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Proposing A Systematic Framework for SQU-Smart Learning Management System (SQU-SLMS)

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Abstract: Using a systematic framework could enhance the educational atmosphere to be creative. It is very important to use smart technology, which integrates innovative technology features to enhance the learning process. This could be taken care of by adopting an effective tool to create a smart educational environment and an effective personalized learning system. To create a smart educational environment, it requires smart tools to help instructors to carefully prepare the learning process, creative content of learning and appealing lessons. Also, smart tools are needed to demonstrate the results of learning in an attractive manner. This paper aims to propose a systematic framework called "SQU-SLMS" for developing a smart learning environment. It uses an existing LMS (i.e. Moodle), which is used at Sultan Qaboos University (SQU). Also, it uses a smart technical-predictive model, which is an incorporated component into a Smart Learning Management System (SLMS). The proposed technical framework consists of several components layers: users, user interface management authentication and authorization, smart aspects and database. The proposed SQU-SLMS has been compared with existing frameworks and ISC/IEC 12207:2008 and ISO/IEC 19796-1 standards. Also, the proposed systematic framework has been evaluated using ISO/IEC 9126-1. One of the outstanding outcomes that can be of a great value to instructors, is that the proposed SQU-SLMS framework can be used as an indicator that supports their teaching and learning process to keep monitoring student performance in a smart way and with less effort.

Keywords: E-learning, Moodle, SLE, Smart Educational tools, SLMS, Learner Behavior tools, Smart technical predictive model.

1. INTRODUCTION

Researchers have started to understand how to develop more safe, efficient and engaging learning environments to cover a wider scale [1]. Making learning smart for the learner is basically the primary objective by which various researchers have performed their work in computer science for the area of education. The smartness of the learning environments was defined according to its engagement, effectiveness and efficiency on a sizeable sustainable scale. Increasing advancement in technology has profoundly resulted in various changes in behaviors of learners and modeling the techniques of teaching [2]. As technology continues to grow, managing the learning behavior will also change resulting in finding better tools to assess learners' skills in the working environment [3].

The availability of a tool or the possibility to design a tool to understand and manage learners' behaviors as they perform different learning activities clearly, would be a great help to enhance the development of learning. From this point of view, it was seen that only a few computerized tools exist which focus on evaluating the learning behaviors of learners through collecting and analyzing their profiles.

Institutions of higher education have learners with diverse needs; those institutions need tools to be able to offer an appropriate learning experience and personalized learning materials to meet the needs of different learners [4]. Thus, there are essential needs to observe the behavior of the learner and know how to deal with it, which leads to promoting learner's performance. For this, a smart learning environment is proposed to provide a solution to the request of learners' needs. Our motivation in proposing a framework for a smart learning environment for learner behavior is to help instructors anticipate learner behavior from two points of view.

On the one hand, currently learners are digital natives, accustomed to learning using emerging technology and apps in a learning environment. Therefore, new strategies

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and approaches must be used to adapt to the needs and abilities of each learner. On the other hand, many academic institutions use Learning Management Systems (LMSs) to facilitate the learning and teaching process. The reuse of existing LMSs could however, be a more effective and intelligent way to construct the smart LMSs. The main concern will be on how to prepare the required tools to build a smart framework around the existing LMS.

The paper is structured as follows. Section 2 relates to the literature review and existing problems. Section 3 describes the proposed framework. Section 4 illustrates the feasibility of the framework. Section 5 offers the SWOT analysis. Section 6 provides the discussion and the last section summarizes the findings.

2. LITERATURE REVIEW

In the literature review, two investigations have been carried out. The first one is on Smart Learning Environment (SLE) and the second is on the Smart Learning Management System (SLMS) to investigate the availability of any framework, approaches and models used by other researchers in both of the two investigations. A systematic literature review until 2018 established a total of eight main papers to be studied and discussed below.

There are other papers published in 2019 about the topics above, but our main concern is to focus on the frameworks, models and approaches that are only related to SLE and SLMS.

A. Smart Learning Environment (SLE)

Smart Learning Environment (SLE) concept has been highlighted and discussed by many researchers to open new opportunities to overcome some limitations in traditional learning. Huang and colleagues offered the idea of a "smart" learning environment which represented a high level of the digital learning environment in order to promote "simple, engaged and efficient" learning for students. They compared the smart learning environment and the digital learning environment by learning resources, tools, learning cultures, teaching ways and learning methods. One of the drawbacks of this study is that it is only a preliminary attempt to explain the roles of SLEs in the proposed model. The author proposed that more research could be conducted on issues of reforming the teaching and learning by improving the existing learning environments towards SLEs [5].

In 2014, Hwang presented a framework for handling SLE's development considerations and architecture to be effective in both real-world learning and online activities.

It consisted of: a learning status detecting module, a learning performance evaluation module, an adaptive learning task module, the adaptive content learning platform, a personal learning support module, a set of learner profile databases, an inference engine and a knowledge base. The proposed framework has been discussed theoretically. The authors, however, posed some research concerns to consider the role of "smart learning," such as recognizing the behavior of learners in online and face-to-face environments that would assist researchers and instructors in creating more efficient learning resources and strategies [6].

Zhu and his colleagues also addressed the idea of smart education in 2016 and proposed a conceptual framework to evaluate learning and to guide educators in designing learning activities in technology-based environments. The proposed framework identified three core elements, including the presence of instructors, the presence of learner and the presence of technology. The instructor's presence integrates learner-centric, customized, and collaborative frameworks to design learning in technology-friendly settings, promoting learning through promotion. Learner's role in smart education consists of three key components: autonomous learner, collaborative learner and an effective technology user. Technological involvement is a mediating factor within the context of smart education. Technological participation in smart education is seen as connective, ubiquitous and personalized. The authors mentioned that incorporating data in smart cities and developing data-centered smart learning is a key challenge for teachers to provide learners with a seamless learning experience and tailored personalized service [7]. Also, Fortino and colleagues suggested an approach based on a metadata model to explain all the cyberphysical characteristics geophysical of smart objects. The metadata model was then used for a smooth incorporation of smart objects into digital libraries. The authors planned to implement the proposed approach in a real digital libraries management system [8].

In 2017, Postelnicu and colleagues proposed a model to link various forms of learning with behavioral patterns in order to offer online students with chances to explore their best ways to acquire knowledge and increase their opportunity to get a job. Their research focused on the particular trends in smart learning environments, with the goal of defining the optimal behavior for a student to increase the job's chances. In this study the number of participants in the survey was small which is 53 students. Also, the study focused only on student behavioral patterns [9].

In 2018, Freigang and colleagues established an interdisciplinary approach to SLE design research and explored a systematic framework that integrated interdisciplinary criteria for the development of SLEs in an educationally profound way [3].

B. Smart Learning Management System (SLMS)

Song and colleagues proposed a framework for Smart Learning Management System (SLMS) that utilized user-profiles and learning objects to provide the student with only the relevant information. The SLMS preserved the

user-profiles and updating if there were any change occur. The learning objects were organized by getting an ontology created. The system collected appropriate learning resources based on the user's profile upon request from the student. The learning resources supplied were appropriate for the subject of the student and sorted by a specific ranking. The proposed framework is a preliminary prototype [10]. To tackle the role of Smart Learning Environments (SLEs) in corporate education field, and the need for their interdisciplinary nature in the face of current problems with Technology Enhanced Learning (TEL) implementation [3]. New principles had been created for the human-centered design of SLEs to meet the requirements of the 21st century. Collaborative learning was suggested as a solution to the lack of adequate support for students in E-learning environments, especially LMSs. As a result, El Mhouti and Erradi have proposed an intelligent LMS capable of enhancing the communication practices in higher education for students. The framework offered instructors with information about each student and the group's levels of cooperation and productivity. Instructors used the data provided to facilitate collaborative learning and encouraged students to employ collaborative tools. The proposal was implemented using an illustrative prototype. The authors planned to put the proposed framework into experimentation in real conditions of E-learning [11].

3. THE PROPOSED SQU-SLMS FRAMEWORK

One of the most difficult aspects is to decide how LMSs are used to influence the behavior, engagement, personality and performance of learners. Because of the existence of LMS architecture (e.g., Sultan Qaboos University (SQU) uses the Moodle platform), it may regularly collect some learner behavior data through its profiles and log file. Moreover, these collected data display only the abstract level of learner behavior, such as learner personal information, number of course accesses and so on, as shown in Figure 1 below. The interaction between an instructor who adds the course and learner (student) who engages in the course depends entirely on the simple way of interaction. It means that the learner will engage in the course to download the materials, view the video, submit the assignment and so on. However, this interaction could not guide the instructor to evaluate and follow the learner's behavior, engagement, personality and performance in a more effective and smarter way.

Therefore, the purpose of proposing the framework for a smart learning management system is to enhance the interaction between instructor and learners and to focus more on how the instructor can benefit from the profiles of the learners in Moodle in order to respond to the needs of the learner. One of the most important points to mention is that the proposed framework is intended to make learners' engagement, behavior and personality more successful in any course chosen. The interaction process for the learner begins with the way learners communicate inside the Moodle with the teacher. This will help to launch a recognized interaction mechanism that could be used to suggest patterns of learner engagement, behavior and personality in a Moodle environment. Students nowadays are using new technologies to learn. Thus, new techniques and methods need to be used to answer the request of each student's needs and abilities. Furthermore, it was seen that there are required features that are missing in the existing Moodle as LMS in terms of: Moodle does not have facilities to follow the student's engagement, behavior and personality in online courses. In order to make the learning environment smarter, this paper suggests reusing the Smart Learning Environment (SLE) features, which were introduced theoretically by Nikolov and colleagues, along with the existing Moodle LMS. The utilization of these features will be mentioned below in more detail [2].

A. Architecture of The Proposed SQU-SLMS Framework

Figure 2 below demonstrates the full proposed SQU-SLMS framework, which consists of four layers: Users, User Interface Management Authentication and Authorization, Smart Aspects (Core Layer) and Database Layer. Each layer of the proposed framework will be explained below in more detail.

Description of Layer 1: Users

In this layer, the main actors are the instructors and learners, who will log in to Moodle. Each user will do a different role. For example, the instructor: will prepare the course and learners: will engage in the course as illustrated in layer1, Figure 2.

Description of Layer 2: User Interface Management Authentication and Authorization

To access Moodle as LMS, the users mentioned in Layer 1 require their university ID and password as shown layer 2, Figure 2.

Description of Layer 3: Smart Aspects (Core Layer)

In this layer, as shown in layer 3 in Figure 2, two models will be available as sub-layers. The main contribution of this paper is this layer, which is the core layer of the proposed framework. The idea behind this layer is to enhance the components of the existing Moodle to become smart. Consequently, to make the new environment more effective and engageable to learners, the authors suggest integrating four features of the Smart Learning Environment (SLE) into Moodle.

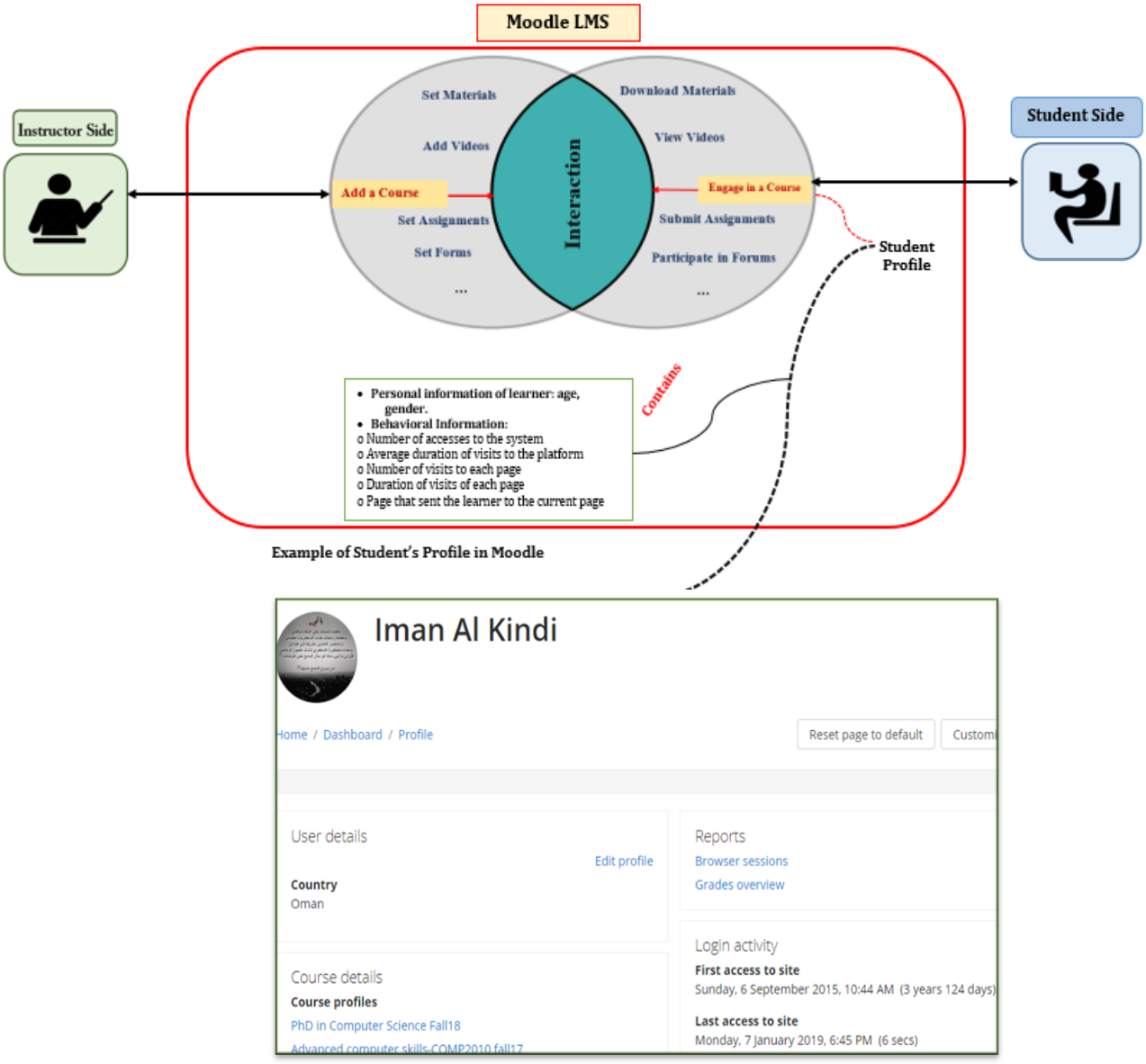

Figure 1: The Moodle LMS used at SQU

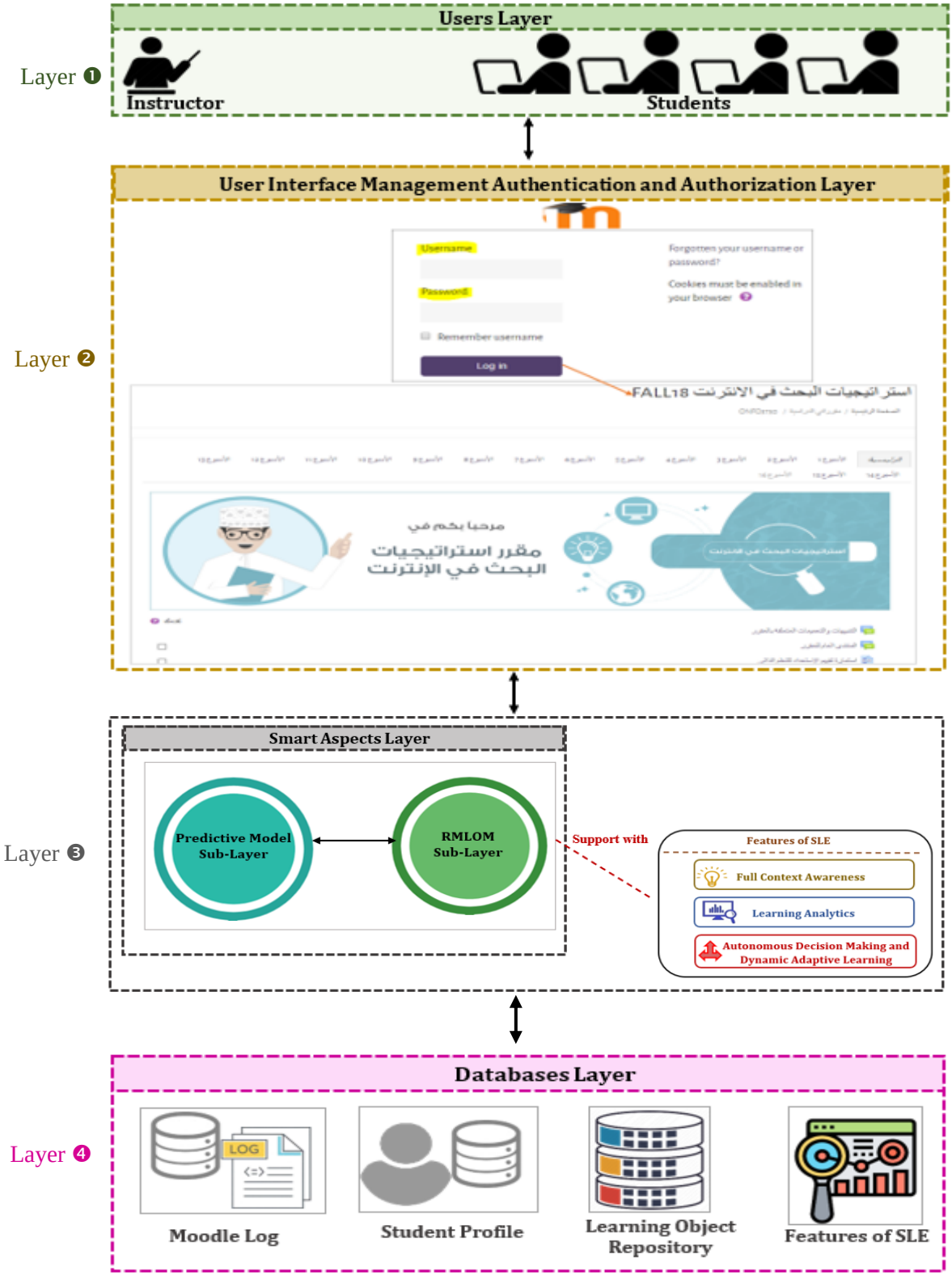

Figure 2: The proposed Framework for Smart Learning Management System (SQU-SLMS)

It is worth mentioning that our proposed framework follows and applies practically Nikolov and colleagues' theoretical work. They did not investigate the practical aspects of the smart features they proposed, including full context awareness, learning analytics and autonomous decision making and dynamic adaptive learning.

Therefore, the purpose of using their features in this paper is to explore their benefits practically and to examine their capability to work or enhance learner's behavior, engagement, personality and performance [2] & [4]. Each feature will encounter different tasks in the below sub-layers. Also, this paper shows how they were integrated and used in the proposed framework. The aim of this paper extends to testing the proposed models of layer 3 in a real environment. More details are provided in the below sub-sections.

The two models sub-layers of layer 3 as shown in Figure 2 are:

Predictive Model sub-layer

The details of this model is shown in Figure 3 will support the learner's profile that is fetched from the Moodle database. Through this smart predictive model, the instructors are required to better understand how students interact and behave on various online course activities [12]. The predictive model works based on the collected learners log files that mainly represent their engagement, behavior and personality in the activities of the course. From those log files, the authors can make patterns of learners to help in preparing personalized learning courses according to the learner' needs and thus are supposed to assist in checking the learners' performance. The process of the predictive model will start once the learner logins to the course on Moodle. Which means that he/she is taking an action that represents his/her behavior. Now, learners will be engaged in the course activities such as watching the videos of the lectures, downloading the materials, submitting the assignment, etc. The system will start generating log files in the backend of the system. Hence, the two features of SLE, which are "Autonomous decision making and dynamic adaptive learning" and "Learning Analytics" will appear to support this process. Using the Learning Analytics feature of SLE in the predictive model sub-layer of layer 3.

The authors deal with the large amount of data coming from the log file obtained from the Moodle. This type of data has to be analyzed in order to know the behavior of the individual learner and how he/she engaged in a selected course. This layer is responsible for organizing and handling the data from the previous smart feature obtained from the analyzed data for the Autonomous decision making and dynamic adaptive learning feature. This data had been categorized in a smart way to make it easier for the instructors in order to allow them to capture the specific learner's behavior.

Once getting the results of analyzing the log file, these results can be used later in the RMLOM sub-layer in terms of helping the instructor to re-prepare or customize the course for a specific learner. Overall, this predictive model's result assumes to enhance and improve the learner's performance in the course.

Reusable Multipurpose Learning Object Model (RMLOM) sub-layer

With a view to guide the instructor to enhance the course for learners getting low and medium performance from the above sub-layer. This paper suggests using Reusable Multipurpose Learning Object Model (RMLOM) [13] & [14]. This model is the output of the MSc project under the supervision of Prof. Zuhoor Al-Khanjari in the Department of Computer Science at SQU. The model provides instructors the freedom to define the details of their course. This would also require instructors to plan courses for each individual learner or group of learners. RMLOM sub-layer as displayed by the pyramid in Figure 4 consists of five layers starting from the bottom to up. The RMLOM sub-layers are:

A. Learning Materials Object Layer: It is a basic set of information. That object of learning material has basic information relevant to an objective. Here, the authors will use two features of SLE which are: Full Context Awareness and Learning Analytics. As we mentioned previously, the learning analytics feature will be used to analyze the log file of all learner's activities in Moodle.

Based on these data the instructor will be guided to know the behavior of the individual learner. The learners have different learning styles preferences. Some may choose to read the text. Others may prefer to follow the lectures via audio or video. So, the learners tend to follow the type of learning style they prefer [15]. Hence, the instructor would prepare suitable learning materials such as text, audio or video and then customize learning content for a specific learner based on their preferable learning style.

B. Data Object Layer: It is a collection of learning materials objects that fulfill a goal of Learning Object (LO).

C. Learning Object Layer: Each learning object has an objective. It consists of data objects. According to the course outline provided by an instructor and assisted by SLE features, which are "Full Context-Awareness" and "Learning Analytics, learning objects are generated by collecting the suitable learning material objects from different data objects with the same objective. Thus, it will help instructors to specify each learner's needs.

D. Course Layer: When the instructors prepare the course outline, it assumes to make sure that his/her course includes chapters in which each chapter has an objective. And concepts in which each concept has at least one objective with a set of aggregate LOs can be used.

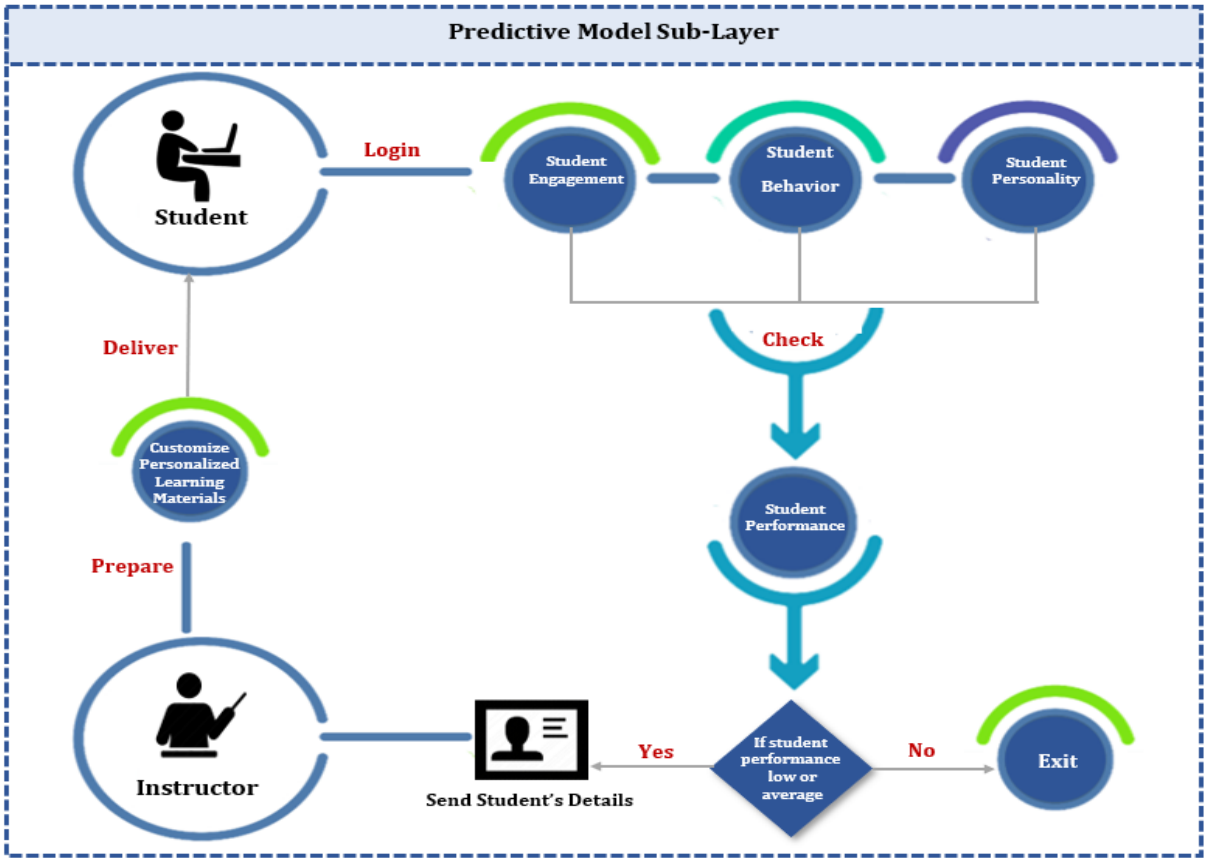

Figure 3: Predictive Model sub-layer of Layer 3 of the proposed SQU-SLMS Framework

E. Credit Hour/ Pass or Fail Course Layer: Each institution offers many either credit hours or pass/fail courses for learners.

Description of Layer 4: Database Layer

In this layer, as shown in layer 4, Figure 2, all the databases are kept in it. For example, learners' profiles contain all information about each learner like learner name, email, university ID and so on. Also, the Moodle log file which is used in the Predictive model sub-layer supposed to be stored in this layer and learning objects repository, which includes the contents of each course prepared in the RMLOM sub-layer. In addition, the features of SLE that are used in this paper are supposed to also be stored in the database layer in terms of analyzing the log file of the learner's course.

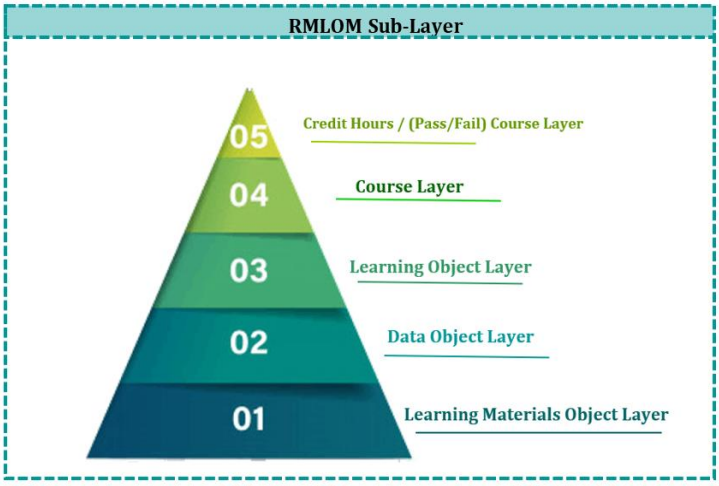

Figure 4: RMLOM sub-layer of Layer 3 of the proposed SQU-SLMS framework [12]

4. COMPARISONS WITH ISO/ IEC 19796-1 AND ISO/ IEC 12207:2008 STANDARDS, EVALUATION OF THE PROPOSED SQU-SLMS FRAMEWORK

A. Comparisons with ISO/ IEC 19796-1 and ISO/ IEC 12207:2008 Standards

The existing frameworks for SLE, smart education and SLMS discussed in the literature review and used in Table1 (coded as 1, 2, 3, 4, 5, 6 and 7)) which represent [5], [6], [7], [8], [9], [10] and [11] from the literature review respectively and (the new proposed SQU-SLMS framework coded as 8). All frameworks are compared with ISO/IEC 19796-1 and ISO/IEC 12207:2008 standards. These comparisons are shown in Table 1, Table 2 and Figure 5.

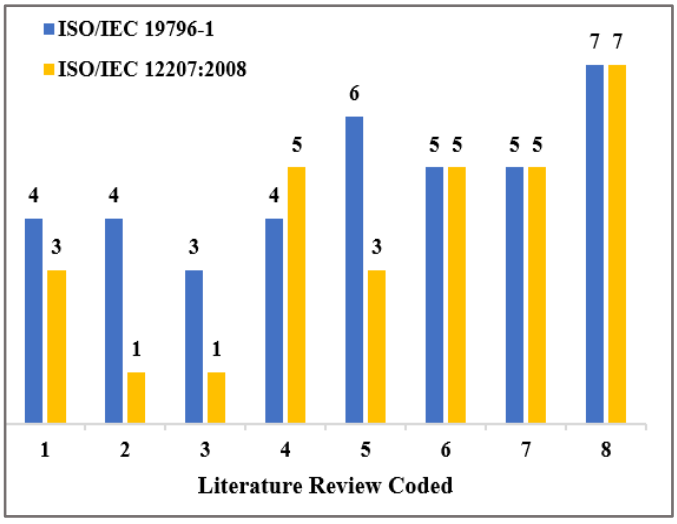

Figure 5: Comparison of SQU-SLMS and existing frameworks with ISO/IEC 19796-1 and ISO/IEC 12207:2008

TABLE 1: THE COMPARISON OF EXISTING FRAMEWORKS AND PROPOSED SQU-SLMS WITH ISO / IEC 19796-1

ISO/IEC 19796-1 Categories	Comparing the Proposed SQU-SLMS Framework against Existing Frameworks							
	1	2	3	4	5	6	7	8
Identification of requirements of an educational project	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Identification of the framework and the context of an educational process	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Design of an educational process	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Development	No	No	No	No	Yes	Yes	Yes	Yes
Implementation of technological components	No	No	No	No	Yes	No	Yes	Yes
Use of the learning process	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Evaluation methods	No	No	Yes	No	No	No	No	Yes

TABLE 2: THE COMPARISON OF EXISTING FRAMEWORKS AND PROPOSED SQU-SLMS WITH ISO / IEC 12207:2008

ISO/IEC 12207:2008 Processes / Software Implementation Processes	Comparing the Proposed SQU-SLMS Framework against Existing Frameworks							
	1	2	3	4	5	6	7	8
Software Implementation Process	No	No	Yes	No	No	Yes	Yes	Yes
Software Requirements Analysis Process	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Software Architectural Design Process	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Software Detailed Design Process	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Software Construction Process	No	No	No	Yes	No	Yes	Yes	Yes
Software Integration Process	No	No	No	Yes	No	No	No	Yes
Software Qualification Testing Process	No	No	No	No	No	No	No	Yes

All seven categories in ISO/IEC 19796-1 standard have been considered for comparisons. ISO / IEC 19796-1 is a quality standard based on quality management principles developed for general learning, education and training, and applied in many applications and programs to meet the unique needs of online service developers and providers and digital resources [16].

For the comparison with the ISO/IEC 12207:2008 standard, seven processes were used. ISO / IEC 12207:2008 provides a standard structure for the processes of the software life cycle. It includes procedures, activities and tasks to be implemented when purchasing a software product. This also includes a framework that can be used to identify, monitor, and optimize the life cycle of software systems (ISO/IEC 12207:2008, 2008). The comparison of the existing frameworks and the proposed SQU-SLMS with ISO/IEC 19796-1 and ISO/IEC 12207:2008 standards (Table 1 and Table 2) demonstrates that not all seven categories in ISO/IEC 19796-1 and not all seven processes in ISO/IEC 12207:2008 are satisfied by any of the existing frameworks. However, the proposed SQU-SLMS framework coded as 7 aims to satisfy all. In addition, most of them have not applied the evaluation methods to evaluate the specified framework and they do not mention the implementation of the technological components that are used while implementing their frameworks. None of them has considered the integration of the learning process and qualification testing steps that have been used.

In relation to the proposed SQU-SLMS framework, this paper identified the requirements of an educational environment, design of the layers of the proposed framework, development, implementation process and considered evaluation methods.

B. Comparison with Existing Frameworks

Smart Learning Environment (SLE) quality is a topic of increasing importance in academic institutions as it has been generally proven that the quality of SLE can contribute to improving learner's performance. To evaluate the suitability of the proposed SQU-SLMS system by contrasting its functionality with other current frameworks. The Smart Learning Management System (SLMS) Framework (coded as 5) and Smart-Cloud Collaborative LMS (coded as 6) are the closest frameworks to the proposed SQU-SLMS framework. Consequently, they are used for comparison with the proposed framework. The proposed evaluation criteria are extracted from the drawbacks and features of the previous existing frameworks and are supposed to be available in the SLMS framework. The criteria used for comparison between The Smart-Cloud Collaborative LMS, Smart Learning Management System (SLMS) and the proposed SQU-SLMS frameworks are:

1) Main Users

2) Interaction details of framework layers

3) Aspects it focuses on

4) Using Smart features/ tools

5) Implementation in the real environment

6) Apply Standards

Table 3 exhibits a comparison between 2 of the selected existing frameworks with the proposed SQU-SLMS framework. The proposed framework has been equipped with the needed criteria, which were not covered in the 2 exiting frameworks.

TABLE 3: SUMMARY OF COMPARING SMART-CLOUD COLLABORATIVE LMS, SLMS AGAINST THE SQU-SLMS FRAMEWORK

Name of the framework Criteria	The Smart Learning Management System (SLMS) Framework [10]	Smart-Cloud Collaborative LMS [11]	Sultan Qaboos University- Smart Learning Management System (SQU-SLMS) Framework
Main Users	Learner	Instructors, tutors and Learners	Instructor and Learners
Interaction details of framework layers/model	Mentioned	Mentioned	Mentioned
Aspects it focuses on	-User Profiler -Learning Object	-Learner Agent -Tutor Agent -Instructor Agent	-Learner Behavior -Learner Engagement -Learner Personality -Learner Performance -Features of SLE -Using RMLOM to prepare personalized course
Using Smart features/ tools	Preprocessed learning object in RDF (Resource Description Framework)	Smart Collaborative Tools	-Using SLE features -Develop tool to assist instructor to predict learner performance at advance stages
Implementation in real environment	No (Only prototype)	No (The proposal was implemented using a illustrative prototype)	Yes
Apply Standards	No	No	Yes

As it is noticed from Table 3, the SLMS framework focused on the User Profiler of learner and learning object without implementing the framework [10] in the real case study. In addition, the Smart-Cloud Collaborative LMS framework [11] 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.

No evaluation for both previous frameworks were assets. However, the comparison highlights the contribution value of the proposed SQU-SLMS framework in the field of distance learning.

This paper focuses on learner behavior, learner engagement and learner performance and the way of 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, which are:

- Both Smart-Cloud Collaborative LMS and SLMS frameworks provided only prototypes for the frameworks with no real implementation conducted.
- No standards are applied to evaluate the quality of the previous frameworks.

C. Evaluation of the Proposed SQU-SLMS Framework

Currently, the market's understanding of SLE efficiency is directly linked to the way of the teaching and learning strategies that the instructors follow to deliver the information and knowledge to learners. To this end, the standard characteristics, sub-characteristics and domain-specific requirements of the International Standard ISO 9126 external frameworks will be used to determine the proposed SQU-SLMS structure. It describes the structure of the quality model, which explains the relationship between the layers. The ISO/ IEC 9126-1 standard comparison covers six features. ISO 9126 was originally developed in 1991 to provide a framework for quality evaluation of the system and then improved over a further ten years [17].

For SQU-SLMS, this paper focuses on 9216-1, which provides a list of quality factors. ISO / IEC 9126-1 is based on the six characteristics: functionality, reliability, usability, efficiency, maintainability and portability [18]. Each of these features has additional sub-features, as shown in Figure 6. The proposed SQU-SLMS framework focuses on the sub-features, which are surrounded by boxes, as shown in Figure 6.

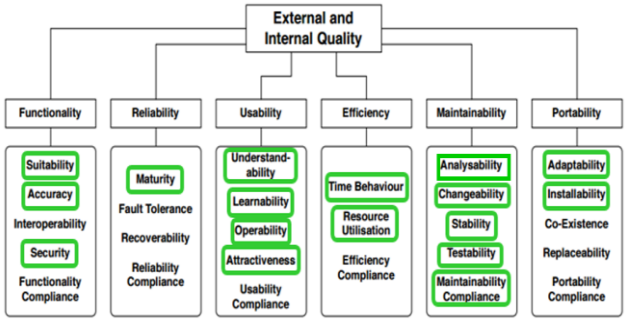

Figure 6: The ISO/IEC 9126-1 Model for Internal and External Quality

For the evaluations of the proposed SQU-SLMS framework, Table 4 illustrates the results. The table shows the calculations of the value for sub-characteristics of each factor where Result % is the number of outcomes achieved (Yes /1 or No /0) divided by the number of subs-characteristics listed in the main standard characteristics multiplied by 100%.

- Result % = (Number of outcomes achieved (Yes /1 or No /0) / the number of sub- characteristics listed in the main standard characteristics * 100)
- For example: the value of functionality characteristics = 3 /5 *100= 60%

TABLE 4: EVALUATION OF THE LMS FRAMEWORK

Characteristic	Sub/Characteristic		Results %
Functionality	Suitability	1	60%
	Accurateness	1	
	Interoperability	0	
	Security	1	
	Functionality Compliance	0	
Reliability	Maturity	1	25%
	Fault Tolerance	0	
	Recoverability	0	
	Reliability Compliance	0	
Usability	Understandability	1	80%
	Learnability	1	
	Operability	1	
	Attractiveness	1	
	Usability Compliance	0	
Efficiency	Time Behavior	1	66.7%
	Resource utilization	1	
	Efficiency Compliance	0	
Maintainability	Analyzability	1	100%
	Changeability	1	
	Stability	1	
	Testability	1	
	Maintainability Compliance	1	
Portability	Adaptability	1	40%
	Installability	1	
	Co-Existence	0	
	Replaceability	0	
	Portability Compliance	0	

In functionality characteristics, the suitability sub-characteristics accomplished when the user of the SQU-SLMS framework is expected to perform the tasks required via Moodle, such as learners engaging in course activities, managing group discussions on topics and instructors update the course syllabus, etc. In reliability characteristics, most of the faults found in the SQU-SLMS have been eliminated over time. For example, the presence of errors when tracking learner's log files in Moodle as maturity sub-characteristics.

Furthermore, in usability sub-characteristics, understandability, learnability, operability and attractiveness sub-characteristics, the instructors understand how to use the implementing framework easily. This includes the importance of following learner engagement in the activity of the course in Moodle. Additionally, in efficiency characteristics, the time behavior of the proposed framework depends on providing appropriate processing time when performing the various functions such as request learners to answer pre and post assessment, etc.

Finally, for maintainability all characteristics were selected and in portability 2 characteristics were selected: adaptability and installability. Moodle as LMS for implementation was easy to use as an academic version and could be integrated with the smart tool in the future that will assist the instructor in predicting learner performance at the advanced stages.

Table 5 determines the evaluation of the proposed SQU-SLMS framework where: Overall percentage of the whole standard = summation of all values / the number of the main standard characteristics.

TABLE 5: THE RESULT OF THE EVALUATION OF THE SQU-SLMS FRAMEWORK AGAINST ISO CRITERIA

ISO Criteria	Proposed SQU-SLMS Framework
Functionality	60%
Reliability	25%
Usability	80%
Efficiency	66.7%
Maintainability	100%
Portability	40%
Overall Percentage	62.96%

To sum up and to our knowledge, there are no existing frameworks found to use such standards that this paper can be compared with them. For example, regarding Smart-Cloud Collaborative LMS and SLMS frameworks, the researchers just discussed the techniques that they used in a framework without using a specific standard to assess their works.

5. SWOT Analysis

There are two dimensions to SWOT Analysis: Internal dimension represented strengths and weaknesses. The external dimension includes opportunities and threats as shown in Figure 7 [19].

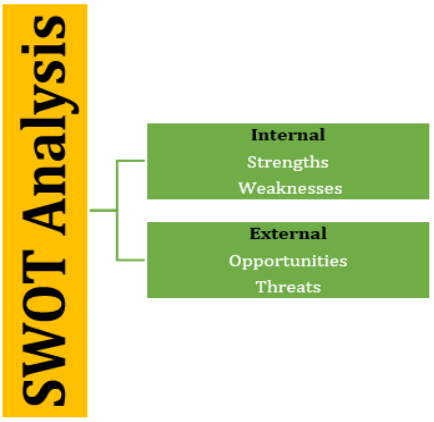

Figure 7: SWOT Analysis

SWOT is a way to evaluate the **S**trengths, **W**eaknesses, **O**pportunities and **T**hreats involved in a project [20]. The SWOT of the proposed SQU-SLMS framework is shown in Figure 8.

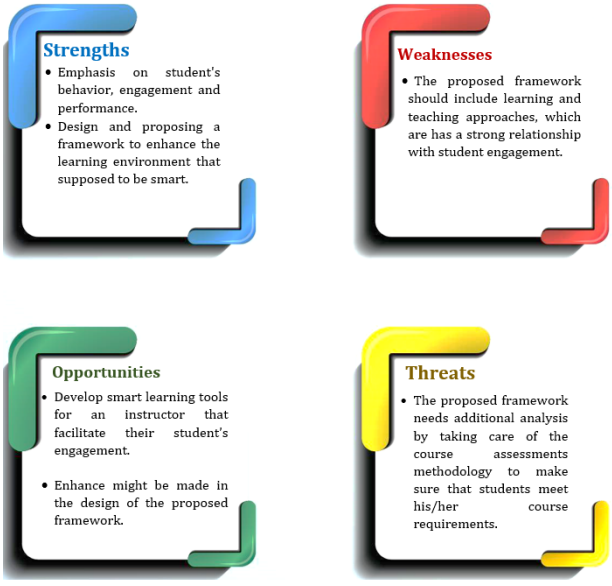

Figure 8: SWOT Analysis for the Proposed SQU-SLMS Framework

6. Discussion

Information and communications technology (ICT) platforms will continue to give learners an exciting way to

communicate exchange and manage knowledge [21]. Moreover, SLE represents an innovative approach of education that will add value in improving the learning process [22].

The world is making headway SLE are being adopted in technology and other high school institutions to support students get a deeper understanding of the materials and courses [23]. By proposing the SQU-SLMS framework, the authors do not only develop a new method for the field of education but they are trying to enhance the features of today's E-Learning and be able to resolve the challenges via entering smart features to the existing LMSs.

7. CONCLUSION

Learning Management Systems (LMSs) are used to support traditional education via its features [24]. They do not contain smart features to predict learner behavior.

As a result, the proposed SQU-SLMS framework could make the interaction between students and instructors more smartly in any selected course using Moodle LMS [25]. This also offers instructors added value to help them to answer student needs based on their preferred learning materials. So, it is not only expected to suggest smart learning behavioral environments but would also be exciting. On the other side, there are some tries towards smart education through the employment of the Internet of Things within the smart object to create cyber physical digital libraries [8]. Thus, will give an indication to the authors to focus on learning object while preparing to customize personalized learning materials to the learner by making those learning object smarter.

Future work of this paper is to perform the experimental phase to test the proposed SQU-SLMS in a real educational environment using Moodle logfile of courses to extract student's data. This paper proposes a framework of ongoing research work, which is now in the implementation process. The authors selected one course as a pilot study and tracked learners during the whole semester by analyzing their engagement, behavior and personality. Also, the authors supposed to develop a smart tool based on the analysis results, to prove that the proposed framework that could succeed in predicting learner behavior and passing the information to the course instructor in order to help learners with more suitable course material, different presentation styles to enable them to work better for a good overall performance before the end of the semester.

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