International Journal of Mobile and Blended Learning
Volume 14 • Issue 2

Considerations of Game Dynamics and Mechanics in College Students' Use of Mobile Games for Learning

Pengiran Shaiffadzillah Pengiran Omarali, Educational Technology Centre, Brunei*

ABSTRACT

Mobile phone ownership has grown exponentially over the years with the development of many forms of mobile applications that replicate, if not replace, existing real-world technologies. The mobile games market follows this trend, usurping the video games console and computer games market with mobile game apps offering multiplayer and networked mobility. Educational mobile games have their own niche, but at the same time many games made for self-entertainment can be re-purposed into teaching and learning, provided the game dynamics and mechanics are sufficiently present for active learning to take place. This paper is an early literature review and preliminary study on identifying students' perception of certain game dynamics and game mechanics so that in turn any decision in introducing mobile game apps into learning is able to measure their relevance and appropriateness to the target student user. The study employed factor analysis to construct a six-factor model that can be used in measuring students' preferences for, and aversions to, specific game dynamics and mechanics.

KEYWORDS

Digital Games-Based Learning, Game Elements, Gamification, Metaphygital, Metaverse, Mobile Game Apps, Mobile Learning, Ubiquitous Learning

INTRODUCTION

The use of digital games in education has become popular in recent years, and their forms of use keep expanding based on the cognitive benefits that they potentially provide to students (Whitton, 2014). With this development, it is useful for educators and policymakers to determine the varied ways that students interact with and are motivated by the use of games as a learning tool, which can vary depending upon age, gender and social class (Gros, 2007).

One of the advantages of current digital games is that many have a massive reach due to their being increasingly available and accessible via mobile devices and henceforth mobile game apps. A large body of literature has already advocated that when used for digital games-based learning, games have interesting dynamics and mechanics that pertain to effective learning environments including but certainly not limited to elements of urgency, complexity, learning by trial-and-error, and scoring points (Furió et al., 2015). Despite recognizing these benefits, it is important to understand that the appropriate use of games within the learning environment involves access to the correct equipment

DOI: 10.4018/IJMBL.309739 *Corresponding Author

and the appropriate technical training of the educators (Whitton, 2012), suggesting that games are not always suitable or affordable for all educational settings (Godwin-Jones, 2014).

Regardless of these constraints, it is vital to remember that students who have access or ownership to mobile devices consequently have access to a wide variety of educational games, including the multiplayer games most commonly played by students both as a casual social part-time activity and as a competitive sport (eSport). With these mobile games becoming increasingly ubiquitous, there is a growing branch of education research that is dedicated to investigating the role of games in education under the research areas of educational games, digital gamification, and digital games-based learning. In tandem with these developing research trends, this research article presents a preliminary study that has been conducted with the objective of unravelling students' perceptions, including preferences and aversions, towards various game mechanics and game dynamics based on students' use of games for casual and entertainment purposes, and in turn for educational purposes.

This study on identifying students' dispositions toward the use of mobile games for education is related to a larger on-going research project dedicated to profiling students based on their varied dispositions towards learning and learning with technologies in general (Omarali, 2016; 2017a; 2017b; Omarali and Motteram, 2017), and most recently to the development of a framework called REVAMP to leverage the knowledge gain from identifying students' dispositions to create learning ecosystems – including games-based learning – that are engaging, virtual-ready, adaptive, multimodal, and personalized (Omarali, 2021). An on-going development in the virtual-ready front is the re-embodiment of the term 'metaverse', that had been mentioned in preceding literature (Kemp and Livingstone, 2006; Dionisio, Burns III and Gilbert, 2013; among others) including in the research on learning using virtual worlds (Schafer, 2016; Nevelsteen, 2018; among others); an area of research that is evocative of the mass multiplayer online (MMO) and social media games accessible via mobile devices.

DIGITAL GAMES-BASED LEARNING RESEARCH

To research on the use of digital games in education, it is not enough to deep-dive into it as an educator, academic researcher, or a psychologist. Researchers also would want to understand how games work from a technology developer perspective, in particular from a game-designer perspective. Research on digital games in education will benefit from having a multi-disciplinary perspective to generate the whole picture of how games are able to engage students in learning. It is not enough to shoe-horn education models such as Ruben Puentedura's SAMR Model or the various Technology Acceptance Models being used in educational research to understand games design. This is because not all games are made for educational purposes, but there are educational digital games, and games that can be adapted for use in learning.

Regardless of the intent of use, the core constituents of any digital game can be divided into three parts, viz. Game Elements, Game Dynamics and Game Mechanics. Having a game-designer perspective is thus useful to understanding a game's dynamics and a game's mechanics, and these two constituents of games have been referred to by much research on digital games-based learning (Suh, Wagner & Liu, 2015; Frost and MacIvor, 2011; Nadolny et al., 2017; Lameras et al., 2017; Proulx, Romero & Arnab, 2017; among many others). However, the use of game dynamics and game mechanics as indicators of students' preferences of digital games for learning is underrepresented in educational research. In addition, their roles in identifying educational games have hitherto been inadequately defined.

For the purpose of this research, the three constituents of games are defined here with reference to selected gaming contexts:

1. Game Elements are defined by this research as the features that keep players engaged – or, at the extreme end, overindulgent. Some players are drawn by the storyline, some others by being

able to have teamwork with people from the other side of the world, some others like to be risk-takers, and some others like taking chances.

2. Game Dynamics are defined by this research as the means or the way by which players achieve the goal of the game. For a farming game, the goal is to build a successful farm, and the game dynamic to achieving that goal is to constantly maintain the farm by making smart decisions to prevent chaos. For a world creation game, the goal is to establish a successful civilization, and the dynamic to achieving that goal is to strategise in collecting, mining, hunting, scavenging resources to keep up with the game cycles of human revolutions and even industrial revolutions. For a car racing game, the goal is the finishing line and winning, and the game dynamic is to modify the car with the right engine, chassis, tyres, and other car parts while keeping in mind the trade-offs of speed, stability and safety.
3. Game Mechanics are defined by this research as the rules and gameplay that dictate how the game is meant to be normally played. For the farming game, they would be progression of the farm and rewards of overcoming problems in livestock and produce. For the world creation game, they would be overcoming the progression of time. For the car racing game, they would be overcoming the obstacles of the racing circuit, of other cars in the race, or of which car parts go with one another.

Certainly, different game dynamics and game mechanics create different game genres but this effect can also be the other way around, whereby for a game to be more attractive in its genre, it has to have interesting game dynamics and mechanics. The list of digital game genres is also extensive. To name a few there are platform games, first-person shooters, fighting games, games that require stealth movements, survival games, battle royale games, games about following rhythms, adventure games, 'metroidvania' games like Super Mario and Sonic the Hedgehog, sandbox games to create virtual worlds or items, construction simulation games, life simulation games, vehicle simulation games, battle arena games, real-time strategy games, sports games, casual games that a person may indulge in whenever there is time to spare while waiting the bus or the train or the interview, mixed reality games, puzzle games, traditional board games but made digital, math education games, language education games, general knowledge games, and other developing genres that are just impossible to be replicated in real life.

These game genres initially started from console-based video games (Omarali, 2017c) but with the advancements in smart mobile phones and devices with the capacity to house and run a variety of different games, access to these games have become ubiquitous. According to Clement from Statista.com, as of September 2021, there were more than 330,000 games in the Apple App Store (Clement, 2021a) and more than 470,000 games in the Google Play Store (Clement, 2021b). Although there is no definite number, from the more than 800,000 mobile games available, a portion of these is bound to be educational games or games that can be adapted for use in learning.

For those representing the education sector, whether as teachers or curriculum developers, educational researchers or educational game developers, the opportunity for research is in addressing the question – which of these mobile games are suitable for education? Games can push norms and boundaries so that they become unsuitable for the younger audience. Games can be highly complex and cognitively demanding, so they might be more appropriate for a specific student demographic, such as college students who may have their own mobile devices (Gao et al, 2014; Mortazavi, 2011, among others). However, there is already a large body of literature on both the negative and positive impacts of mobile phone use among students from different levels of education, such as addiction, sleep deprivation, self-esteem, nomophobia (fear of being separated from one's phone), loneliness and overall psychological health.

This educational research, and its scoping literature review, is primarily focused on a more technology neutrality and design-thinking based scope, viz. college students' use of mobile games for learning based on their preferences of game dynamics and game mechanics.

LITERATURE REVIEW

Mobile Learning (m-Learning)

To understand the role of mobile games in digital games-based learning is to firstly conceptualize mobile learning in general, in that not all mobile learning is games-based learning, but certainly all mobile games-based learning is mobile learning. Through comparing many definitions of m-learning, m-learning is defined as "any e-learning application delivered on-demand via mobile digital device" (Caudill, 2007, p. 3). Within the repositories of Apple Store and Android Play Store, mobile games are universally accepted as applications. In the past, mobile phones were known to have been banned in K-12 schools due to the perception that they are disruptive and contribute to procrastination. However, a number of factors including, but not limited to, their increasing ubiquity, their ability to provide students with anywhere learning opportunities, the growing BYOD (Bring Your Own Device) movement, and mounting demands by parents, students, and school stakeholders, have resulted in a gradual lifting of the ban. The increasing ubiquity and instructional features of these devices has made mobile learning "one of the key current trends of educational applications for new technologies" (Wu et al., 2012, p.818).

Developments in mobile device features and applications "have prompted educators and researchers to take a pedagogical view toward developing educational applications for mobile devices to promote teaching and learning, and (in tandem) research on mobile learning has expanded significantly" (Wu et al., 2012, p. 817). Even in low-resource environments, mobile learning, or m-learning has been on the rise. Michael Trucano, the World Bank's Senior Education and Technology Policy Specialist, points out that discussions of mobile learning in developing countries "previously often led (and even dominated) by academics about the 'potential' ... had been overtaken by conversations with people actually leading such efforts" from 2011 to 2016 (Trucano, 2016. para. 5).

The mobile phone is thus an example of appropriate technology, a device that is easily attainable, reliable, sustainable and one that logically fits the user and the context (Batteau, 2010; Wicklein, 2005; Onguko, 2014; among others). Hence, based on the case studies of challenging landscapes, mobile learning is a realistically viable learning approach for any country that has a stable and comprehensive network coverage and infrastructure. In tandem with the increasing popularity of mobile phone ownership, the use of digital games in education has become increasingly popular in recent years, and their forms and modalities of use continue to expand based on the cognitive benefits that they potentially provide to students (Whitton, 2014). Moreover, games can create motivating learning environments by reducing anxiety, which helps students to express themselves more freely (Thomas, 2012). It is thus not surprising that games have been successfully used as a tool for 'learning via play' from schools up to governmental corporations. The transition of games from computers and console-based platforms to mobile devices however became a pivotal turning point to the success of mobile games developers over console games developers.

Mobile Game Apps in Education

From an educational standpoint, mobile games that are available today provide immediate feedback and ludic human-computer interaction through their dynamics and mechanics. It is thus not surprising that games have been successfully used as a tool for 'learning via play' from schools up to governmental corporations (Furió et al., 2015). Games promote the development of social skills, such as teamwork (Reinders & Wattana, 2015) which could keep students motivated to progress in their learning (Butler, Someya & Fukuhara, 2014). In general, one study on multiplayer gaming found that players showed a noticeable level of positive politeness in the way they communicate, with the incorporation of humour, which in turn facilitates the development of relationships and teamwork (Peterson, 2012).

Similarly, recent research studies report that the use of games for educational purposes is becoming more popular between parents and children as a family activity (Cornillie, Thorne & Desmet, 2012). Further, if the use of games has adequate guidance, and is in moderation, it could also contribute to the development of the children's imagination and creativity which would have a good impact on behavior (Prensky, 2009). The new generation of students has drastically changed as they are surrounded by digital games and mobile phones with digital games installed. The way they receive and process information contrasts wildly to their predecessors (Prensky, 2009).

Game Dynamics and Game Mechanics in Education

To the benefit of students and educators, there is already an extensive range of games that are available as potential tools in different learning areas. As a result, games can be used and adapted to teach a wide variety of content and skills (Felicia, 2009). It is possible to categorise games by their genre: adventure, platform, puzzle, quiz, role playing, shooter, strategy; and by their potential learning areas: problem solving, creativity, planning, numeracy, logic, memory, empathy, social skills, spelling, time management, decision-making, literacy (Whitton, 2014).

Good game dynamics and mechanics simulate elements that are also present in efforts to promote technology-enhanced learning. For games to be educational, they would have mechanics and dynamics that (i) provide virtual platforms for interactive teamwork and collaboration, (ii) introduce the elements of healthy competition that requires knowledge to compete, (iii) inculcate the elements of planning and strategizing, (iv) introduce the real-life probability element of chance and how to rely on informed decision-making to increase probability, (v) present content as interactive designs in game interface settings, (vi) support continuity through pervasive uses of underlying themes, (vii) support context through pervasive uses of storylines, (viii) simulate limitation of resources (work-with-what-you-have approach), (ix) simulate the elements of higher risks and better rewards, (x) simulate the elements of scoring and levelling up that are prevalent in the real-world (e.g. appraisal, tests, promotions, unlocking achievements), and (xi) inculcate the element of rules. Based on these criteria, a preliminary research was conducted on a target student demographic to explore if considerations of game dynamics and mechanics are indeed relevant to using mobile game apps for digital games-based learning. Certainly, this research acknowledges that it is important to take on board the amount of time that educators would spend in developing the technological know-how to appropriately select, adapt or design games, as well as in creating activities to support the use of games (Prensky, 2009). By identifying the appropriate game dynamics and mechanics for teaching and learning, teachers are likely to be more informed of what elements are to be considered - if not prioritized - for designing learning situations where games might actively engage students.

RESEARCH

Research Method

The research adapted an exploratory quantitative study design, abiding to an objectivist research ontology and an empiricist epistemology. The research is the first half of an eventual mixed-method research that employs pragmatism with a subjectivist-interpretivist research perspective. The data analysis employed exploratory factor analysis to infer possible latent variables on each target sample's perception of game dynamics and mechanics. The sampling strategy is non-purposive sampling with the data collection from students (n=133) conducted in 2017 as part of another study investigating student dispositions. A further n=70 students were recruited via online public spheres and WhatsApp in early 2018 to fulfill the requirements of multivariate factor analysis, making the total sample n=203 from a target population of N=3,000 college students. The research ensured anonymity and confidentiality of personal identifiable data through refraining from collecting any form of demographic information (e.g. name, e-mail, age, gender, socio-economic status, college the respondent is from, etc.). The self-constructed questionnaire instrument included 29 question items informed by the reviewed literature of game dynamics and mechanics (Omarali, 2017c; 2019) and enquired students' responses on (a) preference of game dynamics, game mechanics and game elements measured via a 5-point Likert scale, and (b) personal opinions about the use of games for learning via a 5-point Likert scale. The questionnaire was administered online using Lime Survey to students from seven different colleges (names withheld). The method of data analysis involved multiple cycles of Exploratory Factor Analyses supported by statistical due diligence procedures.

Results

Due diligence was performed prior to performing the factor analysis. Tests for normality found the dataset to be non-normally distributed. The non-normality of the data posed a problem because factors are commonly determined by Pearson correlation. The oversensitivity of Pearson's R for non-normally distributed data led to the use of Spearman's rho as the correlation method of the analysis because it is less sensitive to non-normally distributed data and to outliers compared to Pearson (Abdullah, 1990; Balakrishnan & Lai, 2009). A Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity procedure was performed (see Table 1) that suggested the dataset to be favourable for Exploratory Factor Analysis.

A first attempt at PCA Exploratory Factor Analysis using Spearman's rho generated 13 factors based on the 29 items which would not be a realistically viable model. Using alpha correlation coefficient, six items with weak values were omitted as part of an item reduction process, which consequently improved alpha correlation. A second Exploratory Factor Analysis using Spearman's rho was performed but for this cycle using Direct Oblimin Rotation to acknowledge the non-normality of the data. The Extraction Method was Principal Component Analysis. The factor analysis generated 6 factors (see Table 2) with rotation converging in 18 iterations.

Two additional Exploratory Factor Analysis cycles were conducted using Varimax rotation and Monte Carlo Parallel Component Analysis, and both attempts indicated from Factor loadings to scree plots that there are 6 factors. The 6-factor model is thus accepted as the final result.

Several observations support the plausibility of this 6-factor model. Firstly, each factor at has at least 3 question items, which is the rule of thumb for Factor analysis (Fabrigar et al., 1999). Secondly, all the highest loading values are above .420, which is an acceptable threshold to the practice of accepting values above 0.3 (Hair et al., 1998). Thirdly, from the 23 items, only 5 items had noticeable cross-loadings based on the accepted .42 cut-off (i.e. Q06, Q11, Q15 and Q21). A majority are very indicative of single loading. For example, the strongest value for Q01 is .957 in Factor 3, with its values in the other five factors are less than .2.

Findings

Based on the Factor loadings and the meaning of each item, the research is suggestive that considerations on using mobile games for learning may benefit from referring to six measures of game dynamics and mechanics – hence a 6-factor model. For this 6-factor model, each factor is regarded as a continuous spectrum with its extreme ends not a reflection of strength or weakness but rather a representation of diversity. The model is suggestive of every student embodying these six factors in varying degrees, and therefore it is the variances in these six factors that differentiate a student's preference toward certain mobile game genres, game dynamics and game mechanics from other students' preferences.

Table 1. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	.605
Bartlett's Test of Sphericity Approx. Chi-Square	5586.314
df	231
Sig.	.000

Table 2. Students' preference of game dynamics, mechanics and elements based on Factor Analysis

Question items		1	2	3	4	5	6
Q01	The need for teamwork	-.015	-.090	.957	.166	-.087	-.014
Q02	Winning the competition in-game	.758	-.024	.141	-.272	.178	.089
Q03	How the game looks like (colours, animation)	-.054	.039	.068	-.861	-.018	.234
Q04	The idea of making resources to survive	.622	.172	.027	-.382	.078	.310
Q05	The idea of rewards after completing game parts	.213	.111	.881	-.042	-.052	-.067
Q06	The idea of achieving a high score	.486	-.182	.403	.054	.000	.571
Q07	The idea of levelling up and getting high ranks	.379	-.073	.318	-.423	.233	.270
Q08	Games will make me more interested in lessons	-.109	-.954	-.022	-.013	-.017	.134
Q09	Games will make lessons significantly interactive	.023	-.902	-.022	-.022	.153	.011
Q10	Games will make learning fun	.058	-.908	-.018	.115	.147	-.064
Q11	Games will make learning more competitive	-.139	-.550	-.166	.115	.293	.546
Q12	Games will improve my vocabulary and language	.162	-.274	-.012	.094	.812	.119
Q13	Games will improve my understanding of numbers and math	-.039	-.034	-.201	-.214	.827	.146
Q14	Games will improve my creativity and imagination	.128	-.317	.052	.083	.802	-.060
Q15	Games will not affect my learning performance	-.139	.690	.038	.200	.753	.075
Q16	Gaming improves my social skills	-.062	-.291	.236	-.259	.267	-.475
Q17	The game requiring strategy and thinking	.850	-.029	.043	.027	-.063	.005
Q18	The element of chance (e.g. opening a mystery box)	.070	-.001	-.030	-.173	-.030	.855
Q19	How the game experience is (movement, life-like concepts, etc.)	.116	-.054	-.027	-.888	.046	-.017
Q20	The overall theme of the game	-.005	.072	-.168	-.891	-.116	-.086
Q21	The background story behind the game	-.557	-.234	.640	-.261	.108	.094
Q22	The element of time (time limit, countdown)	.308	.077	.647	.038	.086	-.067
Q33	The concept of good versus evil and one prevailing over the other	-.414	.241	.654	.004	-.161	.185

Each of the six factors was labelled with a phrase that collectively depicts the items that it is represented by. This research acknowledges that the naming of factors has always been regarded as contentious. Yong and Pearce (2013) stated that "factor names may not accurately reflect variables within the factor" (p. 81) and for many decades, the literature on the naming of factors from Factor Analysis has been regarded as not having any exact science behind the process, regarding the process as subjective (Eysenck, 1992). Taking consideration of the practice of labelling factors, the factors that constitutes the resulting 6-factor model are described here in no particular order.

- Factor 1 is named 'Risk and Rewards'. Represented by three items (Q02, Q04, Q17), it measures a student's perception towards risk-taking and incentivization. It involves the game constructs of winning, survival, and strategizing. Some students are risk-takers while others avoid risks at all cost, and then there are students in between these two ends of the spectrum with differing levels of preferences.

- Factor 2 is named 'Impact of Games on Learning'. Represented by four items (Q08, Q09, Q10, Q11), it measures how games make lessons more interesting, interactive, fun and competitive. Some students may relish ludic and fun learning while others may prefer games having subtle impacts on learning.
- Factor 3 is named 'Sentimentalism of the Game'. Represented by five items (Q01, Q05, Q21, Q22, Q23), it measures the wanting to experience the game as a team, as a rewarding quest, as a narrative discovery, as an experience worth investing time in, as prevailing over adversity such as good versus evil. There are games that do have sentimental values to them, for example in games where students forge in-game relationships through teamwork with individuals who they might not forge relationships in real-life, such as going on game quests together, being immersed in a fantasy narrative together – experiences that they likely will not have an opportunity to experience in real-life. Even in one-player mode, a student can develop sentimentalism of the game itself – being able to relate to the fictional game characters or the narratives.
- Factor 4 is named 'Aesthetics'. Represented by four items (Q03, Q07, Q19, Q20), it reflects on the visuals of games, how their experience is set and structured, and how there is an underlying but apparent overall theme.
- Factor 5 is named 'Development of Self'. Represented by four items (Q12, Q13, Q14, Q15), it measures how the game influences the students' preferences toward digital games-based learning and of how a game may make lessons more interesting, improve understanding, improve creativity and imagination, all without negatively affecting learning performance. Some students may prefer games that they believe if they commit to them, invest in them, they get something in return, such as the development of real-world skills through simulated skill games.
- Factor 6 is named 'Simulated Real-life Factors'. Represented by three items (Q06, Q16, Q18), it measures instances such as the process of achieving a desired outcome, the use of social skills to reach to that outcome, and the element of chance that may play a part during the process of achieving that outcome.

CONCLUSION

The 6-Factor model generated from the exploratory study suggests that game dynamics and game mechanics certainly play influential roles in a student's selection of and preference for specific game types. Whether the game is an educational mobile game (e.g. Duolingo, Scribblenauts, etc.), or an entertainment game that can be used for education if complemented with creativity (e.g. Fortnite, Roblox, Clash of Clans, etc.), the ability in measuring a student's dispositions towards games with risk or rewards, games with attractive aesthetics, or games within which sentimental experiences can be encountered, enables the educator to be more decisive of which games or game genres work best for which student. With the potential of digital games-based learning being influenced by the very recent developments of virtual reality environments and digital worlds now referred to as the metaverse, it is imperative to understand that game dynamics and game mechanics will likely evolve to be relevant and applicable in the increasingly 'metaphygital' world; with the term 'metaphygital' firstly defined by this research as human states, actions or reactions that manifest in a given virtual space as a result of their translation from the physical to the digital, or from the digital to the physical, or from both forms occurring in unison. In other words, the future of digital games-based learning including the forms that involve the combinations of physical and digital (hence phygital) human-computer interactions and simulations made possible by emerging mobile and wearable technologies – that are not only limited to mobile phones but also mobile phone-based headsets and virtual reality headsets – will bring into consideration phygital game dynamics and game mechanics. This research is thus an early proclamation on the study of metaphygital mobile games and the concept of 'metanetics'; which this research begins to define as the study and science of metaverses, their technologies, and their concomitant constructs in the forms of content, interaction and knowledge.

CONFLICT OF INTEREST

The Author declares that there is no conflict of interest.

FUNDING AGENCY

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Process Dates:

Received: November 12, 2021, Revision: July 2, 2022, Accepted: July 2, 2022

Corresponding Author:

Correspondence should be addressed to Pengiran Shaiffadzillah Omarali, shai.omarali@gmail.com

REFERENCES

Abdullah, M. B. (1990). On a robust correlation coefficient. *The Statistician*, *39*(4), 455–460. doi:10.2307/2349088

Balakrishnan, N., & Lai, C. D. (2009). *Continuous bivariate distributions*. Springer.

Batteau, A. W. (2010). Technological peripheralization. *Science, Technology & Human Values*, *35*(4), 554–574. doi:10.1177/0162243909345834

Butler, Y. G., Someya, Y., & Fukuhara, E. (2014). Online games for young learners' foreign language learning. *ELT Journal*, *68*(3), 265–275. doi:10.1093/elt/ccu008

Caudill, J. G. (2007). The growth of m-learning and the growth of mobile computing: Parallel developments. *International Review of Research in Open and Distributed Learning*, *8*(2), 1–13. doi:10.19173/irrodl.v8i2.348

Clement, J. (2021a). *Apple App Store: number of available gaming apps as of Q1 2021*. https://www.statista.com/statistics/780238/number-of-available-gaming-apps-in-the-apple-app-store-quarter/

Clement, J. (2021b). *Google Play: number of available gaming apps as of Q1 2021*. https://www.statista.com/statistics/780229/number-of-available-gaming-apps-in-the-google-play-store-quarter/

Cornillie, F., Thorne, S. L., & Desmet, P. (2012). ReCALL special issue: Digital games for language learning: challenges and opportunities: Editorial Digital games for language learning: From hype to insight? *ReCALL*, *24*(3), 243–256. doi:10.1017/S0958344012000134

Dionisio, J. D. N., III, W. G. B., & Gilbert, R. (2013). 3D virtual worlds and the metaverse: Current status and future possibilities. *ACM Computing Surveys (CSUR), 45*(3), 1-38.

Eysenck, H. J. (1992). Four ways five factors are not basic. *Personality and Individual Differences*, *13*(6), 667–673. doi:10.1016/0191-8869(92)90237-J

Fabrigar, L. R., Wegener, D. T., MacCallum, R. C., & Strahan, E. J. (1999). Evaluating the use of exploratory factor analysis in psychological research. *Psychological Methods*, *4*(3), 272–299. doi:10.1037/1082-989X.4.3.272

Felicia, P. (2009). *Digital games in schools: Handbook for teachers*. HAL.

Frost, R. D., & MacIvor, E. (2011). Game dynamics in education: Early results and future plans. *Issues in Information Systems*, *12*(2), 87–94.

Furió, D., Juan, M. C., Seguí, I., & Vivó, R. (2015). Mobile learning vs. traditional classroom lessons: A comparative study. *Journal of Computer Assisted Learning*, *31*(3), 189–201. doi:10.1111/jcal.12071

Gao, Q., Yan, Z., Zhao, C., Pan, Y., & Mo, L. (2014). To ban or not to ban: Differences in mobile phone policies at elementary, middle, and high schools. *Computers in Human Behavior*, *38*, 25–32. doi:10.1016/j.chb.2014.05.011

Godwin-Jones, R. (2014). Games in language learning: Opportunities and challenges. *Language Learning & Technology*, *18*(2), 9–19.

Gros, B. (2007). Digital games in education: The design of games-based learning environments. *Journal of Research on Technology in Education*, *40*(1), 23–38. doi:10.1080/15391523.2007.10782494

Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). *Multivariate data analysis* (5th ed.). Prentice Hall.

Kemp, J., & Livingstone, D. (2006, August). Putting a Second Life "metaverse" skin on learning management systems. In *Proceedings of the Second Life education workshop at the Second Life community convention* (Vol. 20). The University of Paisley.

Lameras, P., Arnab, S., Dunwell, I., Stewart, C., Clarke, S., & Petridis, P. (2017). Essential features of serious games design in higher education: Linking learning attributes to game mechanics. *British Journal of Educational Technology*, *48*(4), 972–994. doi:10.1111/bjet.12467

MacCallum, K., & Parsons, D. (2019, September). Teacher perspectives on mobile augmented reality: The potential of metaverse for learning. In *World Conference on Mobile and Contextual Learning* (pp. 21-28). Academic Press.

Mortazavi, S. M. J., Atefi, M., & Kholghi, F. (2011). The pattern of mobile phone use and prevalence of self-reported symptoms in elementary and junior high school students in Shiraz, Iran. *Iranian Journal of Medical Sciences*, *36*(2), 96. PMID:23358105

Nadolny, L., Alaswad, Z., Culver, D., & Wang, W. (2017). Designing with game-based learning: Game mechanics from middle school to higher education. *Simulation & Gaming*, *48*(6), 814–831. doi:10.1177/1046878117736893

Nevelsteen, K. J. (2018). Virtual world, defined from a technological perspective and applied to video games, mixed reality, and the Metaverse. *Computer Animation and Virtual Worlds*, *29*(1), e1752. doi:10.1002/cav.1752

Omarali, P. (2021). REVAMP: Transforming Technology-enhanced Education to Cater for Learners' Dispositions. *The Asian Conference on Education & International Development 2021 Official Conference Proceedings.* 10.22492/issn.2189-101X.2021.16

Omarali, P. S. P. (2016). Investigating the effectiveness of the 'Online Learner Profiling Questionnaire' in generating a profile of learners based on learner dispositions: A pilot study. In *European Distance and E-Learning Network (EDEN) Conference Proceedings* (No. 2, pp. 99-108). European Distance and E-Learning Network.

Omarali, P. S. P. (2017a). Designing a survey study to measure the diversity of digital learners. *International Journal on Integrating Technology in Education*, *6*(1).

Omarali, P. S. P. (2017b). Investigating the Reciprocity of Interviews with the 'Online Learner Profiling Questionnaire' as an Instrument of Triangulation and In-Depth Data Acquisition: A Pilot Study. In *Conference Proceedings. The Future of Education* (pp. 140-143). Libreriauniversitaria. it Edizioni.

Omarali, P. S. P. (2017c, December). *Player Two has entered - Learning through console-based video games* [Paper presentation]. ALT Online Winter Conference 2016, Association for Learning Technology.

Omarali, P. S. P. (2019, October). *The pervasiveness of educational digital games among the students and teachers in Brunei Darussalam* [Paper presentation]. Teachers Day Conference 2019, Brunei Darussalam.

Omarali, P. S. P., & Motteram, G. (2017). Using Pierre Bourdieu's theory of practice to holistically profile online learners. In *Proceedings of the Global Educators' Conference* (Vol. 1, No. 1). Academic Press.

Onguko, B. B. (2014). JiFUNzeni: A blended learning approach for sustainable teachers professional development. *Electronic Journal of E-Learning*, *12*(1), 77–88.

Peterson, M. (2012). Learner interaction in a massively multiplayer online role playing game (MMORPG): A sociocultural discourse analysis. *ReCALL*, *24*(3), 361–380. doi:10.1017/S0958344012000195

Prensky, M. (2009). Sapiens digital: From digital immigrants and digital natives to digital wisdom. *Innovate: Journal of Online Education*, *5*(3).

Proulx, J. N., Romero, M., & Arnab, S. (2017). Learning mechanics and game mechanics under the perspective of self-determination theory to foster motivation in digital game based learning. *Simulation & Gaming*, *48*(1), 81–97. doi:10.1177/1046878116674399

Reinders, H., & Wattana, S. (2015). Affect and willingness to communicate in digital game-based learning. *ReCALL*, *27*(1), 38–57. doi:10.1017/S0958344014000226

Schafer, S. B. (2016). The dream analog: Psychecology video games. In *Exploring the Collective Unconscious in the Age of Digital Media* (pp. 40–78). IGI Global. doi:10.4018/978-1-4666-9891-8.ch002

Suh, A., Wagner, C., & Liu, L. (2015, January). The effects of game dynamics on user engagement in gamified systems. In *2015 48th Hawaii International Conference on System Sciences* (pp. 672-681). IEEE. doi:10.1109/HICSS.2015.87

Thomas, M. (2012). Contextualizing digital game-based language learning: Transformational paradigm shift or business as usual? In H. Reinders (Ed.), *Digital games in language learning and teaching* (pp. 11–31). Palgrave Macmillan. doi:10.1057/9781137005267_2

Trucano, M. (2016). *Global EdTech Expert Reflects on Five Years of Mobile Learning*. https://www.gamesandlearning.org/2016/03/07/global-edtech-expert-reflects-on-five-years-of-mobile-learning/

Whitton, N. (2012). Good game design is good learning design. In N. Whitton (Ed.), *Using games to enhance learning and teaching* (pp. 25–34). Routledge. doi:10.4324/9780203123775

Whitton, N. (2014). *Digital games and learning: Research and theory*. Routledge. doi:10.4324/9780203095935

Wicklein, R. C. (2005). Appropriate technology: value adding application for technology education: students are given more opportunity to be creative, to think logically, to see and understand a technological problem in total, and to act responsibly as they work to solve problems that are important and intrinsic to them. *Technology Teacher*, *65*(1), 10–13.

Wu, W. H., Wu, Y. C. J., Chen, C. Y., Kao, H. Y., Lin, C. H., & Huang, S. H. (2012). Review of trends from mobile learning studies: A meta-analysis. *Computers & Education*, *59*(2), 817–827. doi:10.1016/j.compedu.2012.03.016

Yong, A. G., & Pearce, S. (2013). A beginner's guide to factor analysis: Focusing on exploratory factor analysis. *Tutorials in Quantitative Methods for Psychology*, *9*(2), 79–94. doi:10.20982/tqmp.09.2.p079

Pengiran Shaiffadzillah Pengiran Omarali is an educational technologist with specialisations in new learning technologies and online learning research. He has a PhD in Education and is a Chartered IT Professional from the British Computer Society. His current research areas include Artificial Intelligences, Internet of Everything, Internet of Behaviour, and Metaverses in education.