Review Article

Predictive Learning Analytics for Student Success towards Outcome Based Education Perspective

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Abstract - *Learning analytics is useful technology in examining students' learning performance, skill and attitude in learning environment. It also takes to the next level i.e. rather than focusing on the past issues, it helps to predict learners' future success. The key accountability of most of the education systems is student success. It may be measured as graduating from college, qualifying for a job or further education, acquiring a specified set of skills, or achieving needed credentials. Outcome Based Education is a learner-centered approach that focuses on measuring students' attainment and achievement based on activities and assessments. By leveraging predictive analytics in OBE, faculty members and mentors can identify the non-attainment of the graduate outcomes of a student and intervene earlier with higher impact. Personalized learning style which focuses on the needs of each student and a practice. The proposed approach assists faculty to measure the attainment status of a student with respect to OBE assessment and also predicts the academic performance of students towards Outcome Based Education perspective.*

Keywords - *Learning Analytics, Outcome Based Education, Outcome Based Attainment, Education Analytics, Student Success, Outcome Based Analytics.*

I. INTRODUCTION

Providing quality education to the students is an essential part in higher education learning institutions. Students are the key stakeholders of colleges/universities, and their performance activities contribute significantly to a country's social and economic development by creating talented graduates, entrepreneurs, and innovators. Student's performance can be analysed by measuring the learning assessment and co and extra curricula activities. It provides valuable information for educational authorities which offer diverse opportunities for decision making to and assisting the students to achieve a great performance in their studies. Most of the studies mentioned about graduation being the measure of student's success. Data analytics is one of the most popular techniques used to analyse students' performance. It extracts valuable information from a huge educational database. It is an emerging technique that applied to monitor student performance by combining statistical analysis and predictive modelling that can be used to change academic behaviour of a student.

Current academic model is implemented as hybrid approach such as Choice Based Credit System (CBCS) of flexibility in credit earning, course learning method and outcome driven education model. OBE is a Learner focused methodology that emphases on measuring student performance. It provides a progress for students to articulate the knowledge, skills and experience acquired during their program. It can improve teacher and student perceptions of the education process. The core components of Outcome Based Education (OBE) are College Vision and Mission, Program Vision and Mission, Program Educational Objectives (PEO), Program Outcome (PO) and Program Specific Outcome (PSO), Course Outcome (CO). The teaching and assessment are organized to attain stated educational objectives and outcomes. The Programme Educational Objectives defines that the expected successes in their career and what the graduates should be able to do and succeed in the first three/four years after graduation. Programme Outcomes (POs) describes that what students should be able to do by the time they graduate and Programme Specific Outcomes describes what students can do in their specific discipline. Course Outcome(COs) describes the knowledge, skills and abilities that students are expected to know, understand and perform as a result from their learning experiences in each course. The accreditation bodies such as NAAC, NBA also emphasizes an outcome based systematic approach to education. It concentrates on measuring students' achievement in accordance with the program outcomes based on assessments.

The learning outcomes are used at all stages of the students' academic life. It transforms the learner's experience by augmenting knowledge, skills, abilities, IQ, values and judgement. It is proactive learning and the best way to learn

is to determine the outcomes. Student Information Systems (SIS) stores vast amounts of student data, including: student education details, assessment details (continuous internal assessment and end semester assessment), and semester historical data and other grade information. These data need to be aggregated and analyzed to make informed decisions about how best the student and predict their potential to succeed, and graduate based on OBE. Predictive analytics identifies multiple variables from the SIS and align them with OBE goals to student performance analysis and also it increases the institutional efficiency. It also helps to the faculty members to evaluate the student performance with assessment metrics such as CIA test scores, activity performances, persistent failures, and low grades or poor marks and also identify to predict the students who are most at risk at their academic progress.

Faculty members are currently using Microsoft spread sheets for assessing OBE attainment and analysis. They are in the need to monitor individual students' performance and adapt suitable analysis approach to attain the graduate outcome and improve their performance. And also the system should intervene in student performance if there any risk. The proposed customized outcome based analytics approach will measure the outcomes of a student considering student CIA and external assessment with bloom taxonomy. The dash board visualisation of the course outcome and programme outcome will helpful to the faculty member to identify the status of a student progress.

II. STUDENT LEARNING ANALYTICS

Learning Analytics measures, collects, analyse and report of the data about learners and their background progress. Learning analytics aids educational institutions in improving teaching policies and methods. It also provides personalised learning experience. It holds the ability to predict learner performance and improves quality of outcomes. Assessment of course learning outcomes is a fundamental measure of student learning success in a course and program study. As the complexity and amount of data collected from the teaching-learning process increases, learning analytics can be benefited to all stakeholders in education including students, teachers, administrators and policy makers. The learning analytics can support to improve the education process such as understands students' learning behavior, improves student retention, personalized assistance to students and provides timely feedback and intervention. The learning analytics can reduce the achievement gap, increase learner success and improve the quality of education [1].

The traditional method for learning analytics has been used statistics, but the development of information technology has revolutionized the capabilities of analysis with tools, and methods of analytics. Types of analytics are commonly used, namely Static Reports, Interactive Dashboards, Predictions, and Recommendations. A static report does not have the facility to carry out dynamic analysis on the situation, e.g. getting different views on the data. Interactive dashboards are reporting procedure which provides a summary view on key metrics and indicators of an Institution. It can offer a real-time view on the performance of a student. Predictive analytics is the fastest growing type of analytics. It is an application that makes predictions based on historical data using a statistical algorithm. It can provide to the students / institution with intuitive and better decision making. Recommendations also called Prescriptive Analytics as the applications answer questions like, "what action or selection optimally meets the target?" Predictive models are used in learning analytics to include actionable data. It also promises more personalised learning which would enable students to have more significant learning experiences[13].

The student learning data collected in the beginning of the programme and end of every semester in the period of the study supports the potential for early prediction. The extraction and aggregation of meaningful indicators from the students' data predicts students' performance. It is beneficial to support the teachers and learners improving their teaching and learning process. Student Learning Analytics is personalizing the learning process for each student and identifying to their strengths and encouraging improvement. It provides the early intervention and develops the students with a positive goal toward their studies. It records students' learning behavior, performances, provides the learning information and analysis to stakeholders and improves the outcomes of higher education. It also helps to make analyzing the data using tools and techniques for attainment visualization of the future. Various methods have been proposed by the researchers to analyse the student best performance. The machine learning, deep learning and data mining techniques are used to analyse the students' success. The visualization will help to know and support students' performance and success.

The systematic detailed literature analysis identifies the significant characteristics in predicting students' performance. The frequently used attributes are external and internal assessments. Buenaño Fernández, D and Luján-Mora S presented a survey of educational data mining and learning analytics tools and techniques [2]. Eduardo Fernandesa et al., presented the academic performance of public schools of the Federal District of Brazil students using predictive analysis. A descriptive statistical analysis was presented to improve vision from data. Classification models based on the Gradient Boosting Machine (GBM) were created to predict academic outcomes of student performance [3]. Viet Anh Nguyen et al., proposed a learning analytics model to predict learning outcomes based on interactive data of students with the online learning system [4].

There is a lack of studies on the reasons affecting student's achievements in specific courses. Amirah Mohamed Shahiria presented a detailed literature review on forecasting the student performance by using data mining techniques to improve student's achievements [5]. Asiah Mat et al., reviewed current study on predictive model of student academic performance [6]. Most of the researchers have used CGPA, attendance, gender and assessment mark. Dynamic early indication of student progress with the kind of recommendations that students, teachers, families, and schools can use to best guide learning. Beth Dietz-Uhler & Janet E. Hurn provided an learning analytics summary which includes tools to extract, track, and analyze data. They explored various applications, goals, and examples [7]. Christothea Herodotou et al., estimated students' performance and teachers and assists students at risk[8]. Manuel Fernandez-Delgado et al., applied the Support vector machine classifier to predict achievement of educational objectives of a subject [9].

IBM suggested that the diverse methods to develop student achievement like individual student performance monitoring and identifying outliers, Predicting potential and Analysing standard assessment techniques and instruments [10]. Pooja Chaturvedi, and A. K. Daniel proposed a learning analytics model combined with classroom data analytics. The learning skills adopted by the learners are evaluated against the outcome of the course/subjects using the Naive Bayesian classification technique. The performance of the classifier is evaluated against the ZeroR, SimpleCart, Random Tree, and Decision Table classification technique in terms of precision, recall, and accuracy[11]. Sahar Yassine et al., proposed a structure for developing analytics tool to assess the outcomes in the well-known open source LMS Moodle. The framework is based on direct measure of the course learning outcomes through embedded examination of each outcome and its associated LMS activities, then to analyse the result in order to evaluate the achievement of program outcomes [12].

This paper presented a method to measure students' performance in respect to OBE attainment concept. Student Analytics and graphs used to predicts student academic performance and success towards course outcome and programme outcome of an individual student.

III. PROPOSED FRAMEWORK: OUTCOME BASED LEARNING ANALYTICS

The proposed research framework is divided into two layer phases such as OBE Design and Learning analytics.

A. OBE Model Design & Development

Outcome based Education has been implemented in to approaches. Educational objectives and outcomes are designed and stated in Top-down approach and the design of assessments for classes is done following a bottom-up approach. Now a days all the colleges (engineering, arts and science, pharmacy, education) have planning in OBE implementation. To measure Outcome-Based Education attainment PEO, PO, PSO, CO are defined and implemented. Course Articulation Matrix shows the relationship between CO and PO of a Course. This matrix indicates the level of achieve the course learning objectives. Program Articulation Matrix shows the relationship between CO and PP of all courses in the curriculum.

Outcome Based Assessment process identifies, collects and prepare students formative and summative data to evaluate the achievement of course outcomes and program outcomes. To obtain Course Outcome, every internal assessment metrics mapped to their corresponding CO's. For example, Test - CO1, Quiz - CO2, Seminar – CO3, Assignment – CO4.

A rubric represents the performance expectations for an assessment. It helps to dene the threshold through which level of attainment of a CO's are calculated. Attainment is the achieving a standard result towards accomplishment of desired goals. It is observed by test and/or examination result. Assessment methods are categorized as direct method and indirect method to access CO's and PO"s. The direct methods display the student's knowledge and skills from their performance in the continuous internal assessment tests, semester examinations and supporting activities such as seminars, assignments, case study, group discussion, online quiz, mini project etc., These methods provide a sampling of what students know and/or can do and provide strong evidence of student learning. The indirect method done through surveys and interviews, it asks the students to reflect their views of each course on students' learning.
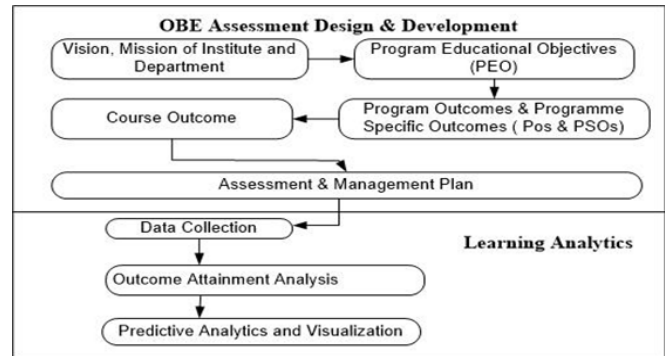

Fig. 1 Outcome based learning analytics

B. Learning Analytics towards OBE

Data Collection: The detailed dataset is collected from the students in the two modes such as direct assessment data and indirect assessment data. The direct assessment data are collected from the student academic information repository. The indirect assessment data are collected using Google form survey.

Outcome Attainment Analysis: Descriptive statistical analysis techniques are applied to calculate the attainment and gain insight from data. The process of CO and PO attainment is explained as below:

- Obtain course outcome.
- Map the course outcomes with program outcomes.
- Assign weightage for CO assessment.
- CO measurement through assessment.
- Obtain CO attainment table through direct and indirect assessment methods.
- Obtain PO attainment table through direct and indirect assessment methods.

Predictive Analytics and Visualization: The data for each student lead to specific insights about the student's learning progress. The attainment are prepared, analytics identifies student success. This predictive visualization analysis ultimately produces actionable intelligence, such as an alert to a faculty member that a student may be at risk of failing. User-friendly interactive web visualization is presented. It provides all the information to educators to perform an intuitive and in-depth analysis.

IV. EXPERIMENTAL RESULTS AND DISCUSSION

This work is implemented using PHP & My SQL. Dash board is created with greater visibility and accessibility of data in a simple and effective manner. To measure the Course Outcome and Program Outcome, initially the Course Articulation Matrix and Program Articulation matrix are uploaded. CO attainment is calculated by direct assessment method and indirect assessment method. They are considered for 80% and 20% weightages respectively. Direct assessment methods used are grouped into two categories: Internal Assessment components (20%) includes test, assignment, seminar, quiz and External Assessment (80%) includes online and Theory. In the tests, all the questions are mapped with Blooms level and on their CO's. This helps to calculate the performance of a student for a CO. The rubrics used for calculating CO Attainment - CO level are: 50% of Student Above 40% = 1; 60% of Student Above 40% =2; 70% of Student Above 40% =3. The direct final course outcome attainment calculations is shown in the fig. 2 and indirect course outcome attainment calculations is shown fig.3.

Fig. 2 Course outcome calculation – Direct assessment

Fig. 3 Final course outcome calculation – Direct & Indirect Assessment

Program Outcomes are also achieved through the direct and indirect methods. The PO attainment is calculated by using the predefined CO/PO matrix and the value of Final CO attainment for the subject. It is calculated by the Avg, of CO's of a PO / 3 is multiplied with Final CO attainment for the subject. The rubrics used for indirect calculation are: 60% Persons are giving above 3=1; 70% Persons are giving above 3=2; 80% Persons are giving above 3= 3. Then, the indirect program attainment is calculated by the Sum of levels of attainment of a PO is divided by 3. The final PO Attainment is shown in the fig.4.

Fig. 4 Final PO attainment

The individual student all course outcome and course total course outcome analysis and attainment in the course is shown in the fig.5 and fig.6. This graph is used to identify the student course knowledge, skill and attitude attainment.
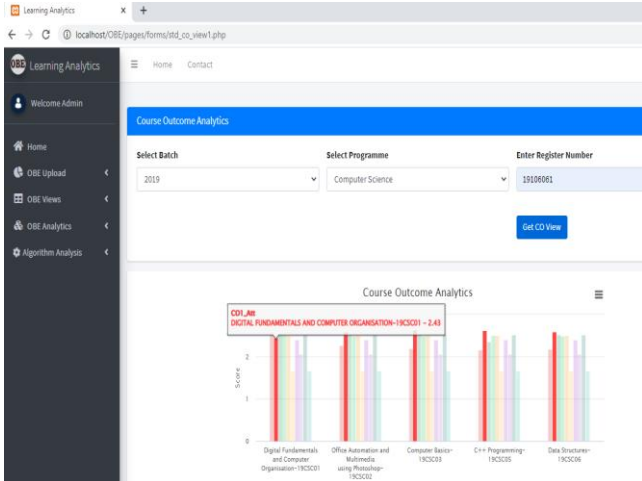
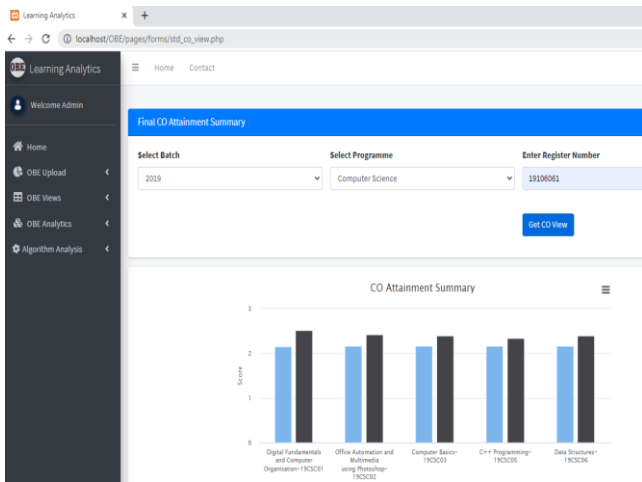**Fig. 5 Attainment of all course outcome in a course in a semester**

Fig. 6 Attainment of course outcome in a semester

The analytical graph can be used by the faculty to motivate the students and improve their knowledge and skill. It will be helpful to track the attainment status in the course / programme outcome.

V. CONCLUSION

Learning analytics is a powerful instrument to inform learners, faculty members, administrators and parents about the student's performance and the progress of the learning process. It is used to forecast student success by examining what and how students learn and how success is maintained by academic programs and institutions. The proposed Outcome analysis and individual student's performance tracking method help students map their progress and status of success toward a degree based on outcome based education approach. It determines their academic pathway and improves skills to enhance their education. It also used to inform the instructor to take corrective actions. It identifies student who want special care and taking suitable action at a right time. In future, Learning Analytics can be integrated with College LMS to assess course learning outcomes and predict the student performance and achievement against specific outcomes. The machine learning and deep learning techniques can be applied to improve the prediction level. And also variable assessment can be chosen for the student attainment prediction.

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