

Technology Enabled Learning to Improve Student Performance: A Survey

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Abstract—The use of recent technology creates more impact in the teaching and learning process nowadays. Improvement of students' knowledge by using the various technologies like smart class room environment, internet, mobile phones, television programs, use of iPods and etc. are play a very important role. Most of the education institutions used classroom teaching using advanced technologies such as smart class environment, visualization by power point projector and etc. This research work focusses on such technologies used for the improvement of student's performance using some of the Data Mining (DM) techniques particularly classification and clustering. Information repositories (Educational Data Bases, Data Warehouses) are the source place for collecting study materials and use them for their learning purposes is the number one source for preparation of examinations. Particularly, this research work analyzes about the use of clustering and classification algorithms to enable the student's performances and their learning capabilities using these modern technologies. During the study period, the student's family background and their economic status are also play a very important role in their daily activities. These things are not considered in this survey work. A comparative study is carried out in this work by comparing students performance based on their results. The comparison is carried out based on the results of some of the classification and clustering algorithms. Finally, it states that the best algorithm for the improvement of students performance using these algorithms.

Keywords: Technology Enabled Learning, Student Performance, Clustering Algorithm, Classification Algorithm

I. INTRODUCTION

The significance of technologies cannot be overemphasized in education. Computers have been generally accepted as modern instruments that enable the teachers/lecturers to select the teaching methods that will increase students' (learners') interest in learning. Computer is an electromechanical device designed to sequentially accept, process and store data on the basis of set of instructions to produce useful information. The students' academic performance can be referred to as the competencies, skills acquired and attitudes learned through the education experience. The main objective of this paper is to discuss the use of classification and clustering algorithms in data mining for the improvement of students performance by using some or most of the recent technologies in the modern world. Only a comparative analysis is performed in this research work using the stated DM algorithms. During this study, it is not considered all types of classification and clustering algorithms, which is limited to certain algorithms alone.

DM is more familiar tool for extract the information from large number of different kinds of data repositories. Data mining takes major role in the part of learning data mining (LDM). It tries to discover a system to acquire new knowledge from the existing information about learners to understand the development of learning and the social and inspiration of the factors envelop learning. In learning field, data mining methods are very useful for enhancing the current learning standards and managements. The size of data is gathers from different meadow exponentially increasing. Data mining has been used special scheme at the intersection of Machine Learning, Artificial Intelligence and statistics. The data mining process is to extract information from huge datasets and transform it into understandable structure for further use. Data mining techniques which extract information from huge amount of data have been becoming popular in education domains. These methods provide a direction to a multiple level of grade, a finding which gives a new sensitivity of how people can becomeskillful in these learning sectors. Data mining has different methods such as Prediction, Association rules, Decisions Tree, Classification, Clustering, Neural Networks and many others. In the middle of these, classification algorithm such as Decision tree ID3 and C4.5 algorithms plays an essential role in LDM. Decision tree induction algorithms can be used for classification in many application areas, such as Education, Medicine, Manufacturing, Production, Financial analysis, Fraud Detection and Astronomy etc. There are several data mining algorithms such as *k*-Means, C4.5, SVM, Apriori, Naive Bayes, EM, PageRank, AdaBoost, *k*NN, and CART etc, which are effectively utilized for classifying the students learning category. A number of clustering algorithms are also applied in LDM for the grouping of student's categories in order to partition the students based on their learning maturities.

With some of these possible methods, one can search an important secretable blueprint for pronouncement opportunity direction and rally round in decision making. Data mining rally round learners by managing effective learning units, redesigning the prospectus and humanizing learning methods. There are number of algorithms in Data Mining, in which decision tree algorithms are the majorly used because of its easy implementation. Identity-efficacy has been related to resolution, resolve, and achievement in learning settings. A meta-investigation of study in learning settings found that identityvalue was related both to academic performance and persistence. The contribution of self-efficacy to learning achievement is based both on the increased use of particular cognitive activities and strategies and on the positive contact of efficacy beliefs on the broader, more general classes of meta cognitive skills and coping abilities.

Computer based experiment have been used since 1960s to experiment information and problem solving skills. Computer based evaluation systems have enabled learners and trainers to author, scheduler, deliver and report on investigation, quizzes, experiment and exams. An effective method of student assessment technique is necessary in assessing student knowledge. Due to an increase in student numbers, ever-escalating work commitments for academic staff, and the advancement of internet technology, the use of computer assisted evaluation has been an attractive proposition for several senior learning institutions. This paper has an insight of students learning perspectives via the recent technologies used for their knowledge growth and improving result performance in the examination of their course examinations.

The structure of this research paper is organized as follows. Section II discusses about the research work carried out by using technology oriented students' performance improvements. The role of classification algorithms for LDM is illustrated in section III, which also have a discussion about the use the classification algorithms Naïve Bayes, J48 and Support Vector Machines. The use of clustering algorithms for LDM is illustrated in section IV. Finally, section V concludes with the research work.

II. TECHNOLOGY ORIENTED STUDENTS PERFORMANCE IMPROVEMENTS

In recent days, the impact of new technologies have a powerful influence on all aspects of our society, from various domains of real world situations. Evidently, education is not an exception. Many technologies have an impact on the way we teach and learn. For example, new mobile devices (e.g., smartphones and tablets) raise student engagement in both indoor and outdoor activities with applications such as mobile augmented reality. Also, some of the social networks play a very vital role in current scenarios. New motion sensors and image-recognition technologies are giving rise to applications with more natural interaction methods, helping non-technical users to interact with computer-based systems, as in the case of new-generation video consoles. In addition, social networks and web tools give students a more active role in their own education, allowing them to become educational presumes.

Many peoples are carrying out research based on the improvement of student's performance using the recent technologies. This section discusses about such articles with an overview of how they chosen data set, what kind of data are selected so far, and what technology utilized for their knowledge improvements. A research paper titled as "Using learning analytics to predict (and improve) student success: A faculty perspective" was done by Dietz-Uhler et al. [1]. In this paper, they define learning analytics, how it has been used in educational institutions, what learning analytics tools are available, and how faculty can make use of data in their courses to monitor and predict student performance. Finally, they discuss several issues and concerns with the use of learning analytics in higher education. This studies have indicated individual faculty can make use of the data they have available in their courses to affect change and improve student success.

These efforts, although seemingly "small-scale", can have a large impact on student success.

Another paper titled as "New technology trends in education seven years of forecasts and convergence" is discussed by Martin et al. [2]. They analyzed the evolution of technology trends from 2004 to 2014 that relate to the long-term predictions of the most recent distance report. The study analyzed through bibliometric analysis which technologies were successful and became a regular part of education systems, which ones failed to have the predicted impact and why, and the shape of technology flows in recent years. The study also displays how the evolution and adulthood of some technologies allowed the renewal of expectations for others. They conclude that the analysis gives some of the methods used is right and some are not in suitably handled.

Another research work titled as "Data mining application in higher learning institutions" was done by Delavari et al. [3]. They studied capabilities of data mining in the background of higher educational system by i) proposing an analytical guideline for higher education institutions to improve their current decision processes, and ii) applying data mining techniques to find out new explicit knowledge which could be helpful for the decision making processes. Their final results had been analyzed and validated with real situations in a university. The factors affecting the anomalies had been discussed in detail. The final result from each model with various techniques, presented that they are all performing similarly.

Peng et al. [4] propose a survey on "A descriptive framework for the field of data mining and knowledge discovery". This paper analyses a vast set of data mining and knowledge discovery (DMKD) literature to give a comprehensive image of current DMKD research and categorize these research works into high-level categories using grounded theory method, it also appraises the longitudinal variations of DMKD study behavior during the last decade. This paper agreed eight main areas of DMKD: DM tasks, learning techniques and methods, mining complex data, fundamentals of DM, DM software and schemes, high performance and distributed DM, DM applications, and DM method and project.

A paper titled "A mobile learning system for scaffolding bird watching learning" carried out by Chen et al. [5]. They aimed to build an outdoor mobile-learning activity by means of up-to-date wireless technology. Their future Bird-Watching Learning (BWL) system is aimed using a wireless mobile ad-hoc network. In the BWL method, each learner has a Personal Digital Assistant (PDA) with a Wi-Fi-based wireless network card. The BWL system provides a mobile learning structure which supports the students learning through scaffolding. The goal of a formative assessment was twofold: to show the expected roles and scaffolding helps that the mobile learning method offers for bird-watching activities and to examine whether student learning profited from the mobility, movability, and individualization of the mobile learning device. They concluded that The BWL system was specifically developed to integrate the scaffolding model with the system. Three elementary schools in Taiwan used the BWL system for bird-watching. A formative evaluation from their experiences

was undertaken. Based on these findings, it was found that the children who used the bird watching system improved their learning, above and beyond what would normally be expected they would learn.

Likewise a paper "A review of recent advances in learner and skill modeling in intelligent learning environments" was explored by Desmarais et al. [6]. They review the learner models that have played the largest roles in the success of these learning environments, and also the latest advances in the modeling and assessment of learner skills. They concluded by discussing related advancements in modeling other key constructs such as learner motivation, emotional and attention state, meta-cognition and self-regulated learning, group learning, and the recent movement towards open and shared learner models.

Aleksandra et al. [7] proposed a paper titled as "e-learning personalization based on hybrid recommendation strategy and learning style identification". This structure identifies different patterns of learning stylishness and learners' habits through testing the learning styles for students and quarrying their serverlogs. Firstly, it processes the clusters based on different learning methods. It examines the habits and the interests of the learners through mining the numerous sequences by the Apriori algorithm. Finally, this system finishes personalized recommendation of the learning content rendering to the scores of these numerous sequences, provided by the Pouts system. Some experiments were carried out with two real groups of learners: the experimental and the control group. Learners of the control group learned in a normal way and did not receive any recommendation or guidance through the course, while the students of the experimental group were required to use the Protus system. The results show suitability of using this recommendation model, in order to suggest online learning activities to learners based on their learning style, knowledge and preferences. This paper describes a personalized e-learning system which can automatically adapt to the interests, habits and knowledge levels of learners. The differences between the learners are determined according to their previous knowledge of the matter, their learning style, their learning characteristics, preferences and goals.

DM scheme have to do with the discovery of secreted association to facilitate individual in learning databases. As we identify extensive assortment of information is stored in learning databases, so in order to get required data and to find the secreted relationship, for that different data mining scheme are developed and used. Some of the articles discussed here provide a better understanding in learning resources.

III. ROLE OF CLASSIFICATION ALGORITHMS FOR LDM

Learning data mining is explain part of scientific doubt come to mind mainly and around the progress of methods for making breakthrough within the singular kinds of data that come from learning settings, and using those methods to better understand students and the settings which they learn. This section discusses about the difference between consequences of students performance learning evaluation system that they use the classification algorithms. Many investigators explores about Students Performance Learning System (SPLS) in their

research work. Classification is an easy method of noticeable prototype that recognizes the relevant features of information classes or impression, for the purpose of being able to use the model to guess the class of stuff whose class marker is nameless. It calculates separate and unordered marker in huge information sets. Institutions across the sphere are migrating toward the use of Technology Based Learning (TBL) to improve students' knowledge. The advantages of using computer knowledge for learning measurement in a global sense have been recognized and these include lower administrative cost, time saving and less demand upon teachers among others.

Saeed et al. [8] proposed a case study on "Emerging Web technologies in higher education: A Case of incorporating blogs, podcasts and social bookmarks in a web programming course based on Students' Learning Styles and technology preferences". This research work has been suggested to incorporate evolving web technologies into higher education based on student's learning methods and technology preferences and a case study has been approved to authorize the proposed structure. An achievement research methodology has been assumed to carry out the study, which covers a study about student's learning methods and technology preferences and incorporating a combination of developing web technologies based on the review findings; and examining key achievements and deficiencies of the study to redefine research purposes. The study delivers support for the suggested framework by highlighting the significant relationships among student's learning methods and technology preferences and their impact on academic presentation. Their findings propose that today's learners are flexible in stretching their learning methods and are able to accommodate different instructional policies including the use of evolving web technologies. They further proposed that learning methods of today's learners are flexible enough to understanding different technologies and their technology preferences are not restricted to a particular technology.

Another article titled as "Microblogs in Higher Education—A chance to facilitate informal and process-oriented learning?" was done by Ebner et al. [9]. This paper reports on a research study that was carried out on the use of a microblogging platform for process-oriented learning in Higher Education. Students of the University of Applied Sciences in Upper Austria used the tool throughout their course. All postings were carefully tracked, examined and analyzed in order to explore the possibilities offered by microblogging in education. It can be concluded that microblogging should be seen as a completely new form of communication that can support informal learning beyond classrooms.

Yadav et al. [10] proposed prediction in a paper titled "Data mining: A prediction for performance improvement of engineering students using classification". In this paper, Classification methods like decision trees, Bayesian network etc can be applied on the learner data for calculating the student's performance in examination. This prediction will help to find the weak students and help them to score better marks. The C4.5, ID3 and CART decision tree algorithms are applied on engineering student's data to predict their performance in the last semester examinations. The result of

the decision tree expected the number of students who are likely to pass, fail or promoted to succeeding year. The results offer steps to increase the performance of the students who were expected to fail or promoted. After the announcement of the results in the final examination the marks acquired by the students are fed into the system and the results were examined for the next session. The comparative study of the results states that the prediction has helped the weaker students to improve and got out improvement in the result. They suggested that the Machine learning algorithms such as the C4.5 decision tree algorithm can learn effective predictive models from the student data accumulated from the previous years. The empirical results show that we can produce short but accurate prediction list for the student by applying the predictive models to the records of incoming new students. This study will also work to identify those students which needed special.

Wu et al. [11] have conducted a survey on "Top 10 algorithms in data mining". This paper offerings the top 10 data mining algorithms approved by the IEEE International Conference on Data Mining (ICDM) in Dec. 2006. C4.5, *k*-Means, SVM, Apriori, EM, PageRank, AdaBoost, *k*NN, Naive Bayes, and CART are considered for this analysis. These top 10 algorithms are among the most influential data mining algorithms in the research community in all fields of DM and its applications. They analyzed with a formal tie with the ICDM conference, Knowledge and Information Systems has been publishing the best papers from ICDM every year, and several of this papers cited for classification, clustering, statistical learning, and association analysis were selected by the previous year ICDM program committees for journal publication in Knowledge and Information Systems after their revisions and expansions. In the same conference many of the articles discussed about the use DM algorithms for the prediction of student's performance by using the various DM algorithms.

A paper titled as "Constructing a personalized e-learning system based on genetic algorithm and case-based reasoning approach" was done by Huang et al. [12]. Their suggested approach is built on the evolution method through computerized adaptive testing (CAT). Then the genetic algorithm (GA) and case-based reasoning (CBR) are engaged to build an optimal learning path for each pupil. This paper makes three critical contributions: (1) it presents a genetic-based curriculum sequencing approach that will generate a personalized curriculum sequencing; (2) it illustrates the case-based reasoning to develop a summative examination or assessment analysis; and (3) it uses empirical research to indicate that the proposed approach can generate the appropriate course materials for learners, based on individual learner requirements, to help them to learn more effectively in a Web-based environment.

Kotsiantis et al. [13] predicting students performance in the article "A combinational incremental ensemble of classifiers as a technique for predicting students' performance in distance education". This paper predicts a student's performance could be useful in a great number of different ways associated with university-level distance learning. Students' marks in a few written assignments can constitute the training set for a supervised machine learning algorithm. Along with the

explosive increase of data and information, incremental learning ability has become more and more important for machine learning approaches. The online algorithms try to forget irrelevant information instead of synthesizing all available information. Nowadays, combining classifiers is proposed as a new direction for the improvement of the classification accuracy. Among other significant conclusions it was found that the proposed algorithm is the most appropriate to be used for the construction of a software support tool.

Recent Methodologies for Improving and Evaluating Academic Performance is carried out by Ajay Varma and Y. S. Chouhan in [14]. The aim of this study is to provide the review of different data mining techniques that have been used in educational field with regard to evaluation of students' academic performance. Academic Data Mining used many techniques including classification algorithms and many others. Using these techniques many kinds of knowledge can be discovered such as association rules, classifications and clustering. The discovered knowledge can be used for prediction and analysis purposes of student patterns. The literature indicates that among the three methods of classification with respect to academic performance, the most widely used classification techniques in educational domain is decision tree.

Zafra et al. [15] analyzed a paper titled "Multiple instance learning for classifying students in learning management systems". In this paper, a new attitude built on multiple instance learning is suggested to predict student's performance and to increase the gained results using typical single instance learning. Multiple instance learning provides a more suitable and optimized representation that is adapted to available information of each student and course eliminating the missing values that make difficult to find efficient solutions when traditional supervised learning is used. To check the efficiency of the new proposed representation, the most popular techniques of traditional supervised learning based on single instances are matched to those based on numerous instance learning. They concluded that computational experiments show that when the problem is regarded as a traditional supervised learning problem, the results obtained are lower than when the problem is regarded as a multi-instance problem. Concretely, the Wilcoxon rank sum test determines with a confidence of 95% that algorithms using multiple instance learning representation achieve significantly better solutions.

A Comparative Analysis on the Evaluation of Classification Algorithms in the Prediction of Students Performance is discussed by Anuratha and Velmurugan in a research work [16]. The goal of this study provides an analysis of final year marks of UG degree students using data mining methods, which carried out in three of the private colleges in Tamil Nadu state of India. The major objective of this research work is to apply the classification techniques to the prediction of the performance of students in end semester university examinations. Particularly, the decision tree algorithm C4.5 (J48), Bayesian classifiers, *k* Nearest Neighbor algorithm and two rule learner's algorithms namely OneR and JRip are used for classifying the performance of students as well as to develop a model of student performance predictors. The result of this study reveals that overall accuracy of the tested

classifiers is above 60%. In addition classification accuracy for the different classes reveals that the predictions are worst for distinction class and fairly good for the first class. The JRip produces highest classification accuracy for the Distinction. Classification of the students based on the attributes reveals that prediction rates are not uniform among the classification algorithms. Also shows that selected data attributes have found to be influenced the classification process. The results showed to be satisfactory.

Thus, this section discussed about the methods used for learning data mining and some other appropriate theme which are used for the principle of improving both learner performance as well as the syllabus of a particular institution. In the largest part of learning setup, a considerable quantity of instructor and learner time is committed to activities which involve assessment by the instructor of learner products or activities. Consideration is given to outcomes involving learning approach, inspiration, and reaching. Where promising, mechanisms are elective that could version for the reported effects. The end resulting from the character meadows are then merged to manufacture an incorporated sketch with clear inference for active learning practice. The main end is that classroom evaluation has powerful direct and circumlocutory Condit, which may be optimistic or pessimistic, and thus merit very thoughtful arrangement and achievement.

V. CLUSTERING ALGORITHM FOR LDM

Clustering as the name suggests is the process of grouping data into classes, so that objects within a cluster have high similarity in comparison to one another, but are very dissimilar to objects in other cluster. Dissimilarities have been observed on the basis of attribute value describing the objects often distance used. It is the process of identification of similar classes of object. It has been used as a grouping a set of physical or abstract objects into classes of similar objects. A cluster is a collection of data objects which are similar to another within the same cluster and dissimilar to the object in other cluster. It is an unsupervised learning technique that shows the natural groupings in data.

Application of k-Means Clustering algorithm for prediction of Students' Academic Performance was discussed by Oyelade et al. in [17]. In this paper, they implemented k-means clustering algorithm for analyzing students' result data in a good manner. The model was combined with the deterministic model to analyze the students' results of a private Institution in Nigeria which is a good standard to monitor the evolution of academic performance of students in higher Institution for the purpose of making an effective decision by the academic organizers. It also enhances the decision making by academic developers to monitor the candidates' performance semester by semester by improving on the upcoming academic results in the subsequent academic meeting.

A paper titled as "Clustering and sequential pattern mining of online collaborative learning data" was done by Perera et al. [18]. They explore how useful reflect information can be mined via a theory-driven approach and a range of clustering and sequential pattern mining. The context is a senior software development project where students use the collaboration tool track. They mined patterns distinguishing the better from the

weaker groups and get insights in the success factors. The results point to the importance of leadership and group interaction, and give promising indications if they are occurring. Patterns indicating good individual practices were also identified. They found that some key measures can be mined from early data. The results are promising for advising groups at the start and early identification of effective and poor practices, in time for remediation. They suggested that this work will enable the learner to provide regular feedback to students throughout the semester if their present work performance is more expected to be associated with positive or negative outcomes and where the problems are. A comparative analysis of various technologies used by different researchers is given in the table 1, which gives an insight about the each and every paper taken for analysis in this survey work.

Table 1: Comparative Analysis

Reference	Authors	Methods used	Results
1	Dietz-Uhler et al.	Learning analytics	This studies have indicated individual faculty can make use of the data they have available in their courses to affect change and improve student success.
2	Martin et al.	Bibliometric analysis	The study analyzed by bibliometric analysis which technologies were successful and became a regular part of learning systems
3	Delavari et al.	HAL	The final result from each model with various techniques, presented that they are all performing similarly.
4	Peng et al.	DMKD	This paper acknowledged eight main areas of DMKD
5	Chen et al.	BWL	The BWL system was specifically developed to integrate the scaffolding model with the system.
6	Desmarais et al.	Cognitive Modeling	Modeling other key constructs such as learner motivation, emotional and attention state, meta-cognition and self regulated learning, group learning, and the

			recent movement towards open and shared learner models.
7	Aleksandr aet al.	Tutoring system	Describing learning style, learning characteristics, preferences and goals.
8	Saeed et al.	Learning styles	Suggested that learning styles of today's learners are flexible enough to experience varying technologies and their technology preferences are not limited to a particular tool.
9	Ebner et al.	Microblogging	Microblogging should be seen as a completely new form of communication that can support informal learning beyond classrooms.
10	Yadav et al.	Decision tree	The Machine learning algorithms such as the C4.5 decision tree algorithm can learn effective predictive models from the student data accumulated from the previous years.
11	Wu et al.	Classification Algorithms	Cited for classification, clustering, statistical learning, and association analysis.
12	Huang et al.	Genetic algorithm	Suggested three critical contributions.
13	Kotsiantis et al.	Naive Bayes	Among other significant conclusions it was found that the proposed algorithm is the most appropriate to be used for the construction of a software support tool.
14	Ajay Varma and Y. S. Chouhan	Bayesian Network	The most widely used classification techniques in educational domain is decision tree.
15	Zafra et	Multiple	Single instances are

	al.	instance learning	compared to those based on multiple instance learning.
16	Anuratha. C and Velmurugan. T	C4.5, Bayesian classifiers, kNN algorithm, OneR and JRip	JRip produces highest classification accuracy
17	Oyelade et al.	k – mean clustering	Enhances the decisionmaking by academic developers to monitor the candidates' performance semester by semester by improving on the upcoming academic results in the subsequent academic meeting.
18	Perera et al.	Collaborative Learning	Enable the learner to provide regular feedback to students during the semester if their current work behavior is more likely to be associated with positive or negative outcomes.

VI. CONCLUSION

The recent technologies like educational websites, smart phones, internets, mobile phones, PDA devices, iPods and software oriented methods like power point presentations, social networks and information repositories are create high impact in the learning as well as teaching process. These technologies are the main keys of modern world nowadays. This survey work addresses the significance of LDM in order to make use of such technology oriented facilities. A number of articles written by using DM algorithms are reviewed in this work, which is utilized for the improvement of student's performance. Based on the observation, many DM algorithms are suitable for LDM. From the various researchers' perspectives, it is enlisted that many advanced technologies are effectively used for learning process. Also, most of the recent teaching methodologies are effectively created high impact in improving the personally as well as the performance of students. Most of the research work has new methods and patterns to maximize the student's performance through LDM techniques. Some of the clustering algorithms and classification algorithms like ID3 and C4.5 are used to identify the various categories of students' performances. For the chosen data concept by the various researchers, the behavior and performance of both the categories of algorithms differ. Many research works finds that C4.5 classification algorithm stamps its superiority in classifying student categories. Thus,

this work concludes that the recent technologies are more useful and a gift for quick learning with less cost.

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