Using a Hybrid Approach of Game Design, Blockchain Technology and Learning Analytics in Higher Education Institutions: A Case Study of the British University in Dubai

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Abstract. The Learning Management System (LMS) tries to resolve the multiple challenges that occur due to limits of time, location, and frequency of teacher-student interactions. As a tool in the e- learning process, the LMS provides several benefits that can help overcome problems that often occur during the learning process.

However, the current deployment of LMS as a learning medium still has its limitations such as low engagement and motivation, secure documents, certification, and exam verification to replace a cumbersome manual process, and ultimately personalization of features that relevant to students' requirements. Recently, some new technologies developed as recent trends to tackle the various difficulties and challenges relevant to these issues and obstacles. In this sense, the Gamification design boosted users' interaction and engagement with the online system by adding a new game concept. Similarly, blockchain technology improves the security of online document exchange, verification, and storage. Ultimately, learning analytics demonstrated to allow the personalization of online platforms based on interactions and data logs. In this work, we studied how combining these strategies might boost the LMS performance and tackle existing issues and problems.

To do that, we employed a design science methodology as a rigor innovation strategy in digital innovation. The results reveal encouraging results of the new systems (LMSD) implementation in Dubai's British university.

Keywords: LMS · e-learning · Gamification · Blockchain · Learning analytics · Innovation

1 Introduction

There is no one disputing that technology plays a big influence in transforming the overall terrain in education. In this digital era, the use of online learning has expanded substantially and become more widespread over the Covid-19 epidemic, displacing the classroom (face to face environment) (face to face setting). Hence, educators should provide students excellent teaching techniques that inspire them to appropriately engage and learn important knowledge (Ulfa and Fatawi 2021; Mestan 2019). Numerous reports,

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expert opinions, and scholarly findings demonstrate, however, that online learning in its various forms and methods currently faces difficulties and obstacles related to trying to incorporate versatility, encouraging engagement, assisting students with their learning processes, and promoting an attitude-based learning environment (Bruggeman et al. 2019).

The United Arab Emirates' Ministry of Education has acknowledged the critical role of ICT in enhancing the teaching and learning process. Leading higher education institutions in the UAE, such as the University of Fujairah and the British University in Dubai, have begun integrating ICT into their educational systems through a blended approach that incorporates different ICT resources into the learning process. Blackboard and Moodle are two examples of successful learning management systems that optimize the learning process (Salloum et al. 2018).

2 Practical Problem

The Like academic findings, the application of e-learning systems in their current forms shows three major problems: low engagement of the students, security, integrity of documents and exams, and systems adaptation to students' needs and persona. Following the design science approach and it is deployment in innovating process, product, and service -as suggested by Hevner et al. (2019), the problem explicated in details as in Table 1.

Table 1. Problem explication

Problem	Explanation	Current solutions
Low engagement of the students	Students are now detached to different degrees, ranging from 25% to more than half. The classes and resources soon bore them. One of the established reasons is their "engrossment in technology."	Psychological Engagement techniques, variety of video and multimedia, and Forums
Security and integrity of documents and exams	Academic transcripts are one of the most time-consuming and labor-intensive processes in higher education. Each entrance must be personally verified consistently before a certified transcript of a student's grades can be published Online exams and students' identity is a cumbersome issue in online learning	Manual verification of documents and personal assurance of exam process integrity

(*continued*)

Table 1. (*continued*)

Problem	Explanation	Current solutions
Systems adaptation to students' needs and persona	The students differ in their requirements when interacting with the online system. Personalizing their profiles to adapt the current system to their actual needs is required	Collecting traditional data regarding students (such as gender, race, age) but does not give the institution a real understanding of who the people are behind the numbers

3 Literature Review

3.1 E-Learning Systems

The debate on the definition and application of e-learning concentrates on the intersection of education, teaching, and learning with ICT. It is unquestionably guided by two other disciplines: education technology and distance learning. Both have made a significant contribution to the intensified use of ICT for academic purposes, but none of it can be exclusively compared to e-learning (Sangrà et al. 2012). We adopt the three definitions found in Kumar Basak et al. (2018: 192) as follows:

1- E-learning is "the learning supported by digital electronic tools and media".
2- M-learning is the "e-learning using mobile devices and wireless transmission".
3- "Digital learning is any type of learning that is facilitated by technology or by instructional practice that makes effective use of technology," and it occurs in all learning areas and domains.

However, as full description of learning management systems was found in Ulfa and Fatawi (2021) as follows:

4- A learning management system (LMS) is a learning tool for conducting an instructional program in an online learning environment that mimics conventional classroom learning practices. Synchronous and asynchronous communication mechanisms, management features, and evaluation functions are all part of an LMS. These functions make it more comfortable for the instructor to arrange the course. As a result, an LMS can be described as a learning setting that empowers both students and teachers to participate in personalized learning.

3.2 Gamification (Game Design)

Gamification is characterized as "the use of game-based mechanics, aesthetics, and game thinking to engage people, inspire action, encourage learning, and solve problems" (Kapp 2012). In essence, gamification applies game thinking, methods, and components in a non-game sense and formal and informal contexts, using gameplay mechanics, which increases motivation and engagement (Kiryakova et al. 2014).

Empirical studies show that Gamification tools are being used to promote learning in a wide range of educational environments and academic subjects and resolve cross-cutting attitudes and behaviors like teamwork, imagination, and self-guided learning (Caponetto et al. 2014). Figure 1 shows the elements used in gamification to support the e-learning processes.

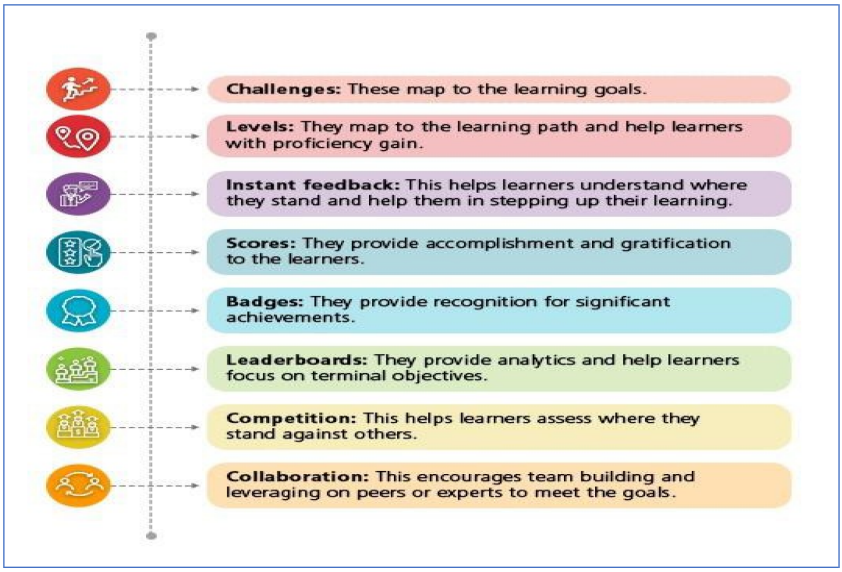

Fig. 1. Gamification elements

3.3 Blockchain Technology

Blockchain, according to Tapscott and Tapscott (2017), is the Internet's second generation. The first-generation stressed interaction and teamwork, but it was created for transferring and storing information rather than meaning. It provides a stable database where one can store important information (such as money accounts, transcripts, and certificates), and having confidence embedded into the technology can help reshape higher education and provide different learning models.

Furthermore, the technology could ensure that the student who enrolled in the course finished it and understood the material. It may include a payment option and enable students to build smart contracts to establish long-term learning strategies. For instance,

the university's course materials may contain an enormous number of pages at the university level. Each page should be manually checked and approved for each student who requires this document (to ensure accuracy). However, if this information is stored on a blockchain, an individual might receive a complete, validated record of content courses and academic qualifications only with a few clicks. Figure 2 shows how the process is accomplished.

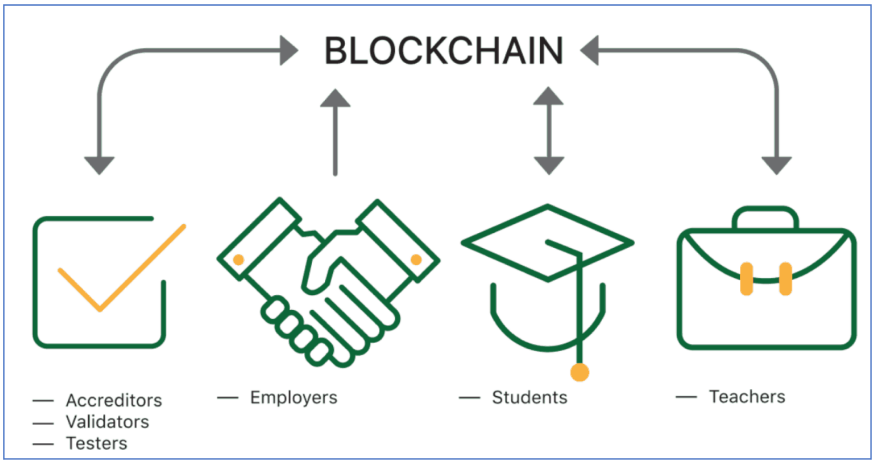

Fig. 2. Blockchain in education

3.4 Learning Analytics

LMSs are capable of collecting and storing activity data and logs. It tracks students' engagement habits, such as where, how long, and how frequently they access various resources, such as content, quizzes, forums, and other tools. Each online learner will produce their own, unique data. Learning Analytics (LA) is a software application that pulls data from a huge volume of log data generated by a learning management system (LMS) (Aldowah et al. 2019).

Learning analytics is used to enhance learning by addressing matters that occur during the education process. A data-driven approach is characterized as the use of data to decide the best plan and objectives (Ulfa and Fatawi 2021). According to Jagadish et al. (2014), a data-driven approach can address a multitude of challenges. The use of LA can help build a more personalized, adaptive, and engaging learning environment, enhancing teaching and learning effectiveness and teachers' and students' output. Figure 3 illustrates the learning analytics types in aggregate form.

4 Innovation Approach

This We use a design science method to create our new artifact in order to address the explicated challenge in this work. According to Peffers et al. (2007), the solution's

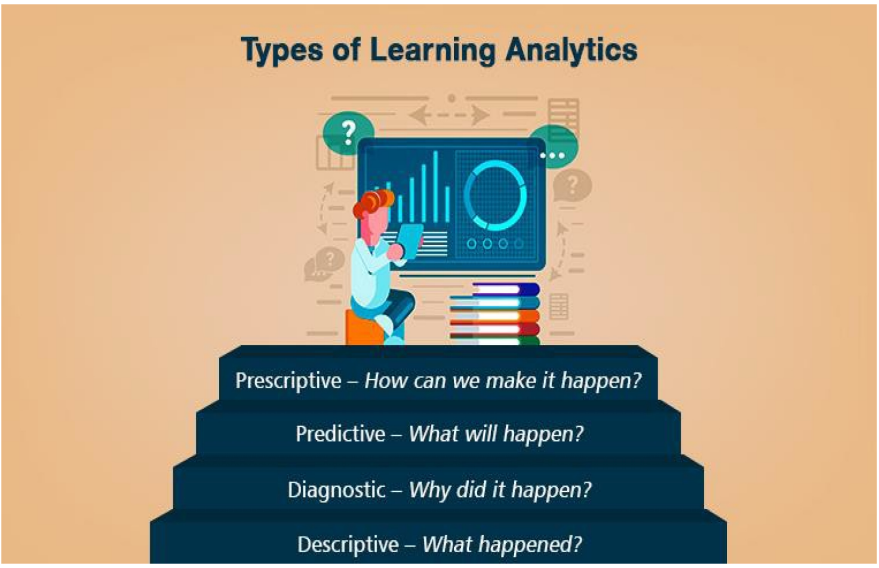

Fig. 3. Learning analytics types

objectives are formed from the established issue and knowledge of what is achievable and practical. The aim might be quantified in terms of how the current solution is superior to the prior one or qualitatively in terms of how the new artifact is intended to aid in the exploration of a solution to an unresolved challenge. Figure 4 depicts the stages of the invention process.

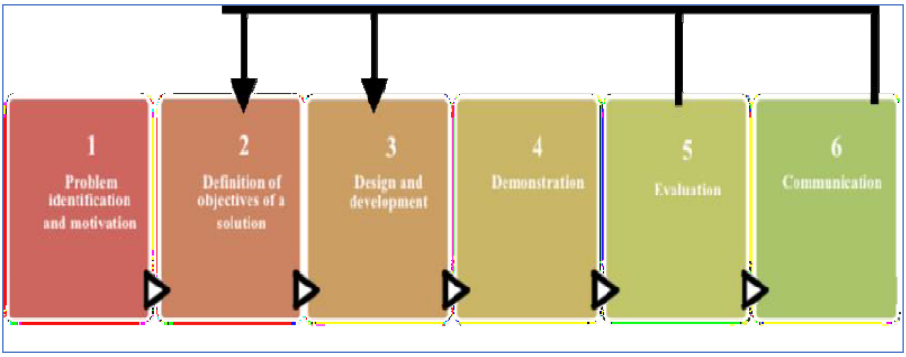

Fig. 4. Design approach

4.1 Design and Development

This stage involves the creation of the artifact, based on problem identification and objective of the design. The ultimate aim of this iteration is to construct a human-

centered interface prototype as a means of communication and explore and test the proposed artifacts' specifications and suggestions from real-life users. Figure 5 shows the prototype design.

Fig. 5. Prototype design

4.2 Demonstration

We created a proof-of-concept software prototype (called LMSD) mobile advertisement platform to obtain feedback and further develop the prototype to demonstrate the proposed artifact in solving highlighted problems. The prototype is a working model (Walker et al. 2002) and the system's first version before it is released. The demonstration phase included three stakeholders of the software, namely students, employees, and teachers.

4.3 Evaluation

Further to the development and refinement phase, verify that the application meets the study objectives and that the prototype is valuable in contributing to measurements and producing satisfactory results.

5 Findings and Analysis

The system's overall evaluation shows positive responses from the three parties involved in the evaluation process. The involved participants were asked to evaluate their perceived usefulness from the system from 1 to 5. Table 2 shows the results of this analysis.

Table 2. LMSD overall evaluation

Stakeholder	N	Mean	Std. Deviation
Students	20	4.2000	.83666
Employees	8	4.4000	.89443
Teachers	8	4.0000	.70711

Furthermore, a set of criteria found in related systems development have been used to confirm the usefulness of LMSD. Table 3 illustrates these criteria and the corresponding descriptive statistics.

Table 3. Overall evaluation criteria of LMSD

Criteria	N	Mean	Std. Deviation
Usefulness to your personal needs	36	4.2222	.66667
Relevancy and convenience	36	4.5556	.72648
Ease of use	36	4.6667	.50000
Utility in term of feedback provided and incentives	36	4.3333	.70711
Privacy concern	36	4.6667	.70711
Not annoying	36	4.7778	.44096
Comprehensiveness	36	3.8889	.60093
Applicability	36	4.5556	.52705

These measurements have reverberated in participants' comments; one of them stated;

"It is not annoying; it saves my time and effort to search a material and make a purchase decision."

Another participant commented;

"It has a great incentive, and who will not be pleased to receive these incentives on a daily basis? Besides, it is secure and protects my privacy and documents."

The descriptive statistics revealed that the students are happy with the gamification elements. However, these elements are ranked according to their priorities and desires

of the students. Some features have been discarded in the final version of the system based on students' feedback. Capture from the analysis is shown in Fig. 6.

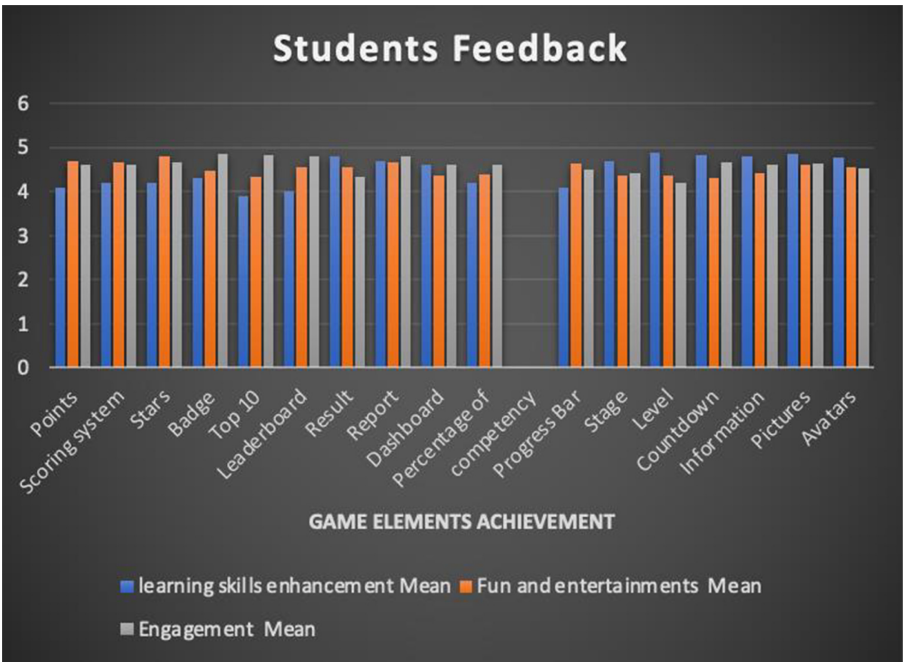

Fig. 6. Students' feedback on Gamification elements

With regard to blockchain, the evaluation was reflected encouraging results. All our participants were very interested in the new options added to the system. Their assessment of the three new options is shown in Table 4.

Table 4. Blockchain features evaluations

Blockchain Features	Students	Employees	Teachers
Payment	4.5	4.8	4.5
Certificate issuance	4.8	4.9	4.6
Exam's security	4.2	4.1	4.9

Despite their good comments, an in-depth chat with them revealed a need for further functionality to be introduced to the system. In this regard, several members of the university's IT department recommended adopting blockchain-based cloud storage to

free up storage space on the university's servers. Additionally, professors and some postgraduate students demonstrated that blockchain security might be utilized to guard against piracy of unpublished material. All of these features were incorporated into the system's final version.

Finally, the evaluation of learning analytics choices revealed a high level of acceptability among participants. Following numerous focus group meetings that included a quick presentation and lengthy conversation, feedback shows widespread interest, particularly among students and instructors.

Students and instructors were intrigued by the possibility of enhancing learning outcomes through LA review. How can students' performance be improved, or how can instructors be motivated to tailor a learning plan and appropriate instructional materials to students' needs and personas? In this example, stakeholders employ LA as an analytical technique to aid in policy development by identifying student inadequacies or learning requirements in online learning. The evaluation of the three stakeholders is depicted in Fig. 7.

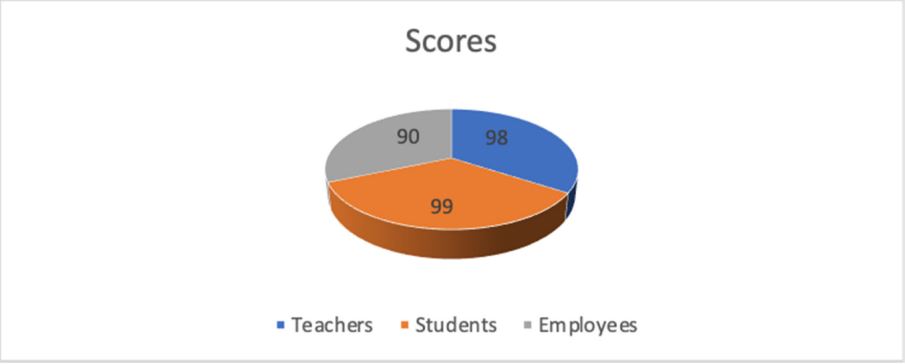

Fig. 7. Learning analytics overall evaluation

6 Case Study: LMSD Deployment in the British University in Dubai

The implementation process starts after the innovation proposal has been successfully delivered to the potential stakeholders and went through several iterations. This is the transition from a conventional e-learning system to a new LMSD system. Continuous improvement extends the life of creativity until the next product substitutes it.

6.1 Final LMSD System

The new system incorporated all inputs from the participants. The final LMSD is an e-learning system containing all the traditional features of LMS such as Module and Blackboard and Gamification elements that support engagement and motivation, blockchain

technology to provide more security to resources, and learning analytics to adapt to students' requirements.

Features of the new system.

1- It makes learning more enjoyable and engaging.
2- It allows students to see how real-world technologies are used.
3- It provides Real-time feedback.
4- It Improves the learning environment.
5- It Speeds up information retrieval.
6- It provides a more secure system.
7- It Replaces manual verification and issuance.
8- It has an effective storage.
9- It has a Personalization.
10- Cost-effectiveness.

6.2 Cost of Implementation

In this section, we present the cost-benefit analysis. The analysis shows myriad benefits that justify the cost of implementation and adopting the new system. Table 5 illustrates this analysis in numbers and added values.

Table 5. LMSD cost and benefits analysis

7	Resources	8	Cost	9	Benefits
10	Gamification system	11	50000 AED	12	Students' retention, effective teaching, more engagements
13	Blockchain technology	14	100000 AED	15	Effective and secure file storage, remove cumbersome manual tasks
16	Learning analytics	17	750000 AED	18	Personalization of the systems. Increased student retention, effective resource allocation

6.3 Other Required Resources

In order to implement the LMSD system, other supportive resources were utilized; Table 6 shows these resources and their related costs.

The numbers showed a significant return on investment (ROI). The current project's actual cost is within the estimated cost limit, and the deployment of the system offers an enhanced overall learning process and higher students retention rate. These results justify all related costs and efforts.

Table 6. LMSD supportive resources associated costs

19	Resources	20	Cost
21	System Training	22	100000 AED
23	New infrastructure	24	200000 AED
25	Programmers	26	20000 AED/month

6.4 Challenges of Implementation

As with any new digital innovation project, this project faces relatively minor challenges compared to others as this system used a combination of pull and push strategy for development. Using a customer-oriented approach and open innovation strategies has increased the new technology resistance from final users. However, a few challenges are listed as follows:

1- The low self-efficacy of some users is a normal issue in deploying new technology.
2- Employee's resistant to accept new technology as they think it will replace their roles.
3- Some system errors prevent participants from completing some tasks.
4- Low trust in technology from some teachers to store their sensitive material in the system.

6.5 Post-implementation Phase

At this stage, all challenges and hurdles are treated in professional ways using the best practice available. To avoid the obstacles in the implementation stages a regular meetings and training sessions were held. The main aim is to permeate how the new system will provide value for all university members and not threaten employees' traditional roles. Additionally, low self-efficacy and trust were handled by professional trainers.

In order to assess the post-implementation Ex post evaluation was used. Ex post assessment is a method of determining a system's value after it has been applied using both financial and non-financial criteria. Ex post assessment methods in information systems can be drawn from a crucial application of the "context, information, and method" model built for assessing organizational change (Venable et al. 2016).

Post-implementation is a crucial phase in innovation that is taken to not rely on first success and become complacent and futile. According to this phase, the system was reinvigorated, and new features were added. For instance, the gamification elements were not standard to all students, and the need to personalize them is in urgent demand. As such, a new feature was added, which is called gamification behavioral analytics. This feature is vital to increase the efficiency of the system.

7 Conclusion

Modern technologies such as gamification, blockchain, and learning analytics have demonstrated their viability in a variety of sectors, one of which is education. We integrated these new technologies into LMS systems in this study to address fundamental issues and obstacles that impede the learning process directly and indirectly. In terms of gamification design, the application increased students' interest and motivation significantly. Additionally, blockchain technology has demonstrated its efficacy in protecting the transmission and storage of digital information. Additionally, several new services, such as payment and cloud-based blockchain storage, have been introduced depending on potential customers' pull approach. Finally, learning analytics plays a significant role in evaluating students' data logs in order to tailor and adjust the features of LMS systems. Additionally, after multiple revisions, the gamification design was evaluated and its features customized depending on student engagement using learning analytics concepts. Overall, the final LMSD system was introduced, and as a fundamental concept of controlling the innovation process, constant assessment is used to make any necessary adjustments. Although some employees and students expressed modest opposition to the method, this resistance was overcome via the provision of essential training and encouragement. The system's early adoption demonstrates a high return on investment and a plethora of benefits that surpass the system's development and deployment expenses.

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