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EFFECTS OF GAMIFICATION ON STUDENTS' LEARNING: A SYSTEMATIC MAPPING STUDY

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Abstract

The purpose of this study was to review the directions and tendencies of the conducted research on the application of gamification in education, and more specifically, to provide insight and understanding on which game elements are mostly used, results generated, predominance context, region, and research approach. A total of 43 articles were filtered from three databases: Scopus, Science Direct, and Jstor. Mapped results show that badges, points, levels, and leaderboards are the predominant game mechanics employed by researchers. In addition, the most used game dynamics in educational context are visual status, social engagement, rapid feedback, freedom to choose, and freedom to fail. Further result shows that Information Technology (IT), Engineering and Education were the predominant context in which gamification research is applied. South-East Asia was found to have received many gamification studies. The most used research approach is quantitative study, involving experiments and surveys. Results were generally mixed, but most results were positive, suggesting that gamification improves learning. From these reviews, a number of gaps were found. It is still not clear which game elements are responsible for the positive impact of gamification. Thus, research is needed to compare the impact of various game elements. The review recommends among other things, that game elements should be integrated into the school curriculum as an alternative to learning different topics, there is also the need to conduct more studies on gamification in different settings to come up with more findings.

Keywords: Gamification, Learning, Systematic Mapping

Introduction

Over the last decades, there has been a rapid growth in technological development and innovation (Mitchell, Schuster & Jin, 2020), with the education sector capitalizing on this growth to integrate new teaching methods such as virtual collaboration, application of mobile learning, and other technology enhanced learning (Bai, Hew & Huang, 2020). A growing influx of research has explored the significance of these alternative classroom processes on students' learning outcomes. Despite the practical benefits of these alternative classroom processes, unfortunately, restructuring classrooms to cater for students' learning needs are always difficult due to logistical issues and limited resources (Sanchez, Langer & Kaur, 2020). Educators are therefore in continual search of possible alternatives that are cost-effective and can improve learning. Gamification has been considered by many authors as one the alternatives that are a cost-effective and efficient tool for improving learning outcomes (Mitchell *et al*., 2020).

Gamification is defined as the use of game elements in non-game game contexts for the purpose of improving learning outcomes (Deterding, Khaled, Nacke & Dixon, 2011). It also refers to game design principles and methods, services, organizations, and activities to create the same experiences and motivations as those experienced in serious games, in

addition to the attainment of educational goals (Mekler *et al*., 2017). The experience afforded by serious games or game-based learning such as sense of enjoyment, flow, autonomy, mastery, and accomplishment are considered to be induced by games and gameplay (Diaz-Ramirez, 2020). These experiences focused on supporting and motivating game users towards behaviour targeted by gamified systems, including healthy behavior and exercise, increase participation in learning, and positive attitude towards learning.

Studies have shown the difference between gamification and other game categories such as serious games and game-based learning. While gamification focused on the application of game elements in a non-game context, serious games or game-based learning focused on full-fledged games for educational purposes. The overall practical difference is that game-based learning and serious games are designed to fit into the confines of the game, whereas gamification involved game elements that are designed to fit the game on the learning content (Zainuddin, 2018). On an overarching level, gamification is comprised of three main elements: mechanics, dynamics, and aesthetics (Zichermann & Cunningham, 2011). These elements are the driving forces of all potential benefits of gamification toward learning.

Game mechanics clarifies the procedures by which games convert specific inputs into output. Dynamics provides and guides the interaction between the players and the games. Aesthetics refers to the interaction between mechanics and dynamics and the game designer's artistry to produce emotional and cultural outcomes (Dicheva *et al*., 2015). Although these elements have their specific sub-elements, a survey of extant literature revealed that there is no general agreement on the classification of game design elements (Dicheva *et al*., 2015). For example, the popular game element "badges" was categorized as a game interface design pattern by Deterding *et al*. (2011), as a game mechanic by Zichermann and Cunningham (2011) and Dicheva *et al*. (2015), as game design by Yildirim (2017), and as game dynamic by Iosup and Epema (2014).

The term "gamification" is quite recent (Dicheva et al., 2015) and it is an emerging and ever-expanding concept since its first use in 2008 (Deterding *et al*., 2011). However, its components have been in use over the last decades. For example, badges and ranks have been in use in the military; in the early Soviet era as an alternative for monetary incentives for high-performing personnel. Because of its potential to shape user behaviour in a desirable direction, recently, the term has attracted widespread adoption in business, marketing, corporate management, and wellness, and ecology projects (Dicheva *et al*., 2015). For example, programs such as Foursquare and Nike+ have been successfully used to gamify mass-market products. In addition, the popular website stackoverflow.com provides an environment where users' reputations increase based on the number of answers to questions and the number of votes they receive for their answers. Furthermore, educational websites such as codeacademy.com and khanacademy.org employ game elements for user engagement. In a business environment, websites such as eBay and Fitocracy employ gamification to improve user engagement and participation, and to encourage competition among users.

A wealth of evidence has shown increased acceptance of gamification as an effective learning strategy employed in the creation of highly engaging learning experiences. This evidence reported high success of digital games in education and have sought to validate the potential effects of gamification in improving motivation, engagement and academic

achievement while providing students with the opportunities to be immersed in experiential learning (Hung, 2018; Huang, Hew & Lo, 2019). In recent years, there is increasing widespread of interest created by gamification among academicians and researchers, prompting them to explore the instructional effects of gamified elements. However, despite the increasing development of technology and its significant impact on teaching and learning, supporting and maintaining learners' engagement in a gamified learning environment remain high challenging tasks (Iosup & Epema, 2014). Moreover, with gamification considered to be a relatively new concept in educational processes, it is anticipated that potential problems that may arise be addressed to develop a more understanding of its nature and process (Zainuddin, Chu, Shujahat & Perera, 2020).

The educational impact of gamification has been explained by a number of theories, including self-determination, goal setting, and flow theory. However, more recently, Landers and Landers (2015) proposed a comprehensive framework that conceptualizes the relationship between gamification and learning. This theory consists of four components instructional content; behaviours and attitudes; game characteristics; and learning outcomes. First, the theory proposed that learners' behaviour as well as their learning outcomes is directly influenced by instructional content. Effective instructional content is an essential component of successful gamification. Second, the theory hypothesized learning outcomes that are influenced by behaviours and attitudes. This can happen either directly or by affecting the relationship between the instructional content and the learning outcomes. Third, game characteristics are expected to directly affect behaviours and attitudes. Importantly, no direct influence of game characteristics on learning outcomes is hypothesized. Gamification affects learning only through an intermediary behaviour or attitude (Landers & Landers, 2015). Therefore, introducing game design elements to increase learning can only be effective if the behaviours they elicit are conducive to learning.

The theory of gamified learning proposes two ways that gamification can influence learning via behaviours and attitudes. Based on their precise nature, behaviours and attitudes can either *moderate* or *mediate* the relationship between instructional content and learning outcomes (Landers & Landers, 2015). In the case of a mediating effect, behaviours directly affect learning outcomes, and therefore, constitute an important part of the causal construct. An example would be the use of gamification to scaffold students' learning process performance, which then in turn can affect learning outcomes. This mediation is supposed to be the primary mechanism of gamification affecting learning outcomes (Hamari, Koivisto & Sarsa, 2014).

Studies on gamification found predominantly positive effects in terms of cognitive and behavioural outcomes. For example, findings of some longitudinal studies conducted by Putz, Hofbauer and Treiblmaier (2020) highlight the potential of gamification to increase students' motivation and engagement, as well as improving their performance. Another recent study showed that gamification can be used in combination of social media to enhance the creation of a community of practice and to increase learning activities (Grangeia *et al*., 2019). However, Hanus and Fox (2015) highlight that extrinsic motivators such as rewards, badges, and leaderboards should be carefully selected and adapted to the needs of learners in order to avoid entertainment effect.

Although it is widely accepted that gamification impacts learning, debate on how exactly this is achieved remains unanswered (Hamari *et al*., 2014). One of the major criticisms of

gamification studies largely focus on whether gamification can modify behaviour. This research gap has provided insufficient explanations on whether the impact of gamification can always be positive or negative and whether its efficacy in new context can be achieved (Sailer *et al*., 2017. Understanding the mechanisms that underpin gamification's impact on behaviour has thus been the focus of recent gamification research (Mavletova, 2015). Some researchers espouse the view that, similar to the motivational pull of video games, gamification appeals to users as it provides greater flow, balancing challenges to create focused engagement (Hamari *et al*., 2014). Others have suggested gamification leverages the appeal of escapism, making behaviours or tasks different and novel.

However, since in practice, most gamification applications are not fully fledged games, but rather elements of games such as points, leaderboards, and badges, the most widely accepted explanation for the behavioural impact of gamification is that it can create intrinsically motivating game-like experiences (Hamari, 2017). This view is based on the concept of motivational affordance, or the properties of an object that determine whether and how it can support motivational needs. In a gamification context, this is best understood as the application of identified sources of video games' motivational affordance (game design elements such as point scoring) to increase the motivational pull of the target behaviour (Deterding *et al*., 2011).

Using games in education has a variety of benefits, and several game design mechanics demonstrated success in educational environments (de-Marcos, Domínguez, Saenz-de-Navarrete, & Page, 2014). Games typically allow the player to restart or play again, making mistakes recoverable. This freedom to fail allows students to experiment without fear and increases student engagement (Lee & Hammer, 2011). Although educational settings provide feedback to students, it is often constrained: In class, teachers can often only evaluate and provide feedback to one student at time, and feedback via grading takes time. Thus, incorporating the immediate and frequent feedback found in game design may be even more beneficial (Kapp, 2012). Additionally, teachers typically present information to their classes in categories that scale by difficulty, a process known as scaffolded instruction, but it can be difficult to accommodate each individual student's needs. Games tailor difficulty progression on an individual basis, keeping players at a particular level until they have demonstrated the requisite mastery to move on (Beed, Hawkins, & Roller, 1991). Creating a narrative context around a task has been shown to increase student motivation and engagement. In addition, other elements of game design commonly applied to gamification might be helpful: leaderboards encourage engagement through competition, and badges offer a visual display of progress (Kapp, 2012).

Despite considerable speculation about the benefits of gamification, empirical research on the effectiveness of gamification is limited. Results from the few empirical studies on various elements of gamification conducted in educational settings are mixed. One study found that students who were given feedback on their course progress in the form of a competitive game enjoyed the experience more, learned more, and had lower rates of failure than in previous classes (Charles, Charles, McNeill, Bustard, & Black, 2011). Another study reported higher student interest and engagement after gamifying an entrepreneurship course using leaderboards, competition, and serious games to teach course concepts (Bellotti *et al*., 2013).

Dominguez *et al*. (2013) gamified an e-learning platform by applying competition, trophies, rewards, and leaderboards and found that students in the gamified class scored

higher overall and were more motivated but tended to participate less in class activities and performed worse on writing assignments. De-Marcos et al. (2014) used a gamification system that gave students rewards, encouraged earned trophies, and used a leaderboard to encourage competition. They compared this and a traditional platform with a social networking learning platform where students could comment, blog, and interact with each other. The authors found that students in both gamification and social networking groups outperformed the control group on the skill assignments, though the control group did better on the final written examination designed to assess course knowledge. Additionally, students tended to have very low participation rates with the gamified (24%) and social networking platforms (38%).

These findings are similar to those that study gamification in non-education contexts. One recent study of over 3000 users found that those that viewed their own badges more frequently positively predicted increased page views, comments, trades, and transactions on an e- commerce website. This increased engagement only occurred among users who were actually interested in the badge system, however. In other words, creating a gamified system alone was insufficient to cause an increase in these behavioural measures; rather, it depended on individual users' interest levels (Hamari, 2013). In another study, Hamari, Koivisto and Sarsa (2014) conducted a comprehensive review of empirical studies of gamification across different contexts (e.g., education, consumer science), but were only able to identify 24 studies. Of those studies, only two reported entirely positive effects. The majority of studies found some positive aspects of gamification, such as increased engagement and enjoyment, but these outcomes are often dependent on the context of the gamified system (e.g., marketing, educational) and the characteristics of the player. Additional work has shown that the appeal of a gamified system might be due to a novelty effect, and that positive effects such as engagement and interest decrease over time.

While several empirical studies have reported positive effects of gamified classroom strategy, it is still not clear why learning is improved from students' perspective because of paucity of research evidence on students' perspectives regarding the effect of gamification in a classroom setting. Furthermore, in several studies employing gamified strategy, it is still unclear which game elements positively affect students' learning, which game elements are widely in use in gamification research, and discipline received most gamification research. A more focused study is required to investigate which elements of gamification are most effective to help practitioners make the most of its application. This review therefore mapped findings of different studies that investigated the impact of gamification on students' learning.

The research questions behind this study were:

i. what game elements have been predominantly applied in gamifying educational systems?
ii. What educational context predominantly received research on gamification?
iii. Which region is research on gamification predominantly conducted? and
iv. What results were derived from these studies?

Methodology

The study employed a systematic mapping design. Systematic mapping studies are similar to systematic reviews, except that the former employs broader inclusion criteria and intend to map out topics rather than synthesize results (Decheva et al., 2015). A systematic mapping study provides a categorical structure for classifying published research reports and results. This study covers existing work in the field of gamification in education, including articles and conferences published and indexed in three high impact databases from 2015 to 2019. This recency was informed by high influx of published articles within the selected period (Dicheva *et al.*, 2015).

Inclusion, search and screening

A number of gamification research have been conducted in an educational context, with the inclusion of variables such as motivation, attitude, participation and performance (Grangeia *et al*., 2019; Hamari *et al.*, 2014; Hanus & Fox, 2015; Koivisto & Hamari, 2019). Therefore, it would be natural to consider them as the central and fundamental concepts of gamification research. Thus, gamification studies that involved these educational variables were included as the central focus of this paper within the selected period. The researcher searched three scientific databases: Scopus, Science Direct and Jstor. Three keywords were used for the search: "gamification", "gamify", "gameful". After searching and removal of duplicates, a total of 1066 articles were obtained according to the databases: Scopus (517), Science Direct (311), and Jstor (238). Based on abstract, 719 articles were removed. These studies were generally considered not related to education. This screening was followed by second round of filtering in which, based on full text, articles that are not related to application of gamification in learning, and those that are related to full-fledged games were removed. The resulting set contained 43 articles that presented empirical studies to be analyzed and classified (see Appendix I).

Categorization criteria

In order to address the above research questions, the researcher conducted a concept-centric review focusing on categories. This review provided the researcher with information concerning the classification along the following dimensions:

- Game elements (mechanics and dynamics)
- Context (IT & Engineering, Pure and Applied Science, education, Arts &Social Sciences)
- Region (Africa, America, Asia, Europe)
- Results (positive, negative, mixed)

Mapping study results

Game mechanics

Figure 1 presents the number of articles that employed the use of different game mechanics. From the figure, it can be observed that the most popular game mechanism are points, badges, levels and leaderboards.

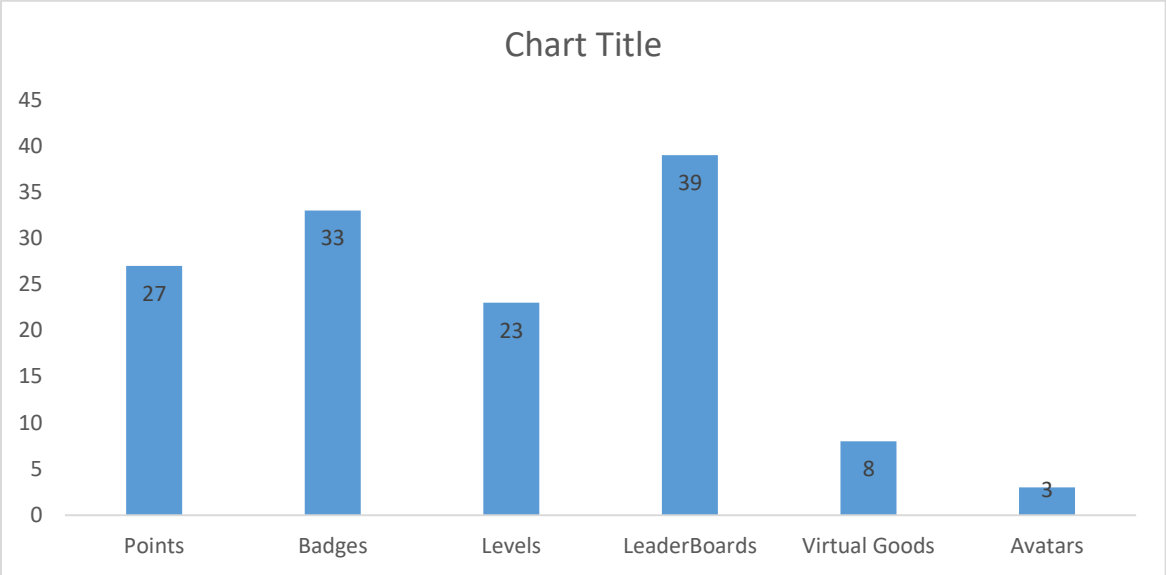

Fig.1: Mapped game mechanics. Source: Researchers'-generated chart

Regarding the use of badges, they are used for different purposes, including increasing challenge and performance, trigger competitive motivation and participation, and improve time management (Koivisto & Hamari, 2019; Zainuddin, 2018). With regards to leaderboards, they are used in most recent studies to boost engagement and learning and improve productivity. In its simplest term, a leaderboard is a high score listing that indicate who performs best in a certain activity. Thus, ranking players according to their relative success is the major function of leaderboard, hence its importance in boosting engagement. With regards to levels, some of the reviewed studies considered three types of levels: game levels, playing levels, and player levels (Grangeia *et al*., 2019; Zainuddin *et al*., 2020). In their study Goehle (2013) recommends the use of levels so that learning can proceed from simple to complex. In most studies that employed 'virtual goods', they were significant in buying more time and lifeline to enable the player to remain in the game. Dicheva *et al*. (2015) posit that the use of virtual goods can be helpful in increasing students' motivation during the gameplay, and thus foster active engagement.

Game dynamics

As can be observed in figure 2, the most used game dynamics in an educational context are visual status, social engagement, rapid feedback, freedom to choose, and freedom to fail. Articles that employed the dynamics of personalization, time restriction and unlocking contents are rare. Dicheva *et al*. (2015), considered these to be the fundamental principles of instruction and educational applications based on the target of lifelong learning.

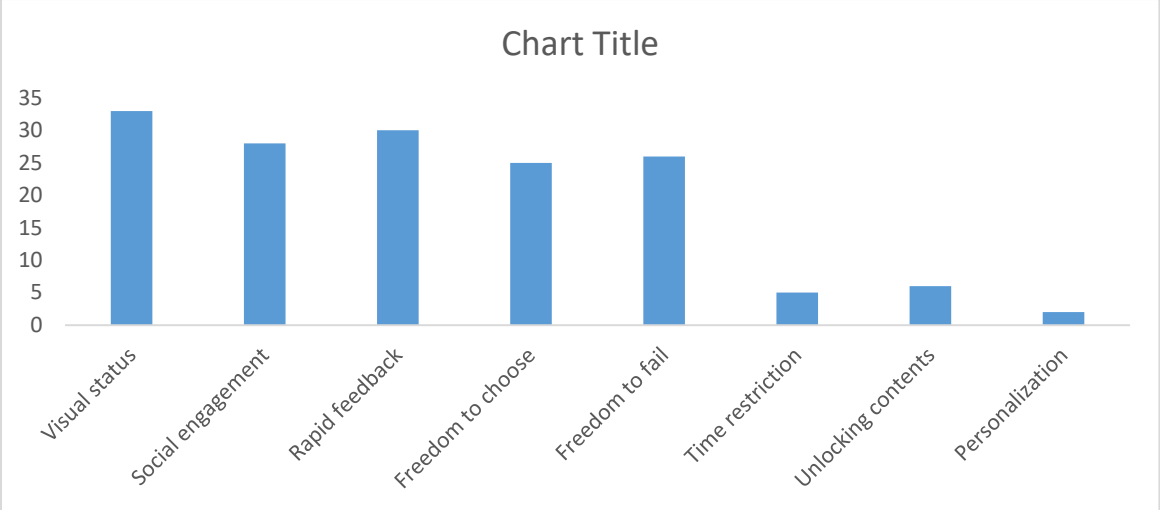

Fig. 2: Mapped game dynamics. Source: Researchers'-generated chart

Hence, advancements related to these rarely used dynamics would not be considered a result of gamifying educational context. Visual status is mostly used for displaying the status of players, such as experts, masters, beginners, etc. This enhances competition among students as they strive to achieve a given status. Rapid feedback is used for giving immediate feedback to students based on the correctness of answered questions. Studies have shown that immediate feedback is one of the fundamental components of educational assessment (Yusuf & Mwebesa, 2016). Students are likely to improve their scores in gameplay through immediate feedback.

The dynamic of "freedom to choose" has been applied differently in the reviewed studies, including the possibility for students to choose what type of challenges to complete and what level to begin with based on their level of expertise (Zamora-Polo, 2019). The dynamic of freedom to fail" presumes no penalties on poor performance and typically includes allowing students to replay a game level as many times as possible. Although this dynamic is one of the most controversial dynamics in a typical conventional classroom (Dicheva *et al*., 2015), giving students the freedom to revise a particular concept is the central tenet of mastery learning which entails the repetition of concept until some level of mastery is achieved. However, a number of studies have criticized such an approach, arguing that it cannot be applied in competitive educational assessment, as repetition cannot guarantee competition and expertise.

Social engagement is applied by many studies as individual or team competition (Sprint & Fox, 2020; Su & Cheng; Yildirim, 2017). Several studies have argued that taking part in a group learning enhances team spirit and sharing of ideas, which in turn improves motivation, participation and performance. However, other studies recognized individualized instruction as the best to strategy to differentiate instruction by learners' learning style, learning impairments and personality profile (Yusuf, Bello, Faruk & Mani, 2019).

It should be noted that both game mechanics and dynamics are not mutually exclusive as most studies employ more than one game dynamic and mechanics.

Context

From figure 3 below, the educational context in which gamification studies were predominantly applied is 'Education' (Landers & Landers, 2015), followed by IT and Engineering (Çakıroglu *et al*., 2017). However, social sciences received limited study. This is contrary with previous mapping review which revealed that computer science and IT received more gamification studies between 2010 and 2014 (Dicheva *et al*., 2015). By implication, it suggests that while trend in gamification study has relatively changed, disciplines such as arts and social sciences are yet to be taken into consideration.

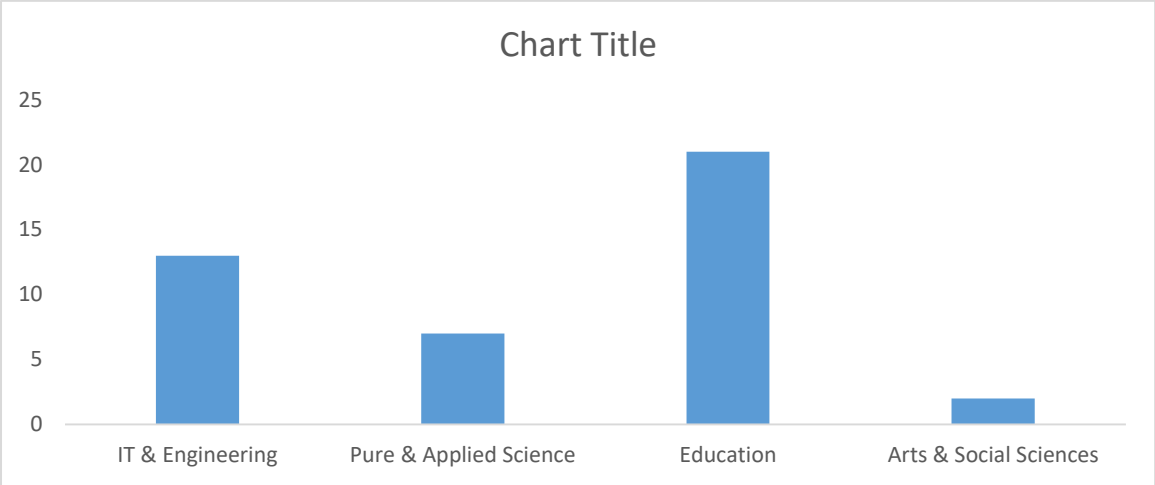

Fig. 3: Mapping study by context. Source: Researchers'-generated chart

Region

As presented in figure 4, most of the reviewed studies are from Asia region, particularly from South-East Asia, including Malaysia, China, Singapore, and India (Huang, 2018; Yildirim, 2017; Zainuddin, 2018). Studies in Africa, particularly Sub-Saharan Africa region, is scarce.

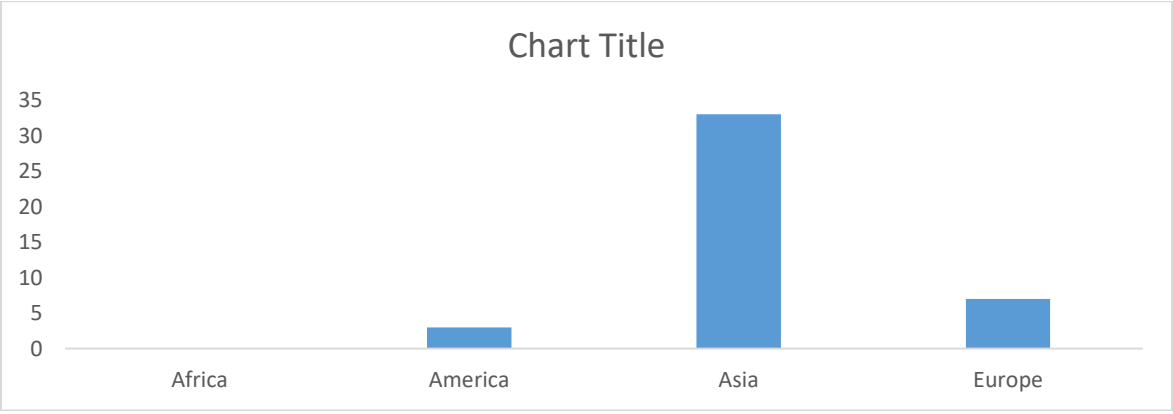

Fig. 5: Mapping study by region. Source: Researchers'-generated chart

Research approach

Across the reviewed articles, the dominant research approach used is quantitative method, including experiment and survey (Dias, 2017; Hamari, 2017). This is followed by mixed method, involving quantitative and qualitative components. However, this is limited. No study employed only qualitative approach. While experimental procedures tend to find the actual impact of gamification on learning, qualitative approach is needed to explain causality and relationships. Thus, students would be able to explain the potential impacts of gamification in a subjective manner.

Fig. 6: Mapping study by research approach. Source: Researchers'-generated chart

Result

Although results concerning impact of gamification were mixed, most studies show positive results (Su & Cheng, 2015; Zainuddin et al., 2020; Zamora-Polo et al., 2019). The positive results indicates that gamification improves students' learning such as enhancing motivation, increasing engagement, and improving performance.

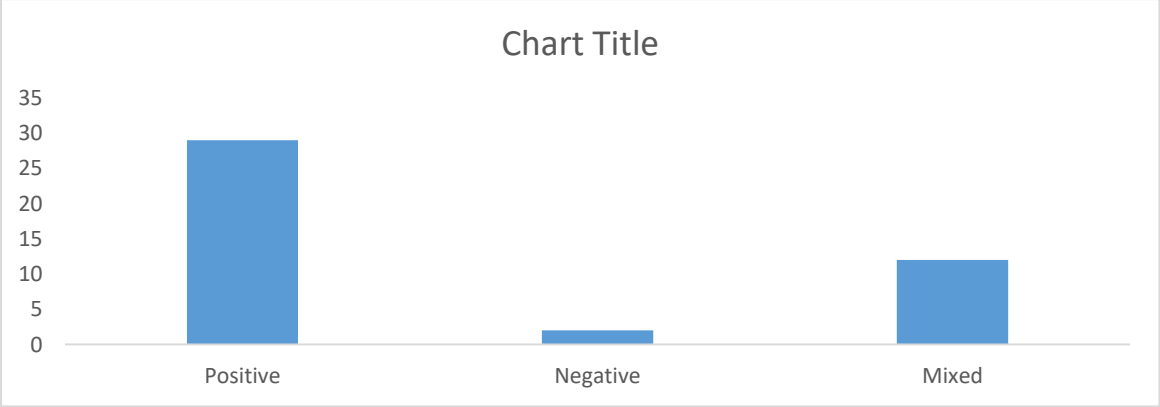

Fig. 6: Mapping study by results. Source: Researchers'-generated chart

Conclusion

The purpose of this study was to review the directions and tendencies of the conducted research on the application of gamification in education, and more specifically, to provide insight and understanding on which game elements are mostly used, results generated,

predominant context and region, and research approach. Mapped results show that badges, points, levels and leaderboards are the predominant game mechanics employed by researchers. In addition, the most used game dynamics in the educational context are visual status, social engagement, rapid feedback, freedom to choose, and freedom to fail. Further result shows that IT and Engineering and Education were the predominant context in which gamification research is applied. South-East Asia was found to have received much gamification studies. The most used research approach is a quantitative study, involving experiment and survey. Lastly, results were generally mixed, but most results were positive, suggesting that gamification improves learning.

From this review, a number of gaps were found. First, it is still not clear which game elements are responsible for the positive impact of gamification. Thus, research is needed to compare the impact of various game elements. Second, there is no gamification study found in Africa. This suggests that a comprehensive study is needed to be conducted in Africa and compare results with others found in other settings. While experimental procedures tend to find the actual impact of gamification on learning, a qualitative approach is needed to explain causality and relationships. Thus, students would be able to explain the potential impacts of gamification in a subjective manner.

Recommendations

As games become an important teaching strategy to achieve long-term goals in many countries, it is imperative to expose teachers to rigorous empirical investigations on how game elements should be used alongside other activity-based methods to teach a wide range of topics. The findings of the review will encourage researchers to carry out more investigations in this field of study to fill the research gaps and build a body of literature. However, to harness the full potential of game elements, researchers need to adopt maximum intervention fidelity in their research. Educators also need to integrate game elements in their teaching with the help of instructional design specialists to build game learning strategies that are relevant to students' levels. This review concludes that program game elements should be integrated into the school curriculum as an alternative to learning different topics. Before this, theory and practice of game instructions should be reviewed by school administrators and researchers to increase the success of these programs.

References

Bai, S., Hew, K.F. & Huang, B. (2020). Does gamification improve learning outcome? Evidence from a meta-analysis and synthesis of qualitative data in educational context. *Educational Research Review,* **30**. https://doi.org/10.1016/j.edurev.2020.100322

Beed, P. L., Hawkins, E. M. and Roller, C. M. (1991). Moving learners toward independence: the power of scaffolded instruction. *The Reading Teacher*, **44**: 648-655.

Bellotti, F., Berta, R., De Gloria, A., Lavagnino, E., Dagnino, M. F. and Antonaci, A. (2013). A gamified short course for promoting entrepreneurship among ICT engineering students. In 2013 IEEE 13th International Conference on Advanced Learning Technologies.

Çakıroglu, Ü., Basibüyük, B., Güler, M., Atabay, M. and YılmazMemis¸ B. (2017). Gamifying an ICT course: Influences on engagement and academic performance.

Computers in Human Behavior, **69**: 98-107. https://doi.org/10.1016/j.chb.2016.12.018

Charles, D., Charles, T., McNeill, M., Bustard, D. and Black, M. (2011). Game-based feedback for educational multi-user virtual environments. *British Journal of Educational Technology*, **42** (4): 638-654. https://doi.org/10.1111/j.1467-8535.2010.01068.x

de-Marcos, L., Domínguez, A., Saenz-de-Navarrete, J., & Pages, C. (2014). An empirical study comparing gamification and social networking on e-learning. *Computers & Education*, **75**: 82-91. https://doi.org/10.1016/j.compedu.2014.01.012

Deterding, S., Sicart, M., Nacke, L., O'Hara, K., & Dixon, D. (2011). Gamification: using game-design elements in non-gaming contexts. In Proceedings of the 2011 Annual Conference on Human Factors in Computing Systems (425-2428)

Dias, J. (2017). Teaching operations research to undergraduate management students: The role of gamification. *International Journal of Management in Education*, **15** (1): 98-111.

Diaz-Ramirez, J. (2020). Gamification in engineering education: An empirical assessment on learning and game performance. *Heliyon*, **6** (9). https://doi.org/10.1016/j.heliyon.2020.e04972

Dicheva, D., Dichev, C, Agre, G. and Angelova, G. (2015). Gamification in Education: A systematic mapping study. *Journal of Educational Technology and Society*, **18** (3): 75-88.

Domínguez, A., Saenz-de-Navarrete, J., de-Marcos, L., Ferna_ndez-Sanz, L., Pages, C., and Martínez-Herra_iz, J. J. (2013). Gamifying learning experiences: practical implications and outcomes. *Computers & Education*, **63**: 380-392. https://doi.org/10.1016/j.compedu.2012.12.020

Grangeia, T.d. A. G., Jorge, B. de, Cecílio-Fernandes, D., Tio, R. A. and Carvalho-Filho, M. A. de (2019). Learn + Fun: Social media and gamification sum up to foster a community of practice during an emergency medicine rotation. *Health Professions Education*, **5** (4): 321-335.

Hamari, J. (2017). Do badges increase user activity? A field experiment on the effects of gamification. *Computers in Human Behavior*, **71**: 469-478. https://doi.org/10.1016/j.chb.2015.03.036

Hamari, J., Koivisto, J. and Sarsa, H. (2014). Does gamification work? A literature review of empirical studies on gamification. In System sciences (HICSS), 2014 47th Hawaii International Conference, 3025-3034. Hawaii: HICSS

Hamari, J. (2013). Transforming homo economicus into homo ludens: A field experiment on gamification in a utilitarian peer-to-peer trading service. *Electronic Commerce Research and Applications*, **12** (4): 236-245. https://doi.org/10.1016/j.elerap.2013.01.004

Hanus, M. D. and Fox, J. (2015). Assessing the effects of gamification in the classroom: A longitudinal study on intrinsic motivation, social comparison, satisfaction, effort, and academic performance. *Computer and Education*, **80**: 152-161. https://doi.org/10.1016/j.compedu.2014.08.019

Huang, B., Hew, K. F. and Lo, C. K. (2019). Investigating the effects of gamification-enhanced flipped learning on undergraduate students' behavioral and cognitive engagement. *Interactive Learning Environments*, **27** (8): 1106-1126.

Hung, H. T. (2018). Gamifying the flipped classroom using game-based learning materials. *ELT Journal*, ***72*** (3): 296–308.

Iosup, A., and Epema, D. (2014). An experience report on using gamification in technical higher education. In J. Dougherty, and K. Nagel (Eds.), *Special Interest Group on Computer Science Education 2014*, 27-32.

Kapp, K. M. (2012). *The gamification of learning and instruction: Game-based methods and strategies for training and education*. San Francisco, CA: Pfieffer

Landers, R.N. & Landers, A.K. (2015). An empirical test of theory of gamified learning: The effect of leaderboards on time-on-task and academic performance. *Simulation and Gaming*, **45** (6): 1-17. https://doi.org/10.1177/1046878114563662

Langendahl, P. A., Cook, M. and Mark-Herbert, C. (2017). Exploring gamification in management education for sustainable development. *Creative Education*, **8** (14): 2243-2257. https://doi.org/10.4236/ce.2017.814154

Lee, J. J., & Hammer, J. (2011). Gamification in education: what, how, why bother? *Academic Exchange Quarterly*, **15** (2): 146.

Legaki, N., Xi, N., Hamari, J., Karpouzis, K. and Assimakopoulos, V. (2020). The effect of challenge-based gamification on learning: An experiment in the context of statistics education. *International Journal of Human-Computer Studies*, **144**. https://doi.org/10.1016/j.ijhcs.2020.102496

Mavletova, A. (2015). A gamification effect in longitudinal web surveys among children and adolescents. *International Journal of Market Research*, **57** (3): 413–438.

Mekler, E. D., Brühlmann, F., Tuch, A. N. and Opwis, K. (2017). Towards understanding the effects of individual gamification elements on intrinsic motivation and performance. *Computers in Human Behavior*, **71**: 525-534. https://doi.org/10.1016/j.chb.2015.08.048

Mitchell, R., Schuster, L. and Jin, H.S. (2020). Gamification and the impact of extrinsic motivation on needs satisfaction: Making work fun? *Journal of Business Research*, **106**: 323-330.

Putz, L., Hofbauer, F. & Tremiblmaier, H. (2020). Can gamification help to improve education? Findings from a longitudinal study. *Computer in Human Behavior*, **110**. https://doi.org/10.1016/j.chb.2020.106392

Sailer, M., Hense, J. U., Mayr, S. K. and Mandl, H. (2017). How gamification motivates: An experimental study of the effects of specific game design elements on psychological need satisfaction. *Computers in Human Behavior*, **69**: 371-380. https://doi.org/10.1016/j.chb.2016.12.033

Sailer, M. &Sailer, M. (2020). Gamification of in-class activities in flipped classroom lectures. *British Journal of Educational Technology*, **52** (1): 75-90. https://doi.org/10.1111/bjet.12948

Sanchez, D. R., Langer, M. and Kaur, R. (2020). Gamification in the classroom: Examining the impact of gamified quizzes on student learning. *Computer and Education, 144*. https://doi.org/10.1016/j.compedu.2019.103666

Sprint, G. and Fox, E. (2020). Improving student study choices in CS1 with gamification and flipped classrooms. *SIGCSE '20: Proceedings of the 51st ACM Technical Symposium on Computer Science Education*, 773-779. https://doi.org/10.1145/3328778.3366888

Yildirim, I. (2017). The effects of gamification-based teaching practices on student achievement and students' attitudes towards lessons. *Internet and Higher Education*, **33**: 86-92. https://doi.org/10.1016/j.iheduc.2017.02.002

Zainuddin, Z., Chu, S.K., Shujahat, M. and Perera, C.J. (2020). The impact of gamification on learning and instruction: A systematic review of empirical evidence. *Educational Research Review*, **30**. https://doi.org/10.1016/j.edurev.2020.100326

Zainiddin, Z., Shujahat, M., Haruna, H. and Chu, S.K. (2020). The role of gamified e-quizzes on student learning and engagement: An interactive gamification solution for a formative assessment system. *Computer and Education*, **145**. https://doi.org/10.1016/j.compedu.2019.103729

Zainuddin, Z. (2018). Students' learning performance and perceived motivation in gamified flipped-class instruction. *Computer & Education*, **126** : 75-88. https://doi.org/10.1016/j.compedu.2018.07.003

Zamora-Polo, F., Corrales-Serrano, M., Sanchez-Martin, J. and Espejo-Antunez, L. (2019). Nonscientific university students training in general science using an active-learning merged pedagogy: Gamification in a flipped classroom. *Education Science*, **9** (4): 297-315. https://doi.org/10.3390/educsci9040297

Zichermann, G. and Cunningham, C. (2011). Gamification by design: Implementing game mechanics in Web and mobile apps. *Creative Education*, ***7*** (10).