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Data mining application in education

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Abstract

In the digital era we live, the education produces huge amount of data from different resources like learning management system, electronic tests, students records. Educational Data Mining is the discovery of hidden useful knowledge and pattern in educational data concerned with studying and analyzing data from academic database, which is very large datasets to reveal main concept and relationships that improves education process and making more precise decisions. In this paper we explored common data mining techniques and their application in educational context, were automatically used to extract knowledge from huge datasets in the form of patterns and relationships review a set of criteria with a group of impact factors on each then describing percent of impacting.

Today, educational data faces the biggest challenges are the rapid growth of data and using it to improve educational system for the students and their performance, different data mining methods works and process data in various data mining tasks like: clustering, classification, association rule, prediction. This paper offers a review of the latest data mining techniques application in education including improving teacher and student's learning performance, course adaptation, predicting drop-out students, knowledge discovery on academic achievement and Enhancing academic research also describe benefit and challenges that faced

Keywords: Educational Data Mining (EDM); Data Mining (DM); Education; Student's learning performance

1. Introduction

Any country growth and development depends on its educational system, most of big country have a high literacy rate. This growing demand establishing a new universities not by governmental but also private universities this generates vast datasets every year. That data can be processed and transmitted with data mining methods. Weka an example of DM system that is useful in generating results. A primary aim of educational and learning system provides students with knowledge and experts wanted in real world work and be successful in limited time. educational systems global goal is determinant of both economic and social progress [2].

A quality of teaching is a main target for universities to develop and continue, and it is measure of quality by weighting of teachers score in the students final result, the impact factor of teaching quality is important large amount of students data is collected in educational management system. It is hard mission to provide a decision for administrators through efficient process and analysis for data that have precious hidden knowledge that be mined [12].

Data mining is an efficient techniques to obtain useful information from big datasets, today many teaching systems evaluation depends upon data mining techniques. Providing high quality teaching became very hard also guidance for a vast number of students is difficult. So, so many students fail to accomplish their degrees requirement's through specified periods. Educational data mining can provides a significant amount of relevant information and a clear vision

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of hardness in student learning. One of Students failing causes in advanced subjects that they did not taught the basics in the previous study [3].

Data mining techniques used to analyze student data that can support to determine student failures reasons. Then used it to develop learning about educational students, and learning setting they take. DM applied to educational information for research topics such as improving the learning method and leading students education or getting a deeper understanding of educational system [5].

This paper focuses on data mining technique and its application in educational management system. To be specific, describing five DM applications are: the association rule, classification, predicting, clustering and discovery with models, and their efficiency on five educational chosen approaches in learning system are : improving teacher and student's learning performance, course adaptation, predicting drop-out student, knowledge discovery on academic achievement, Enhancing academic research and describing who it could be developed by using data mining technologies.

2. Literature review

We present a discussion on some of educational data mining topic works, where the evolution of technology leads to store huge amount of data in different institutions especially in educational systems these information very beneficial as knowledge information invested in data mining which is one of recent sciences that uses knowledge discovery hidden in data. The study in [1] evaluate students that undergraduate academic performance each end course exam. Applying data mining techniques like artificial neural network, farthest- first, k-nearest neighbor and decision tree to classify data from national defense university of Malaysia.

In [2] analyzing of academic performance for students are viewed using data mining techniques to analyze the effective factors in student performance aiming to improve quality of education and presents recommendations for developing education process by applying some of data mining methods like decision tree and association rules. Study in [3] focuses on educational data mining through searching on five different databases, in spite of 33 attempt to collect literature review but some gabs are determined. In [4] search the studies in the field of education in data mining between 2014-2020 with data mining methods from the "Science Direct" database. Almost 60 articles studies were related to data mining in education.

In [5] the study aims to predict teacher evaluation in education through many of data presents by the students' performance in higher education from search and test to extract the result on a group of references from prediction application focusing on educational data mining. Previous study do not focus on building data storage all focusing on extracting patterns and relationships in database.

3. Educational Data Mining

EDM it is one of data mining fields concerned with evaluating ways for discovering knowledge from educational information comes from educational datasets and learning management system (LMS) tags for best grasp students education management. Data mining outcomes are of (serious, implicit, unknown before and usually useful) data knowledge or patterns from big data, we know how is educational database as known so big with huge amount of data [9].

DM take these data and find hidden relationship implicit in using different data mining methods, there is a varieties of data mining task within EDM like: classification, clustering, association rules, predicting and discovery with models etc. Which can be used in educational system as: improving student's learning performance, course adaptation, predicting drop-out student, knowledge discovery on academic achievement, Enhancing academic research, data mining became as one of strongest tool for education instruments, it assist improving quality of education, making decision depends on data that leads to more specialized and effective education experience [3].

EDM is dealing with enhanced strategy for exploring special kinds of information comes from educational datasets, employing them to better understand students, also rules they learn in. Using data mining in educational system in many fields as: relationship between the student university entrance examination results and their success, predicting student's academic performance, discovery of strongly related subjects in the undergraduate students, knowledge discovery on academic achievement, classification of students' performance in computer programming course according to learning style, investing the similarity & difference between universities [11].

DM application in education by analyzing students degrees to discover students' performance and finding important and useful patterns could be rich in information necessary to support high education inflammation decision like students topic evaluation, difficulties students face, classification of students as active, hesitate and idle [21]

4. Data mining Methods

Data mining tasks used in education are described as the following categories:

4.1. Clustering

Clustering defined as a process of collecting similar objects into a class of similar sets, that is classified into number of subgroups or clusters referred to clustering task is unsupervised learning method because class labels are unknown unlike classification and prediction analyzing labeled class data objects, clustering analysis data objects without council defined class label giving the user view of what happening in dataset, clustering method collect data while classification and prediction analyze labeled data classes in clustering data analyses without mentor a known class label, there is no class label in the training data where objects in cluster has similarity by comparing to another cluster [14].

Clustering application in education by helping in finding academic trends, grouping students after partition students types into similar groups, course selections, dividing them by age, gender, behavior of students and other characteristics into clusters of similar groups, group numbers are predefined in clustering algorithm it is used to minimize the volume of study area, it is useful in cases of data set are not known in progress within common categories, clustering algorithm can start either with no previous knowledge for data clusters like k-means algorithm with random restart or start with specific theory possibly in prior research with different data like expectation maximization algorithm, such clustering algorithm data belong to one clusters k-means models as example the other belongs to more than one cluster or no cluster Gaussian mixture models as example [16].

4.2. Classification

Classification is the processing of getting a set of exemplary characterize and differentiates data classes or objects, the result symbolized in many forms like (if-then) rules, decision tree and neural network are examples of classifications models. Data Classification into limited number of groups used for categorical variables it can be classified into supervised when the objects are known and unsupervised when the objects not known in advance, there are many algorithms using classification method like : decision tree, k-nearest neighbor, genetic algorithm, neural network and SVM [4].

Classification of data is one of the oldest DM techniques, so it is most popular used in education and e-learning with accuracy more benefit for identifying low academic performance of the students, classification task consists two steps:

- Model construction: including set of predefined classes, every sample belong to predefined class these set applied as training set for model construction, this model as decision tree.
- Model usage: it is applied for classifying properties or unknown objects, the label of test set compared with classified outcome from the pattern. Testing set independent of training set.

Training data set analyzed by classification algorithm in learning and testing data set used to estimate accuracy of the classification rule in classification. If the accuracy is acceptable the rules can be applied to the new data tuples. The algorithm called classifier-training uses these pre-classified models to determine the groups of parameters required for suitable recognitions. Then encodes these parameters into a model called a classifier by the algorithm [14].

4.3. Predicting

In prediction the target is to evolve a model to conclude a single concept of predicted data from some mix of other concepts of predictor variables, predicting requires labels for output data for limited data, label describes trusted information for result variables to finding evaluable suitable way. Regression analysis is the common used prediction technique it consist one or more predictor variables based on relationship between known data and the needed to be predicted if particular attributes as domain knowledge and communication level of a student is defined than place possibility can be predicted by multi regression and it depends on variable indicates by y and domain knowledge and communication level are indicated by x. In learning system data mining prediction can be used for educational data to detect student behavior or understanding educational outcomes [4].

Decision tree algorithm, Logistic Regression, Neural Network and SVM they are indicated as the important predictors of student has scholarship or not and student has previous test experience while decision tree gives the best predictor, in educational data prediction has two main uses first using prediction method to study model features that is needed for prediction underlying information it commonly used to predict student educational outcome, the second usage of prediction method is used to predict the output value that is not needed to find label for structure used in research attempting studying relationship between learning and gaming the system trying to success a learning environments [2].

Three public predictions types are:

- Classification uses previous knowledge to construct a learning model then used as categorical parameter for the new data. Enumerate models build and applied as classifiers likes logistic regression and SVM.
- Regression model is used to predict variables, many type of regression and classification models to predict persistent variables. Various methods of regression, as neural network and linear regression, broadly used in educational data mining to predict classified as at danger students.
- Density estimation depends on many of kernel functions consist Gaussian functions. Prediction method used in educational data mining in various ways. The common is studying properties used in prediction and applying these properties in specific construct, to predicts student educational outcomes [3].

4.4. Association rules

Association rule is the process of exploring important or relationship between data otherwise summaries the whole data, it can be used to find the relationship between the students properties and helping in relationship finding perfectly. As example student who select commercial course will also select management course as students who select finance can also select marketing as a specialization, association rule can be used for opening new colleges, new courses and speculation based on certain rules that derived from dataset patterns according to specific case.

Association rule mining involves identifying patterns in a transaction database that consist of binary variables. The use of Apriori method is a common algorithm for this type of mining, the goal of association analysis is to uncover relationships between attributes and values that appear together frequently in a given dataset. The rule A=> B means the database tuples that meet the criteria of both A and B [6].

Relationship mining can be classified into four types: correlation mining, association rule mining, sequential pattern mining and casual data mining. The main objective of association rule mining is discovering if-then rules, where particular set of values for certain variables tends to result in a specific value for another variable. For instance, one rule may show that when a student is frustrated, their goal of learning tends to outweigh their goal of performance, which leads to them asking for help more frequently. Correlation mining involves identifying linear correlations between variables, either positive or negative. In sequential pattern mining the focus is on finding temporal connections between events. This could involve determining the sequence of student behaviors that ultimately leads to a significant learning event, finally in casual data mining the objective is to establish whether one event or construct caused another event or construct. This can be achieved by analyzing the covariance between the two events, for example, if a pedagogical event is randomly chosen using automated testing and frequently leads to a positive learning outcome, causal relationship can be inferred[20].

4.5. Discovery with models

Discovery with a model, is a model of event work out via prediction, clustering, or in some job knowledge engineering. In knowledge engineering the model is work out by human thinking more than automated algorithms. The model is used as an element in another analysis, such as in prediction or association rule mining. In prediction case, the component model's predictions are used as predictor inconstant to predict a new inconstant. For example, analyses of complex constructs like gaming method within online learning have totally depended on rating of possibility that student knows the instant knowledge element being learned [6].

The student estimation of knowledge depends on models of knowledge elements in a sphere, commonly denoted as a mapping between training within the learning software and knowledge elements. In association rule mining status, the relationship between the new models predictions and moreover variables are studied. This can enabling a researcher to study the relationship between a complicated end construct and large different of notable constructs. Sometimes, browsing with models headers validated commonly of prediction model through context [9].

5. Data mining application in education

EDM department study data to find answers to educational query. trying to investigate the hidden patterns following a testing of curriculum, learning behavior, and student information collected from different educational situations. To illustrate the link between data objects, association rules are used. DM techniques divided into two types: supervised and unsupervised employ labeled training data for identifying (classification, regression), while unsupervised techniques employ unlabeled data to identify existing hidden patterns (clustering) [10].

Many Research showed how DM could be used in education, specifically to increase student performance. Using Database course and collect all accessible data, also using an association rule, a classification rule using a decision tree, classified the students using educational mining clustering. They put the discovered knowledge used to help improving their performance [12]. table (1) below shows the data mining techniques role and their purpose of use in education.

Table 1 Various data mining techniques and their role in education [2]

Techniques	Purpose
Classification	Detection of student behavior Development of domain models Discovering student learning styles and preferences Understanding the educational outcomes of the students
Clustering	Grouping similar students based on learning behavior and their performance
Predictive modeling	Prediction of either a student qualifies a course or not
Relationship mining	Discovering the curriculum associations in a course Finding bottleneck in a specific study programs
Visual analytics	Analyzing of educational processes or erudition outcome by visualization the model
Discovery with models	Student characteristics or contextual variables. Determining the relations among different students behaviors
Refinement of data for individual decision	Labeling the data that helps in the improvement of the prediction model Identification of the students learning patterns

Here are some of approaches of education using data mining techniques:

5.1. Improving teacher and student's learning performance

Data mining is a popular used method to predict students' performance. Different prediction tools are found like regression and correlation analysis, decision tree, Bayesian networks, neural network and others. Technically, classification methods like decision tree and Naive Bayes depends on students ID and degrees recorded in course. Suggesting data mining process can be work to the lectures to classifying performance that helping in benefactor higher education organism [10].

It assist students and teachers to develop students' performance. by proposing different techniques to develop graduate students performing and identifying factors that influence the instruction of teaching performance in university using data mining technology like decision tree and regression other factor can affect students and teacher performance instructor attitude, student attendance and students feedback affect teaching performance, data mining techniques based on students ID, marks scored in course and suggestions can be done by DM for teachers to classify performance and which assets in developing higher education levels, methods of data mining helps in teachers and students improve performance [15].

Some of impact factor on attaining education like number of studying hours, present percent, interaction with learning activity and using e-learning techniques depending on review reports on academic classification on Times Higher

Education (THE) " a global ranking university's evaluate university according many specific factors" [8]. The highest impact factor is number of study hours on performance by 40% as show in table 2 below.

Table 2 Impact factor on education performance

Factor	Impact on academic performance (%)
Number of studying hours	40%
Present percent	25%
Interaction with learning activity	20%
Using e-learning techniques in study	15%

5.2. Course adaptation

Course adaptation can offer a variety of workspaces to present information sharing and communication between course participants. The educators can submit information to students, prepare assignments and exams, join in discussions, distance classes today, one of the most commonly used is Moodle is a free learning management system enabling the creation of powerful, flexible and engaging online courses and experiences [13].

Instructors and course teacher demand tools to help students in the task on a continual basis. Some platform offering report tools, it is hard sometimes for educators to extract useful knowledge where a large number of students found, where specific tools help educator to apply some learning job is not found this can less education activities. So establishing this objective area by using data mining method to help administrators to evolve leaning system, DM in database is the automatic extract of hidden and useful patterns from large data set. Some of DM methods and tasks relieve new useful knowledge based on students data used like visualization, classification, clustering and association rule mining [17].

Estimation of students learning performance, recommendation and course adaptation providing based on learning behavioral are some of subjects data mining dealing with evaluating learning material and provide feedback for both students and teachers of learning courses and detecting a typical students courses, Most of data mining tools are not easy for students to use. As a result, apply data mining techniques to produce reports for instructors who then use these reports to make decisions about how to improve the student's learning courses [19].

Some impact factor in course adaptation like scheduling difficult course topics at morning, rest between long lessons, minimize daily lessons, distribution theoretical and practical and improving class environment depending on review reports on academic classification on Times Higher Education (THE) [8], table 3 below describes the impact factor on course adaptation the highest is improving class environment.

Table 3 Impact factor on course adaptation

Factor	**Impact on course adaptation (%)**
scheduling difficult course topics at morning	65%
rest between long lessons	50%
minimize daily lessons	40%
distribution theoretical and practical	55%
improving class environment	70%

5.3. Predicting drop-out student

Predicting dropout student is very necessary and objective case for universities and educators, to classify the dropout student, the popular data mining algorithms were applied based on k-Nearest Neighbour (k-NN), Decision Tree (DT), Naive Bayes (NB) and Neural Networks (NN. using data mining techniques in educational studies minds opportunities for students and researchers to achieve knowledge and more interesting relationships between variables from the large data sets. data mining take researchers to discover behaviors and decisions that lead to learner success, identify learners

who are at risk of dropping out or failing, personalize and adapt learning content and instruction to meet individual needs, and improve and optimize the use of institutional support structures to assist learners [2].

Overall, it appears that more students will be taking online learning courses and programs in the coming years. Therefore, more data about different types of student information will be collected in the database. We need more research that leverages data mining efforts in online spaces to extract and generalize meaningful knowledge from student information.

More attention could be paid to identifying parameters and measures that increase the efficiency of the website and adapt it to user behavior, as well as Other researchers could replicate this type of study using larger data sets from students in a variety of online degree and certificate programs. Additionally, further research could include changing and adding variables, applying other algorithms, and modifying preprocessing methods [9].

Some impact factor on drop out students are poor academically, financial situation, not interested, social problems, far study place and lake of study environment depending on review reports on academic classification on Times Higher Education (THE) [8], where the last one is the highest-ranking percent 50%. Table 4 shows the impact factor on prediction drop out students.

Table 4 Impact factor on predicting drop out student

Factor	**Impact on predicting drop out student (%)**
poor academically	40%
financial situation	35%
not interested	25%
social problems	30%
far study place	20%
lake of study environment	50%

5.4. Knowledge discovery on academic achievement

However, this knowledge is useful not only for the educator, but also for the users themselves students, since it can be targeted at different goals for different actions in the process. It can recommend activities and resources to learners for students, suggest shortcuts or simple links to enhance and enhance their learning, or provide educators with more objective teaching feedback. teachers can evaluate the structure of course content and its effectiveness in the learning process, as well as group learners according to their guidance and supervision needs. learner's regular and irregular patterns can be identified, allowing the most commonly made errors to be identified and more effective activities designed [7].

better institutional resources (human or material) and better organization of educational activities. data mining has been applied to data from different types of educational systems. On the other hand, there are traditional face teaching settings such as special education and higher education. There are computer based education as well as network based education, such as the famous learning management system and intelligent tutoring system [11].

The main difference between the two systems is the data available in each system. Traditional classrooms only have information about student attendance, course information, course objective and personal schedule data. However, computer and web based education can provide much more information because these systems can record all information about student behavior and interactions in log files and data bases [18].

Some impact factor on knowledge discovery on academic achievement are independent search for information, using technology in learning, involvement in research activities, extracurricular reading and critical thinking and problem solving which highest impact ranking as well as independent search for information depending on review reports on academic classification on Times Higher Education (THE) [8], table 5 shows the impact factor on knowledge discovery on academic achievement percent.

Table 5 Impact factor on knowledge discovery on academic achievement percent

Factor	Impact on knowledge discovery on academic achievement (%)
independent search for information	70%
using technology in learning	65%
involvement in research activities	60%
extracurricular reading	50%
critical thinking and problem solving	75%

5.5. Enhancing academic research

Data mining used by researchers to analyze big educational datasets revealing trends and find out the contribute to educational methods and training all this called data driven insights. In collaborative research data mining can facilitate collaborate with researchers by finding common knowledge of educational data.

Data mining in education can transforms institutions realize and improve the basic leading to better outcomes for educators and students like educational experience.

Data mining techniques used in enhancing academic research like SVM and neural network to guide student for better learning systems using the directors that depends on learning systems information by analyzing students data, discovering the difficulties in the study materials helping to improve them to be compatible and effective for students [15].

Some impact factor on Enhancing academic research are using authentic scientific resources, apply a rigorous research methodology, provide academic support, data analysis skills, using artificial intelligence in research and correct academic writing, where the last is the highest ranking depending on review reports on academic classification on Times Higher Education (THE) [8], table 6 shows the impact factor on enhancing academic research percent.

Table 6 The impact factor on enhancing academic research percent

Factor	**Impact on enhancing academic research %**
using authentic scientific resources	80%
apply a rigorous research methodology	75%
provide academic support	70%
data analysis skills	65%
using artificial intelligence in research	60%
correct academic writing	85%

6. Conclusion

EDM is very interesting topic these days because a large number of students and educators in the institutions, so educational data mining and its technology very beneficial in analyzing these data by understanding students, appropriate profiling and accurate predictions will not only raise the quality of education, also raise well learning experience to the students. Increasing use of internet by students today, cause large data available online. data mining, can extract useful information to assist the education system for shaping appropriate systems for our students.

This paper shows data mining applications in education through prediction enrollment of students into universities various courses, also for classifying and clustering students prosperity based on their favorite, demographic, psychographic and behavioral variables. Otherwise, it can demonstrate the log of successful and unsuccessful based on the data collected during the year. Also can find dropout students, academic students' performance, knowledge discovery on academic achievement and enhancing academic research.

EDM helps developments methods to extract important data translate it for useful information, that can work for more powerful understanding of the students and the educational system setting's, DM proves its really good in quality of learning improvement through analysis huge amount of data and extract valuable information used in analysis of student performance, predicting feedback and customize teaching methods so leading more specialist and successful teaching

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