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An Adaptive Gamification Model for E-Learning

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Abstract: Gamification has gained currency in the recent past and has widely being deployed in various disciplines such as health, education, marketing amongst others. The main driving factor of deploying gamification is due to its motivational element. Gamification, particularly in education, has been used to motivate and elicit engagement in learners. However the implementation of gamification within e-learning platforms has been of the "One size fits all" i.e., uniform application of gamification elements to all learners, albeit learners possess different characters which are distinct from each other. The need to embrace the "One size does not fit all" approach necessitates introduction of adaptive gamification. This study sought to develop an adaptive gamification model. The study used the Design science research methodology (DSRM) using the problem instantiation approach to develop the adaptive gamification model, which can be used to guide and implement adaptivity within e-learning platforms. In the development of the model the study reviewed 15 adaptive gamification studies from which the key components of an adaptive gamification model were synthesized and a final model proposed.

Keywords: Adaptive Gamification, E-learning, Design science research methodology, game elements

1. Introduction

Gamification has rapidly expanded due to the combined influence of ubiquitous sensor and mobile technology, growth of digital games been a cultural norm, market and business model orienting towards customer centrism and finally public policy makers realization for need to motivate and engage members of the public [1]. Consequently, these technical, political, economic and cultural forces propelled by the need for user engagement and motivation birthed gamification phenomenon [1]. Gamification" as defined [2] is the use of game design elements in non-game context "they opine that gamification is distinct and separate from serious games, video games. Gamification as defined by [3] is the use of game mechanics, dynamics, and frameworks to promote desired behaviours. Gamification outlined by [4] is use of game based mechanics, aesthetics and game thinking motivate action, promote learning and solve problems whilst [5] describe gamification as a process of enhancing a service with affordances for gameful experiences in order to support user's overall value creation. [6] outlines Opine gamification as the intentional use of game elements for a gameful experience of non-game tasks and contexts. Game elements are patterns, objects, principles, models, and methods directly inspired by games. The view taken by [7] on gamification that it is a discipline widely used in marketing, extended to other areas such as health, environment, government and education. [3] provides a basis for use of gamification in education in that it motivates students to engage in classroom, give

teachers better tools to guide and reward students, facilitate immersive learning while [8] indicates that opines gamification in education aims to increase people's engagement and to promote certain behaviors. They argue that the key contribution of gamification in education is to increase the level of engagement of students. Deductively therefore the aim of gamification in education is to extract the game elements that make good games enjoyable and fun to play, adapt them and use those elements in the teaching processes. Thus, students learn, not by playing specific games but they learn as if they were playing a game.

In education, content delivery is of vital importance. There are various forms including the traditional face-to-face classroom, flipped classroom, blended learning, distance learning and E-learning amongst others. E-learning is a vital tool in pedagogy. E-learning described by [9] is a learning mode which encompasses web-based technologies or virtual learning environments in which learning process can occur electronically anytime and anywhere via the internet or intranets. The importance of virtual learning is due to the advantages of efficiency in transferring knowledge, learning environment customization, adaptability for multiple forms of interactive learning, time flexibility, enabling autonomy of self-evaluation processes and having a greater number of students. In many learning environments, pedagogy assumes that all learners are of homogeneous characteristics. However [10] argue that individualized or personalized training is of immerse benefit to the learner , due to the fact that all learners differ in preference, style and abilities with regard to the learning processes with or without technology mediation. Failure to take cognizance of this leads to learner disinterest, frustrations and disengagement. Gamified e-learning systems have been fraught with failure due the uniform application of gamification elements amongst learners' i.e., "*One size fits all"*[11]. This dictum has been countered by [1] who advocate for "*one size does not fit all* "since learners are unique in learning characteristics, individuality and learning approaches. [12] aver that most gamification projects are not working, because they are designed for a group of system users without considering the personal needs of each user. To motivate system users and to make an information system appealing to them, it is necessary to focus on system users and their individual preferences through a suitable gamification element design [13], [14]. Beyond overcoming the quite obvious problems, it seems promising to enhance the effectiveness and success of gamification by tailoring the gamification elements to the individual preferences of users. Hence, it is necessary to develop individualized gamification designs that provide adaptivity of gamification elements focusing on personal needs [15]. Indeed [11], [13] argue this challenge is overcome through suitable gamification design elements of matching the systems users to their preferences. [15] affirms by recommending that games and gamification projects should aspire to have an individualized design for adaptive elements for personalized needs. Further [16] posit for the need of adaptive gamification for successful gamification projects. E-learning platforms are amenable to implementation of gamification. [17] outlined that many initiatives towards adaptivity of gamification within e-learning platforms have been initiated and evaluated revealing varying degree of success and impacts. As a nascent research area [18], [19] note that none of the studies has provided a model for adaptive gamification implementation in an e-learning platform. As such the study seeks to address this gap.

2. Objectives

[16] advances the need of adaptive gamification for successful gamification projects particularly within the e-learning domain. As such the study sought to:

1. Review literature on the Adaptive gamification frameworks/model suitable for e-learning platforms.
2. Propose an adaptive gamification design model for an e-learning platform.

3. Methodology

This study used Design Science research methodology (DSRM) to develop the adaptive model. This is a research approach that focuses on development of artefacts to be utilized in a study. Figure 1 shows the steps involved in DSRM:

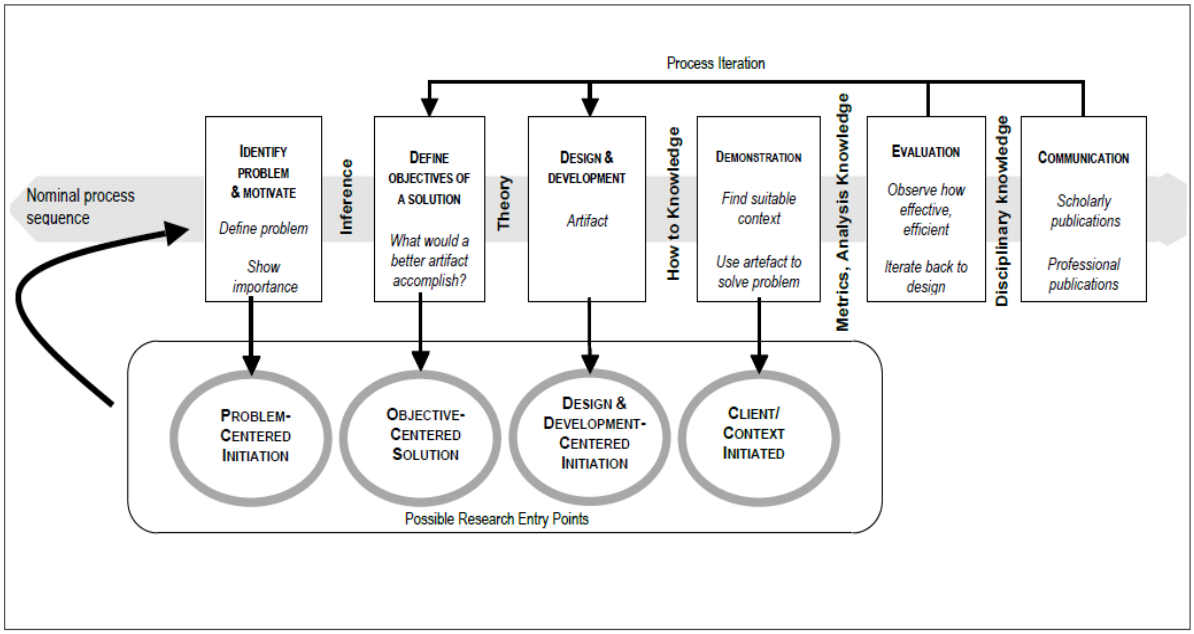

Figure 1: Design science research methodology Source: [20]

[20] elaborate the Process of DSRM that involves

a) Problem Identification and Motivation: The problem is that of developing an adaptive gamification design model that can provide sustained Motivation, Engagement and Adaptivity, this has to be established through review of prior research studies.
b) Define the objectives of the Solution: The objective is developing an adaptive gamification design model, to inform the Development of a LMS using the Design model with adaptivity functionalities and gamification analytics
c) Design and development: This refers to the creation of the artefact i.e. The Model, adaptivity functions and gamified LMS or e-learning platform
d) Demonstration of Artefact: This is to be used to show that problem of motivation and engagement with students.
e) Evaluation of the Artefact. The Artefact will be evaluated against the solution offered to the problem and determine its efficacy
f) Communication: The results of the performance and evaluation will be communicated

The Researcher has adopted Entry level 1 since the problem area has been identified from prior research paper so as to clearly delineate the problem domain. The research work will be done iteratively once starting with problem elaboration, objectives, development of adaptive gamification design, demonstration, evaluation, iteration and finally communicate the results of the research output .The research particularly focussed on step 1-3, step 4-6 will be implemented in the next phase of the works.

For the researchers to understand the problem (elements of adaptive gamification model) well, a detailed systematic literature review was conducted on studies of adaptive gamification in e-learning platforms. The review of works was carried out in indexed databases such as Scopus, Web of Science (WOS), ProQuest and Google Scholar, also in

digital libraries such as ACM Digital Library, Science Direct (Elsevier), IEEE Xplore and Springer with the following search keywords of adaptive personalized or tailored gamification models in e-learning , in the title, abstract, metadata and full-text , with the inclusion and exclusion criteria adapted from [23] as presented in Table 1. A complementary manual search using Google for relevant Conferences and journals in the search area described.

Table 1: Inclusion and Exclusion criteria

Classification	Inclusion criteria	Exclusion Criteria	Number
Language	*English*	*Not in English*	*302*
Gamification in E-learning Platforms	Explicitly Discussed	Not Explicitly Discussed	65
Adaptive or personalized or tailored gamification in e-learning Platform	Explicitly Discussed	Not Explicitly Discussed	15

4. Findings

The results of the findings are of adaptive gamification studies are presented in Table 2. The table presents the various studies conducted, examines the adaptivity basis, theoretical underpinning and any challenges attendant in the study.

4.1 Adaptive gamification review

The study adopted a design science research methodology (DSRM), with a focus of problem-oriented initiation that requires a detailed review of prior research works as presented in Table 2. Summary discussion of the table is presented

- Publications in respect of the problem focus area of adaptive gamification

Table 2: Summary of adaptive gamification in e-learning platforms

S.N	AUTHOR	BASIS OF ADAPTIVITY & GAME ELEMENTS	THEORETICAL UNDERPINNING	SHORTCOMING OR CHALLENGES
1.	(Ferro, Walz, & Greuter, 2013)	Learning style, personality behavior No game Elements	- The Various theories on Player typologies (Bartle, fullerton, caillois) - Personality types and traits by Eysenck Raymond Cattell, Five Factor Model	- Not Validated empirically
2.	(Codish & Ravid, 2014)	Playfulness Proposed Points, Bars feedback , leaderboards	- IS theory of utilitarian and hedonistic Systems , MDA Framework	Not Validated empirically
3.	(Monterrat, Lavoué E., & S., 2015)	Player types Uses Epiphtyes	Bartle Player classification Makes use of adaptation Engine based on player	Not Validated empirically
4.	(Luo, Yang, & Meinel, 2015)	Reward difficulty Uses Points Badges , leaderboards	Implicitly refers to SDT, user centered design, theory of game addiction mechanism	Not Optimized for e-learning platform
5.	(Naik & Kamat, 2015)	Uses points, badges, levels and the leaderboard	None but Uses the Adaptive framework	Adaptive + gamification system separate, not in built
6	(Roosta, Taghiyareh, & Mosharraf., 2016)	Personality trait Uses Badge, Feedback , Leaderboard, Point, Bars	Not explicitly referred to but references to Myer-Briggs, Jung, Freud	No gamification present adaptation framework
7.	(Shi & Cristea, 2016)	Variety of Game elements	Uses Self Determination Theory esp Relatedness , competence , Autonomy	No gamification Present adaptation framework
8.	(Jia, Xu, Karanam, & Voida, 2016)	Personality traits Uses Variety of game	The Personality trait theory of OCEAN	No gamification Present adaptation

		elements		framework for LMS
9	Monterrat, B., Lavoué, É., & George, S. (2017)	Gamification player typology	Develop engine to predict the profile and games elements	Implemented and evaluated mixed results
10	Santos1, W. O. d., Bittencourt, I., & Vassileva, J. (2018)	Gamification typology	Not explicitly referred to, Flow theory	Implemented and validated to have positive impact
11.	Knutas, A., Roy, R. v., Hynninen, T., Granato, M., Kasurinen, J., & Ikonen, J. (2018)	Gamification player typology based hedax element categorization	Using of DSRM, atomic lense development, and the use of ML for CSCL	Proposed
12.	Böckle, M., Micheel, I., Bick, M., & Novak, J. (2018)	Based on usage data, use, player or personality	Developed an adaptive framework model with set criteria.	Evaluated and shown to have impact
13.	Hassan, M. A., Habiba, U., Majeed, F., & Shoaib, (2019)	Learning styles	Learning theories and use of formulae to assign the game elements .	Implemented and evaluated mixed results
14.	Chtouka, E., Guezguez, W., & Amor, N. B. (2019).	Learner and gamification typologies	Reinforced learning and Q-algorithm	Implemented, but not validated
15.	Lavoue, E., Monterrat, B., Desmarais, M., & George, S. (2019)	Gamification Player typology	use of adaptation Engine based on player model	Implemented and evaluated to showed impact

Table 3: Summary of the Adaptive gamification studies

Year	2013	2014	2015	2016	2017	2018	2019
No of Publications	1	1	3	3	1	3	3

The research focussed on the period 2013 - 2019, the distribution can be varied dissected into twice part 1 from 2013 – 2017 the focus was proposal development of how to assign learners on the various criteria (gamer , learning styles , personality) and matching them to the specific game elements. Part 2 from 2017 focus shift from proposal to actual implementation in the e-leaning platforms where evaluations are carried out. The former part largely dealt with adaptive frameworks whilst the latter part dealt with actual design mechanism (matrix, algebraic, machine learning approaches) of adaptive gamification implementations.

- Theoretical underpinning of the adaptive gamification studies

From Table 1, it can be synthesized that the adaptivity criteria significantly influence the theoretical frame of the study as well as the focus of the study whether its motivation or engagement. The most predominant is the Self-determination theory, followed by the personality trait theories. [6] lament that there are a scarcity of theories in the development of adaptive gamification studies.

- Basis of Adaptivity

This usually informs how the adaptation of game elements within gamification studies will directed and implemented. This forms the adaptivity criteria upon which adaptation is implemented. From Table 1 it can be inferred the most predominate criteria is gamification gamer typology at 27%, next is both personality trait and Bartle player style at 13% each, with learning style at 7%. Various studies have deployed a combination of at least two approaches either Bartle player, gamification player, learning or personality styles at 13%. . Adaptivity can either be static referring to the adaptation based on the learner profile or dynamic based on the learner activity and profile [19] The establishment of the activity or profile can either be manually implemented through the use of questionnaires or the automatically by the systems through analysis of user activities and interactions of the e-learning systems.

- Shortfalls and challenges

Most notable aspect of the studies is that nearly 50% were proposals of the adaptivity gamification approach proffering on various adaptivity framework, which learner profiles are amenable to which type of game elements matching. Only 33% the studies involved full implementation and evaluations out of which 60% showed impact of adaptive gamification. However [1] observe that there is still limited studies to comprehensively elaborate the key nuances for gamification project.

4.2 Synthesized elements of the adaptive gamification model

From the review and evaluation of the 15 studies the critical components and elements of an adaptive gamification model for an e-learning platform as guided by [21] and [22] are

a. The Adaptive engine or module. This is adaptive process is undertaken, either statically or dynamically, of which the process can be system automated or manually implemented. This component is the most critical in the adaptive gamification since its where the adaptivity criteria is implemented to facilitate the matching or pairing of the system users to game elements.
b. Management of e-learning, this refers to the organizing, planning, staffing, leading and controlling all important elements of e-learning which include pedagogical, technological, design, administration, human, financial and gamification elements [21]
c. Elements of gamification. These would refer to the mechanics, dynamics and the aesthetics as per the MDA framework. The mechanics are the actual game elements such as points, leaderboard , dynamics are the goals of the game rewards, achievement, competition
d. The Focus or effect of adaptive gamification. This refers to the end goal of why adaptivity has been introduced to the e-learning platform. Predominately the implementation of adaptivity is to enhance suitability of use of the e-learning platform so as to increase motivation, engagement, and satisfaction of the users for enhanced learning.

5. Proposed Adaptive Gamification Framework/Model

From the reviewed literature, the proposed adaptive gamification model is shown in Figure 2. The Key elements are

i) The Adaptive gamification engine. This is module that focuses on how to provide game elements and learning content aligned to the learner characteristics. The matching termed as adaptation can either be static or dynamic , which aligns the enrolled students' profiles to appropriate game elements and learning content
ii) Management of the E-learning platform enables the key administrative functions of user addition, roles access rights and control.
iii) Adaptive game elements techniques and dynamics. This function of this module it's a repository all game elements are initiated, rules and goals established and the desired game dynamics outlined. Game elements are the motivational affordances that trigger the motivational aspect of gaming during learning. The Dynamic aspect is the resultant behaviour during the gaming. All these are appropriately matched to the learner characteristics.
iv) Adapted gamified course. This is a product of systematic process where teaching, learning material, resources and curriculum are developed and established in conformity to gamification strategies implemented by the adaptive engine .

The desired impact of adaptive gamification. This is focus of the adaptive gamified e-learning platform. Gamification is enabled so to achieve better learning outcomes through

enhanced motivation and engagement, better learning experiences and increased knowledge.

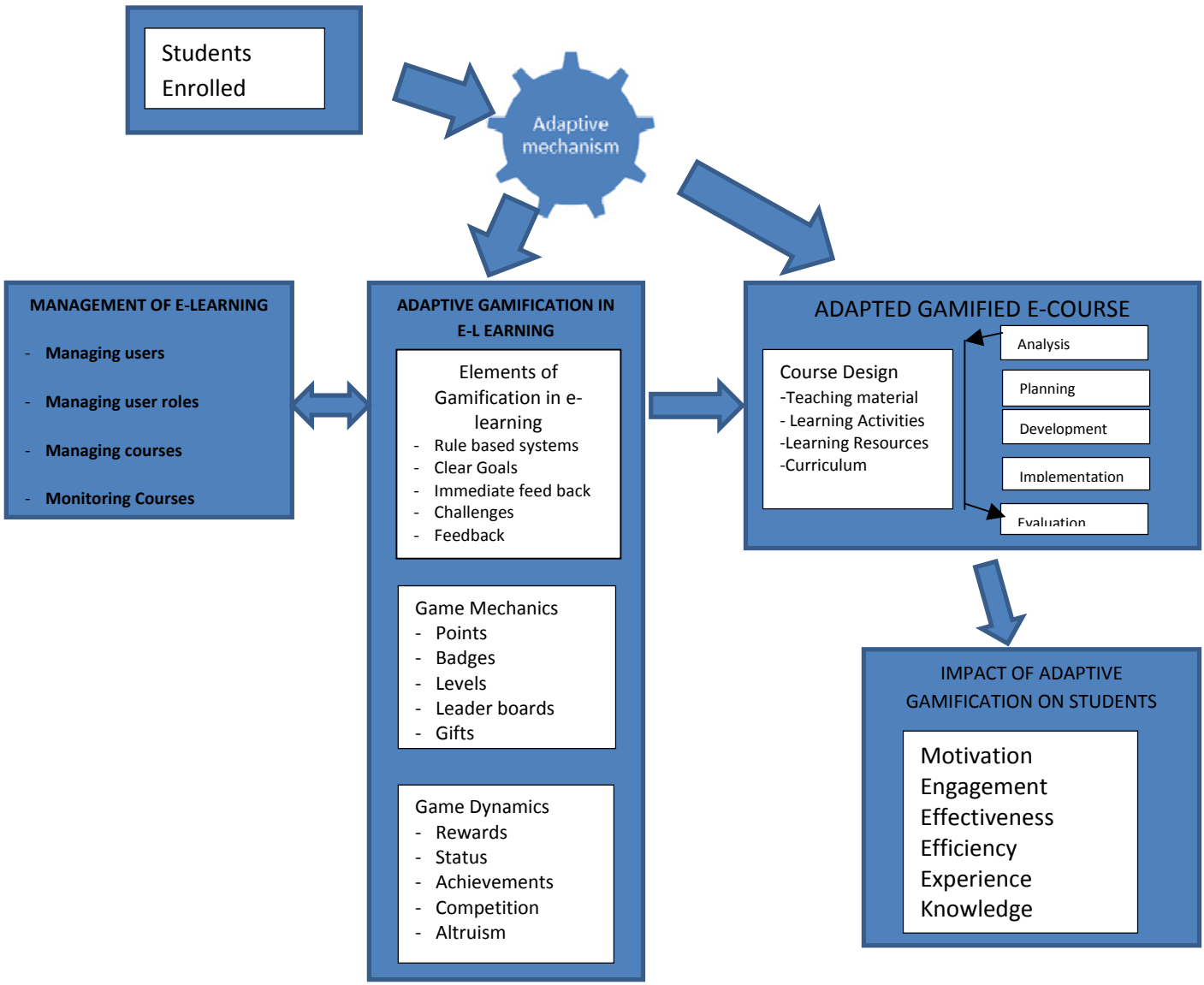

Figure 2: Proposed Adaptive Gamification model for E-learning Platform. Adapted from [21] [22]

6. Business Benefits of the Model

E-learning Platforms are critical in modern day educational pedagogy; however they can be inefficient and ineffective if poorly designed particularly when gamification is introduced and have no regard for learner individuality. A remedy to this, is to have a well defined elaborated method for design and implementation for adaptive gamification

The model proposed provides a platform to situate adaptive gamification research within an e-learning platform, it allows the researchers to have a lens for guidance on the research design, data collection procedures and tools and importantly enabling evaluation rigour in the study. The model allows for the development and establishment of design principles of adaptive gamification within e-learning platforms, as it outlines the keys development aspects and expected output for such a system.

The model proposed allows the researchers to be guided in the next phase 2 which is the development of the adaptively designed e-learning, implementation and its validation which are the final phases of the DSRM. The model will assist teachers understand how adaptive gamified e-learning systems works and how to assist in making content suitable for the

learners particularly bearing in mind that learners have different learning styles , habits and motivation .

To the developers of adaptive gamification projects within an e-learning systems context it guides the setting of architectural layout and framework of the system, how the interaction within the system should be implemented and enhanced, and importantly to test the effectiveness of the system in a learning environment.

Finally for the policy makers to understand how adaptive gamification of e-learning can be introduced, identify the resources needed and how to evaluate the effectiveness of the system.

7. Conclusions

The study was a review and development of the adaptive gamification model and how it's can be adapted within the e-learning domain. The study through the design science research methodology specifically using the problem initiation approach sought to develop an adaptive gamification model for e-learning.

Gamification is vital in education, as it provides for learner motivation and engagement. However learner's have individuality and therefore for gamification to be introduced it must be well designed and theoretically ground to inform the adaptation process for a proper adaptive gamification model suited for e-learning, it must be theoretical derived on user centred design, motivational theories, e-learning theories and vigorous validation. We intend to do further research by developing a gamified e-learning prototype and integrate it in a LMS such as Moodle based on the proposed gamification framework work utilizing the adaptive gamification approach. Also it can study whether there are game elements that are preferred over others.

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References

1. Nacke, L. E., & Deterding, S. (2017). The maturing of gamification research. Computers in Human Behavior
2. Deterding, S., Sicart, M., Nacke, L., O'Hara,, & K., D., D.,. (2011). Gamification: using game-design elements in non-gaming contexts.. In:Proceedings of the 2011Annual Conference Extended Abstracts on Human Factors in Computing Systems, Vancouver.
3. Lee, J. J., & Hammer, J. (2011). Gamification in Education: What, How, Why Bother? Academic Exchange Quarterly, Vol 15(No. 2).
4. Kapp, K. M. (2012). The gamification of learning and instruction: Game-based methods and strategies for training and education. San Francisco, CA: John Wiley & Sons.
5. Huotari, K., & Hamari, J. (2012). Defining gamification – a service marketing perspective. Paper presented at the In Proceedings of the16th International Academic Mind TrekConference., Presented at MindTrek'12
6. Seaborn, K., & Fels, D. (2015). Gamification in theory and action :A survey. International Journal Of Computer Studies (74), pgs 14 -31.
7. Harman, K., Koohang, A., & Paliszkiewicz., J. (2014). Scholarly interest in gamification: a citation network analysis. Industrial Management & Data Systems, Vol. 114 (No. 9), pp. 1438-1452.
8. Simões, J., Redondo, R. D., & Vilas, A. F. (2012). A social gamification framework for a K-6 learning Platform Computers in Human Behavior, Vol 29(2), pg 345–353.
9. Wang, H. C., & Chiu, Y. F. (2011). Assessing e-learning 2.0 System Success. Computer & Education, Vol 57 (2), pp. 1790–1800
10. Naik, V., & Kamat, V. (2015). Adaptive and Gamified Learning Environment(AGLE). Paper presented at the IEEE Seventh International Conference on Technology for Education, Warangal, India.

11. Roosta, F., Taghiyareh, F., & Mosharraf., M. (2016). Personalization of Gamification-elements in an E-Learning Environment based on Learners' Motivation. Paper presented at the 8th International Symposium on Telecommunications.
12. Schöbel, S., & Söllner, M. (2016). How to Gamify information systems Adapting gamification to individuals preferences Paper presented at the European Conference on Information Systems (ECIS), Istanbul, Turkey.
13. Burgers, C., Eden, A., Engelenburg, M. D. v., & Buningh, S. (2015). How feedback boosts motivation and play in a brain-training game. Computers in Human Behavior Vol 48, pp 94–103.
14. Hamari, J., & Koivistoa., J. (2015). Why do people use gamification services? International Journal of Information Management (35), pgs 419–431.
15. Cheng, M.-T., Lin, Y.-W., & She, H.-C. (2015). Learning through playing Virtual Age: Exploring the interactions among student concept learning, gaming performance, in-game behaviors, and the use of in-game characters. Computers & Education (2015) Vol 86(pp 18 - 29)
16. Codish, D., & Ravid, G. (2014). Adaptive Approach for Gamification Optimization Paper presented at the IEEE/ACM 7th International Conference on Utility and Cloud Computing, London, UK.
17. Darina Dicheva, et al. (2015). "Gamification in Education: A Systematic Mapping Study." Educational Technology & Society **18**(3).
18. Böckle, M., Novak, J., & Bick, M. (2017). TOWARDS ADAPTIVE GAMIFICATION: A SYNTHESIS OF CURRENT DEVELOPMENTS. Paper presented at the 25th European Conference on Information Systems (ECIS), , Guimarães, Portugal
19. Stuart, H., Serna, A., Marty, J.-C., & Lavoué, E. (2019). Adaptive gamification in education: A literature review of current trends and developments. Paper presented at the European Conference on Technology Enhanced Learning (EC-TEL), Delft, Netherlands.
20. Peffers, K., Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. (2007). A Design Science Research Methodology for Information Systems Research. Journal of Management Information Systems, Vol 24(3), pp 45-77.
21. Urha, M., Vukovica, G., Jereba, E., & Pintara, R. (2015). The model for introduction of gamification into e-learning in higher education. Paper presented at the 7th World Conference on Educational Sciences, (WCES-2015), 05-07 February 2015, Novotel Athens Convention Center, Athens, Greece.
22. Zaric, N., Scepanović, S., & Vujicic, T. (2017). The Model for Gamification of E-learning in Higher Education Based on Learning Styles. Paper presented at the 10 ICT INNOVATION CONFERENCE Macedonia
23. Kamunya S, Maina E & Oboko R (2019) A Gamification Model for eLearning Platforms. In IST-Africa 2019 Conference Proceedings, Paul Cunningham and Miriam Cunningham (Eds), IIMC International Information Management Corporation, 2019, ISBN: 978-1-905824-62-5

Appendices for the Reviewed Articles

1. Ferro, L. S., Walz, S. P., & Greuter, S. (2013). *Towards personalised, gamified systems: an investigation into game design, personality and player typologies.* Paper presented at the 9th Australasian Conference on Interactive Entertainment: Matters of Life and Death, Melbourne, Australia.
2. Codish, D., & Ravid, G. (2014). Adaptive Approach for Gamification Optimization Paper presented at the IEEE/ACM 7th International Conference on Utility and Cloud Computing, London, UK
3. Monterrat, B., Desmarais, M., Lavoué, É., & George, S. (2015). A Player Model for Adaptive Gamification in Learning Environments. Paper presented at the Artificial intelligence in Education Madrid,Spain.
4. Luo, S., Yang, H., & Meinel, C. (2015). *Reward-based Intermittent Reinforcement in Gamification for E-learning.* Paper presented at the In Proceedings of the 7th International Conference on Computer Supported Education.
5. Naik, V., & Kamat, V. (2015). Adaptive and Gamified Learning Environment(AGLE). Paper presented at the IEEE Seventh International Conference on Technology for Education, Warangal, India.
6. Roosta, F., Taghiyareh, F., & Mosharraf., M. (2016). Personalization of Gamification-elements in an E-Learning Environment based on Learners' Motivation. Paper presented at the 8th International Symposium on Telecommunications.
7. Shi, L., & Cristea, A. I. (2016). *Motivational Gamification Strategies Rooted in Self-Determination Theory for Social Adaptive E-Learning.* Paper presented at the Intelligent Tutoring Systems Zagreb, Croatia.
8. Jia, Y., Xu, B., Karanam, Y., & Voida, S. (2016). Personality targeted Gamification: A Survey Study on Personality Traits and Motivational Affordances. Paper presented at the Conference on Human Factors in Computing Systems, San Jose, California, USA.

9. Monterrat, B., Lavoué, É., & George, S. (2017). Adaptation of Gaming Features for Motivating Learners. Simulation & Gaming, Vol. 48 (5), pp 625 - 656
10. Santos1, W. O. d., Bittencourt, I., & Vassileva, J. (2018). Gamification Design to Tailor Gamified Educational Systems Based on Gamer Types. Paper presented at the SBGames 2018, Brazil
11. Knutas, A., Roy, R. v., Hynninen, T., Granato, M., Kasurinen, J., & Ikonen, J. (2018). A process for designing algorithm-based personalized gamification. Multimedia Tools and Applications
12. Böckle, M., Micheel, I., Bick, M., & Novak, J. (2018). A Design Framework for Adaptive Gamification Applications. Paper presented at the 51st Hawaii International Conference on System Sciences, Hawaii
13. Hassan, M. A., Habiba, U., Majeed, F., & Shoaib, M. (2019). Adaptive gamification in e-learning based on students' learning styles. Interactive Learning Environments.
14. Knutas, A., Roy, R. v., Hynninen, T., Granato, M., Kasurinen, J., & Ikonen, J. (2018). A process for designing algorithm-based personalized gamification. Multimedia Tools and Applications
15. Lavoue, E., Monterrat, B., Desmarais, M., & George, S. (2019). Adaptive Gamification for Learning Environments. IEEE TRANSACTIONS ON LEARNING TECHNOLOGIES,12(1) , 16 - 28