Computational Analytics for Measuring Successive Attainment of Course Outcomes

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ABSTRACT

Analytical techniques in software brings edge over traditional information systems. The intervention of technology in teaching learning progress has manifold advantages. However, the data generated in these systems like other software systems is enormous and may be periodic or aperiodic. The data is generated by registration system, administration system, and learning management system. In this paper, we propose and demonstrate automated computational analytics that shall measure the attainment of course outcomes. The proposed system is illustrated with a sample case study of course. The demonstrated case study aids to develop and improve the processes of attainment and highlights the nuances to readers; however this does not claim completeness or idealness of the case.

Keywords: Analytics, Course Outcomes, Assessment Methods.

INTRODUCTION

The generation and growth of data is inevitable as computers have penetrated in everyday life. The technical challenges of data are its storage, size, variety, and the frequency of arrival. Educational management systems are not exception to explosion of data. Use of data mining and learning analytics in every application has become formidable. Analytics in course management shall facilitate in revealing, abstracting, and organizing more information. In this paper, we shall be applying analytics to measure course outcomes with various combinations that shall facilitate Instructors to focus on growing and weaker side of learning. Analytics shall produce parameterized computations of attainment of whole learning class. The reports produced are well documented and useful for decisions to be taken on further improvement cycle.

The content delivery in the class are planned by faculty has variety of modes. Instructors have to take many decisions like: curriculum topics, assessment methods, students' performance, Instruction, and more. Taking decisions is challenging task; rather correctness of decision is more challenging, if the following parameters are also considered in the process:

(a) Planning and designing (redesigning in the next cycle) effective course instruction, (b) Recording and monitoring performances involved in the processes,
(c) Predicting optimal performance,
(d) Planning and identifying suitable assessment techniques, (e) Selecting and addressing the groups that needs attention,

(f) Cumulating the performance over different electives, etc., and
(g) Evaluating, designing, and testing the course contents and resources.

This motivates the computational analytics that shall collect, analyze, and generate reports for decisions and presentations using data from academic, learning, and assessment systems.

LITERATURE SURVEY

Learning Analytics [10,11] is defined as "the measurement, collection, analysis, and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs."

There are research attempts [5, 6, 12, 13] in different directions that collect data and uses it for the effectiveness of teaching learning processes. An e-learning tool [12] based on object oriented approach that uses texts, graphics, and audio as objects. If the student requests tool, then customized course is dynamically created based on profile available in learning management systems. There are available also other tools [14] in learning analytics that facilitate in taking the management of courses.

In the literature there are approaches and methods [1, 3] on delivering contents to the audience. The remote learning management systems are used to transmit the delivery methods [13] wherein contents based on request are made available. It has more focus on delivering automatically transmitting contents to remote learning management system. It also maintains and updates automatically the course catalog. The Academic Analysis Tool [15] is the software that uses computational analytics to student's behavior that reflects how students learn and use the courses.

System Architecture of Implementation for Measuring the Attainment of Course Outcomes

The cycle of 'design – delivery – assess' in the class-rooms, we have implemented by providing computation analytics. This implementation allows to focus more on (a) effectively bringing up the course outcomes that are low scale in attainment, (b) redesign the course outcomes to cover more scope and contents that are high scale on attainment. This implementation gives results in quantized values mapped with parameters of interests especially in the assessment and delivery of contents.

The implemented methodology gives flexibility in planning and defining the sequence of assessment, and in assigning weightages. Models built provide results on the attainment of course outcomes.

Figure 1 depicts the system architecture with layout of components. Its implementation computes attainment of course outcomes. Following are the analytical modules or components used in the system architecture:

- Course Outcomes module,
- Assessment Design module,
- Learning Analytics module, and
- Report generation module

There two main interactive modules are: (1) Course Outcomes module, and (2) Assessment Design module, for designing various types of assessments. This modules require to enter program outcomes mapped to course outcomes, as this forms basis of performance evaluation.

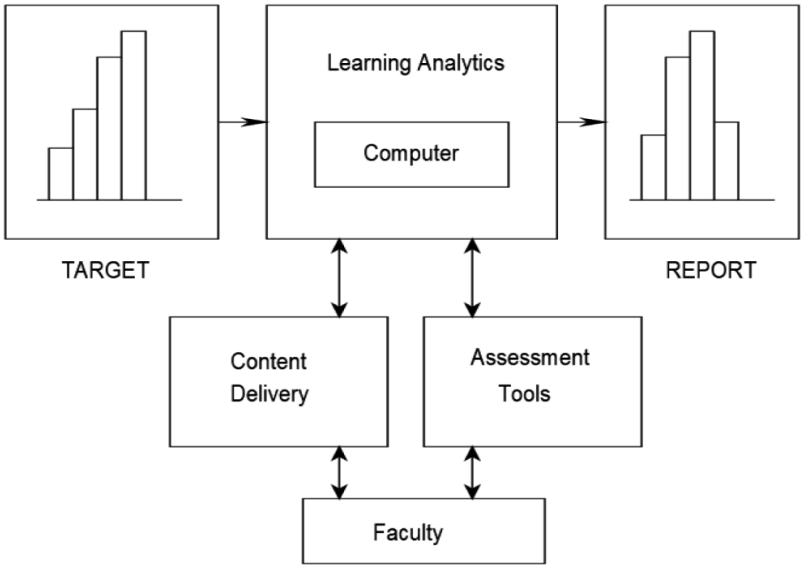


Fig. 1: System Architecture of Implementation for Measurement of Attainment of Course Outcomes

In the following section we shall illustrate the proposed computational analytics for a sample case study.

Case Study

The parametric computations of attainment of course outcomes are carried over the whole semester for the class that has following details. This sample case study is to demonstrate the thinking on developing various ways to improve the processes; and it does not claim completeness and idealness.

Course: Introduction to Business Analytics (IBA), Code: CT (DE)-14005, Course Type: Department Elective (DE) Students, Enrollment: 61, Duration: July 15, 2015 to December

15, 2015.

Assessment Methods

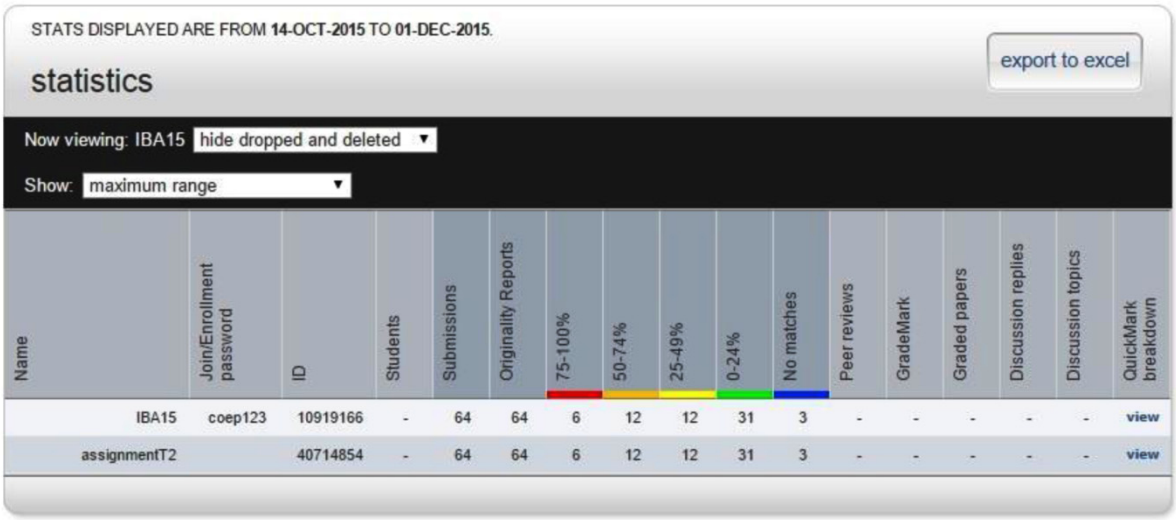
The complete course is with weightage of 100 units and is assessed in two parts: (a) continuous assessment during the semester and (b) an end semester examination upon conclusion of the course synchronized with institute/ university-wide schedule of other examinations.

Continuous Assessment

Continuous assessment carried weightage of 40 units. The objective of continuous assessment was to improve analysis, creativity, and writing skills. First Test examination was planned and was having objective test questions that make students to 'apply analysis' skills over the given examples. The half part of the questions were on understanding the basics of business analytics.

Second Test examination was an assignment that shall improvise the writing skills. Students were given topics from the course but not usually covered in text books or topics that shall require learning beyond the syllabus, or topics within research areas. Students were advised and facilitated to the use internet, Wikipedia, online books, other text books, and have to draft essay as complete comprehensive article. All the selected 61 students to this business elective (were having CGPA > 7.5; that is 40% from top side, from the 4th year B Tech class of 150 enrollment), were under test of these skills.

All the received assignment responses were evaluated through the plagiarism tool [4]. Assignments were iteratively asked to revise based on the scores. Final statistics of the results is given below in Figure 2. Most students did well, more than average in scores. After undergoing this exercise, the students have learnt the writing skills, analyzing the existing literature with respect to the topic of interest, and have become aware of how to practice it to improve further.


STATS DISPLAYED ARE FROM **14-OCT-2015** TO **01-DEC-2015**.

statistics

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Name	Join/Enrollment password	ID	Students	Submissions	Originality Reports	75-100%	50-74%	25-49%	0-24%	No matches	Peer reviews	GradeMark	Graded papers	Discussion replies	Discussion topics	QuickMark breakdown
IBA15	coep123	10919166	-	64	64	6	12	12	31	3	-	-	-	-	-	view
assignmentT2		40714854	-	64	64	6	12	12	31	3	-	-	-	-	-	view

Fig. 2: Statistics Depicting the Plagiarism Evaluation of Assignments Submitted by 61 Students in the Course. 31 Students have Written Exceptionally well. 24 Student's Writing is Accepted after Revision, while 6 Students Writing is Rejected

Semester Examination

This is termed as 'end semester examination'. The questions and problems were designed to examine how far the students have achieved the designed course outcomes. Partial coverage was on testing the understanding of students' ability to demonstrate the theoretical basis of concepts. The weightage given to this part of evaluation was 60 units. More weightage was given so that the evaluation shall correctly reflect the importance of attainment of course outcomes.

Mapping Course Outcomes to Questions and Curriculum

This is the crucial. What you map is what you see. The correctness should be ensured as the same gets validated further in the processes. The role of faculty is not replaceable compared to the

online/ objective type examinations, as these are subjective questions needs heedful design and choice to fit into the intended course outcomes; and that shall express rightly the importance of course topic.

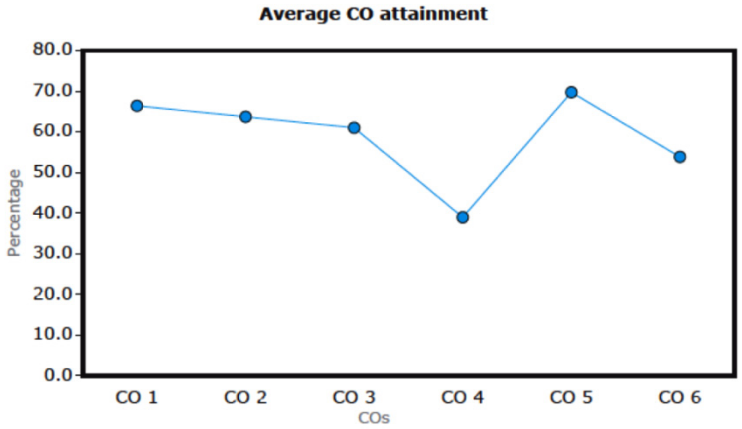
By mapping course outcomes judiciously benefits the teaching-learning process [8-10] in many ways:

- Identifies the contribution of course in achieving program outcomes,
- Linkages expressed directly shall allow to focus on attainment,
- Reflects in revealing gaps in curriculum, and
- Increases the attainment of student achievements in program outcomes.

This is continuous cyclic process, wherein Instructor's is involved in theory and practice, who designs, delivers, maps, what s/he wants to see.

Attainment of Course Outcomes

Parametric attainment of course outcomes (CO's) is important to take various decisions. Computations are continuous through-out the semester. In the following **Figure 3:** (a) to (d) shows the course outcomes attainment and its relevance mappings. An average course attainment is shown in (a), achievement of outcomes by numbers of students is shown in (b), and mapping of outcomes to Bloom's Taxonomy is shown in (c) and to Questions is shown in (d).



(a) Average Course Outcomes Attainment

	Number of students achieving 75% or more	Number of students achieving less than 35%
CO 1	13 (50 %)	3 (11.54 %)
CO 2	11 (42.31 %)	3 (11.54 %)
CO 3	15 (57.69 %)	5 (19.23 %)
CO 4	7 (26.92 %)	12 (46.15 %)
CO 5	15 (57.69 %)	3 (11.54 %)
CO 6	9 (34.62 %)	7 (26.92 %)

(b) Achievement of Course Outcomes

	Bloom's Taxonomy categories
CO 1	Analysis
CO 2	Application, Analysis, Synthesis
CO 3	Analysis
CO 4	Analysis, Synthesis
CO 5	Analysis, Synthesis
CO 6	Application, Analysis, Synthesis, Evaluation

(c) Classifying Course Outcomes to Bloom's Taxonomy

Questions	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
1	1	1				
2		1	1			
3					1	
4				1		
5						1

(d) Mapping of Questions to Course Outcomes

Fig. 3: Course outcomes attainment on an average shown in (a), achievement of outcomes by numbers of students is shown in (b), and mapping of outcomes to Bloom's Taxonomy and Questions is in (c) and (d) respectively.

With the given details of analytics of attainment in easy to use way, it allows to focus on practice and prepare for the next cycle:

1. CO's with having higher attainment can be formalized further by strengthening the relevant resource materials.
2. CO's having lower attainment, the contents delivery methodology may be switched to or recommended to attempt new ways to reach; or resource material that shall bring more concepts and illustrations be researched and offered.
3. Effectively by observing performance, the gaps in program outcomes can be minimized by revising CO's or by deleting or introducing new CO's.

In the following section we shall introduce, the sample rubric used in above mentioned analytics course. This can be discussed in appropriate academic forums/ program committees and also more importantly can used for comparing students performances across branches and still can keep the overall grading same.

Sample Rubric

In the following Table 1 shows the rubric used in evaluation to see the problems solving skills. The questions were specific and focused to see the attainment of these skills.

Table 1: Rubric Used to See Problem Solving Skills in the Sample Course Case Study

Topic	*Excellent (A)**	*Good (B)*	*Satisfactory(C)*	*Marginal Pass (D)*	*Fail (D)*
Problem solving skills	Can effectively Apply analytics techniques to solve a given problem	Can correctly apply analytics techniques to solve a given problem	Can apply analytics techniques to solve given problem with some degree of effectiveness	Can apply analytics techniques to solve substantial part of a given problem	Cannot apply analytics techniques to solve a given problem

*Grade range nomenclatures modified instead of AA, AB, BB… that is in actual practice.

CONCLUSION

The proposed methodology is implemented, is resulting in automated computational analytics for measurement of parametric attainment of course outcomes. We have demonstrated a case study that shows the effective use of computational analytics in validating the attainment. Since it is focused in showing attainment of outcomes, as is generic solution, this can be applied in general education or other professional education courses rather than restricting to engineering education.

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