling privacy concerns, and fostering relationships among data scientists and educators. Creating strong methods and structures is essential for ensuring that data-driven choices are ethical and dependable[4]. Overall, incorporating data mining into curriculum development is a major procedure forward in creating courses of study that are more adaptive and evidence-based. This literature review delves into the implications of methodologies for data mining on designing curricula, evaluating their merits, and pointing out the best approach for higher educational institutions[1].

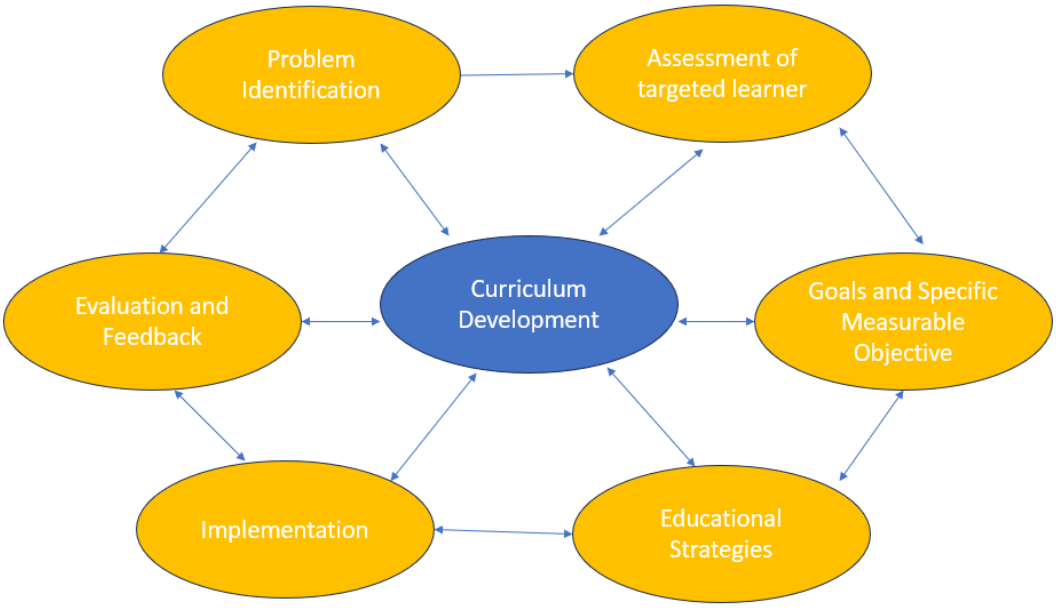
2 Background

In the framework of higher education, a precursor to data mining The procedure of identifying patterns, correlations, and abnormalities within vast databases is known as data mining. This particular branch of data science involves the application of a variety of techniques from the disciplines of machine learning, statistical analysis, and database systems. In the setting of higher learning, data mining is an effective instrument that may be used to further comprehend educational processes and outcomes, as well as assist in their development. The implementation of data mining methods to completely rewrite curriculum in higher education is an ongoing area of interest that has the potential to enhance the quality of higher education by aligning educational offerings with the changing needs of the industry and society[5]. This is an emerging field of study that currently has the potential to enhance education.

2.1 The Development of Curriculum in Higher Education: An Evolution Perspective

Curriculum development in higher education usually follows a continuous procedure driven by academic committees, faculty expertise, and accreditation criteria. This process has been in place for quite some time. Throughout the course of history, educational programs have been developed based on academic theories, professional norms, and the experiences of instructors. On the other hand, this traditional approach has been criticized for its slowness in adapting to changes in the requirements of the industry, improvements in technology, and the requirements of the students [6]. As an outcome of this, there has been a growing need for curriculum design methods that are more dynamic and data-driven. This is especially true following years of the National Education Policy (NEP) 2020, which emphasizes adaptability, learning across subject areas, and the development of skills (Ministry of Education, 2020). By utilizing massive volumes of educational data to guide decision-making, data mining provides a transformational approach to the process of curriculum creation. Data such as student performance indicators, course ratings, trends in the job market, and comments from stakeholders are all instances of this type of information. Educators and administrators can gain insights into the effectiveness of existing the curriculum and identify areas that require development using the analysis of different data sources[7]. In the research of [8], techniques for data mining such as categorization, clustering, association rule mining, and mining text can unearth hidden patterns and correlations that might not be readily apparent when using traditional methods.

The following image Fig(a) provides a breakdown of the process when creating a curriculum, beginning with of identifying faults or holes in the existing curriculum. After that, it concentrates on determining the requirements and characteristics of the learners who are being targeted in order to adapt the program accordingly. The first step is to identify objectives that are crystal clear, detailed, and measurable. The next step is to create effective instructional tactics to achieve these objectives. The implementation phase takes responsibility for ensuring that the curriculum design is carried out with the appropriate supplies and training for educators.



Fig(a): Major Six steps of curriculum development

Identification of the Problem:

Identifying the shortcomings or difficulties that exist within the existing educational framework or curriculum is the first element in the overall process.
In addition to laying the groundwork for the process, this stage contributes to a better awareness of the necessity of transitioning or developing.

Evaluation of Learners Who Are Being Targeted:

Throughout this stage, the primary focus is on gaining an understanding of the personalities, requirements, and objectives of those students who will benefit from the program.

A thorough examination of their existing knowledge, learning styles, and potential obstacles is included in this process.

Targets and Objectives That Can Be Evaluate Specifically: The desired learning outcomes are defined in a clear and concise manner at this step. These objectives must be SMART, which stands for specific, measurable, attainable, relevant, and time-bound.

Teaching Methods and Techniques: This entails the process of designing the strategies and procedures that will be implemented in order to accomplish the goals of the curriculum. Lectures, hands-on exercises, group discussions, and digital tools are some examples of these types of activities.

Putting into action: The execution of the curriculum plan is the primary emphasis of this phase. The distribution of resources, the training of instructors, and the distribution of materials are all involved. In order to ensure that the strategies are in line with the goals, effective implementation is required.

Assessing and Providing Feedback: Evaluation of the effectiveness of the curriculum takes place after it has been implemented.
It is vital to collect feedback from stakeholders, which includes students, instructors, and administrators, in order to make the required adjustments for improvement.

2.2 Implementation of Data Mining in the Processes of Curriculum Revamping Evaluation of Students Analysis:

Data mining can be used to identify the factors that influence the success or failure of students in particular classes or programs. According to [9], this information can be employed to modify the curriculum in schools to better support the educational goals of learners.

Market Trend Analysis: Educational institutions can connect their programs with the needs of the industry by examining data from the job market[10]. This ensures that graduates possess the skills and knowledge that are relevant to the business.

Text Mining of Student Feedback and Course Evaluations: According to[1], text mining of student feedback and course evaluations can reveal strengths and flaws in the curriculum, hence influencing modifications and innovations made to the curriculum.

Analytics Predictive: Predictive models can foresee future trends in education and labor markets, which enables educational organizations to modifications their curricula proactively according to future demands [11].

2.3 Considerations and Obstacles to Overcome:

Several obstacles need to be conquered because the potential benefits of data mining in the process of curriculum redesigning are enormous. Data quality and availability, issues regarding privacy, and the need for cross-disciplinary cooperation between data scientists and educators are some of the problems that fall under this category. In addition, there is a requirement for robust frameworks and processes to guarantee that decisions that are founded on data are valid, dependable, and ethically acceptable[12]. A substantial movement toward learning that is more evidence-based, responsive, and focused on the future is represented by the incorporation of data mining tools into the process of curriculum building. The purpose of this literature review is to investigate the various data mining techniques and their applications in the creation of programs of study, estimate the impact of these draws near, and identify the best practices to implement these techniques in higher education[1].

3 Literature Review

In recent years, the application of data mining techniques in higher education has gained significant momentum. Researchers have explored various approaches to leverage the power of data mining to improve overall achievements in higher education. This literature review aims to provide an overview of the existing research in this domain and identify gaps that can be addressed by future studies.

3.1 Data Mining Techniques in Higher Education: According to [13] the governing body of higher education has an important challenge when it relates to predicting the academic achievement of a student. The key results are the identification of factors that determine the choices students make of their subject matter of study, the development of predictive tools for anticipating behavior among students, and the provision of a paradigm to forecast achievement among students. Outcome is Improving student accomplishments, predicting student success, and anticipating student behavior, attitudes, and performance are all important aspects of education.

Importantly,[14] educational data mining assists in the settlement of challenges regarding the prediction and characteristics of not only children but also other stakeholders involved in the education sector. The main findings of the study explore the practical use of Data Mining tools and techniques to deal with concerns regarding anticipating pupil achievement and profiling participants in the education sector. Specifically, the paper focuses on the possible consequences of these methods and instruments. Predictability of students' performance and the demographic

makeup of those students through the incorporation of Data Mining tools and techniques is the result that [14] perceives to be of the greatest significance or pursue degree consequence.Data mining represents one of the technical advancements that have proven incredibly helpful and important in the area of education. Whenever it pertains to predicting achievement among pupils, classifying students, and examining the impact that technology has on both students and teachers, the main findings of the study emphasize the significance of classification. Furthermore, it is essential to point out that the sources that were analyzed didn't contain any information from the administration or parents, [15]conclude that programs of educational data mining and learning analytics for higher education can help build a strategy that is centered around the student and provide the necessary resources that institutions will be able to use for continuous improvement. Learning analytics (LA), as well as educational data mining (EDM), are two distinct methods that can successfully address an assortment of learning problems that are common in higher education. Participating in the establishment of student-centered methods and resources for continuous enhancement can be facilitated by the adoption of EDM and LA in higher education institutions. The importance of educational data mining (EDM) along with learning analytics (LA) techniques on the educational operations and outcomes of students was investigated and reviewed. [16]Offering decision assistance in educational institutions is a function ideally appropriate to be performed through the use of data mining to help decision-making. In the main findings, the implementation of data mining methods in decision-making processes in higher education, the examination of course tastes, the construction of concept hierarchies, the establishment of course timetables, the evaluation of course activities, the organization of learning resources, and the enhancement of decision-making in learning environments are all included. Participation preferences in extension education courses at a university, as well as the percentage of students who complete those classes.

[17] explains that the mining of data is an approach that offers an enormous amount of information about educators and pupils. Data mining is utilized in the field of education for forecasting and classifying the academic achievement of both students and teachers, understanding the conditions under which pupils learn, predicting the number of students who drop out of school, and enhancing instructional strategies. The use of educational data mining instruments the performance of students and teachers, in addition to teaching staff dropouts.

[18] offers precise forecasts on the academic performance of future students, and educational methods for data mining are utilized. The primary results include the utilization of Educational Data Mining tools to facilitate the admissions process, the prediction of student performance before admission according to 35 parameters, and the inclusion of recommendations for additional study. The anticipated level of the educational outcomes of prospective students and the factors that influence their performance before admission were measured by the result of the experiment. [19] study demonstrates the efficacy of data mining tools, including decision trees and support vector machines, in accurately assessing instructor performance. The investigation emphasizes the importance of feature selection and recommends practical uses to strengthen instructor evaluation in higher education. Although the study provides thorough analysis and practical applicability, it would be advantageous to incorporate more types of data and adopt a longitudinal approach. In summary, [19]work provides a valuable foundation for additional research and practical use in the discipline of educational data mining. [20]The research that Wang is going to perform in 2021 investigates how data mining techniques may be beneficial to the long-term growth of higher education. The research discovers trends that improve the quality of education and resource management by analyzing various kinds of data sources that are located within institutions. Clustering, classification, and association rule mining are some of the methods that have been highlighted in this study. Particularly significant findings suggest that data mining has the potential to improve processes for making decisions and increase academic performance. A more comprehensive dataset and a greater focus on long-term consequences would prove beneficial to the document, it has a strong emphasis on practical applications and extensive evaluation. Whenever taken as a whole,[20] work reveals extremely helpful insights into the implementation of data mining for ethical teaching methods.

[21]examines the utilization of educational data mining to forecast the standard of performance achieved by students seeking bachelor's degrees. In the research, significant indicators of success in school are identified using the utilization of techniques such as regression analysis, decision trees, and neural networks. These methods have been used to identify variables such as attendance, previous performance in school, and involvement in extracurricular activities. The study indicates that methods for data mining have a chance to reach exceptional forecasting accuracy and,

therefore can assist in the early detection of students who are at risk. It might be beneficial for the research to possess a greater variety of samples and continuous data to properly assess its effectiveness across the long term, even though it is methodically solid and practically relevant. In general, [21]work offers valuable suggestions regarding enhancing the arrangements that are functioning to serve students.

3.2 Data Mining and Python in revamping curriculum: [22]explains that the process of data mining assesses student learning to improve the educational curriculum. Throughout the curriculum, Python is utilized for teaching and the gathering of student data. The implementation of a questionnaire before the curriculum Continuous evaluations of teaching and learning every week techniques of instruction that have been improved, as well as the interest of students in the Python programming curriculum. The results obtained seemed beneficial in terms of enhancing the quality of blended education. [23] goal is to develop a higher education system that employs a parallel association rules algorithm to improve the quality of learning online. The system has been divided into six modules: the main screen, course, instructor, pupil, administrator, and personal center. This allows for the full management of learners, instruction, and educational resources. The system combines data mining association rules and the parallel association rules algorithm to rapidly analyze data, offer personalized educational asset recommendations, and implement educational evaluation feedback. The findings from the experiment show that the suggested approach attains a high flow of data, rapid response times, and a resource utilization rate of over 90%, while additionally improving audio materials for instruction.[23] additionally explores techniques for gathering and assessing student scores, as well as the construction of the instructor's module to account for authority and the execution of logic associated with the teaching goals. The study offers a methodical strategy for improving online education by utilizing intelligent data processing alongside customized suggested changes, and this is further strengthened by empirical validation.

[24]study centers around the redesigning of online teaching curricula through the application of Universal Design for Learning (UDL) principles, the taxonomy of meaningful education, and integrated curriculum design (ICD). It highlights the importance of developing online learning experiences that are easy to use and captivating, while also providing students with a range of supported options for learning. The endeavor seeks to enhance student learning, engagement, and

happiness by optimizing the redesign process, with a focus on the collaboration between academics and instructional designers. Data collecting strategies used in assessing the performance of the curriculum reform include gathering student comments, performing course assessments, evaluating data, and obtaining expert reflections. The curriculum redesign improves the quality of online learning through the inclusion of activities that are more reflective, educational, and social, hence fostering meaningful learning experiences. [24]The research underlines the significance of combining components that tackle different student requirements and tastes in distance education. [25]discusses the present research, with an emphasis on its role in the process of Knowledge Discovery in Databases (KDD) life cycle especially at the graduate level. Given its versatility in tasks such as pattern extraction, data preprocessing, predictive modeling, and representation, Python is the language preferred for teaching data science courses. The experiences dealt with in the paper provide an understanding of the instructional techniques implemented with graduate students and highlight how well Python functions for project growth and education goals. Furthermore, [25]based on research and teaching experiences in addition to insights, the article offers suggested approaches for teaching Python in undergraduate data science programs. These recommendations are intended to improve Python instruction in comparable programs while making sure that students are prepared to use Python to face the difficulties of data science assignments. The paper subsequently benefits students as well as instructors in the domain by providing a useful manual for educators offering to better utilize their Python instruction strategies in graduate data science courses. The following can be accomplished by detailing seven in total instructional strategies. [26] studied that the ACID algorithm allows the use of social intelligence to simulate student opinions using the extraction of educational websites. It fills the need to provide support to academics who do not have experience in educational sciences, with an emphasis on the components that impact computer science instruction. With the application of learner feedback, ACID provides educators with useful information that can assist them in enhancing their teaching strategies for better results for students. In general, such as it can deliver educators with a data-driven solution that could enhance methodologies for instruction with the help of online data evaluation. [27] introduces an innovative strategy in optimizing the university curriculum. The approach involves moving from explicit modeling towards data mining. Educational Data Mining is utilized to enhance academic processes by considering the achievement of students. The

individual learner profiles are the primary emphasis for making individualized GPA projections. It renders use of the history of education and vocational goals of students to find relevant didactic knowledge. A promising strategy which renders capitalizes on data mining for enhancing educational processes and optimizing student learning results is outlined by the dynamic appearance of students centered around the present academic performance. That approach shows the potential for increasing the authenticity of educational frameworks. investigates the potential for using data mining techniques to enhance teaching and learning processes in higher education. The paper concentrates on academic data analytics and mining in educational programs. These techniques are addressed in relation to their ability to help in gaining an understanding of student behaviors, incorrect assumptions, and reasons, resulting ultimately in more targeted interventions and improved results for students. Additionally, the study highlights the importance of making software for data mining available to individual instructors and accessible to students. It also underscores the necessity for providing targeted faculty training along with individualized course administration systems to respond to the distinctive pedagogical and technological necessities of institutions of learning.

4 Conclusion

The reviewed papers emphasize the important function of mining data for encouraging educational outcomes, including increases in student performance as well as assistance for decision-making in educational settings. However, there are still obvious deficiencies in this research. An apparent shortcoming is the lack of consideration devoted to the scalability of the practical implementation obstacles of data mining technologies in various educational settings. Moreover, several studies fail to adequately investigate new progressions in data mining technologies, such as artificial learning and artificial intelligence, which have the potential to provide more resilient and adaptable options. The lack of thorough discussions regarding the privacy of information, security, and ethical issues is a serious deficiency, considering the sensitive nature of educational data.

5 Future Scope

The prospects for the future of educational data mining (EDM) along with learning analytics (LA) include the integration of advanced artificial intelligence and machine learning techniques, the development of specific educational routes, and a solution of ethical and privacy issues. For

effectively implementing insights, it is essential to have multidisciplinary applications, perform impact analysis of actions, and foster more cooperation between stakeholders. Research ought to emphasize scalability and address problems with implementation. It ought to investigate the potential for innovative data sources, determine sophisticated engagement measures, and adopt data-driven curriculum design. The overall objective of these directions is to strengthen educational procedures by increasing the efficacy, adaptation, and availability of learning, accordingly closing the gaps between academic research and actual improvements in education.

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