SERIES 2

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Proposing a Framework for Smart Learning Behavior Environment

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ABSTRACT
To meet the needs of various students and understand that students are different in their grades, different in engaging and behaving in course activities, higher education institutions must enhance the current online learning environment. For this, a “smart” learning environment is required to provide a solution to answer the request of students' needs and keep following and observing how they perform when they are in an online learning environment. Since academic institutions worldwide use Learning Management Systems (LMSs), so it is easier to utilize and reuse LMSs more effectively via study the log files generated from the LMSs of any selected course to explore that student’s Engagement (E), Behavior (B) and Personality (P) can be considered indicators of student’s performance. The purpose of adding the term "Smart" to the existing online learning environments is to improve learning and teaching processes by using technology aspects and pedagogical aspects that assist both instructors and students in accomplishing learning goals and outcomes. In addition, the evaluation of this framework is conducted by a case study using Moodle LMS by collecting and analyzing log files of the selected course. Following by proposing the EBP (Engagement, Behavior and Personality of the student) predictive model to potentially assist instructors proactively and effectively in tracking students' EBP and enhancing the learning content for the low and average student's performance as an incorporated component into the proposed SQU-SLMS framework. This study uses real student data collected from the log file of Moodle Learning Management System at SQU. The result disclosed that there is a clear relationship between student engagement, behavior and personality among the case study that could enhance students’ performance. These experimental results validated the accuracy of returned results of the proposed EBP predictive model. Based on the results of the predictive model, the authors develop the Tracking Student Performance Tool (TSPT) to guide the instructors to monitor their student's EBP and Performance automatically. This study concluded that the proposed SQU-SLMS framework, predictive model and TSPT would help instructors develop better learning strategies, providing good guides to them to improve the learning material for the students based on their requirements. As well as to be able to use emerging technologies in the teaching and learning process by implementing such a proposed tool and demonstrate a constructive attitude toward it.

Key Words: SMART Learning Environment, Student Engagement, Student Behavior, Student Personality, Student Performance.

1. INTRODUCTION

Authors have started understanding how learning environments can be modelled to be more efficient, effective and engaged to cover a broader scale (Spector, 2014). Essentially, making learning smart for the student is the primary objective whereby numerous researchers have conducted their study in the education and computer science fields. The smartness of the learning environments was defined according to their engagement, effectiveness and efficiency on a sizeable sustainable scale. Increasing

advancement in technology has highly resulted in various changes in students' behaviors and modeling the techniques of teaching (Nikolov et al., 2016). There is no doubt that students are considered a significant factor in all processes of learning. On the one hand, students nowadays are digital natives adapted to learn in a learning environment using new technologies and devices. Thus, new techniques and methods need to be used to answer each student's needs and abilities. On the other hand, Learning Management Systems (LMSs) are adopted by many institutions to support the learning process. However, this utilization could be reused more effectively and smartly without needing to build it from scratch. In the current LMS (e.g. Moodle), no enough attention is given to the student's engagement, behavior and personality. Some studies discussed one aspect of it, such as student's behavior and disregard other aspects and vice versa. From the perspective of the authors, it was seen that there are required features that are missing in the existing LMS in terms of:

1. LMS (e.g. Moodle) does not have facilities to follow the student's Engagement, Behavior, Personality and Performance in online courses. It only collects general students' profiles such as how many times the students access the course or the date on which he/she submits the assignment and etc.
2. LMS (e.g. Moodle) does not contain a smart tool solution that helps instructors provide personalized learning to the students by collecting and analyzing their profiles and log files of the courses.

Table 1 Operational Definition of Study Concepts

Concept	Definition	Operational Definition
Smart	Specific definitions of smart learning environments focus on the resources (and sometimes the techniques) contained inside them or constituted by them (Dron, 2018).	SMART in this study is an acronym that stands for Specific: the proposing framework is well defined for a specific target which is instructors and students in the learning environment, Measurable: with specific criteria how goanna the authors to measure student EBP and performance in any selected course, Analyzing the log file of any selected course, Realistic: use real data of students extracted from LMS that is relevant to their EBP and performance, and Technology: by proposing the tool to help instructors to easy knowing their student performance during the course.
Student's Engagement	Student's engagement has been defined as "the degree to which a student engages in activities that have been shown to be related to high-quality learning outcomes" (Krause & Coates, 2008)	The authors assume that student engagement is student participation in course-related activities, which consists of a forum, quizzes, exams, assignments, projects, learning materials, etc. Based on the number of student's activities, the authors assume to category the student's engagement into three levels: High, Mid and Low engagement.
Student 's Behavior	Student behavior is "a two-way interaction between students and the learning environment, aimed at causing changes that are relatively stable in what students know and what they can do" (Nurjaman, 2018).	The authors assume that the student is behaving as he/she acts on each component of the course activities. Such as post and reply to the forum, download or non-download the lecture materials, etc.
Student's Personality	Personality is "a consistent predictor of student's satisfaction, academic motivation and academic performance" (Bhagat et al., 2019).	The authors assume that personality is a value of the number of accessed elements by a student without duplication. This value is calculated by tracking the interaction of students with all elements. One point determines that the student interacts with this element, while zero point determines that the student does not interact with this element.
Student's Performance	Student's performance is: "The outcomes of the teaching and learning process in terms of knowledge and skills in students acquired from schools and colleges as measures by scores obtained in exams" (Maganga, 2016).	The authors are assuming that student's performance is based on student's results in exams, quizzes, assignments and projects.

As a result, LMS should be a smart LMS, which is essential as a solution or enhancement to the current LMS. The provided study proposes a Smart Learning Behavior Environment framework called Sultan Qaboos University - Smart Learning Management System "SQU-SLMS", which uses an existing Learning Management System which is Modular Object-Oriented Dynamic Learning Environment (Moodle) and smart predictive Engagement, Behaviors and Personality (EBP) model like an incorporated component into the proposed framework. SMART in this study is an acronym that stands for Specific: the proposing framework is well defined for a specific target which is instructors and students in the learning environment, Measurable: with specific criteria how goanna the authors to measure student EBP and performance in any selected course, Analyzing the log file of any selected course, Realistic: use real data of students extracted from LMS that is relevant to their EBP and performance, and Technology: by proposing the tool to help instructors to easy knowing their student performance during the course.

2. LITERATURE REVIEW

Two investigations were conducted as part of the literature evaluation. The first is to examine the availability of any framework, techniques, or models used by other researchers in the disciplines of SLMS by reviewing the various extant studies used by writers in Smart Learning Management System (SLMS). The second investigation aims to define the terms "Student Engagement," "Student Behavior," and "Student Personality" in the context of online learning.

2.1. Smart Learning Management System (SLMS) Frameworks

Table 2 summarize the previous studies about SLMS along with their description, objective and limitations.

Table 2 Operational Definition of Study Concepts

Author/Year	Brief Description	Objective	Focus on	Limitations
(Song et al., 2012)	Proposed a framework for the smart learning (SLMS).	User profiles and semantically organized learning objects were used to ensure that only the most pertinent information was presented to the user.	User profiles	The author focused only on user profiles.
(El Mhouti, & Erradi, 2018)	Proposed an LMS called "smart-Cloud Collaborative LMS".	In this form of e-learning environment, which is commonly utilized in higher education, collaborative learning techniques are supported.	Focused on each student's and group's level of collaboration and production.	They intended to test the smart Cloud Collaborative LMS in the real world in higher education with a group of students and teachers.

As it is noticed from Table 2, the SLMS framework focused on the User Profiler of learner and learning objects without implementing the framework (Song et al., 2012) in the real case study. In addition, the Smart-Cloud Collaborative LMS framework (El Mhouti and Erradi, 2018) covers some aspects. For example, it concentrates on smart, collaborative LMS with no implementation in the real environment. The proposal was implemented using a representative prototype. This study focuses on student behavior, student engagement and student personality, and the teaching and learning strategy followed in SQU as a higher education institution. To summarize, the proposed SQU-SLMS framework is considered better because it offers better features than the other frameworks and solves the limitations of the previous researchers, in terms that both Smart-Cloud Collaborative LMS and SLMS frameworks provided only prototypes for the frameworks with no real implementation conducted.

2.2. Student Engagement, Student Behavior and Student Personality

Students' Engagement in academic activities is frequently divided into "academic engagement," which is directly related to the learning process, such as time spent on task or participation in planned learning activities and "interactional engagement," which is defined as the nature of students' interactions with instructors or peers (Finn et al., 2003). Dixson's study validated the Online Student Engagement Scale by integrating student self-reports of involvement with monitoring data of student behavior from an online course management system (Dixson, 2015). Abdullah presented a method for classifying students based on their learning styles. The method was tested with 35 students in a Moodle-based Data Structure online course. Felder and Silverman's approach were used to identify each student's learning type based on their behavior and data from the Moodle log (Abdullah, 2015). Personality has an impact on students' conduct in a variety of areas, including their interactions with peers and instructors, as well as their motivation and academic success. Students' personalities have an impact on their academic achievement, interactions with other students and teachers, and future conduct in society (Cheaib, 2018).

The investigation of existing studies in section 2.2 regarding student engagement, student behavior and student personality focused on only one aspect and ignoring others. Since some studies discussed student engagement and student behavior, others focused on student engagement in LMS. Plus, some studies explored student personality and engagement in LMS. Therefore, this study has been recommended to focus on all the previous aspects.

3. METHODOLOGY

The development phases of this study have been divided into three parts. The first part was the proposed SQU-SLMS framework and predictive EBP model. The second part was conducted a case study and the third part deal with the development of the Tracking Student Performance Tool.

3.1. Proposed Framework and Predictive EBP Model

The proposed framework is supposed to make students' engagement in any selected course smart and effective. The student engagement process starts with the way students will interact with the instructor inside the Moodle environment (Al-Khanjari & Al-Kindi, 2021):

As Figure 1 displays that SQU-SLMS consists of four layers:

- Users: which are the instructor and students who will log in to Moodle.
- User Interface Management Authentication and Authorization: To access Moodle as LMS, the users mentioned in Layer 1 require their university ID and password.
- Smart Aspects (Core Layer): two models will be available as sub-layers in this layer. First model: (Engagement, Behavior and Personality) EBP Smart Predictive Model. The EBP model's objective is to indicate how the student engages and behaves in online courses. Also, to predict all the possibilities in which students' performance can differ depending on their personality. Case studies have been conducted to follow how students engage, behave and personalize throughout the online courses (Al-Khanjari & Al-Kindi, 2020). Second Model: Reusable Multipurpose Learning Object Model (RMLOM) sub-layer. To guide the instructor to enhance the course for students getting low and average performance from the previous model. The model provides instructors the freedom to define the details of their course. This would also require instructors to plan courses for each student or group of students (Al-Kindi et al., 2020).
- Database Layer: all the databases are kept in this layer. For example, students' profiles and Moodle log files.

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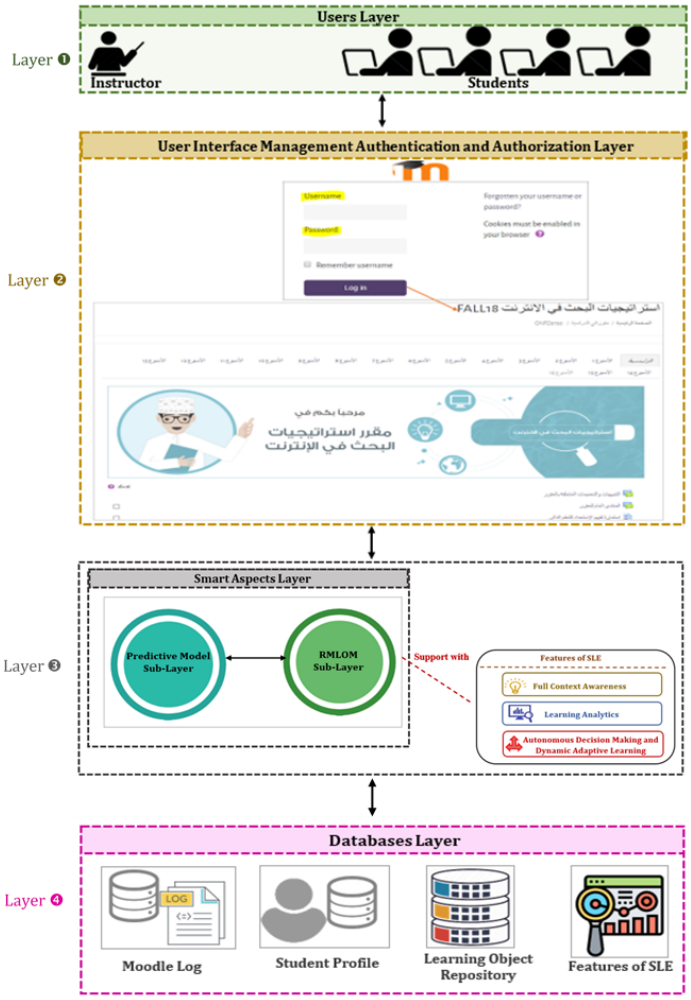

Figure 1 The proposed Framework for Smart Learning Management System (SQU-SLMS) (Al-Khanjari & Al-Kindi, 2021)

3.2. Case Study

Introduction to Computer Science course, which was given in Spring 2020 by the Department of Computer Science, College of Science, SQU. There were 6 sections for this course. The authors choose only one section as a case study in this study. 18 undergraduate students enrolled in this section. This course introduced some fundamental topics in computer science. This includes numbering systems, data representation, problem-solving and algorithm design. Furthermore, the course included the study and practice of basic programming concepts such as data types, variables, arrays, selection, repetition, data files and functions. The theory part was delivered during the lectures and student programming skills were developed during the lab sessions. From this course, the authors extracted 273906 records from the log file of this section. It should be note that, the authors already did another experimentation on different course to prove the concept of the study. The results of this experimentation available here (Al-Kindi and Al-Khanjari, 2021).

Extracting log file of the case study

The log file of the course used in this case study has been extracted from Moodle as .CSV file. And has been going through numbers of phases till reach the final format that used later to get the relationship between the factors. Each factor (Engagement, Behavior, Personality and Performance) has been

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analysing separately in a manual analysis process. You refer to (Al-Kindi and Al-Khanjari, 2021) to get a look for the complete details in how the authors extracted the and analysing the file.

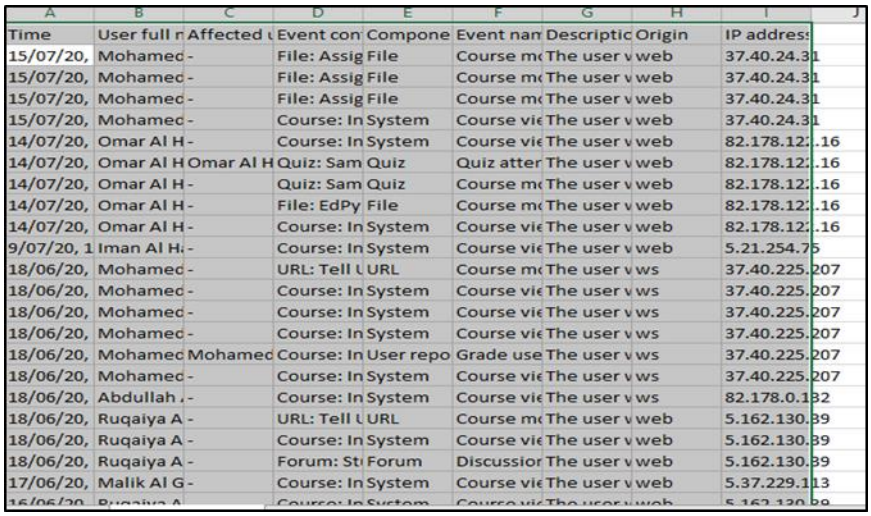

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Figure 2 A sample log file of "Introduction to Computer Science" course in SQU Moodle (data available on request)

The Relationship between Student EBP and Performance Factors

The authors set the below measurement supposed based on the collected dataset to decide what to measure and how to measure it. The details displayed in Table 3.

Table 3 Measurement Factors of the study

Factor	Metrics	How to measure
Performance	Summation of the marks of assessments	The marks of students
Engagement	Count all the activities of the student in the course.	The activities of student
Behavior	(The number of elements that the student has interacted with ÷ total number of elements available in the course)	The elements that the student has interacted with
Personality	Count the accessed elements of the student.	The elements that the student has interacted with

The details of the three factors (EBP) and Performance extracted from the log file of the selected course for the students are illustrated in Table 4 and Table 5.

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Table 4 The details of EBP factors and Performance with Numbers

Student ID	Engagement	Behavior	Personality	Performance
ST1	60.8	82.4	82.3	80.53
ST2	62.0	88.2	88.2	84.77
ST3	71.9	76.5	76.4	79.59
ST4	39.2	76.5	76.4	75.69
ST5	51.8	70.6	70.6	83.2
ST6	59.7	76.5	76.4	96.48
ST7	100.0	88.2	88.2	78.28
ST8	57.3	88.2	88.2	67.08
ST9	73.5	76.5	76.4	85.5
ST10	39.4	76.5	76.4	77.5
ST11	78.3	100.0	100	73.78
ST12	47.8	88.2	88.2	67.07
ST13	66.1	82.4	82.3	84.21
ST14	38.4	64.7	64.7	74.03
ST15	45.1	76.5	76.4	86.58
ST16	48.1	76.5	76.4	84.93
ST17	67.8	94.1	94.1	87.96
ST18	80.7	100.0	100	85.56

Table 5 The details of EBP factors and Performance with categories

Student ID	Engagement	Behavior	Personality	Performance
ST1	Average	High	High	High
ST2	Average	High	High	High
ST3	Average	High	High	High
ST4	Average	High	High	High
ST5	Average	Average	Average	High
ST6	Average	High	High	High
ST7	High	High	High	High
ST8	Average	High	High	Average
ST9	Average	High	High	High
ST10	Average	High	High	High
ST11	High	High	High	Average
ST12	Average	High	High	Average
ST13	Average	High	High	High
ST14	Average	Average	Average	Average
ST15	Average	High	High	High
ST16	Average	High	High	High
ST17	Average	High	High	High
ST18	High	High	High	High

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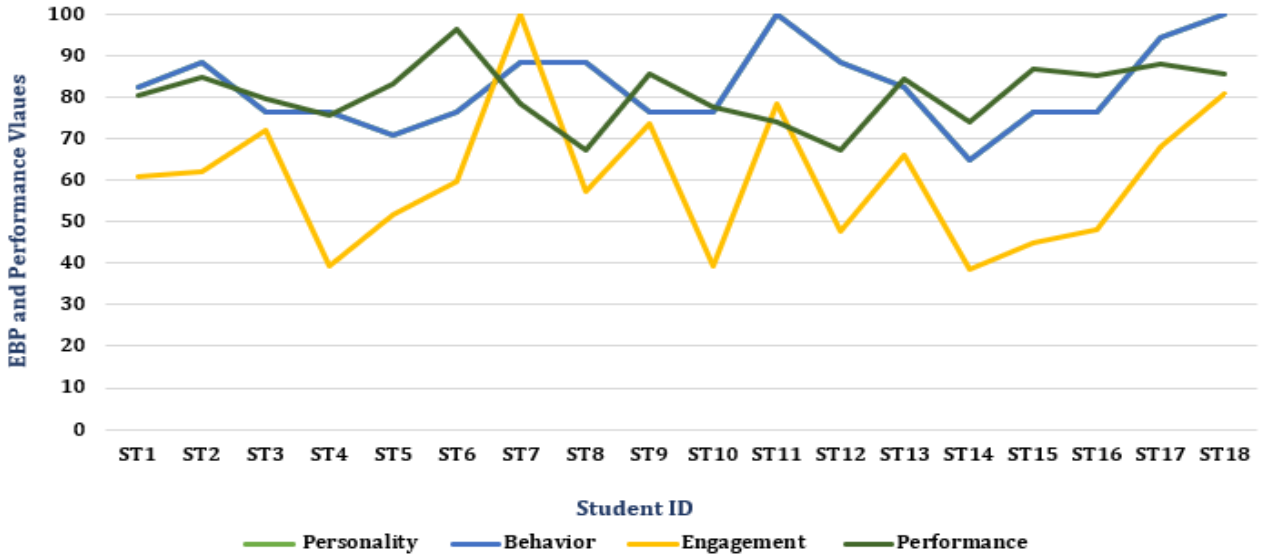

Figure 3 The Relationship between Performance and EBP factors

The clear relationships between them were detected, as it is shown in Figure 3 and Table 5, mostly the factors were affected with others. When the value of any factor is high, the category of performance is high and when all of them are average, then the performance is average. These observations are clearer in rules. It is very clear the factor of behavior and personality are symmetric. These results from Table 5 can be represented using AND/OR rules as follow:

- If [(Behavior = High OR Average) AND (Personality = High OR Average) AND (Engagement = High OR Average)]
- Then (Performance = High OR Average)

It is clear that the effectiveness of the four factors is nested. They collaborate to influence student performance.

Based on Table 6, there are three patterns extracted from the case study, while there are 3 cases that cannot be considered as a pattern because they have appeared only once. The patterns are:

Table 6 The patterns of the case study with their frequencies

Pattern No.	Personality	Behavior	Engagement	Performance	Frequency
1	High	High	High	High	2
2	High	High	Average	High	11
3	High	High	Average	Average	2

As Table 5 show, the most frequent patterns are all. This proves that the performance of students is affected by other factors. But we can note in the two patterns (2 and 3), the value of engagement is Average. This means the interaction of students with Moodle is inferior, but their academic achievement is High. This needs more interactional actions from the instructor to motivate students to increase reactivity with Moodle.

3.3. TSPT Implementation

The development of the Tracking Student Performance Tool is carried out using Python programming language and Microsoft Excel. These programs have been selected for implementation due to their features which cope with the functionalities of EBP predictive model. Python is a high-level, general-purpose programming language that is interpreted. Python's programming philosophy prioritizes code readability, as shown by the extensive use of indentation. Its language constructs and object-oriented style are aimed at assisting programmers in writing simple, logical code for both small and large-scale

projects (Wikipedia, “n.d.”). Microsoft Excel is a program that allows you to create spreadsheets. Excel is a handy go-to program that is both understandable and familiar, and a core feature of Excel is the ability to do ad hoc analysis (Feldman, 2021). As the data was in the form of excel files, so the authors use Python to read and import Excel files. Excel is used to store the data, but the manipulation of the results is stored and visualized in the tool directly.

This tool is developed as a prototype to support the proposed EBP model inside the SQ-SLMS framework achievement. It is an easy tool that can help instructors to analyze and display the relationship between student Engagement, Behavior, Personality and Performance. TSPT, which consists of four main processes along with the exact steps needed to complete a process, which are Sign Up, Login, Add Course and Display Course. In each process, there are certain numbers of subprocesses needed to be taken place in order to achieve the goal behind the main process.

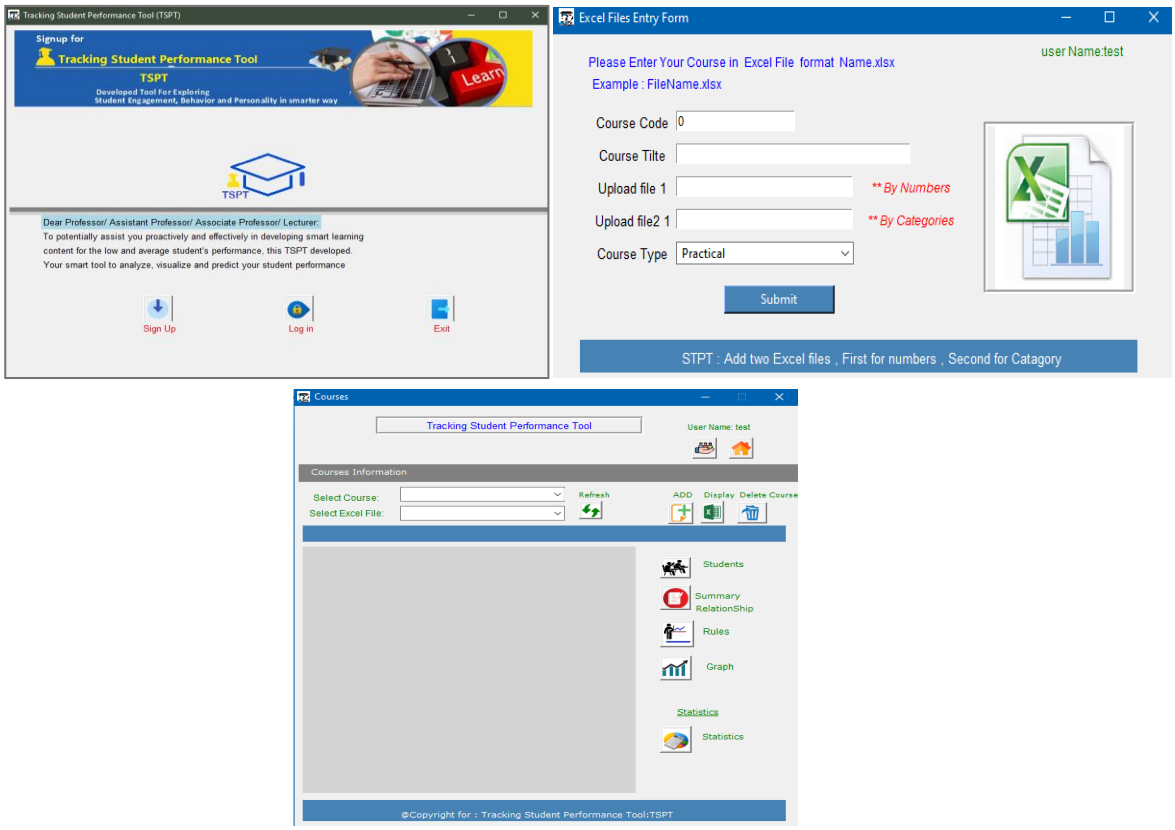

Figure 4 TSPT Screens

In order to validate the proposed TSPT, the authors compare the results obtained from manual analysis and the results extracted from the tool to check if the tool gives us the same results. By comparing the results, they were identical.

4. DISCUSSION

Limitations in existing LMS frameworks motivate us to propose a new framework to overcome some missing features and functions in these frameworks. The proposed framework has been designed to extract Moodle courses log files and analyze them based on EBP predictive model. It enables the reuse of existing Moodle with no need to develop a new system from scratch. The proposed framework can add value to the different parties in the learning and teaching process. The instructors can benefit the most from this study, as it is targeting the learning and teaching process. Besides, student engagement, behavior and personality can be considered as indicators of student overall learning outcome and

performance. These indicators are very much essential for a healthy learning environment, which is necessary for both a teacher and a student. These indicators make the learning interesting and informative and productive. “I think that what has been mentioned reflects the positive aspects, but it does not mean that there are no challenges or difficulties, as usually, our experience was in emergency conditions, which is the Corona pandemic, which cannot be judged, but with the continuation of electronic education later and in normal circumstances, other indicators can appear,” one interviewee said.

5. CONCLUSION

The main contribution of this study is proposing a “smart” learning environment framework for student behavior support. The authors proposed the framework as an attempt to overcome the existing limitations in the current Moodle LMS, particularly the lack of facilities to follow student engagement, behavior, personality and performance. Furthermore, the proposed SQU-SLMS framework had been evaluated by conducting a case study and implemented through developing TSPT tool to show its feasibility and benefits for instructors in the higher education field.

The findings from this study will serve as a foundation for enhancing a better learning environment and is the basis for reforming instruction and learning practices. However, authors or instructors may propose new thoughts about smart learning environments using new technologies such as the Internet of Things to explore new tools or applications to enhance overall student performance.

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