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Towards an Intelligent System to Improve Student Engagement and Retention

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Abstract

The impact of the learning platforms on student performance has always been a popular subject of research on improving student academic performance during the course study. A variety of research and studies have been conducted based on the student opinions to determine the effectiveness of the student engagement in learning platform on student performance. However, these opinions may not be accurately affected. In this paper, we will track the student activities inside the learning platform in real-time during their course study. Only the meaningful activities such as downloading assignments, lectures, viewing notification and visiting the resources will be extracted from the learning platform. An algorithm has been developed for mining and measuring student performance inside the learning platform.

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1. Introduction

The engagement of students has played an imperative role and focused by the governments as well as the higher

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education institutions. In recent years, most education institutions are encouraging their students to keep them to be actively enrolled in their course study. Thus, the importance of the engagement will be reflected positively to the academic outcomes like retention, progression, and completion. The concept of student engagement means that “What the student did for improving their learning experience” [1]. A variety of researches have been taken regarding the area of education, course structure, and any technologies that support the learning platform for indicating the learning experiences [1] [2].

The educational institutions provide information to their students about their course study via some learning platforms such as Moodle, Blackboard, and Edmodo. [3]. These platforms provide the student with the most of required facilities such as uploading and download the assignments, browsing and discovering all the module materials, view the announcement the submitted by the module tutor, and viewing the grades of all the modules that are regarding the students. However, there is some limitation behind the current use of these platforms as the tutor cannot track his student activities. For instance, the personal tutor cannot get in touch with his student activities during his study as the current environments do not provide these services. The students who are not engaging in their courses at the university will affect badly on their progression during their study. As a result, these issues may lead to reducing the number of university incomes as some students may have failed in their courses.

Despite the effectiveness of using the learning platform in the educational institutions, little evidence shows that these systems will not improve student performance in the course [1] [4]. Most of the studies are purely based on the user subjective interpretation by taking surveys as evidence of investigating the effectiveness of these systems. However, taking user perceptions through surveys may not provide an accuracy of the indications [1].

The proposed idea is to integrate the learning platform with data mining, analysis, and notification feature so that learning/engagement can be better tracked, and intervention can be made where appropriate. The learning platform courses, methods for capturing the experience data, and analyzing the data for providing a useful way which helps in making the educational decisions [5] [6]. The most significant aim of the new system is to improve the education quality of the current learning management systems to provide the learner with relevant educational experience in the most nominal and well-organized method. Therefore, this system will measure the student’s performance in a specific subject area by extracting learner experiences from the learning platform and analyzing these activities carefully for making an educational decision.

This paper structured as follow, section 2 showing the background of this research. Section 3 illustrates the literature review. Section 4, describing the methodology chosen for developing this system. Section 5 showing the design and development of the system. Section 6 showing the conclusion and the future work of this system.

2. Background

2.1. Learning platform

The learning platform became a widely used for the higher education institutions in recent years as it allows the individual student to perform their learning activities such as download assignment, download lectures, viewing notifications, submit an assignment, and viewing resources during the course study [7]. In other meaning, the learning platform used to add online elements to the courses and allow the student to access the educational curriculum outside the traditional classroom. Thus, the need for technological devices is essential as it used to share and obtain the information [7].

The use of the learning platform will significantly contribute to the notion of big data. More data flow will be generated with the increasing number of engaging students to the online materials. So, the use of the data analysis will become crucial for making the use of the gathered data from the learning platform [7] [8].

2.2. Student Engagement and Retention

Student engagement is the construct that facilitates the relationship between student learning outcomes and the degree of their involvement with their academic peers, teachers, and broader communities [8]. In other words, the meaning of student engagement is the student involvement activities that are linked with high-quality learning. The

student engagement is the involvement in an educational purpose. The focus on students' activities posits on the students who are more interactive on the course study. The retention refers to the number of students who are enrolled in the program study within the institution [1].

2.3. Data Collection

The learning platform provides a database where the information about the student profiles, courses, assignments, academic results are stored [3]. The student can navigate through his course study which allows the system to save his activities in the database. The meaningful activities such as the downloaded assignments, number of downloaded lectures, number of notifications viewed, and number of resources visited can be retrieved and analyzed carefully for decision making. All the retrieved data is based on some students that are engaged in the system [4].

2.4. Data Mining

Data mining is the concept of retrieving the needed information from a large and it involves different steps such as selection, transforming interpretation, and data analysis. The first step of discovering the knowledge in the database is the selection. The selection used to simplify the data, quickly retrieving the data, only needed information is extracted by the user and ignoring the unneeded data [9] [10]. Then, these data will be analyzed by removing the noisy data obtained from the extensive database. Transformation is the process of converting the data format into data values, such as retrieving the data elements from the source to the destination based on the user needed. Finally, the data interpretation is the process of retrieving meaningful information only from the raw [9].

3. Literature Review

Previous work has been conducted on how to improve student engagement and retention in an institution. The student engagement has played an essential role in the academic achievement of the student. The engagement is not only mean that the student should be active in a class but, the most important is the cognitive and behavioral engagement. Most studies were purely taken based on different data sets and applying some analytics techniques to prove the results. The engagement is not only the one which effect on the student performance, but it found that the learning management system, e-learning has also been impacted on the student retentions [11] [1].

In 2014, a study was undertaken by Selim Gunuc to examine the relationship between student engagement and their achievement [7] [11]. The author has collected a sample of 304 students' data to do the research using a tool called "Student Engagement Scale and Demographic Variables Form [1]." The researcher has used some of the analysis methods for analyzing the data such as regression analysis, cluster analysis, and others. The author has clarified that there was a high relationship between student engagement and academic achievement. As a summary, the student with a high level of engagement had a high level of academic accomplishments and vice versa [1] [10].

Also, the student engagement is not only the one which effects on the academic performance, but the learning management system can also effect. A study has been done at Delta State University for examining the impact of the learning management system on student performance by using the theory of student involvement and virtual competency [11]. A research model utilizing theories have been developed in an information system for examining the moderating impact in the relationship of the academic performance and the learning management system. Several colleges have been surveyed to test the research model, and the Partial Least Squares equation has used to analyze the data [11].

The engagement itself can be a reason for the student performance effect. However, there are some other ways to achieve the students' performance and improve it in their course study including the student engagement such as predicting the detecting the unfair means of online examination, indicating the abnormal results, and predict the student performance. The knowledge will be extracted using the data mining technique. The authors have evaluated the student performance using the classification task and practically the tree method. The authors have implemented this task of extracting the knowledge by the end of the semester examination, and that will help to predict the student division rely on a previous database [5] [12].

To sum up, there has been exciting work regarding the improvement of student engagement and retention in an education institution. Some of the work has focused on the effectiveness of student engagement as well as the learning management system on the performance of the student. In addition, the other discussion was conducted about how to improve student performance but is not real-time, and that study was purely based on previous datasets [12]. All the data which are used to improve the student performance and engagement were a previous dataset. In our work, the improvement of the student engagement and retention will be assessed and measured in a real-time by extracting the student activities and save them in a database [13]. Once the data saved in the database, these data will be retrieved in real-time and processed based on our algorithm for predicting student performance. The proposed solution will help the institution to improve student performance on time, and the data will be analyzed based on the current student activities in the courses [6] [14].

4. Proposed System

The proposed idea in this paper is to create a platform that shows the student performance based on their engagement in that learning platform during the course study. In this part, we will discuss in detail the chosen data storage for storing and retrieving the student activities, the method of extracting and storing these activities, as well as the algorithm that has been developed for measuring the student performance in the learning platform.

4.1. Track Student Activities

Tracking student activities inside the learning platform is the main aim of our system. After the student logs in to the system, any action performed by the student inside the learning platform will be analyzed based on our algorithm to determine whether this action is an activity or not. The useless activities will be ignored such as visiting the home page, visit the lecture page, and others [7]. The meaningful activities will be captured and stored in our data storage.

The measurement of the student engagement performance must be efficient and useful. For that reason, the developed algorithm will check whether this specific activity type for the same student has been performed or not to avoid the duplication of the activity type and deliver an accurate measurement percentage [9] [15]. Algorithm 1 shows the process of tracking student activities inside the learning platform.

Algorithm 1: Algorithm for capturing the meaningful activities performed by student in learning platform

```

1 function Student Activity ();
  Declare: Student ID st1, Action performed ac, Meaningful activity ma,
        Activity a;
2 while ac do
3   if ac ≠ a then
4     | return to line 2;
5   end
6   else
7     | ac is a;
8   end
9   if a = ma then
10    | if count (ma) ≥ 1 then
11    | | return to line 2
12    | end
13    | else
14    | | store ma;
15    | end
16  end
17 end
18
```

Fig. 1. Algorithm to track student activities in the learning platform

4.2. Measure Student Performance

A flexible algorithm has been developed to measure the student performance accurately by considering all the possible activities done by the student during the course study [6] [16]. The meaningful activities have only been considered for measuring student engagement performance in the course study. These activities are download assignments, download lectures, and view notifications. Each activity has a specific weight based on its effectiveness on student performance during the course [7]. The following formula is to calculate the student performance for each activity type in the learning platform.

$$X = \left(\frac{1}{n} \sum_{i=1}^n C_i\right) \times w \quad (1) \qquad TA = \sum_{i=0}^n X_i \quad (2)$$

Equation 1 gives a clear view of what data should be calculated for measuring student performance in the learning platform. We have a set of activities {C1, C2, C3,, Ci}, the Ci is representing the number of activities for a specific activity type that performed by the student inside the learning platform. The summation of the performed activities in a specific activity type will be divided by the total number of available activities for the same type. For instance, if the number of available assignments in the learning platform is 5 and the student has downloaded only 3, then, the performed activities will be divided by the total number of available activities (3/5). W is the specific weight for this specific activity type. X representing the result of student performance in this activity type.

$$TW = \sum_{i=0}^n W_i \quad (3) \qquad TP = \frac{TA}{TW} * 100 \quad (4)$$

The second equation is to calculate the overall engagement level for all the activities performed by the student. The TA is the result of overall engagement level. Finally, we should calculate the percentage of the engagement as shown in the fourth equation.

Algorithm 1: Algorithm for calculating the total performance for all student in the system

```

1 function StudentActivity ();
  Declare: Students[], ActivityWeights[];
  Output: Studentperf;
2 foreach Student in Students do
3
4   lect = FindLecturesActivites(Student);
5   assig=FindAssignmentActivites(Student);
6   notif=FindNotificationActivites(Student);
7
8   perfL = (lect/TotalL)* ActivityWeights[L];
9   perfA = (assig/TotalA)* ActivityWeights[A];
10  perfN = (notif/TotalN)* ActivityWeights[N];
11
12  Studentperf = (perfL+perfL+perfL) / sum (ActivityWeights);
13 end

```

Fig. 2. Calculate the student performance in the learning platform

Equation 4 shows that the overall engagement performance is calculated by combining all the performance percentage for each activity type divided by the total amount of weight of these activities. After applying this equation to each student, we will get the result of the overall performance. The following tables represent some of the data for each student.

Table 1. Sample data on student engagement

Student Names	Download Assignment				Download lecture				Viewing notifications			
	Xi	N	W	Assign	Xi	N	W	Lect	Xi	N	W	notif
St1	4	4	2	2	13	13	1	1	8	8	1	1
St2	1	4	2	0.5	3	13	1	0.23	7	8	1	0.87
St3	1	4	2	0.5	3	13	1	0.23	8	8	1	1
St4	2	4	2	1	0	13	1	0	7	8	1	0.87

Table 2. Sample of the overall student performance percentage in the learning platform

Student Names	Download Assignments	Download Lectures	Viewing Notifications	Overall Performance
St1	2	1	1	100%
St2	0.5	0.23	0.87	40%
St3	0.5	0.23	1	43.25%
St4	1	0	0.87	46.75%

5. Design and development

The overall system requirement is to create a learning environment to measure student performance based on his engagement in that environment during the course study. The student performance measurement is the main aim of our system which helps to improve student engagement and retention. As is clear from the figure below (figure 3) that we have a learning management system which holds all the functionalities to allow the students and staff to interact inside it. The system proposed that student performance measurement is purely based on meaningful activities which mean that only the essential activities inside the learning platform such as downloading the assignments, downloading the lectures, as well as view the notifications will be extracted and considered for making the decisions.

Any activity performed by the students inside the learning platform will be sent to the data storage (MySQL database). After storing these activities in the database, all the activities will be retrieved and processed by the learning data analysis. After processing the data carefully, the outcomes will be sent to the analysis result action for making the decision. Finally, the dashboard will show all the retrieved result after processing.

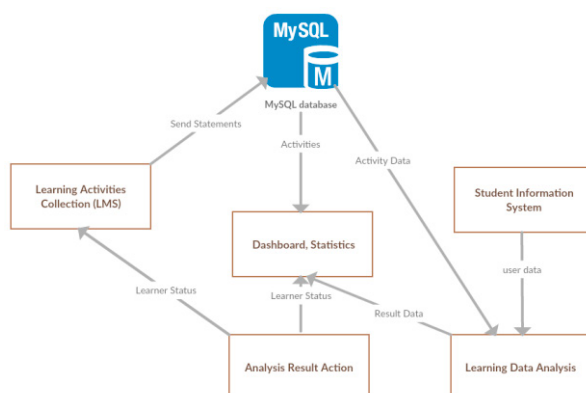


Fig. 3. System Architecture

The system is entirely web-based, so, the design of the system will be using the HTML and Bootstrap CSS. After designing the system (learning platform), the user activities will be extracted and saved in the MySQL database. Finally, the PHP MySQL has used to create the system with the help of AJAX technique to fetch or add data in the system dynamically.

The dashboard contains some nice and animated charts provided by the CanvasJS library which allows the personal tutor to visualize the student activities in different chart types. Spline chart, Column chart, and Pie chart has been used to allow the student and staff to visualize the statistics in different chart types. Some of the results have provided below.

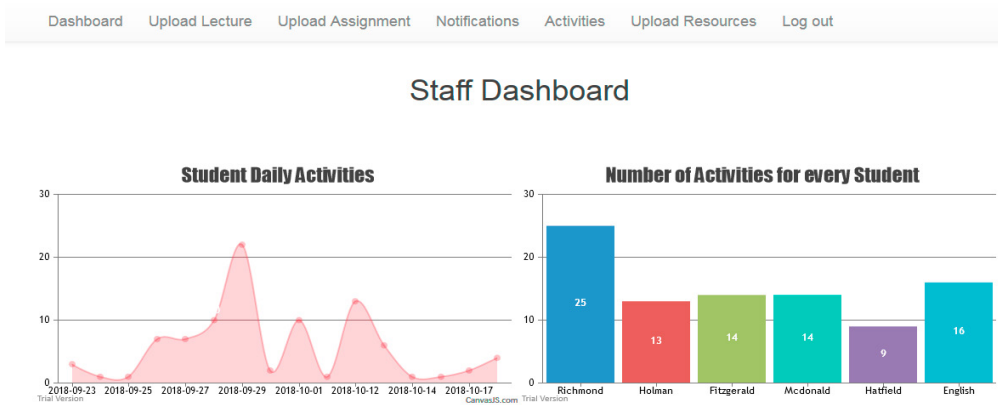


Fig. 4. Graphical representation in staff dashboard

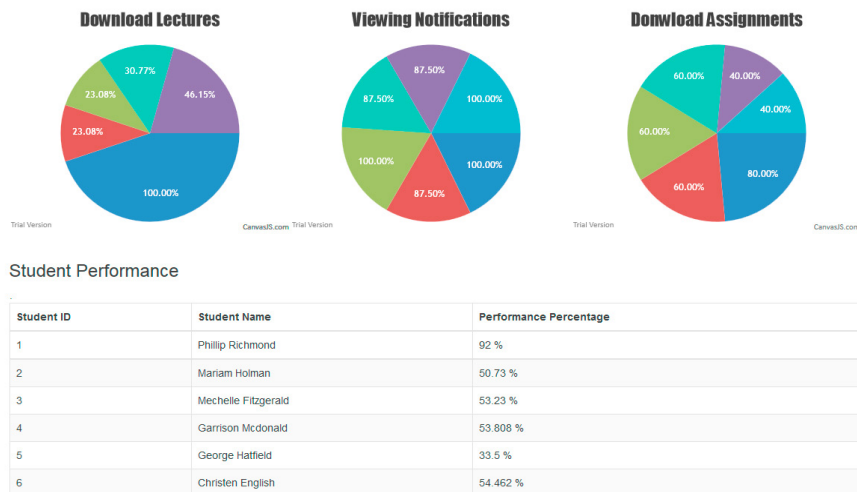


Fig. 5. Staff dashboard.

6. Conclusion and Future improvements

In this paper, studies were conducted for improving student engagement and retention. This system was targeting to develop an algorithm to measure student engagement performance in a learning platform based on their activities. We first created a simple learning platform in order to be used as a prototype for capturing student activities. The user activities have been tracked and captured in a perfect and secure method and saved in MySQL database. The process of retrieving user data has securely implemented based on the mentioned algorithm to measure student performance in real time. This system was implemented in a one-course study which has over 100 students. Only meaningful activities have been captured to develop the system and the useless activities in the learning platform have been ignored. The problem domains, design methodologies, implementation have been illustrated in detail for both the user and staff permissions.

Most of the system targets have achieved. However, there are some future improvements have been conducted for the system which are listed below:

- Improve the current learning platform and make it more efficient than it is.
- Considering some more user activities such as submitting the quizzes and the total time spent while solving the quiz questions.
- Ensuring that there is enough number of active students that interact inside the system to ensure that the results are real.

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