



Features in Smartphone Games Encouraging Physical Exercise: A Review of Gamification Trends

Aoran Li¹, Ian Chai², Kok-Why Ng³

^{1,2,3} Faculty of Computing and Informatics, Multimedia University, 63100 Cyberjaya, Selangor, Malaysia

* Corresponding author. Email: ianchai@mmu.edu.my

Abstract. As smartphones become increasingly useful, people are incorporating them into their daily lives, resulting in lifestyle changes. Moreover, smartphones can serve as a means to promote a healthy lifestyle. In today's fast-paced world, where pressure is pervasive, it is crucial for individuals to prioritise their own health. According to the latest research by the World Health Organization, obesity has emerged as a significant health threat, emphasising the importance of regular exercise for improving overall well-being. This paper aims to explore the significance of physical exercise, the application of gamification, the theoretical foundations of designing exercise games, and to investigate and analyse successful gamified exercise apps' gameplay and game elements. The ultimate objective is to establish a strong foundation for future research in creating exceptional smartphone exergames that enhance motivation for sustained physical activity. This involves incorporating appropriate game elements to enhance user experience and enabling individuals to attain both health and happiness through engaging in physical exercise.

Keywords: Smartphone, Gamification, Healthy, Physical, Exercise, Element.

1 Introduction

Many individuals nowadays lead sedentary lifestyles and lack regular exercise infrequently, despite its importance for maintaining good health. People often find themselves caught up in work, studies, social interactions, and family matters, neglecting the need for physical activity. Engaging in regular physical activity has a significant impact on energy levels and overall well-being [1]. Despite the acknowledged significance of maintaining and promoting health, many have struggle to stay motivated to exercise. Gamification has the potential to make challenging tasks more enjoyable, and incorporating it into exercise apps can enhance individuals' engagement in physical activity [2].

This paper will provide an overview of the latest technology that utilises smartphone games to encourage physical exercise. In the future, we plan to utilise game engines to develop a mobile exergame that enables people to engage in physical exercise indoors at home, thus promoting their health.

1.1 Importance of physical exercise

Fig. 1. Showing Malaysia has the highest adult obesity rate in Southeast Asia. According to the latest National Health and Morbidity Survey (as of writing, the results for 2019 – 2020 have not yet been released), 50.1% of adults were reported to be overweight (30.4%) or obese (19.7%), as illustrated in

Figure 1. Excessive obesity can have a detrimental impact on individuals' physical health and can lead to various diseases. Engaging in regular physical activity can significantly improve the quality of life and help reduce anxiety. Research has shown that physical activity can lead to better sleep, including reduced sleep latency (falling asleep faster) and improved sleep quality (deeper sleep) through increased moderate-to-vigorous physical activity [3].

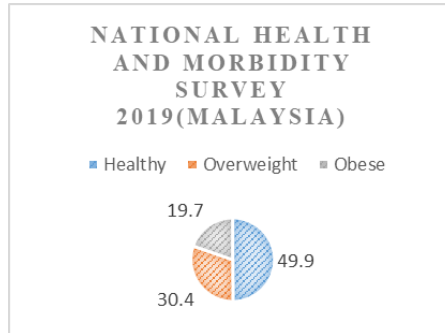


Fig. 1. National Health and Morbidity Survey 2019 (Malaysia)

Engaging in moderate to vigorous physical activity can help maintain healthy brains. The benefits include improved understanding and enhanced thinking, especially for children aged 6 to 13. Additionally, it can help reduce short-term anxiety in adults. Regular physical activity contributes to clearer minds, improved focus on learning, and keener judgment. Moreover, it may lower the risk of depression and anxiety [4].

2 Literature review

Currently, most health-promoting fitness apps often fail to motivate individuals to exercise or are abandoned after a few uses. However, incorporating gamification and game elements into fitness applications has been shown in many studies to enhance the user experience and is becoming a key trend in promoting physical activity.

Suryadibrata et al. developed a mobile health application using a gamification framework called Octalysis and measured the impact of gamification on user acceptance using a questionnaire. The study found that 74.59% of users were immersed in the app, and 81.43% of users strongly believed that they would continue using the app in the future [5].

By investigating the health management performance of target difficulty and achievement incentives, Yang & Li demonstrated that gamification functions, such as goal setting and reward systems, can motivate people to manage their health and engage in physical exercise [6].

64% of mobile health and fitness applications, especially the more popular ones, incorporate gamification. These applications often integrate social network functions based on a combination of psychological and behavioural science theories. The Technical Acceptance Model (TAM) has been used to measure the perceived user experience in a mobile app system developed using gamification-based interactive technology [7].

Goldhill & Roodt added game elements such as achievement and badges, a point system, a levelling-up system, and a leaderboard, to an m-Health Application and found that this has a positive impact on health behaviour. Adding game elements to m-Health Applications has been done to achieve gamification [8].

Brauner et al use a prototype exergame to compare young and elderly users and investigated user types, personality factors, and performance within the exergame. They concluded that performance is affected by player type, not by motivation and addition of gamification to mobile application health programs has a positive impact on people's health behaviour. The most effective types of gamification are achievement and progress-oriented, such as points, badges, and leaderboards, as they increase user engagement and help users reach their fitness goals [9].

Saboia et al. found that if food intake and calories can be calculated and displayed in an app, it can motivate people to control their weight [10].

Payne et al. showed that physical exercise and health games on mobile phones appear to be more effective than computer exercise games in maintaining people's exercise routines [11].

Edwards et al. found that exercise games on mobile phones can help people persist in exercising once they decide to do it [12].

Fitness strategies through gamification are currently widely used [13]. As mentioned earlier, gamification makes difficult tasks in life interesting. Therefore, the gamification of exercise apps can improve people's engagement in physical exercise.

3 Methodology

This paper is organized into three sections. First, we determine the key structures used to evaluate gamification features, game elements, and theoretical foundations employed in exercise-related games, following a methodology similar to the one used by Lister et al. [14]. Second, we identify the games selected for analysis in this paper. Finally, we summarize the game elements that have been found to be most effective in promoting increased physical activity.

Buntoro et al. conducted a study testing a simple gamification feature: the challenge. Using 10 participants to test the application, the experiments and results demonstrated that subjects found the challenge feature interesting and that it helps maintain healthier habits [15]. While gamification is a viable solution, some individuals may not be particularly interested in-game elements such as levelling up, virtual rewards, feedback, and the app's storyline. Therefore, it is necessary to incorporate new game elements such as reminders, avatar design, challenges, and competitions to encourage people to engage in exercise [16].

Shameli et al. examined the impact of competition on physical activity, specifically focusing on walking in smartphone exercise tracking apps, and developed statistical models of the data as a guide to help design more interesting competitions that can effectively motivate individuals to change their exercise behaviour [17].

King et al. found that gamification helps individuals achieve their goals for healthy behaviour [18]. Furthermore, qualitative and quantitative analysis by Kappen et al. indicated that gamified group experiences result in higher levels of motivation, enjoyment, and engagement as compared to non-gamified versions [19].

As evident from the reviewed literature, gamification has the potential to make challenging tasks in life more interesting. Incorporating gamification into exercise apps can improve consistency in physical exercise.

Sepehr & Head conducted a longitudinal survey study that demonstrated how competition serves as a crucial factor in motivating people to engage in gamified tasks [20]. Mokadam et al. incorporated competitive game elements in gamification to enhance users' exercise motivation [21].

Huang & Jiang examined the influence of social networking features in physical exercise applications on individuals' participation in physical exercise. Their findings indicate that social game elements contribute to increased physical activity levels [22].

Weber et al. conducted a study investigating the impact of changes in game mechanics on a cycling program and how it affected participants' frequency of bicycle riding. The inclusion of a leaderboard enhanced participants' enjoyment of the racing experience [23].

Positive recognition, social influence, and reciprocity have a positive impact on willingness to exercise, attitude, and willingness to use gamification services [24].

Muangsrinon et al. suggest a combination of gamification elements, including points, feedback, levels, leaderboards, challenges, and more, to motivate players to successfully complete physical exercise challenges. [25] They highlight that gamification can effectively motivate players to complete physical exercise challenges by incorporating game dynamics, game mechanics, game components, game elements such as levels, points, feedback, leaderboards, and challenges. These elements contribute to making the overall process more exciting and engaging for the players [25].

Performing real physical activities to obtain virtual time-based rewards can motivate players to engage in physical activities [26].

A survey of 411 Nike Run Club (NRC) app users revealed that adding challenging game elements are an important way to influence user exercise, enjoyment, and social interaction [27].

As seen from the literature review, adding effective game elements to a game can enhance user experience. Elements like competition and in-game rewards increase user exercise motivation and engagement in physical activities. The inclusion of challenging game elements and leaderboards has also been shown to make games more enjoyable and engaging for users. Additionally, the influence of social interactions and social influence has been found to be beneficial in encouraging physical activity.

By using keyword searches in the Google Play and iOS App Stores, we found top gamified exergames and examined them to deduce gameplay and game elements that contribute to their success.

The Fitness RPG converts users' steps into virtual currency known as "free energy" which is then used to level up heroes within the game. By assuming the role of a hero on a quest, players engage in battles with monsters and work towards saving the realm. This immersive experience allows players to take on a sense of responsibility for others through their in-game actions.

In the game *Zombies, Run*, players listen to mission instructions and accompanying music through headphones, creating an immersive experience where they feel like they are being chased by zombies. His unique concept is designed to motivate people to run and exercise. The game features numerous missions, and during certain intervals known as a "Zombie chase" players must increase their pace, alternating between jogging and fast running to escape the pursuing zombies. Additionally, *Zombies, Run* incorporates a base-building aspect, where running automatically collects supplies that can be used to enhance and expand the player's base.

Walkr is a game that serves as a motivator for people to walk more by offering an exciting concept of exploring an infinite universe. The game utilizes a pedometer that records the user's daily walking steps. As players accumulate steps in real life, they progress through the game's universe, discovering new galaxies.

Virtuagym Fitness provides clear 3D-animated exercise videos, and full workouts for use at home as well as in a gym. Its gamification includes setting a challenge, completing a target, and earning rewards for exercising.

Fitocracy users are required to complete exercise tasks and earn experience points, with the goal of continuous improvement. The Fitocracy application provides a wide range of workout routines and expert advice to motivate users to engage in physical exercise. Additionally, Fitocracy has a supportive exercise community that helps to enhance motivation.

Jefit addresses the issue of exercise motivation by allowing users to connect socially with friends and like-minded individuals who share common fitness goals. This social connection enables users to encourage and support each other in maintaining their exercise routines.

Strava incorporates gamification into its run tracking feature. It records various metrics such as running speed, running distance travelled, time taken, and routes followed. Additionally, Strava integrates game elements like leaderboards, achievements, and challenges. The platform offers a wide range of challenges and collectible badges, encouraging users to share their experiences and compare their results.

Fitbit calculates activity steps and distance, as well as calories burned and exercise duration, and records daily progress. These features help users optimize workouts and improve. Fitbit also records meals and combines that with activity statistics for a better understanding of calorie intake and output. It also allows one to join groups, connect with friends, and engage in challenges.

Wokamon combines the function of a pedometer with the engagement of a virtual pet. Every calorie burned feeds the player's virtual pet and unlocks more fun characters to play with. The more active the player is, the more virtual pets they can get and the more their virtual pets will grow.

Plaiisce combines the intensity of with the enjoyment of play. The user stands in front of the smartphone with the front camera capturing their movements, which are then translated into on-screen game controls. This immersive experience allows users to forget that they are exercising instead fully engage in the fun of the game.

The above survey shows that each game has its own characteristics as well as benefits, and they offer a variety of ways for people of all ages to use gamification to promote exercise while helping them to stay healthy.

Costigan, et al., found that gamification in fitness and health applications is extremely popular and that there is a correlation between gamified components and useful game elements, though experiments show that different age groups have different perceptions of game elements and performance in gamified applications [28].

According to Bitrián et al., the most effective gamification types are those that are achievement and progress-oriented, for example, points, badges, and leaderboards. These can increase user engagement and help users reach their fitness goals [29].

Goh & Razikin et al. propose three design principles for gamified exercise applications: 1. A point system will encourage users to continue to be willing to exercise. 2. Social support is essential for motivating individuals to exercise, because players can encourage one another. 3. Some people do not like the competitive aspect, because they feel too much pressure from competition. This suggests that excessive competition should be avoided [30].

Table 1. Game elements and description in order of popularity.

Game Elements	Description
Goals	Measurable and clearly defined goals that users must achieve.

Levels	Progress through role upgrade (e.g., level 1 to level 10) or rank of status (e.g., silver to gold).
Challenges	Can be time limit challenge, or achievement-based, e.g. unlock new chapters to advance the plot.
Leaderboard	Motivate the user by comparing with the performance of others.
Social influence	Performance is publicly displayed, or gives players the ability to communicate directly with other members of the community.
Reward	When the player is in the process of achieving the goals, the player is constantly rewarded. This encourages the player to persevere in exercising.
Points	Accumulate points from exercising or completing fitness tasks that help you progress in the game or redeem rewards in the game.
Competitions	Players can compete with other players, either directly, or through a leaderboard on various tasks.
Badges	Rewards and recognition given to players after completing difficult tasks.
Achievement	Special rewards for players who complete some special and difficult tasks.
Progress bars	A visual or graphical representation showing progress towards completing a task.

Table 1 shows that much research has demonstrated that gamification can effectively promote physical exercise, increase motivation to continue exercising, and enhance the gaming experience for players by incorporating distinct gamification elements in a sensible manner. We plan to combine these game elements to maximize their effectiveness, enabling players to exercise and maintain physical health while enjoying the game.

4 Conclusion

Physical exercise is important, many find it difficult to persist. The reviewed literature shows that combining gamification with mobile health applications and smartphone exercise games can promote physical activity. We have identified game elements that frequently appear in successful smartphone exercise games. However, this study also has certain limitations regarding user preferences and diversity. The study may not have fully considered individual differences in game element preferences or the

different needs and preferences of target groups. Different people may respond differently to a particular gamification strategy.

5 Future work

The survey indicates that most of the prior research has focused on outdoor games. However, outdoor exercises often hindered by weather conditions such as rain, high humidity, or safety concerns, making them infeasible at times. Additionally, certain environments may lack suitable places for outdoor exercise. Factors like fatigue from work and other obligations can also make it challenging to engage in daily outdoor exercise.

Furthermore, the ongoing COVID-19 pandemic has introduced the necessity of wearing masks when going outside, which can impede the increased need for breathing during exercise. Hence, there are numerous reasons why it might not be feasible to engage in outdoor exercise on a daily basis.

Indoor exercise offers advantages by eliminating weather constraints and the need for a safe outdoor exercise space. It is not limited by the time of day, and individuals have the freedom to customise their goals and routines.

Given these considerations, our research aims to investigate suitable gamification features for indoor exercises. We plan to develop mobile exergames specifically designed to encourage indoor exercise when outdoors exercise is not feasible. Subsequently, we will conduct tests using different versions of exergames to determine which game elements are most effective in motivating individuals to consistently engage in indoor exercise.

Authors 'contributions

Aoran Li: Original draft preparation, Data Curation, Investigation, Methodology;

Chai Ian: Conceptualization, Supervision, Reviewing and Editing;

Kok-Why Ng: Supervision, Reviewing and Editing.

References

1. Avancini, A., D'Amico, F., Tregnago, D., Trestini, I., Belluomini, L., Vincenzi, S., Canzan, F., Saiani, L., Milella, M., & Pilotto, S. (2021). Nurses' perspectives on physical activity promotion in cancer patients: A qualitative research. *European Journal of Oncology Nursing*, 55, 102061. <https://doi.org/10.1016/j.ejon.2021.102061>.
2. Lopez, C. E., & Tucker, C. S. (2019). The effects of player type on performance: A gamification case study. *Computers in Human Behavior*, 91, 333-345. doi:10.1016/j.chb.2018.10.005. [3]C. Baier, J-P. Katoen, *Principles of Model Checking*, MIT Press, 2008.
3. Mohd-Sidik, S., Lekhraj, R., & Foo, C. N. (2021). Prevalence, Associated Factors and Psychological Determinants of Obesity among Adults in Selangor, Malaysia. *International Journal of Environmental Research and Public Health*, 18(3), 868. doi:10.3390/ijerph18030868.
4. Antczak, D., Lonsdale, C., Lee, J., Hilland, T., Duncan, M. J., del Pozo Cruz, B., Hulteen, R. M., Parker, P. D., & Sanders, T. (2020). Physical activity and sleep are inconsistently related in healthy children: A systematic review and meta-analysis. *Sleep Medicine Reviews*, 51, 101278. <https://doi.org/10.1016/j.smr.2020.101278>.

5. Setiawan, S. S., & Suryadibrata, A. (2019). Fitrust: Promoting healthy lifestyle through Gamified Mobile Health Application. 2019 5th International Conference on New Media Studies (CONMEDIA). <https://doi.org/10.1109/conmedia46929.2019.8981840>.
6. Yang, H., & Li, D. (2021). Health Management Gamification: Understanding the effects of goal difficulty, achievement incentives, and social networks on performance. *Technological Forecasting and Social Change*, 169, 120839. <https://doi.org/10.1016/j.techfore.2021.120839>.
7. Wen, M. H., (2017). Applying gamification and social network techniques to promote health activities. 2017 International Conference on Applied System Innovation (ICASI). <https://doi.org/10.1109/icasi.2017.7988474>.
8. Goldhill, J., & Roodt, S. (2018). Gamification in M-health applications and its effects on health behavioural changes in net generation students. 2018 International Conference on Intelligent and Innovative Computing Applications (ICONIC). <https://doi.org/10.1109/iconic.2018.8601206>.
9. Brauner, P., Calero Valdez, A., Schroeder, U., & Ziefle, M. (2013). Increase physical fitness and create health awareness through Exergames and gamification. *Lecture Notes in Computer Science*, 349–362. https://doi.org/10.1007/978-3-642-39062-3_22.
10. Saboia, I. F., Almeida, A. M., Pernencar, C., & Veloso, A. I. (2018). Gamification strategies in weight control applications, where “losing (weight) is winning.” 2018 IEEE 6th International Conference on Serious Games and Applications for Health (SeGAH). <https://doi.org/10.1109/seгах.2018.8401375>.
11. Payne, H. E., Moxley, V. B. A.; MacDonald, E. (2015). Health behavior theory in physical activity game apps: A content analysis. *JMIR Serious Games*, 3(2). <https://doi.org/10.2196/games.4187>.
12. Edwards, E. A., Lumsden, J., Rivas, C., Steed, L., Edwards, L. A., Thyagarajan, A., Sohanpal, R., Caton, H., Griffiths, C. J., Munafò, M. R., Taylor, S., & Walton, R. T. (2016). Gamification for Health Promotion: Systematic review of behaviour change techniques in smartphone apps. *BMJ Open*, 6(10). <https://doi.org/10.1136/bmjopen-2016-012447>.
13. Kawachi, I. (2017). It’s All in the Game—The Uses of Gamification to Motivate Behavior Change. *JAMA Internal Medicine*, 177(11), 1593. doi:10.1001/jamainternmed.2017.4798.
14. Lister, C., West, J. H., Cannon, B., Sax, T., & Brodegard, D. (2014). Just a fad? gamification in health and fitness apps. *JMIR Serious Games*, 2(2). <https://doi.org/10.2196/games.3413>.
15. Buntoro, I. K., & Kosala, R. (2019). Experimentation of gamification for Health and Fitness Mobile Application. 2019 International Congress on Applied Information Technology (AIT). <https://doi.org/10.1109/ait49014.2019.9144842>.
16. Meixner, C., Baumann, H., Fenger, A., & Wollesen, B. (2019). Gamification in health apps to increase physical activity within families. 2019 International Conference on Wireless and Mobile Computing, Networking and Communications (WiMob). <https://doi.org/10.1109/wimob.2019.8923332>.
17. Shameli, A., Althoff, T., Saberi, A., & Leskovec, J. (2017). How gamification affects physical activity. Proceedings of the 26th International Conference on World Wide Web Companion - WWW '17 Companion. <https://doi.org/10.1145/3041021.3054172>.
18. King, D., Greaves, F., Exeter, C., & Darzi, A. (2013). ‘gamification’: Influencing health behaviours with games. *Journal of the Royal Society of Medicine*, 106(3), 76–78. <https://doi.org/10.1177/0141076813480996>.
19. Kappen, D., Mirza-Babaei, P., & Nacke, L. (2018). Gamification of older adults’ physical activity: An Eight-week study. Proceedings of the 51st Hawaii International Conference on System Sciences. <https://doi.org/10.24251/hicss.2018.149>.

20. Sepehr, S., & Head, M. (2013). Competition as an element of gamification for learning. Proceedings of the First International Conference on Gameful Design, Research, and Applications. <https://doi.org/10.1145/2583008.2583009>.
21. Mokadam, N. A., Lee, R., Vaporciyan, A. A., Walker, J. D., Cerfolio, R. J., Hermsen, J. L., Baker, C. J., Mark, R., Aloia, L., Enter, D. H., Carpenter, A. J., Moon, M. R., Verrier, E. D., & Fann, J. I. (2015). Gamification in Thoracic Surgical Education: Using competition to Fuel Performance. *The Journal of Thoracic and Cardiovascular Surgery*, 150(5), 1052–1058. <https://doi.org/10.1016/j.jtcvs.2015.07.064>.
22. Huang, G., Sun, M., & Jiang, L. C. (2022). Core social network size is associated with physical activity participation for fitness app users: The role of social comparison and social support. *Computers in Human Behavior*, 129, 107169. <https://doi.org/10.1016/j.chb.2021.107169>.
23. Weber, J., Azad, M., Riggs, W., & Cherry, C. R. (2018). The convergence of smartphone apps, gamification and competition to increase cycling. *Transportation Research Part F: Traffic Psychology and Behaviour*, 56, 333–343. <https://doi.org/10.1016/j.trf.2018.04.025>.
24. Hamari, J., & Koivisto, J. (2015). “working out for likes”: An empirical study on social influence in exercise gamification. *Computers in Human Behavior*, 50, 333–347. <https://doi.org/10.1016/j.chb.2015.04.018>.
25. Muangsrinoon, S., & Boonbrahm, P. (2019). Game elements from literature review of gamification in healthcare context. *Journal of Technology and Science Education*, 9(1), 20. <https://doi.org/10.3926/jotse.556>.
26. Neupane, A., Hansen, D., Fails, J. A., & Sharma, A. (2021). The Role of Steps and Game Elements in Gamified Fitness Tracker Apps: A Systematic Review. *Multimodal Technologies and Interaction*, 5(2), 5. doi:10.3390/mti5020005.
27. Hui-Chen Ho & Hsi-Peng Lu (2020). Exploring the impact of gamification on users’ Engagement for Sustainable Development: A case study in brand applications. *Sustainability*, 12(10), 4169. <https://doi.org/10.3390/su12104169>.
28. Costigan, S. A., Lubans, D. R., Lonsdale, C., Sanders, T., & del Pozo Cruz, B. (2019). Associations between physical activity intensity and well-being in adolescents. *Preventive Medicine*, 125, 55–61. <https://doi.org/10.1016/j.ypmed.2019.05.009>.
29. Bitrián, P., Buil, I., & Catalán, S. (2021). Enhancing user engagement: The role of gamification in mobile apps. *Journal of Business Research*, 132, 170–185. <https://doi.org/10.1016/j.jbusres.2021.04.028>.
30. Goh, D. H.-L., & Razikin, K. (2015). Is gamification effective in motivating exercise? *Human-Computer Interaction: Interaction Technologies*, 608–617. https://doi.org/10.1007/978-3-319-20916-6_56.

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

