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Avia Saga: A Gamified Mobile-Based Learning Management System

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***Abstract*—The usage of Learning Management Systems (LMS) has increased since the Covid-19 pandemic. LMS has drawbacks despite the advantages they provide. To fully support the advantages it provides, students must be motivated and involved. Adding gamification to the LMS is one way to potentially solve this issue. The MDA framework and Octalysis are combined in this research's gamification approach. The application, named Avia Saga, was designed and built using Flutter and Spring Boot as a mobile application. A trial of the application was conducted with 38 students majoring in Informatics. The evaluation of the application was done using the Hedonic-Motivation System Adoption Model (HMSAM) with a Likert scale. The research results revealed a 7% increase in the behavioral intention to use category, suggesting a greater inclination for reusing the application, and an 11.7% increase in the immersion category, indicating elevated sentiments of users being carried away by the ambiance while using the application.**

Keywords—Avia Saga; Gamification; Learning Management System; MDA; Octalysis

I. INTRODUCTION

The use of Learning Management Systems (LMS) represents the embodiment of technological advancements in the educational sector, which have become increasingly prevalent since the onset of the COVID-19 pandemic [1–3]. LMS enables users to interact with learning content as well as with educators [4]. Studies have shown that the utilization of LMS has a positive impact on academic performance [5–7]. However, the use of LMS is not without its drawbacks.

The success of LMS depends on the motivation of its users [8]. The benefits and positive impacts provided by LMS can only be fully realized if users have the motivation and drive to participate. There is a high tendency for academic failure among students who lack learning motivation [9]. This is also aligned with another drawback of LMS, which is the lack of student engagement or passivity. A decline in student motivation and engagement also diminishes the users' learning experience. Students' motivation in learning tends to decrease [10, 11]. Research indicates that the current use of LMS is largely reduced to being a repository/storage space [8]. One highly potential solution to address this issue is the implementation of gamification in LMS [12].

Gamification is a method of designing a system to provide experiences and motivation similar to those of a game [13]. Gamification has been widely applied in various fields, including business [14], finance [15], health [16], and education [17]. The application of gamification in education has a positive impact on the learning experience, motivation, and academic performance of students [18, 19]. There are several well-known frameworks for designing effective gamification experiences, including the Octalysis and MDA Frameworks [20].

The Octalysis framework is a gamification framework focused on enhancing user motivation and engagement with a system [21]. Octalysis analyzes eight core drives within an individual to determine the gamification components to be implemented in the system. Meanwhile, the MDA Framework is a framework that focuses on the fundamental components and elements when designing a game [22]. MDA is used to design and analyze a game by dividing the gaming experience into mechanics, dynamics, and aesthetics. This framework aims to bridge the gap between game design and development, game criticism, and technical game research [23].

Similar research has been conducted previously using various gamification methods and evaluations [24–26]. There is a study that employed the Octalysis framework [27]. Using the Technique for User Experience Evaluation in e-Learning (TUXEL) method, the system received positive scores in the User Experience Evaluation for practicality, creativity, motivation, and enjoyment, and an average score (0.77) for ease of use. However, various issues were also identified. Thirteen issues were found related to Usability Inspection and eight issues were related to

Pedagogical Usability. It is recommended that the use of Octalysis and TUXEL be continued in future research, but with improvements in application design.

There is also a study that introduced a Multi-Layer Gamification Framework called the NEWTON-Enhanced Gamification Model (N-EGM) [20]. N-EGM was developed by combining aspects from the MDA framework, Design Six, and Octalysis, and adding a socialization element. This study implemented the N-EGM Model in a STEM learning system. The results showed that this gamification approach increased engagement among 78% of the student respondents. There was an improvement in the assimilation of material/knowledge among the students, verified with a confidence level of 95%.

Designing an LMS with the Octalysis framework has yielded positive results in several aspects, but it also has issues, particularly with usability, indicating the need for design improvements. The MDA framework provides an understanding of how game components can affect user experience. This insight from MDA can be used as "fuel" to create a new design [22].

Behavioral Intention to Use (BIU) refers to a person's willingness to reuse a system, while immersion is the degree of engagement and involvement in using the system [28]. BIU is an important factor for assessing the acceptance of a system [29]. Immersion is a key factor for evaluating user engagement with the system [30]. The Hedonic-Motivation System Adoption Model (HMSAM) focuses on testing systems designed to meet users' intrinsic motivations and evaluating both behavioral intention to use and immersion [28]. Studies show that HMSAM is a promising and effective model for assessing students' acceptance of gamified learning [31].

Mobile-based technology has a positive effect on students' academic performance [32]. Research indicates that students desire more learning activities to be conducted on mobile applications [33]. Therefore, there is a need for a mobile-based Learning Management System designed using gamification methods with the MDA and Octalysis frameworks. The method used to evaluate the implementation of gamification in the LMS is the Hedonic-Motivation System Adoption Model (HMSAM).

II. Literature Review

A. MDA Framework

The Mechanics-Dynamics-Aesthetics (MDA) Framework is a tool to analyze a game [23]. Fig. 1 shows a diagram of the division of a game into three elements in the MDA Framework, namely Mechanics, Dynamics, and Aesthetics. Each element affects the formation of the next part. Mechanics creates dynamics, which trigger aesthetics.

Mechanics describes the components that are identical to the game. Anything that can explicitly trigger dynamics can be referred to as a mechanic [22]. Game mechanics consist of points, levels, leaderboards, badges, challenges/quests, onboarding, and social engagement loops.

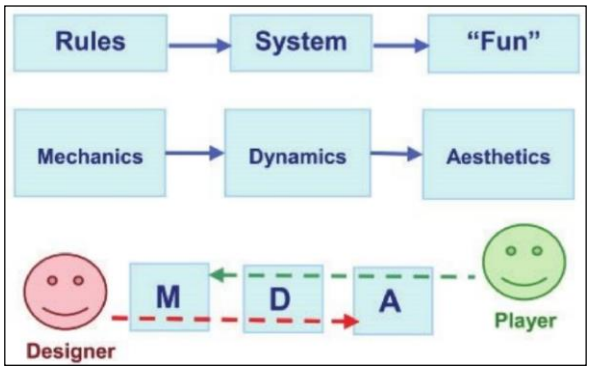


Fig. 1. MDA framework order of influence [23]

Dynamics describes the driving behavior of mechanics that occurs based on player actions and reactions to those actions. Dynamics acts as a bridge between game designers and players. When well defined, dynamics will support the design process and improve the efficiency of game development [23]. Dynamics keeps the user motivated towards the mechanics. It comprises rewards, status, achievement, self-expression, competition, and altruism.

Fun has a complicated definition. It is difficult to define what makes a game fun. Intrinsic and extrinsic motivations motivate people to play games, but intrinsic motivation is the main motivation. A good game should use extrinsic rewards to motivate players and help them reach a mental state of flow. To maintain this state, the game must balance the challenge provided with the user's ability. This can be achieved by utilizing various categories to account for pleasure and aesthetics: sensation, fantasy, narrative, challenge, friendship, discovery, expression, and submission [23].

B. Octalysis

The Octalysis gamification framework consists of eight gamification core drives as follows [21].

1. Epic Meaning & Calling

It is a core drive when a player believes that what the player is doing is bigger than themselves or that the player is chosen to do something. This is reflected when the player dedicates a lot of time to other things related to the game. Another element of this core drive is the luck effect. This effect makes the player believe that the player has a special talent to get something good when just starting the game. Examples of the implementation of this core drive are the use of narrative, beginner's luck, and exclusivity.

2. Development & Accomplishment

It is a core drive that is internally generated. It triggers the drive to take on challenges and make new achievements. This core drive is the easiest to implement. An example of implementing this core drive is the use of leaderboards, badges, and quests that come with challenges.

3. Empowerment of Creativity & Feedback

It is a core drive that occurs when players are required to do something repetitively to find out something. A player needs a way to express their creativity and also see the results of that creativity. An example of implementing this core drive is the use of combinations and instant feedback.

4. Ownership & Possession

It is a core drive that occurs when players feel motivated by a sense of ownership. A sense of ownership makes players want to continue to develop what they have to be better. An example of this core drive implementation is the use of avatars and redeemable points or rewards.

5. Social Influence & Relatedness

It is a core drive related to social elements. Many companies are now focusing on developing social features online. When a player sees another player achieving a certain milestone, it will be a push for that player to be able to achieve the same thing. Examples of the implementation of this core drive are friendship features, gifting between players, and working on challenges together.

6. Scarcity & Impatience

It is a core drive that creates a condition where something cannot be obtained even though it is highly desired. An example of the implementation of this core drive is the waiting period. The waiting period makes the player impatient and makes the player keep thinking about the desired thing until it can be obtained.

7. Unpredictability & Curiosity

It is a core drive that makes players want to know what happens next. The human brain tends to keep thinking about what will happen, just like when reading a book or watching a movie. An example of implementing this core drive is by giving easter eggs and gifts out of the blue.

8. Loss & Avoidance

It is a core drive that prevents something negative from happening. An example of implementing this core drive is creating temporary events. The player will be afraid to lose the opportunity for the event if the player does not do it right away.

III. METHODOLOGY

A. *Gamification Design*

The Gamification design is conducted by combining two frameworks: Octalysis and MDA. MDA is used to determine the mechanics, dynamics, and aesthetics that will trigger the eight core drives in Octalysis. The elements used in the application are summarized in Table I according to each core drive that aims to be achieved.

TABLE I. GAMIFICATION ELEMENT

Core Drive	Mechanics	Dynamics	Aesthetics
Epic Meaning & Calling	Theme	Rewards Progression	Narrative
Core Development & Accomplishment	Leader-board Progress Bar Badge Points Quest Boss Fights	Rewards Compe-tition	Challenge
Empowerment of Creativity & Feedback	Milestone - Unlocks	Achieve-ment	Discovery
Ownership & Possession	Character	Persona-lization	Expression
Social Influence & Relatedness	Trophy Shelf	Achieve-ment	Challenge
Scarcity & Impatience	Waiting Time	Urgency	Submission
Unpredictability & Curiosity	Mystery Gif	Random-ness	Penalty Status
Loss & Avoidance	Penalty	Penalty Status	Submission

B. *Application Development*

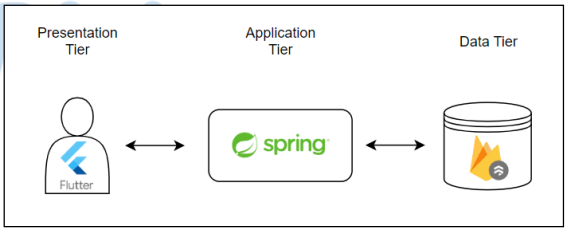


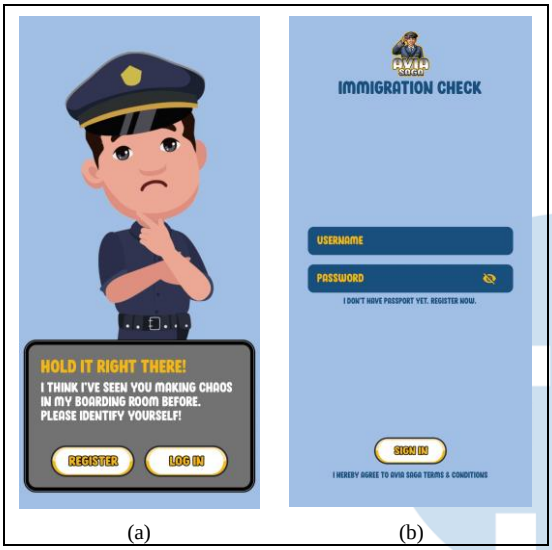
Fig. 2. System architecture

Fig. 2 shows the system architecture used in the application development, which is the 3-Tier Architecture. This architecture consists of the Presentation Tier, Application Tier, and Data Tier. The Application Tier/API will serve as the bridge connecting CRUD operations between the Presentation Tier and the Data Tier. The Presentation Tier is developed using the Dart programming language with the Flutter framework, the Application Tier is implemented using the Java programming language with the Spring Boot framework, and the Data Tier or data storage will use Cloud Firestore provided by Firebase.

IV. IMPLEMENTATION

A. Onboarding and Login

Fig. 3(a) displays the onboarding page that presents users with options to either register or log in by clicking the available buttons. If the user clicks the register button, they will be directed to the registration page. There are three pieces of information requested from the user on the registration process. The questions asked are the username, full name, and password. On the registration process, Conversely, if the user clicks the login button, they will be directed to the login page. The login page is shown in Fig. 3(b).



(a) (b)

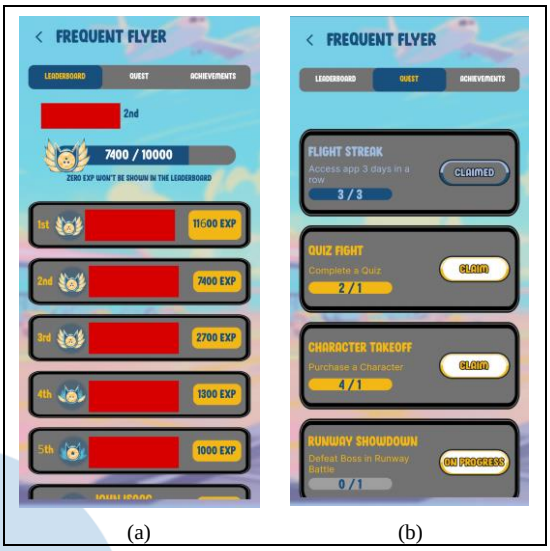
Fig. 3. (a) Onboarding page (b) Login page

B. Home

Fig. 4. Home page

Fig. 4 displays the home page. On the home page, there are user badges and points, miles owned, the currently active character, and a menu list. When the badge is pressed, the user will be directed to the frequent flyer page. An animation is applied to the character to give a flying effect to the character image. There are four menus that users can choose from, namely flights, passport, duty-free, and runway. Users will be directed to the feature page selected in the menu.

C. Frequent Flyer



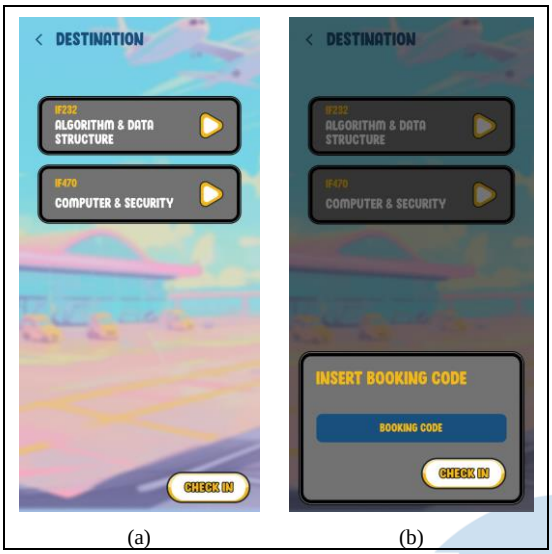
(a) (b)

Fig. 5. (a) Leaderboard tab (b) Quest tab

Fig. 5 displays the frequent flyer page. This page has three menus shown in a tabbed layout: leaderboard, quest, and achievement. The leaderboard tab shows the user's name, rank, and points, along with the ranking data of other users, as shown in Fig. 5(a). The quest in Fig. 5(b) shows a list of quests that users can undertake. Each quest displays a title, description, progress, and an action button. Progress is shown with a progress bar. When the progress is complete, the action button, which was previously "on progress," changes to "claim." By pressing the claim button, the user will receive a mystery gift and be directed to the mystery gift page. The achievement tab displays a collection of cards owned by the user. The card collection consists of bosses defeated in the runway feature. Cards will be colored when unlocked and black-and-white when locked. The achievement tab is shown in Fig. 6.

Fig. 6. Achievement tab

D. Flights



(a) (b)

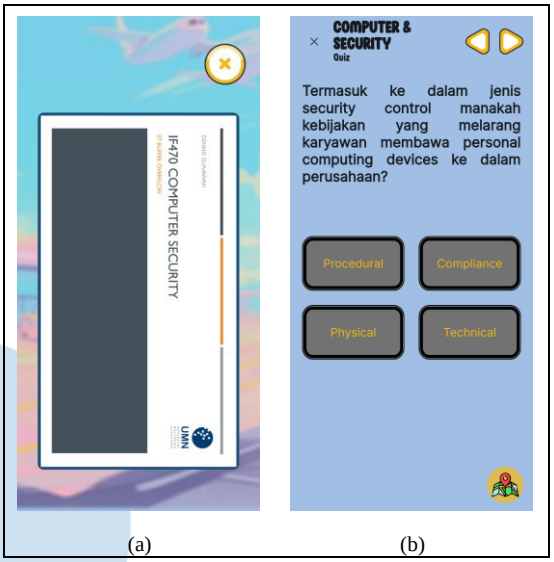
Fig. 7. (a) Flight destination (b) Check-in pop-up

Fig. 7(a) displays the flights page. This page will show a list of destinations (courses) currently being taken by the user. Users can add courses using the check-in button, which is displayed as a floating action button. Fig. 7(b) shows a pop-up when the user presses the check-in button. The user will be asked to enter a booking code. If the code is valid, the course associated with that code will be added to the list of destinations. Users will be directed to the course page when pressing the arrow button on each destination.

Fig. 8. Course page

Fig. 8 displays the course page, which contains a list of content for each lecture session. To access the content, users can press buttons labeled with numbers corresponding to the lecture sessions. When a button is pressed, a pop-up will appear showing the meeting topic along with the content and quiz menu. The quiz menu will only be displayed if the session includes a quiz. Fig. 9(a) shows the content material page.

Fig. 9(b) shows the quiz page. The quiz is displayed in a multiple-choice format. Users can press the map button to display the list of questions or press the arrow button to go to the previous/next question. If users want to exit the quiz page, they can press the close button.



(a) (b)

Fig. 9. (a) Content material page (b) Quiz page

E. Duty-free

Fig. 10. Duty-free page

Fig. 10 displays the duty-free page. This page contains characters owned by or available for purchase by the user. Users can view the list of characters by swiping. Each character will display its name, power, and health. If the user already owns the character, the text "owned" and a button for activation will be displayed. If the user does not own the character, the price of the character and a button for purchase will be

shown. Purchased characters will be automatically activated and become active characters.

F. Runway

Fig. 11. Runway page

Fig. 11 displays the page when the user accesses the runway feature. The runway will show the user's and boss's characters and life, the available maneuvers to choose from, the time to select a maneuver, and a button to perform the maneuver. In each round, the user has 10 seconds to choose a desired maneuver and press the maneuver button to confirm. If no maneuver is selected within 10 seconds, a maneuver will be chosen automatically.

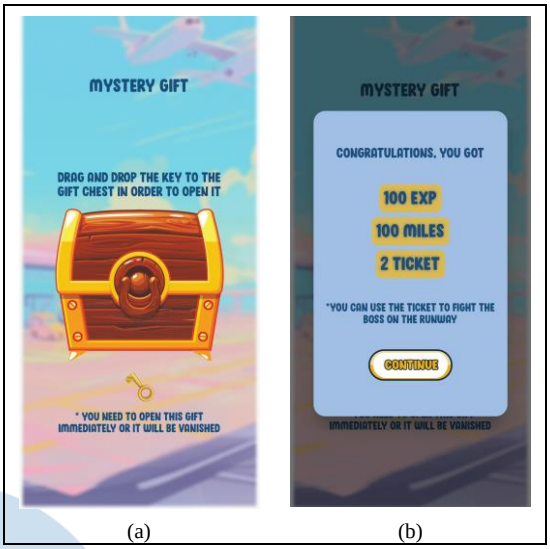
After the user selects a maneuver, the boss will randomly choose a maneuver. The boss's maneuver will be compared with the user's maneuver based on the following rules:

- Roll defeats Climb.
- Climb defeats Dive.
- Dive defeats Roll.
- A tie if the maneuvers are the same.

If the user wins the round, a pop-up will be displayed, and the boss will receive a reduction in life according to the power of the user's character. If the user loses the round, a pop-up will be displayed, and the user will receive a reduction in life according to the power of the boss's character. There is no life reduction if the result is a tie. A new round will start if both the user and the boss still have life remaining. After one player (user or boss) runs out of life, the game will end and display a pop-up indicating whether the user won the game.

G. Mystery Gift

Fig. 12(a) displays the mystery gift page. Users are directed to this page when they receive a mystery gift. To open the mystery gift, users can drag and drop a key onto a chest. Once this is done, an opening animation will play, and a notification will appear showing the number of points, miles, and tickets received. The results of the mystery gift contain points, miles, and tickets obtained by the user, as shown in Fig. 12(b).



(a) (b)

Fig. 12. (a) Mystery gift (b) Rewards details

V. Results and Discussions

The application was evaluated using the Hedonic-Motivation System Adoption Model (HMSAM). Thirty-eight students majoring in Informatics voluntarily tried and evaluated the application by answering the given questions. The questions given to the respondents were divided into two parts, namely questions for the Moodle-based LMS and Avia Saga. Each part consists of 36 questions across seven categories: perceived ease-of-use, perceived usefulness, curiosity, control, joy, behavioral intention to use, and immersion.

The questions were given and answered using the Likert Scale. The responses to each question were tallied according to each scale. Subsequently, the aggregate numbers were calculated to derive the score percentage for each system. Table II shows the score percentage comparison of Moodle-based LMS and Avia Saga.

TABLE II. Score Percentage Comparison

Category	Moodle-Based LMS	Avia Saga	Increase
Perceived Ease-of-Use	81,58%	79,67%	-1,9%
Perceived Usefulness	66,63%	79,79%	13,2%
Curiosity	65,96%	84,56%	18,6%
Control	66,67%	72,63%	6,0%
Joy	67,37%	76,49%	9,1%
Behavioral Intention to Use	71,05%	78,07%	7,0%
Focused Immersion	61,26%	72,95%	11,7%

All categories exhibited enhancements, despite a slight decrease of 1.9% in the perceived ease-of-use category. The assessment of perceived usefulness increased by 13.2%. Curiosity ratings saw a notable rise of 18.6%. Control ratings increased by 6%. Joy ratings experienced an uplift of 9.1%. Behavioral intention to use ratings escalated by 7%. Meanwhile, focused immersion ratings showed an increase of 11.7%.

Based on respondents' comments on the questionnaire, the decrease in the perceived ease of use may be caused by the absence of confirmation to leave the application, the lack of information on running out of tickets, and the absence of boss statistics on the runway feature. According to the user feedback, some improvements have been made and the solution has been released.

VI. Conclusions and Future Works

A gamified mobile-based Learning Management System, named Avia Saga has been successfully designed and developed implementing Octalysis and MDA Framework. The application implements gamification elements for each core drive of the Octalysis Framework and is enhanced with the MDA Framework. Flutter and Spring Boot Framework were used in the application development.

The application was evaluated by 38 respondents using the Hedonic Motivation System Adoption Model. The results revealed a 7% increase in the behavioral intention to use category, suggesting a greater inclination for reusing the application, and an 11.7% increase in the immersion category, indicating elevated sentiments of users being carried away by the ambiance while using the application.

Future studies could investigate the association between the choices of application theme with user motivation to use the Learning Management System. In addition, future attempts could add several elements such as group quest and background music/sound effect. These implementations could add fellowship and sensation to aesthetics.

References

[1] I. Maslov, S. Nikou, and P. Hansen, "Exploring user experience of learning management system," International Journal of Information and Learning Technology, vol. 38, 2021.

[2] O. D. Triswidrananta, A. N. Pramudhita, and I. D. Wijaya, "Learning management system based on assessment for learning to improve computational thinking," International Journal of Interactive Mobile Technologies, vol. 16, 2022.

[3] I. Makruf, A. A. Rifa'i, and Y. Triana, "Moodle-based online learning management in higher education," International Journal of Instruction, vol. 15, 2022.

[4] M. Sahin and H. Yurdugul, "Learners' needs in online learning environments ¨ and third generation learning management systems (lms 3.0)," Technology, Knowledge and Learning, vol. 27, 2022.

[5] M. Furqon, P. Sinaga, L. Liliasari, and L. S. Riza, "The impact of learning management system (lms) usage on students," TEM Journal, vol. 12, 2023.

[6] M. Amin, A. M. Sibuea, and B. Mustaqim, "The effectiveness of moodle among engineering education college students in indonesia," International Journal of Evaluation and Research in Education, vol. 12, 2023.

[7] R. Jayashanka, E. Hettiarachchi, and K. P. Hewagamage, "Technology enhanced learning analytics dashboard in higher education," Electronic Journal of e-Learning, vol. 20, 2022.

[8] I. O. Biskupic, S. Lackovic, and K. Jurina, "Successful and proactive ´ e-learning environment fostered by teachers' motivation in technology use," Procedia - Social and Behavioral Sciences, vol. 174, pp. 3656–3662, 2 2015. [Online].

[9] A. S. L. Yudhana and W. A. Kusuma, "Kelebihan dan kekurangan pembelajaran jarak jauh atau e-learning dan learning management system (lms) menggunkan pendekatan literature review, dan user persona," Jurnal Syntax Admiration, vol. 2, pp. 1617–1628, 9 2021.

[10] K. J. Kim and T. Frick, "Changes in student motivation during online learning," Journal of Educational Computing Research, vol. 44, 2011.

[11] C. G. Isaksen and S. F. Hole, "How to evaluate student motivation engagement in e-learning," Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC) 2016, 2016.

[12] M. Ekici, "A systematic review of the use of gamification in flipped learning," Education and Information Technologies, vol. 26, 2021. [13]

[13] J. Koivisto and J. Hamari, "The rise of motivational information systems: A review of gamification research," 2019. [14]

[14] S. Al-Rayes, F. A. A. Yaqoub, A. Alfayez, D. Alsalman, F. Alanezi, S. Alyousef, H. AlNujaidi, A. K. Al-Saif, R. Attar, D. Aljabri, S. Al-Mubarak, M. M. Al-Juwair, S. Alrawiai, L. Saraireh, A. Saadah, A. Al-umran, and T. M. Alanzi, "Gaming elements, applications, and challenges of gamification in healthcare," 2022.

[15] A. van der Heide and D. Zelinsk ˇ y, "'level up your money game': an analysis ´ of gamification discourse in financial services," Journal of Cultural Economy, vol. 14, 2021.

[16] N. Xi and J. Hamari, "Does gamification affect brand engagement and equity? a study in online brand communities," Journal of Business Research, vol. 109, 2020.

[17] A. Vrcelj, N. Hoic-Bo ´ zi˘ c, and M. H. Dlab, "Use of gamification in primary and ´ secondary education: A systematic literature review," International Journal of Educational Methodology, vol. 9, 2023.

[18] J. M. Prieto-Andreu, J. D. Gomez-Escalonilla-Torrijos, and E. Said-Hung, ´ "Gamification, motivation, and performance in education: A systematic review," 2022.

[19] S. Ede, "Gamification and motivation," Issues and Trends in Learning Technologies, vol. 10, 2022.

[20] D. Zhao, J. Playfoot, C. De Nicola, G. Guarino, M. Bratu, F. Di Salvadore, and G.-M. Muntean, "An innovative multi-layer gamification framework for improved stem learning experience," IEEE Access, vol. 10, pp. 3879–3889, 2022.

[21] Y.-K. Chou, "The octalysis framework for gamification behavioral design." [Online]. Available: https://yukaichou.com/gamification-examples/octalysis-complete-gamification-framework/

[22] R. Hunicke, M. Leblanc, and R. Zubek, "Mda: A formal approach to game design and game research," vol. WS-04-04, 2004.

[23] T. Guo Xin, "The framework of a game design (mda framework)," 04 2022.

[24] S. B. Garnisa, D. Tresnawati, and S. Rahayu, "Penerapan sistem gamifikasi pada learning management system," Jurnal Algoritma, vol. 20, pp. 252–263, 10 2023. [Online]. Available: https://jurnal.itg.ac.id/index.php/algoritma/ article/view/1299

[25] L. H. Firdaus, “Desain gamifikasi adaptif untuk learning management system menggunakan gaming achievement goal,” Jurnal Tekno Kompak, vol. 15, 2021. [26]

[26] N. Limantara, Meyliana, F. L. Gaol, and H. Prabowo, “Designing gamified learning management systems for higher education,” International Journal of Information and Education Technology, vol. 13, pp. 25–32, 1 2023.

[27] V. D. Azis, H. Tolle, and A. D. Herlambang, “Tampilan perancangan user experience dan gamifikasi pada aplikasi pembelajaran online jurusan sistem informasi menggunakan octalysis framework,” 11 2020. [Online]. Available: https://j-ptiik.ub.ac.id/index.php/j-ptiik/article/view/8251/3837

[28] P. B. Lowry, J. E. Gaskin, N. W. Twyman, B. Hammer, and T. L. Roberts, “Taking ”fun and games” seriously: Proposing the hedonic-motivation system adoption model (hmsam),” Journal of the Association for Information Systems, vol. 14, 2013.

[29] S. Solmaz, K. Gerling, L. Kester, and T. V. Gerven, “Behavioral intention, perception and user assessment in an immersive virtual reality environment with cfd simulations,” Virtual Reality, vol. 28, pp. 1–20, 6 2024. [Online]. Available: https://link.springer.com/article/10.1007/s10055-024-00985-2

[30] A. M. Grinberg, J. S. Careaga, M. R. Mehl, and M. F. O’Connor, “Social engagement and user immersion in a socially based virtual world,” Computers in Human Behavior, vol. 36, pp. 479–486, 7 2014.

[31] D. Oluwajana, A. Idowu, M. Nat, V. Vanduhe, and S. Fadiya, “The adoption of students’ hedonic motivation system model to gamified learning environment,” Journal of Theoretical and Applied Electronic Commerce Research, vol. 14, 2019.

[32] O. Ozan and Ma, “Scaffolding in connectivist mobile learning environment,” Turkish Online Journal of Distance Education, vol. 14, pp. 14–2, 05 2013.

[33] K. Demir and E. Akpınar, “The effect of mobile learning applications on students’ academic achievement and attitudes toward mobile learning,” Malaysian Online Journal of Educational Technology, vol. 6, 2018.