

A Systematic Mapping of Adaptive Gamification in E-learning

Samuel Kamunya

*South Eastern University of Kenya, KENYA
School of Information Technology, Nairobi*

Robert Oboko

*University of Nairobi, KENYA
School of Computing and Informatics, Nairobi*

Elizaphan Maina

Kenyatta University, School of Engineering, Nairobi, KENYA

Received 1 December 2019 ▪ Revised 26 December 2019 ▪ Accepted 27 December 2019

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 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, however learners possess different characters which are distinct from each other. The need to embrace “*One size does not fit all*” approach necessitates introduction of adaptive gamification. This study sought to establish the state of the art of adaptive gamification applied within e-learning using a systematic mapping approach. The study identified 122 studies and distilled to final 23 for detailed review and mapping. The study found out that gamification elements are mostly used as structural gamification, with basis of adaptivity been predominately static and the methodological implement been mathematical. Overall it was found that adaptive gamification has positive effect within the e-learning platform

Keywords: gamification, e-learning, adaptive, systematic mapping, motivation.

1. Introduction

Gamification as has rapidly expanded due 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 (Nacke & Deterding, 2017). Consequently, these technical, political, economic and cultural forces propelled by the need for user engagement and motivation birthed gamification phenomenon (Nacke & Deterding, 2017). “Gamification” as defined by (Deterding, Sicart, Nacke & K., 2011) is the use of game design elements in non-game

context and they opine that gamification is distinct and separate from serious games, video games. (Lee & Hammer, 2011) define gamification as the use of game mechanics, dynamics, and frameworks to promote desired behaviours. Gamification outlined by (Kapp, 2012) is use of game-based mechanics, aesthetics and game thinking motivate action, promote learning and solve problems, whilst Huotari and Hamari (2012) define gamification as a process of enhancing a service with affordances for gameful experiences in order to support user's overall value creation. Seaborn and Fels (2015) 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 Harman, Koohang and Paliszkiwicz (2014) on gamification that it's a discipline widely used in marketing, extended to other areas such as health, environment, government and education. Lee and Hammer (2011) provide a basis for use of gamification in education in that its, motivates student to engage in classroom, give teachers better tools to guide and reward students, facilitate immersive learning, while Simões, Redondo and Vilas (2012) 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 classroom face to face, flipped classroom, blended learning, distance learning and E-learning amongst others. In education, E-learning is a vital tool in pedagogy. E-learning described by Wang and Chui (2011) 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. They state the importance of virtual learning is due to the advantages of efficiency in transferring knowledge, learning environment customization according to specific individual needs and learning styles, adaptability for multiple forms of interactive learning, time flexibility, allowing pauses at specific points and, if necessary, repetition of specific parts, enabling autonomy of self-evaluation processes and allows having a greater number of students. In many learning environments, pedagogy assumes that all learners are of homogeneous characteristics. However, Naik and Kamat (2015) argue that individualized or personal 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 distribution of gamification elements amongst learners, i.e. "*one size fits all*" (Roosta, Taghiyareh & Mosharraf, 2016). This dictum has been countered by Nacke and Deterding (2017) who advocate for "*one size does not fit all*", since learners are unique in learning characteristics, individuality and learning approaches. Schöbel and Söllner (2016) claim that most gamification projects are not working, because they are designed for a crowd 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 (Burgers, Eden, Engelenburg & Buningh, 2015; Ha-mari & Koivisto, 2015). 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 (Smalls, 2013). Hence, it is necessary to develop individualized gamification designs that provide adaptivity of gamification elements focusing on personal needs (Cheng, Lin & She, 2015). Indeed, Burgers et al. (2015), Roosta, Taghiyareh and Mosharraf (2016) argue this challenge is overcome through suitable gamification design elements of matching the systems users to their preferences. Cheng, Lin and She (2015) affirms by recommending that games and gamification projects should aspire to have an individualized design for adaptive elements for

personalized needs. Further, Codish and Ravid (2014) posit for the need of adaptive gamification for successful gamification projects. E-learning platforms are amenable to implementation of gamification. Comprehensive systematic literature review on gamification in e-learning (Dicheva & Dichev, 2015; Ortiz et al., 2016) has been conducted, revealing the potential and impact accorded to learners. 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 there has been but two comprehensive reviews by Böckle, Novak and Bick (2017), and Stuart, Serna, Marty and Lavoué (2019), but no systematic mapping study, as such the study seeks to address this gap.

The remainder of this paper is structured as follows: Section 2 describes the systematic mapping process; it presents the research questions and the search string, along with the inclusion and exclusion criteria and data extraction process. Section 3 reports the results obtained from the mapping process. Section 4 discusses the main findings, states the limitations of the studies and outlines the implications for practice and research. Our conclusions and future work are presented in Section 5.

2. Systematic mapping process

In systematic mapping aim is to provide an overview of the research area identifying the quantity, type and results (Petersen, Feldt, Mujtaba & Mattsson, 2008). The focus of this study is to provide an overview on the state of adaptive gamification within e-learning platforms. Dalmina, Barbosa & Vianna (2019) elaborate that the goal of a systematic mapping is to insightfully provide a state of art in a focus area, identifying the key trends and revealing the research gaps.

The purpose of this study is to determine and characterize the state of the art of adaptive gamification in e-learning, analyzing the existing proposals and research work and thus identifying potential gaps and opportunities for future research. The main research question guiding this study is therefore:

What is the state of the art of adaptive gamification applied to e-learning?

In order to conduct the systematic mapping process, the researcher followed steps elaborated by Petersen et al. (2008): (i) definition of research questions, (ii) performing the search for relevant primary studies, (iii) screening of papers, (iv) key wording of abstracts, and (v) data extraction and mapping.

2.1 Definition of research questions

The study was carried out in last quarter of 2019 and covered the period 2014 -2019. The summary of questions in as tabulated in Table 1.

Table 1. Research questions

ID	Research Question
RQ1:	In which context of e-learning has adaptive gamification been applied?
	RQ1.1. What types of courses and education level have been implemented in adaptive gamification?
	RQ1.2. which educational activities have utilized adaptive gamification?
	RQ1.3. what is the nature of adaptive gamification?
RQ2:	How has Adaptive gamification been implemented in E-learning platforms

RQ2.1. Which gamification elements have pre-dominantly being adapted?

RQ2.2. On what basis has adaptive gamification been implemented?

RQ2.3. What kind of Methodologies/tools/instruments have been used to implement the adaptive gamification?

RQ3: What is the evidential impact of Adaptive gamification on e-learning?

RQ3.1. What the outcome of adaptive gamification is as deployed within e-learning Platforms?

RQ1 seeks to understand the environment in which the adaptive gamification was implemented specifically the course implemented, education level, which educational activities and nature of gamification adaptation.

RQ2 sought to examine in detail the nature and implementation of the adaptive processes starting the game elements or mechanics deployed, the basis of adaptivity and the methodologies employed to realise the adaptation process.

RQ3 examined the evidential impact of adaptive gamification effort. Whether it resulted to positive, negative or neutral outcomes.

2.2 *The search and study selection process*

In- order to achieve the objective there was need to identify the list of databases to search, they included IEEE explore, Science Direct, ACM digital library, Google scholar, Springer link, since these databases contain numerous to filter and gather the specific information there was need to develop a search string

The research string was:

Gamification captured as *gamif** OR *game elements*. Gamif* as a wild card for gamification, gamify, gamified,

AND

Adaptive captured as (*adapt** OR *personali** OR *individual**) for the wildcards for adaptive, adaptivity adaptable. Personal wild card for personalisation, personalized and individual for individualized or individualization,

AND

E-learning Platform as “(e-learning OR Virtual learning Environment OR online learning OR Learning management systems)”.

The selection process of primary studies was composed of two screening stages. During the first stage, the titles and abstract were read to measure relevance. During the second stage, the full text was read to make a decision on inclusion or exclusion. To avoid the premature exclusion of studies, doubtful studies were always included for further and detailed reading during the second stage. The inclusion and Exclusion criteria as elaborated by Petersen, Vakkalanka and Kuzniarz (2015) was:

Inclusion criteria:

- INC1 Academic journal, conference and workshop papers which are peered reviewed
- INC2 Studies are in the field of adaptive gamification in e-learning.
- INC3 Studies present the research method and results

Exclusion criteria:

- EC1 Studies dealing with Adaptive serious games or adaptive game-based learning or not explicitly using adaptive gamification within and an e-learning Context.
- EC2 Studies presenting summaries of conferences/editorials or guidelines/templates for conducting mapping studies.
- EC3 Studies presenting non-peer reviewed material.
- EC4 Works not written in English
- EC5 Works not accessible in full-text
- EC6 Books and gray literature

The search and selection process is illustrated in Figure 1.

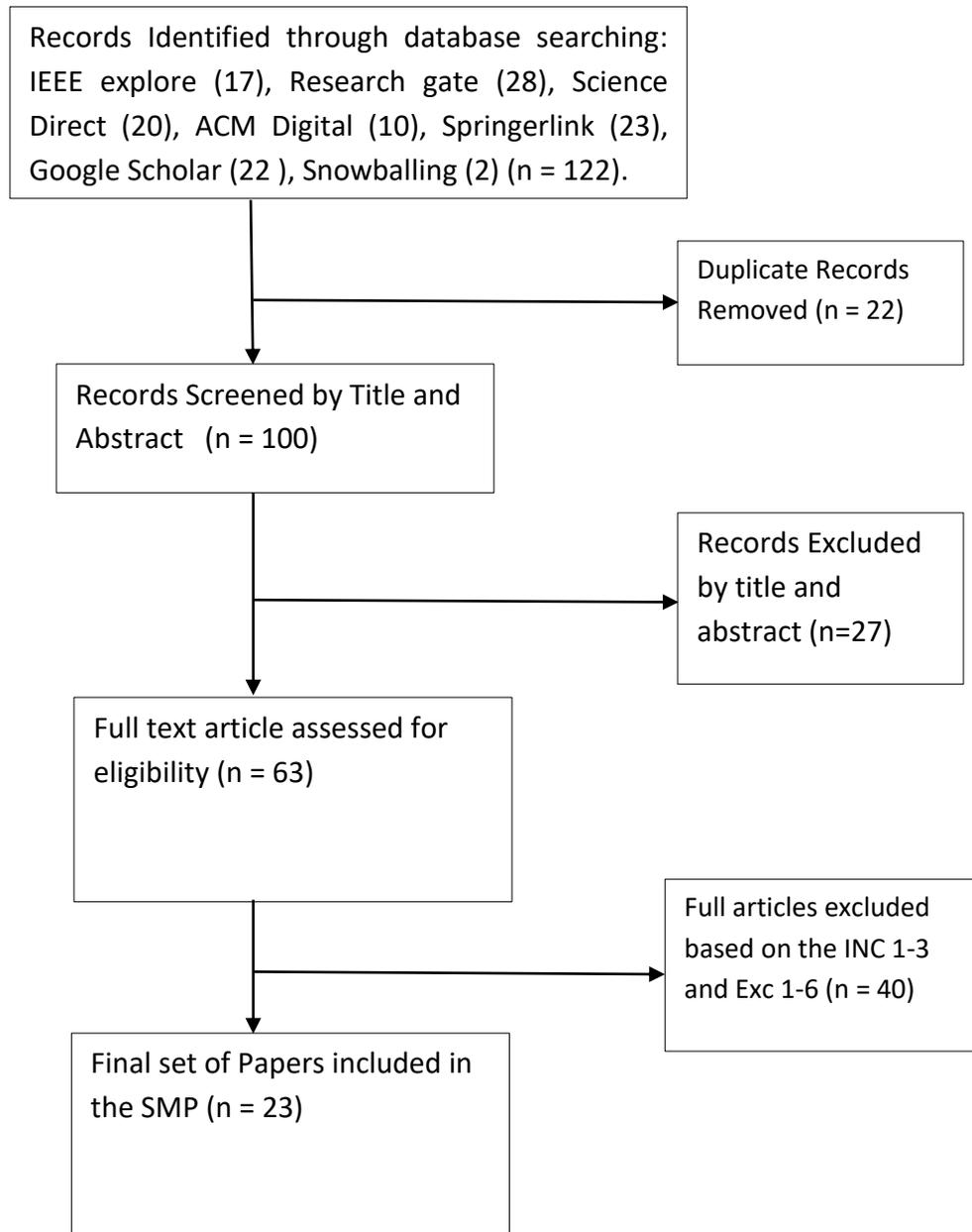


Figure 1. Study selection process

Our search identified 122 papers. After removing duplicates 100 papers remained. Of these 23 were removed based on screening of title and abstract. The remaining 63 articles were considered and assessed as full texts. 40 did not pass the inclusion and exclusion criteria. 23 final eligible studies remained and were individually assessed for this systematic mapping study.

2.3 The data extraction process

To extract data from the primary sources identified, we followed the guidelines of Petersen, Vakkalanka and Kuzniarz (2015), Alhammad and Moreno (2018) that had the following steps design the data extraction template, data extraction and its validation. The key fields were:

- Research Type: The following classifications were adapted from (Petersen and Feldt, 2008) to the education field in order to record the type of research reported in the primary studies:
 - Evaluation research: A study reporting adaptive gamification applied in e-learning course, where evaluation is conducted in a real setting e.g. classroom.
 - Validation research: A study reporting adaptive gamification applied in e-learning course where the gamified solution was validated in a laboratory setting (e.g., a pilot study, experiment with volunteer students).
 - Solution proposal: A study proposing an adaptive gamified solution for an e-learning course that was neither evaluated in a real setting nor validated in laboratory environment.
 - Experience paper: A study reporting the authors' experience, reflections, benefits and drawbacks of adaptive gamification of e-learning platform.
 - Philosophical papers: A study describing a new conceptual idea, implying a new way of adaptive gamification.
 - Opinion paper: A study reporting the authors "opinion" about applying adaptive gamification rather than describing a new result of applying adaptive gamification as a novel design, or a conceptual idea.
- What types of courses and education level have been implemented in adaptive gamification
- Which educational activities have utilized adaptive gamification that is, the type of educational activity, such as projects, assignments, lectures, etc. that has been gamified.
- What is the nature of adaptive gamification, how has adaptivity been implemented using static, dynamic approach.
- Which gamification dynamics, mechanics, and elements have pre-dominantly being adapted.
- On what basis has adaptive gamification been implemented, used learning style which model FLSM/ KOLB, personality MBTI personality, gaming behavior Bartle model, Andrezwicki hexad brainer scale
- What kind of tools/instruments have been used to implement the adaptive gamification, how is adaptivity implemented using some matrix, machine learning, algorithms, mathematical formulae.
- Purpose of applying adaptive gamification, recording information about the aim or reason behind adaptive gamification, do the authors want to improve student performance, motivation, etc.
- Gamification impact, gathering information regarding the evidenced effect of applying adaptive gamification in e-learning

The Data Extraction Form

Data Item	Value	RQ
Study ID	<i>First author's last name + year of publication</i>	
Article Title	<i>Name of the article</i>	
Author Name	<i>Names of all the authors</i>	
Year of Publication	<i>Calendar year</i>	
Venue	<i>Name of publication venue</i>	
Type of Research	<i>Evaluation research, solution proposal, validation research, experience paper, philosophical paper, or opinion paper.</i>	
Type of Course	<i>What is the type or format of the gamified course?</i>	RQ1.1
Adaptive gamified Activity	<i>Which educational activities/components have utilized adaptive gamification?</i>	RQ1.2
Nature of adaptivity	<i>How has adaptivity been implemented using Static or dynamic adaptive gamification approach?</i>	RQ1.3
Adapted game Elements	<i>Which gamification dynamics, mechanics, and elements have pre-dominantly being adapted?</i>	RQ2.1
Basis of adaptive	<i>Which approach was used for adaptivity learning style Personality, gamification, Player?</i>	RQ2.2
Methodological Approach	<i>How has adaptive gamification implemented the tools, Mathematical formulae, Machine learning algorithms,</i>	RQ2.3
Impact of Applying Adaptive gamification	<i>Was the impact of applying adaptive gamification in e-learning positive, negative, or neutral?</i>	RQ3.1

2.4 Data analysis

During the data analysis, the information of each item extracted was tabulated and grouped according to their values, providing the information required to generate the figures and tables presented in Section 3. To generate the statistical data, the papers belonging to each group of an item were counted. Throughout the study, the papers were organised under the classification categories, corresponding to each of the research questions of the systematic mapping, including focused and statistical questions.

2.5 Validity evaluation

As with any systematic review or systematic mapping studies a number factors that may affect the conclusions drawn, i.e. threats to the validity as defined by Petersen, Vakkalanka and Kuzniarz (2015), Alhammad and Moreno (2018), key amongst them are:

- (1) Descriptive validity the extent to which observations are described accurately and objectively this overcome using the data extraction template.
- (2) Study Selection: This threat concerns the possibility of researcher bias and author disagreement on exclusion and inclusion. We applied a strategy to deal with this threat. We deployed the inclusion and exclusion criteria for identification of acceptable studies.
- (3) Search Coverage. This threat concerns the completeness of the search process and the preventive measures taken to avoid leaving out relevant studies by using a broad exhaustive search string in well recognized databases.

3. Results

3.1 General results

This section reports the general finding relating to the primary studies. Figure 2 illustrates the distribution of studies yearly. The period of study was from 2013 to Oct 2019. The publications on adaptive gamification have picked up from 2016 indicating more research focus. Figure 3 focuses on the distribution avenues of the studies, without doubt conference take a significant share at 61 % since they are usually the turnaround duration is less as compared to journals at 35% and workshop 4 %. Figure 4 describes the research type conducted in respect of adaptive gamification, it reveals both Evaluation and Solution proposal studies even matched followed by validation research and lastly philosophical study. The Evaluation studies consisted of developed adaptive platforms tested in actual classroom environments while validation studies were adaptive platforms though tested on voluntary limited basis.

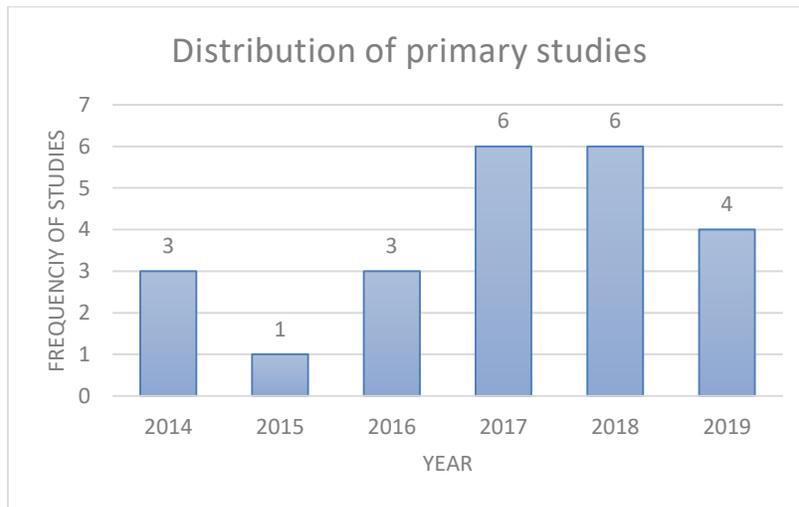


Figure 2. Distribution of studies yearly

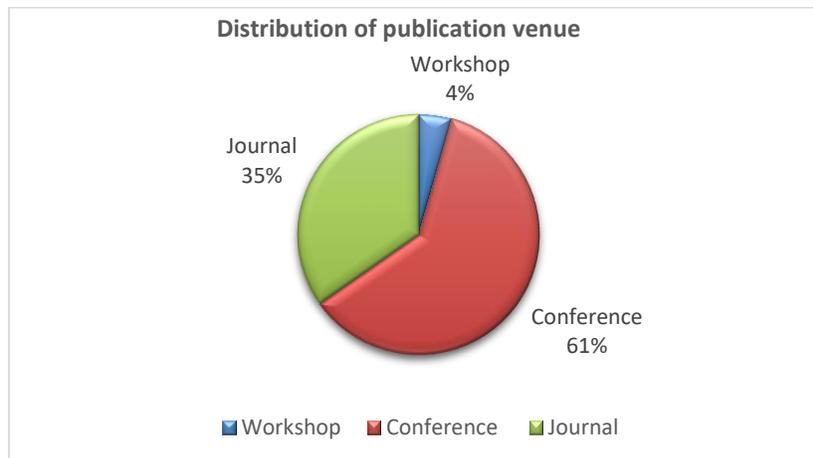


Figure 3. Distribution of publication venue

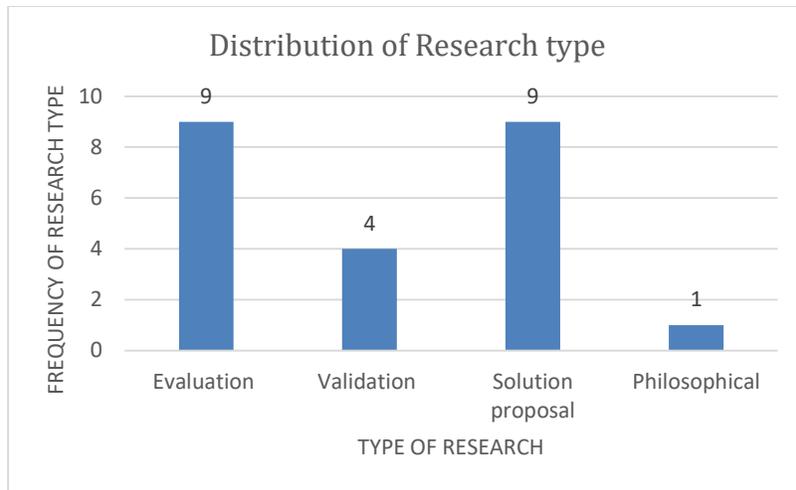


Figure 4. Distribution of type of research

3.2 RQ1 – Context of application

The section deals with the type of course, which activity utilizes the adaptive gamification and the nature of adaptive gamification

3.2.1 RQ 1.1 – Type of course

The results show that nearly 50% (11 studies) do not state which courses the course platform has been adaptively gamified. The STEM courses especially Computer Science courses are most pre dominate this probably attributable to the researchers back ground and ease of access to the experiment study area. A few studies focussed on languages [A6, A7, and A16]

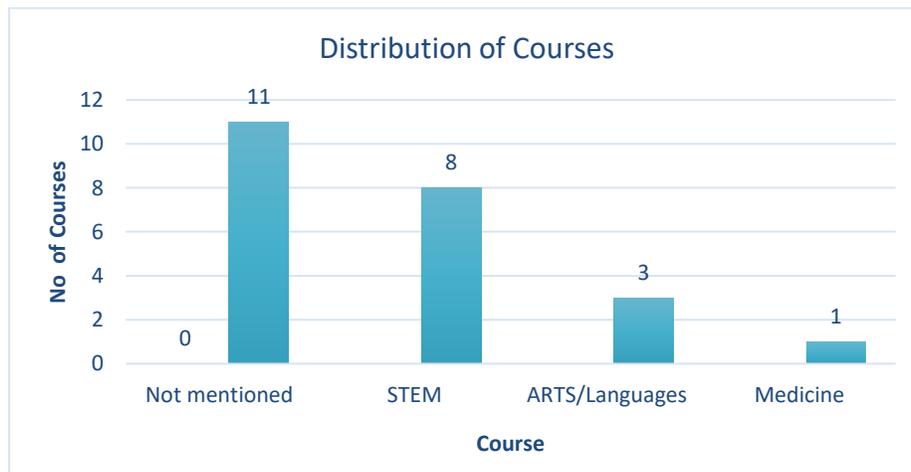


Figure 5. Distribution of courses

3.2.2 RQ 1.2 – Educational activity

The research question examine which activity was adaptively gamified there were four key classes. The most adaptively gamified activity was learning (Materials presentation, Assignments, quizzes Chats quizzes), next was both Group formation [A1, A8] and also social networking activities were also gamified [A11, A21]. Finally, 3 studies focused on mentoring.

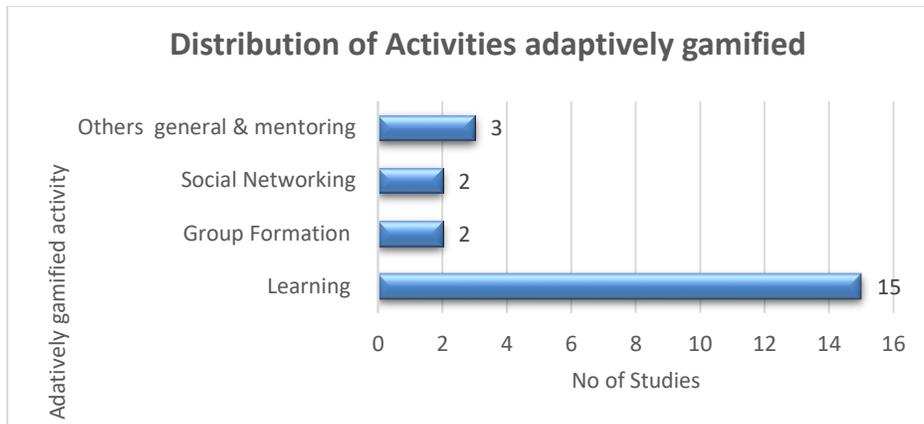


Figure 6. Activities adaptively gamified

3.2.3 RQ 1.3 – Nature of adaptivity

The question examined how adaptivity was implemented either statically, whether the gamified status of the user is determined once mostly by use of questionnaires or dynamically where the system automatically recognizes the user through various approaches (user data, usage data) to create a profile and adapt the system on the derived profile. It should be noted though this profile discovery can be done once or continuously during the usage of the system. In the static approaches the system made use of validated instruments for profile creation, such as MBTI for Personality profiles, HEXAD brain type for gamification profiles, FLSM for learning styles, as such the user was requested to answer some questions which lead to his profiling. The results show that 57% of the studies had static nature of adaptivity as opposed to 39% which utilized dynamic approach to adaptive gamification which required the development of adaptive engine. One study [13] deployed mixed approach starting of using static method but the user profile is dynamically update with use of the system

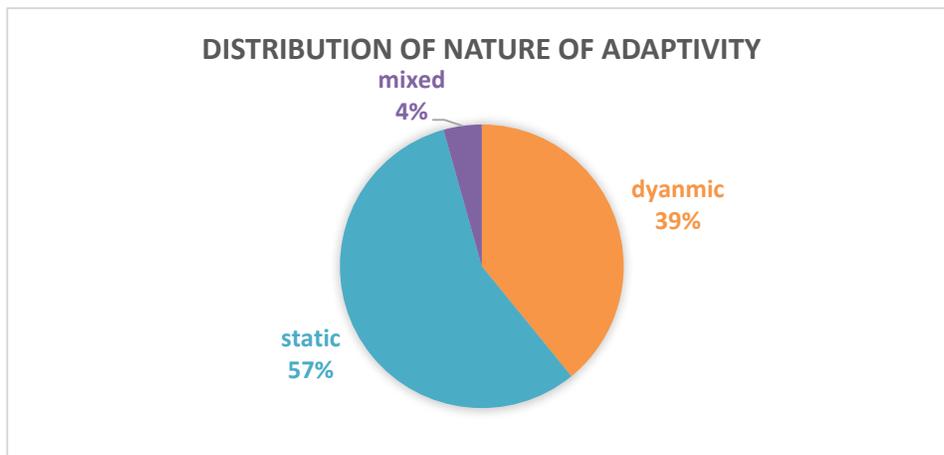


Figure 7. Nature of adaptivity

3.3 RQ 2.2 – Basis of adaptive gamification

The goal of this section is to examine how adaptivity gamification was implemented, which gamification elements were used, the basis of adaptivity and the approach deployed.

3.3.1 RQ 2.1 – Gamification elements

In the discussion of elements, we ascribe to the MDA framework that dissects the components of game. (Werbach & Hunter, 2012) elaborates this framework in the light of gamification as mechanics as “the processes that drive actions forward”, a game dynamic can be defined as a pattern of loops that turns them into a large sequence of play and the components the specific elements. The Figure 8, bundles and summaries the three main items of the framework and bundles each of the instances into the three main items. By far elements (avatars, points, badges etc) are the most prevalent, followed by the mechanics (challenges, feedback, competition) and the least is dynamics (narratives, emotions). It reveals more effort is required to incorporate dynamics in gamification which is meaningful.

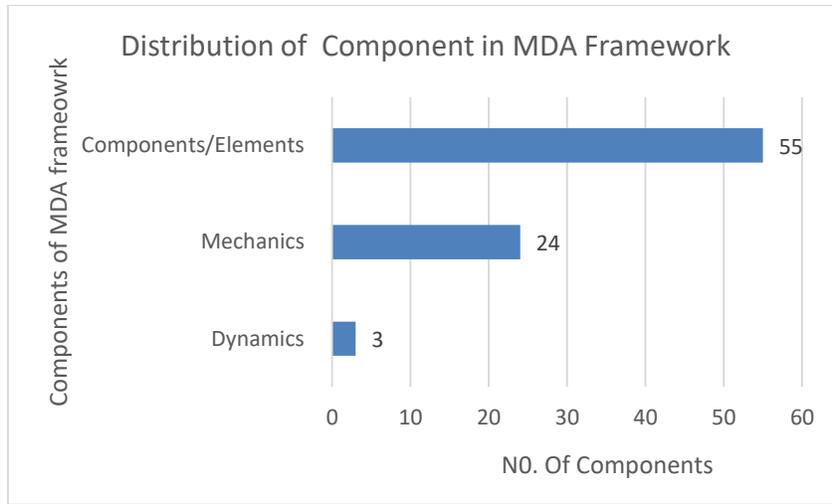


Figure 8. MDE Distribution

3.3.2 RQ 2.2 – Basis of adaptive gamification

This is a critical question on how adaptive gamification was implemented. For Adaptivity to be implemented a suitable method of matching the user and game elements must be deployed. The approaches are learning style of the learner, Personality of the learner, Player profile of the learner or gamification profile or the learner.

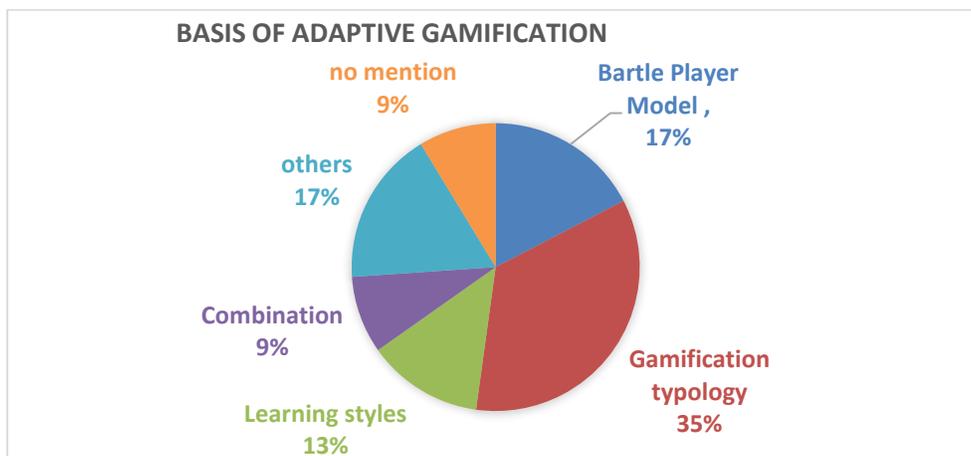


Figure 9. Basis of adaptivity

From the results the most predominate approach is gamification typology (35%) using the Hedax Brain scale, followed by the battle player model (17%), with learning styles (13%) basis specifically the FDLMS approach method. Some the studies used a combination of approaches such learning and player model approach. In the others category this constituted the timer approach, attractiveness index of the element, collaborative approaches in recommender systems.

3.3.3 RQ 2.3 – Methodological approach

In the research question the focus is how the identified adaptivity approach (gamification typology, Player model, learning styles) are implemented. From the study the most prevalent method is the mathematical modeling approach which uses either algebraic functions or matrices. In machine learning approach (26%) the emphasis is usually on supervised learning (classifiers) and unsupervised (k-Means). For the others segment (17%) the use tabular and adaptation rules.

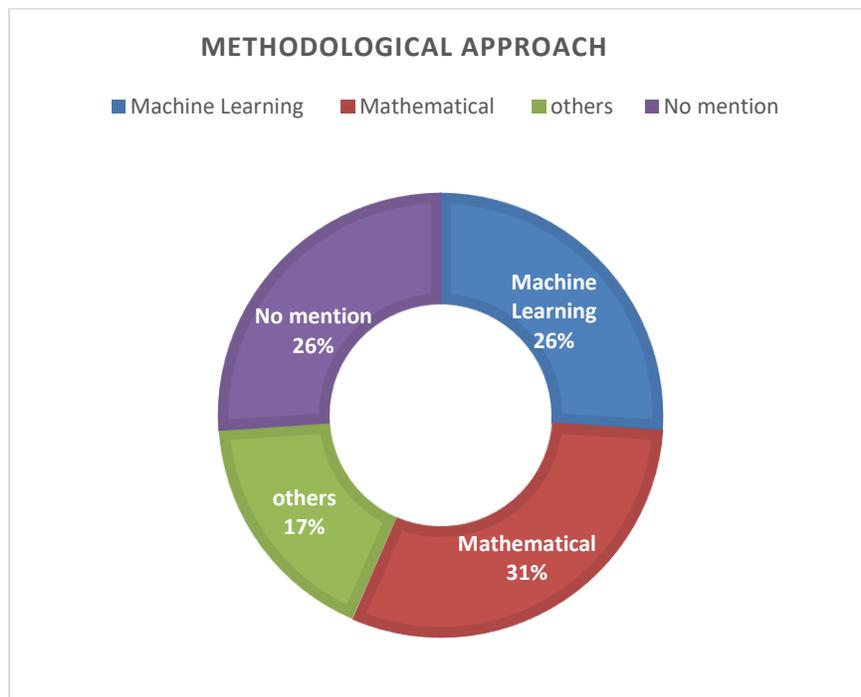


Figure 10. Methodological approach

3.4 RQ3 – Impact of adaptive gamification

The ultimate focus of adaptivity is whether there is contribution to enhance performance in learning such as more motivated students who are better engaged leading to better academic performances. Adaptive gamification is a novel idea where we seek to provide well suited game elements to elicit better intrinsic motivation and responses. From the studies reviewed, adaptive gamification does have a positive impact (84%). However, does not mean that adaptive gamification is a panacea to learning challenges, however its indicative that if well implemented its has great benefits to the learner. There is need for more effort required to ensure that adaptive gamification is effectively utilized in e-learning platforms.

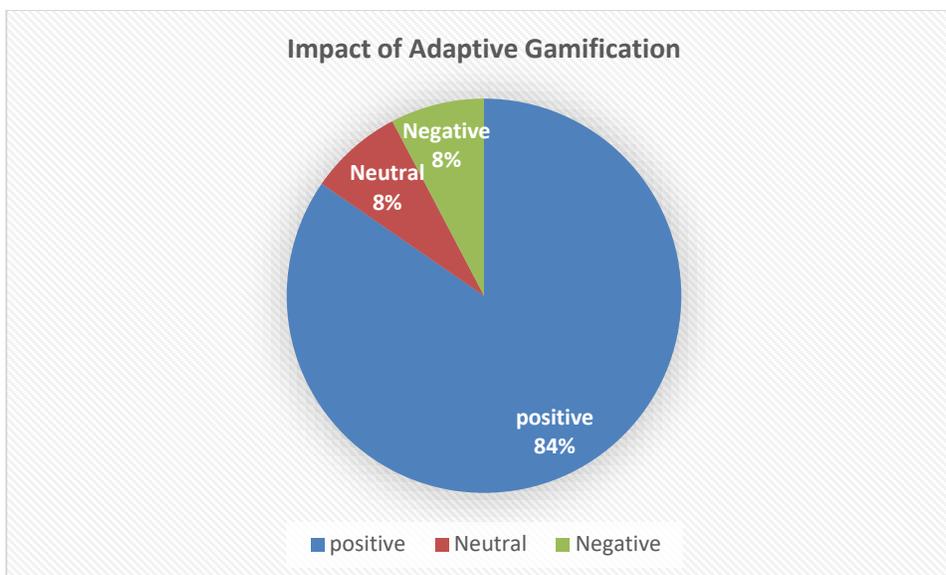


Figure 11. Impact of adaptive gamification

4. Discussions

From the results obtained the reviewed has revealed that much work has been done and accomplished of e-learning incorporating adaptive gamification.

Research questions 1, the context of adaptive gamification. From the study we can deduce that STEM courses have been better studied as opposed to the ARTS courses. Learning activities have greatly benefitted from adaptive effort and finally adaptive basis has been static as opposed to dynamic. Its recommended that emphasis been on dynamic adaptation since in the static approach consider time is spent in user profiling processes and may lead to learner disinterest, hence more subtle way is demanded that still provides the requisite information for data handling.

Research questions 2. Pertaining to the basis of adaptive gamification, the study has revealed game elements are the most used components, however there is need to introduce enhanced learning experience through more mechanics and dynamics through meaningful gamification that is user centered. As noted, it's vital to ensure that adaptive gamification moves from structuralist mode and adopt meaningful gamification that is based on user centred design framework. As for the basis of adaptivity the most preferred is gamification typology profile with player model been the next best option, however it's recommended that a combination of the two or more adaptive basis would give a better outcome. In respect of the methodological approach the utilized approach is mathematical models such matrices and algebra. However, there is need more use of machine learning techniques are they offer apt in dealing with user dynamism, hence consider using gamification analytics and learning analytics to give grounded approach for adaptivity

Research question 3, revealed that adaptive gamification has positive outcomes or positively influences in the area of study. However, contexts are different there is need therefore to find whether adaptivity is context specific of game elements, learner preferences and whether gamification can result in collaborative or competing outcomes for students. Still the sample of the studies is few and also there is need for longer study periods afforded by longitudinal studies.

5. Conclusions and recommendations

Adaptive gamification has gain prominence in e-learning platform, hence the need to review and understand its effectiveness and impact the study was a systematic mapping research, in which we identified 122 articles and distilled to 23 articles for consideration. These papers were investigated using 3 research questions focusing on the context in which adaptive gamification is deployed, the basis of adaptivity and the impact of adaptive gamification within the e-learning context. It revealed that learning activities are the most adapted activities in the e-learning platform, within adaptivity been predominately static. Further it revealed that there is need for more use higher gamification dynamics and mechanisms than the rudimentary mechanics. With respect to basis of adaptivity the study show that gamification typology is most predominate with mathematical models as the most preferred methodological approach. This call for researchers to embrace new adaptive approaches which can combine two or basis of adaptivity and also consider enhance use of machine learning techniques for methodological implementation. Overall the study reveals that there is a positive impact of adaptive gamification in e-learning however there is also need to review the negative effects.

In conclusion adaptive gamification does have positive impact within the e-learning platforms, though still at its infancy. In particular there is need for cognizance that learning is individualized hence there is need to account for learner individuality and design system which are adaptable to them for enhanced gamified e-learning platforms

Acknowledgements

This research was supported by the National Research Fund 2016/2017 grant award under the multidisciplinary-multi-institutional category involving Kenyatta University, University of Nairobi and The Cooperative University of Kenya.

The authors declare no competing interests.

References

- Alhammad, M. M., & Moreno, A. M. (2018). Gamification in software engineering education: A systematic mapping. *The Journal of Systems & Software*, *141*, 131-150.
- 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
- 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*, *48*, 94-103.
- 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*, *86*, 18-29.
- 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.
- Deterding, S., Sicart, M., Nacke, L., O'Hara, & K., D., D., (2011). Gamification: Using game-design elements in non-gaming contexts., BC. In: *Proceedings of the 2011 Annual Conference Extended Abstracts on Human Factors in Computing Systems*. Vancouver.

- Dicheva, D. et al. (2015). Gamification in education: A systematic mapping study. *Educational Technology & Society*, 18(3).
- Harman, K., Koohang, A., & Paliszkievicz, J. (2014). Scholarly interest in gamification: A citation network analysis. *Industrial Management & Data Systems*, 114(9), 1438-1452.
- Huotari, K., & Hamari, J. (2012). Defining gamification – A service marketing perspective. In: Proceedings of the 16th International Academic Mind TrekConference.
- 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.
- Lee, J. J., & Hammer, J. (2011). Gamification in education: What, how, why bother? *Academic Exchange Quarterly*, 15(2).
- Nacke, L. E., & Deterding, S. (2017). The maturing of gamification research. *Computers in Human Behavior*. <http://dx.doi.org/10.1016/j.chb.2016.11.062>
- 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.
- Petersen, K., Feldt, R., Mujtaba, S., & Mattsson, M. (2008). Systematic mapping studies in software engineering. Paper presented at the 12th International Conference on Evaluation and Assessment in Software Engineering. Italy.
- Petersen, K., Vakkalanka, S., & Kuzniarz, L. (2015). Gamification in software engineering – A systematic mapping. *Information and Software Technology*, 57, 157-168.
- 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.
- 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.
- Seaborn, K., & Fels, D. (2015). Gamification in theory and action: A survey. *International Journal of Computer Studies*, 74, 14 -31.
- Simões, J., Redondo, R. D., & Vilas, A. F. (2012). A social gamification framework for a K-6 learning platform *Computers in Human Behavior*, 29(2), 345-353.
- 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.
- Wang, H. C., & Chiu, Y. F. (2011). Assessing e-learning 2.0 System Success. *Computer & Education*, 57(2), 1790-1800.
- Werbach, K. & Hunter, D., 2012. *The gamification toolkit: Dynamics, mechanics, and components for the win*. Wharton Digital Press.

