

Effective use of Data Analysis and Data Visualization in E-Learning

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Abstract— Rapid development of Internet technologies has dramatically increased the ways of teaching and learning. Among these new approaches, online web based education has become a promising field. Every College and University is discovering exciting new ways of using information technology to enhance the process of teaching and learning and to extend access to new populations of students. In recent years the term ‘Data Science’ became more prominent word in higher education. For enhanced services through E-Learning, majority of academic institutions are adopting data analysis and data visualization techniques. Data science in higher educations is being used to identify the student needs, to gauge their skills in assessments and online learning. Besides, data analysis facilitates teachers to reflect on teaching and assessment standards. This paper we present sample case study that focus on how University of Technology and Applied Sciences(UTAS)will effectively utilize data science in E-Learning platform called as Moodle.

Keywords— Data science in academia, E-Learning, Analyzing assessments, data visualization

I. INTRODUCTION

Since the emergence of the Internet as a mainstream technology, there have been extreme views about the role of technology in learning. The rapid development of computer and Internet

technologies has dramatically increased the ways of teaching and learning. Among these new approaches, online web based education has become a promising field. College and Universities are discovering exciting new ways of using information technology to enhance the process of teaching and learning [1]. The combination of education and technology has been considered the main key to human progress. Education feeds technology, which in turn forms the basis for education. It is therefore not surprising that to be ‘developed’ is to have education based on science and technology [2]. Online education can be defined as an approach to teaching and learning that utilizes Internet technologies to communicate and collaborate in an educational context. This includes technology that supplements traditional classroom training with web-based components and learning environments where the educational process is experienced online [3]. The use of data for decision-making in educational institutions is neither a new topic nor an unknown practice. Data science is a broader term covering many diverse topics. Data science in the past few years has been used to refer to almost everything related to data (data analysis, data mining, machine learning, etc.). Languages such as R, Python, SQL, Scala, Java, Julia are popular for data science applications and provides many libraries for quick processing of data. For example, R provides thousands of packages (Approximately 15000) that can integrate with C++, Java, Python. R has become world’s largest repository for statistical knowledge. In recent decade, Python

become popular for data science, artificial intelligence, machine learning and internet of things.

II. MOODLE BASED VIRTUAL LEARNING

The emergence of Information and Communication Technology (ICT) has led to a tremendous interest to incorporate the constructivist problem based learning approach into the Web-based environment [4]. Technology will enable education that is learner-centric, individualized, and interactive, making education far more relevant to the needs of individuals. It will allow for anytime, anyplace learning, which will be particularly attractive to working adults, and it will enable true lifelong learning in a formal sense.

We at UTAS, incorporated the facility of an open source software Modular Object-Oriented Dynamic Learning Environment (Moodle) as E-Learning platform and is incorporated with college website(<https://elearning.ibriect.edu.om/>). Moodle can be used to create an informational website or an interactive learning environment online. It is an e-Learning portal being used as Communication tool, Student Collaboration, 24/7 Access, Student/teacher interaction, Online learning, Digital tools, Discussion board, Assessment Tools. Students of UTAS access E-Learning with their credentials (student id and password) to read course manuals, participate in forums, communicate with their friends of class, write quiz and submit assignments [1].

A course teacher can create assignments, open a chat, organize a choice (poll) for a selection or election, post questions to a forum, create lessons, design and give a quiz, initiate a wiki, conduct a workshop and can keep track of all these activities, and many more, with a variety of administrative tools. To give access to students, enrollment key for the topic need to be issued to students. Teacher is authorized to set the privileges of student to access the resources.

Online learning implies learner-centric education, where learners take responsibility to

choose learning activities of most value and relevance to them. Student willing to avail the services of Moodle portal has to register and acquire subject enrollment key from the teacher, join in forum and can discuss a topic of selection.

III. DATA ANALYSIS IN E-LEARNING PLATFORM

Data analysis refers to the process of examining, transforming and arranging a given data set in specific ways in order to study its individual parts and extract useful information. The terms data analysis and data analytics are interchangeable. The only difference is the scale of data. There are many open source data analysis tools which are user friendly and performance oriented. Some of the popular data analysis tools are: R programming, Tableau, Python, Rapidminer, SAS, Apache Spark, Microsoft Excel.

We define a sample scenario to illustrate data analysis and visualization on an assessment.

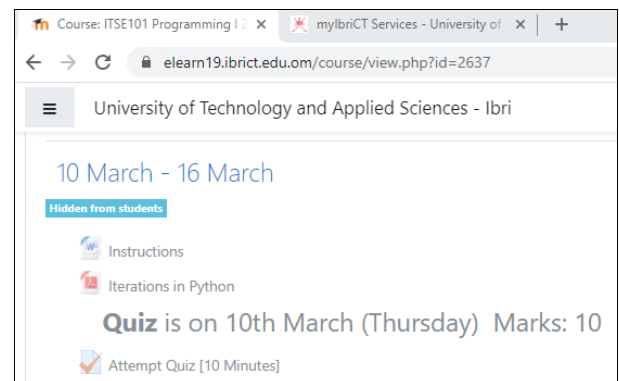


Fig 1: Scheduling a quiz in Moodle at UTAS

In Moodle, a prior information is given to students about the assessment as shown in Fig.1. Typically, it consists of assessment instructions and link to assessment. Assessment link (Attempt Quiz in Fig.1) is hidden until the quiz time.

Course teacher conducts an assessment using E-Learning platform. UTAS uses Moodle as E-Learning platform. Assessment process involves the following steps.

- Design an assessment based on given syllabus
- Upload the assessment in E-Learning (Moodle)

- Set the time for students to attempt the assessment
- Review the results
- Provide feedback on assessment and results and discuss with students.
- Device an improvement plan if the results are not as expected in relation with cognitive levels.

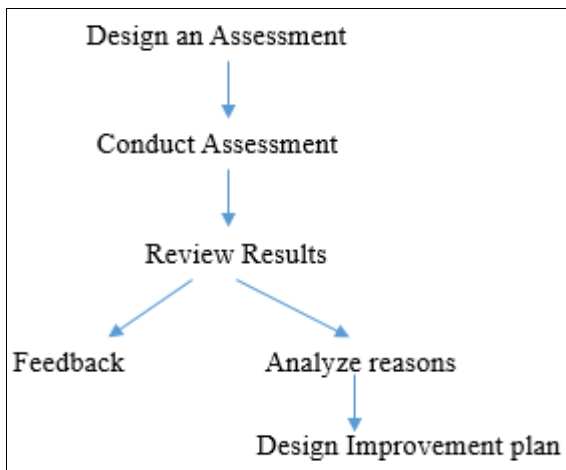


Fig-2: Assessment procedure in Moodle at UTAS

As shown in Fig-2, a course teacher prepares an assessment based on some criteria. At UTAS, assessment is prepared with two cognitive levels Low Order Thinking (LoT) and High Order Thinking (HoT). Questions of HoT category are increased difficulty levels and LoT are basically at knowledge and comprehensive levels [4] [5]. Upon reviewing results, the course teacher will follow one of the two choices. Feedback is prepared on assessment if the results are at accepted level. Variances in results will lead to analyze the reasons and design an improvement plan. This depends on multiple factors. One such a factor is students are well prepared and have answered majority. Other reason could be the assessment is made as easy. This means that applying cognitive skills is effective to this assessment and hence, the course teacher prepares a improvement plan for the next assessment.

The results of assessment can be accessed in .XLS file and can be converted to .CSV for visualization if required. For Illustration, we consider dataset with 10 students marks in quiz.

Table 1: Student's quiz marks

	A	B	C	D	E	F	G	H
1	ID	Q1	Q2	Q3	Q4	Q5	Q6	Total
2	S98234	1	1	1	0	2	0	5
3	S99271	1	1	1	2	2	2	9
4	J50022	0	1	1	1	1	0	4
5	S45902	1	0	1	1	1	1	5
6	J98387	1	1	0	1	1	2	6
7	J56210	1	1	0	2	1	2	7
8	J56924	1	1	1	1	0	0	4
9	J39027	0	1	1	1	2	2	7
10	S94414	0	1	1	1	0	2	5
11	S94909	1	0	1	1	0	2	5
12		7	8	8	2+7	3+4	6+1	5.7

The above table quiz of 10 marks for 10 students. It is clear that there are six questions (Q1 to Q6). This assessment is designed based on Fig-2 with 3 questions are with LoT cognitive level and 3 questions are with HoT cognitive level. The total score is shown in row 12 in the Table 1. A comparison is made between LoT and HoT. It clear that students scored good marks in LoT based questions (Q1, Q2, Q3) compared to HoT based questions (Q4, Q5, Q6). Still, column G which is Q6 is answered by majority of students (six out of ten students scored full marks). From the teacher perspective, it is deemed as not a HoT based question. There could be other reasons such as students performance, syllabus coverage, time duration.

IV. DATA VISUALIZATION

A large part of the human brain is devoted to vision; with some studies claiming that up to 80% of sensory input is processed by the visual pathway. The importance of vision is demonstrated by the use of the verb “see”. We see dreams; we see a solution etc. Hence, it is no wonder that data visualization is an essential part of data science [6].

As a statement says thousand word = one picture, visualizations makes easy for humans to understand. Data visualization plays important role in analyzing large datasets and real-time data [7]. At UTAS, data visualization involves the following phases: Data Collection, Numerical Transformation, Data Refining and Cleaning, Data

Analysis, Graphical Interpretation, User Interaction. Few courses have 200 to 300 student's data to be processed and visualized through graphs, charts, tables and maps. Data visualization is graphical representation of information. In the word of Big Data, visualization tools are essential to analyze huge amounts of information and make strategic decisions. Data visualization is useful for data cleaning, exploring data structure, detecting outliers and unusual groups, identifying trends and clusters, spotting local patterns, evaluating modeling output, and presenting results. Common general types of visualizations include: charts, graphs, maps, tables, dashboards and infographics[8][9].

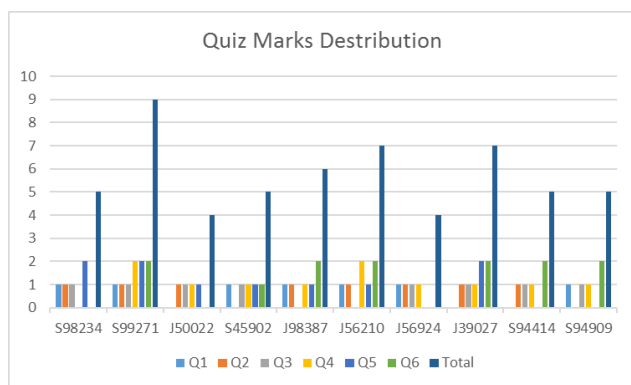


Fig 3: Quiz marks distribution

Fig.3 illustrates, quiz marks for all questions and total marks scored by all students. X-axis represents student id's and Y-axis represents marks.

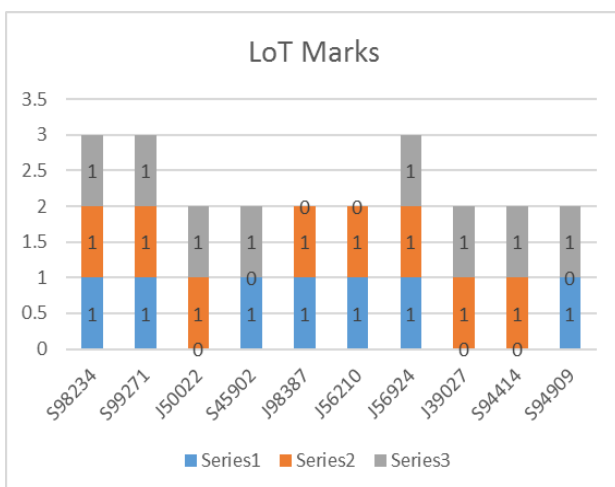


Fig 4: LoT Marks distribution

Fig.4 represents marks scored by students in low order thinking cognitive based questions.

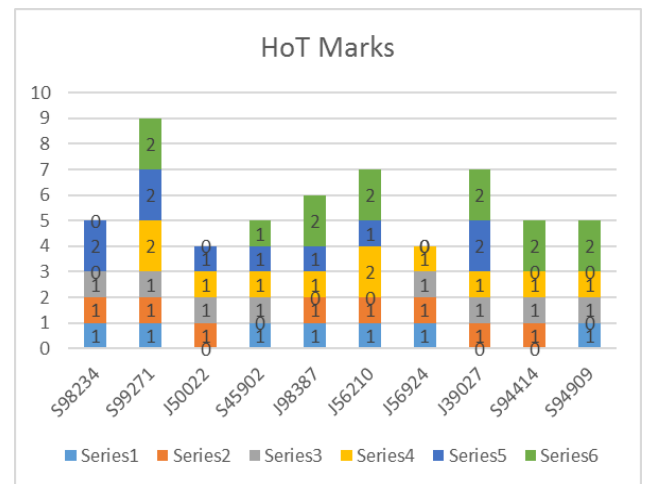


Fig 5: HoT Marks distribution

Fig.5 represents marks scored by students in high order thinking cognitive based questions.

V. CONCLUSION

Technology allows students to become much more engaged in constructing their own knowledge and cognitive studies show that ability is key to learning success. In recent years the term 'Data Science' became more prominent word in higher education. For enhanced services through E-Learning, majority of academic institutions are adopting data analysis and data visualization techniques. To illustrate data analysis and visualization process at UTAS, marks of 10 students in quiz is considered. The assessment is designed with respective cognitive levels. Three different charts are illustrated for better visualization and clear understanding. The example case study emphasis on data analysis and visualization process in UTAS on an E-Learning platform called as Moodle.

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