

West Visayas State University
COLLEGE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
La Paz, Iloilo City

Graduate School

CLASSROOM GAME-ON: A GAMIFIED COMPUTER PROGRAMMING TOOL FOR
INFORMATION TECHNOLOGY STUDENTS

A Master Thesis Presented to the
Faculty of the Graduate School
College of Information and Communication Technology
West Visayas State University
La Paz, Iloilo City

In Partial Fulfilment
of the Requirements for the Degree of
Master in Information Technology

by

Gienelle O. Guinanao

May 2023

West Visayas State University
COLLEGE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
La Paz, Iloilo City

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Approval Sheet

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Guinanao, Gienelle O., "Classroom Game-On: A Gamified Computer Programming Tool for Information Technology Students" Unpublished Graduate School Document, Master's in Information Technology, West Visayas State University, Iloilo City, Philippines, May 2023.

Abstract

This study examines the effectiveness of a gamified approach in teaching JavaScript programming logic compared to a traditional approach. A web-based game application, Classroom Game-On, was developed to incorporate gamification techniques for teaching programming concepts. Results indicated that the gamified approach significantly improved student performance, highlighting its potential as an engaging and effective instructional method. Recommendations include conducting larger-scale replications to validate the findings across diverse populations and further exploring the impact of cultural and social factors on the acceptance and success of gamified approaches in programming education. These findings contribute to advancing educational strategies and informing the development of interactive and immersive learning environments in programming instruction.

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References

- Abidin, M. K. Z., & Ismail, A. (2021). Developing a 3d action-adventure game called "Code-E" for learning C++ function codes. *Journal of ICT in Education*, 8(3), 13-26.
- Ajzen, I. (1980). *Understanding attitudes and predicting social behavior*. Englewood cliffs.
- Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In *Action control: From cognition to behavior* (pp. 11-39). Berlin, Heidelberg: Springer Berlin Heidelberg.
- Bai, S., Hew, K. F., & Huang, B. (2020). Is gamification "bullshit"? Evidence from a meta-analysis and synthesis of qualitative data in educational contexts. *Educational Research Review*, 100322.
- Balcan, M. F., Dick, T., Sandholm, T., & Vitercik, E. (2018, July). Learning to branch. In *International conference on machine learning* (pp. 344-353). PMLR.
- Bangare, S. L., Gupta, S., Dalal, M., & Inamdar, A. (2016). Using Node. Js to build high-speed and scalable backend database server. *International Journal of Research in Advent Technology*, 4, 19.

- Crockford, D. (2008). JavaScript: The Good Parts: The Good Parts. " O'Reilly Media, Inc."
- Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, 16(3), 297-334.
- Cu Hao, L., Delantar, M. B., & Tan, G. J. (2021, February). C++ Adventure: A Mixed Methods Pilot Study on Digital Game-Based Learning of Coding and Effect on Motivation. In 2021 4th International Conference on Data Storage and Data Engineering (pp. 100-106).
- Dale, S. (2014). Gamification: Making work fun, or making fun of work?. *Business information review*, 31(2), 82-90.
- Davis, F. D. (1985). A technology acceptance model for empirically testing new end-user information systems: Theory and results (Doctoral dissertation, Massachusetts Institute of Technology).
- Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly*, 319-340.
- De-Marcos, L., Domínguez, A., Saenz-de-Navarrete, J., & Pagés, C. (2014). An empirical study comparing gamification and social networking on e-learning. *Computers & education*, 75, 82-91.

Graduate School

- Deterding, S., Sicart, M., Nacke, L., O'Hara, K., & Dixon, D. (2011). Gamification. using game-design elements in non-gaming contexts. In CHI'11 extended abstracts on human factors in computing systems (pp. 2425-2428).
- Dichev, C., & Dicheva, D. (2017). Gamifying education is a critical review of what is known, what is believed, and what remains uncertain. *International Journal of Educational Technology in Higher Education*, 14(1), 9.
- Dicheva, Darina & Dichev, Christo & Agre, Gennady & Angelova, Galia. (2015). Gamification in Education: A Systematic Mapping Study. *Educational Technology & Society*. 18.
- Edsys. Retrieved from <https://www.edsys.in/benefits-of-gamification-in-learning-and-instruction/>
- Education Alliance. (2022, January 18). Gamification & Game-Based Learning in EdTech: Mechanics and Dynamics | Education Alliance Finland - Global Quality Standard for Education. Education Alliance Finland. <https://educationalliancefinland.com/news/gamification-game-based-learning-edtech-mechanics-and-dynamics>
- Field, A. (2013). *Discovering statistics using IBM SPSS statistics*. Sage.

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┐

Flanagan, D. (2020). JavaScript: The Definitive Guide: Master the World's Most-Used Programming Language. O'Reilly Media.

Folmar, D. (2015). Game it up!: Using gamification to incentivize your library (Vol. 7). Rowman & Littlefield.

Garber, D., & Hazan, E. (2013, October 1). Playing Non-linear Games with Linear Oracles. IEEE Xplore.
<https://doi.org/10.1109/FOCS.2013.52>

Gaudel, MC. (2005). Formal Methods and Testing: Hypotheses, and Correctness Approximations. In: Fitzgerald, J., Hayes, I.J., Tarlecki, A. (eds) FM 2005: Formal Methods. FM 2005. Lecture Notes in Computer Science, vol 3582. Springer, Berlin, Heidelberg.
https://doi.org/10.1007/11526841_2

Ghelani, Diptiben & Hua, Tan & Koduru, Surendra Kumar Reddy. (2022). Cyber Security Threats, Vulnerabilities, and Security Solutions Models in Banking.
[10.22541/au.166385206.63311335/v1](https://doi.org/10.22541/au.166385206.63311335/v1).

Gidel, G., Jebara, T., & Lacoste-Julien, S. (2017, April). Frank-Wolfe algorithms for saddle point problems. In Artificial Intelligence and Statistics (pp. 362-371). PMLR.

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┌ Graduate School ┐

González, C. S., Gómez, N., Navarro, V., Cairós, M., Quirce, C., Toledo, P., & Marrero-Gordillo, N. (2016). Learning healthy lifestyles through active videogames, motor games and the gamification of educational activities. *Computers in human behavior*, 55, 529-551.

Hamari, J., Koivisto, J., & Sarsa, H. (2014). Does Gamification Work? - A Literature Review of Empirical Studies on Gamification. In *Proceedings of the 47th Hawaii International Conference on System Sciences*, Hawaii, USA, January 6-9, 2014.

Hanus, M.D., & Fox, J. (2015). Assessing the effects of Gamify. In the classroom. *Computers & Education*, pp. 80, 152-161.

Haverbeke, M. (2018). *Eloquent javascript: A modern introduction to programming*. No Starch Press.

Hwang, G., Yang, L., & Wang, S. (2013). A concept map-embedded educational computer game for improving students learning performance in natural science courses. *Elsevier Computers & Education*. 69, 121-130. doi 10.1016/ j. comp edu. 2013.07.008.

Huang, L., Soman, D., & Nowlis, S. M. (2016). Gamification of education: Effects on learning and engagement. In

└ ┘

Handbook of research on serious games for educational applications (pp. 485-503). IGI Global.

Hsu, T. C., Hwang, G. J., & Chang, C. K. (2013). A personalized recommendation-based mobile learning approach to improving the reading performance of EFL students. *Educational Technology & Society*, 16(3), 327-337.

Jonassen, D. H. (2010). *Learning to solve problems: A handbook for designing problem-solving learning environments*. Routledge.

Ju, S. Y., & Adam, Z. (2018). Implementing Quizizz as game based learning in the Arabic classroom. *European Journal of Social Science Education and Research*, 5(1), 194-198.

Kahu, E. R. (2013). Framing student engagement in higher education. *Studies in Higher Education*, 38(5), 758-773.

Kember, D., Leung, D. Y., Jones, A., Loke, A. Y., McKay, J., Sinclair, K., ... & Webb, C. (2010). Development of a questionnaire to measure the level of reflective thinking. *Assessment & Evaluation in Higher Education*, 35(3), 267-285.

Graduate School

- Kasinathan, V., Mustapha, A., Fauzi, R., & Rani, M. F. C. A. (2018). Questionify: gamification in education. *International Journal of Integrated Engineering*, 10(6).
- King, W. R., & He, J. (2006). A meta-analysis of the technology acceptance model. *Information & management*, 43(6), 740-755.
- Lai, P. C. (2017). The literature review of technology adoption models and theories for the novelty technology. *JISTEM-Journal of Information Systems and Technology Management*, 14, 21-38.
- Landers, R. N., & Landers, A. K. (2014). An empirical test of the theory of gamified learning: The effect of leaderboards on time-on-task and academic performance. *Simulation & Gaming*, 45(6), 769-785.
- Lau, C. & Lam, T. & Kam, B. & Nkhoma, M. & Richardson, J. & Thomas, S. (2017). The role of textbook learning resources in e-learning: A taxonomic study. *Computers & Education*. 118. 10.1016/j.compedu.2017.11.005.
- Lee, J., & Junoh, J. (2019). Implementing unplugged coding activities in early childhood classrooms. *Early Childhood Education Journal*, 47, 709-716.

Graduate School

Lee, M. C. (2009). Factors influencing the adoption of internet banking: An integration of TAM and TPB with perceived risk and perceived benefit. *Electronic commerce research and applications*, 8(3), 130-141.

Lee, Y., Kozar, K. A., & Larsen, K. R. (2003). The technology acceptance model: Past, present, and future. *Communications of the Association for information systems*, 12(1), 50.

Legris, P., Ingham, J., & Colletette, P. (2003). Why do people use information technology? A critical review of the technology acceptance model. *Information & management*, 40(3), 191-204.

linde.com. (2022, March 17). How can gamification improve learning outcomes? Linde.
<https://vr.linde.com/2022/03/17/how-can-gamification-improve-learning-outcomes/#:~:text=Gamification%20enhances%20learning%20and%20stimulates>

Marangunić, N., & Granić, A. (2015). Technology acceptance model: a literature review from 1986 to 2013. *Universal access in the information society*, 14, 81-95.

Graduate School

Mannila, L., Dagiene, V., Demo, B., Grgurina, N., Mirolo, C., Rolandsson, L., & Settle, A. (2014, June). Computational thinking in K-9 education. In Proceedings of the working group reports of the 2014 on innovation & technology in computer science education conference (pp. 1-29).

Maskeliūnas, R., Kulikajevas, A., Blažauskas, T., Damaševičius, R., & Swacha, J. (2020). An interactive serious mobile game for supporting the learning of programming in javascript in the context of eco-friendly city management. *Computers*, 9(4), 102.

Mino S. (2022). 8 Reasons Why PHP Is Still So Important For Web Development. Jobsity.
<https://www.jobsity.com/blog/8-reasons-why-php-is-still-so-important-for-web-development>

Mulani, S. (2022). Linear Search Algorithm and Implementation in C | DigitalOcean. [Www.digitalocean.com](http://www.digitalocean.com).
<https://www.digitalocean.com/community/tutorials/linear-search-algorithm-c#linear-search-algorithm>

Mulkeen, D. (2021, May 26). The Top 5 Benefits of Gamification in Learning. Learnlight.
<https://www.learnlight.com/en/articles/5-benefits-of-gamification-in-learning/>

- Morschheuser, B., Hassan, L., Werder, K., & Hamari, J. (2018). How to design gamification? A method for engineering gamified software. *Information and Software Technology*, 95, 219-237.
- Nacke, L. E., & Deterding, S. (2017). The maturing of gamification research. *Computers in Human Behavior*, 71, 450-454.
- Parmar, A. K. (2020, January 17). 4 Types of Tree Traversal Algorithms. Medium. <https://towardsdatascience.com/4-types-of-tree-traversal-algorithms-d56328450846>
<https://www.theedadvocate.org/how-does-gamification-affect-the-learning-process/>
- Papadakis, S., & Kalogiannakis, M. (2018). Using gamification for supporting an introductory programming course. The case of classcraft in a secondary education classroom. In *Interactivity, Game Creation, Design, Learning, and Innovation: 6th International Conference, ArtsIT 2017, and Second International Conference, DLI 2017, Heraklion, Crete, Greece, October 30-31, 2017, Proceedings 6* (pp. 366-375). Springer International Publishing.

Sakka, L., Sundararajah, K., & Kulkarni, M. (2017).

Treefuser: a framework for analyzing and fusing general recursive tree traversals. *Proceedings of the ACM on Programming Languages*, 1(OOPSLA), 1-30.

Scherer, R., Siddiq, F., & Tondeur, J. (2019). The technology acceptance model (TAM): A meta-analytic structural equation modeling approach to explaining teachers' adoption of digital technology in education. *Computers & Education*, 128, 13-35.

Sharp, J. H. (2006). Development, extension, and application: a review of the technology acceptance model. *Director*, 7(9), 3-11.

Roznovsky A. (n.d). Why Use PHP? Main Advantages and Disadvantages. Light IT Global. Retrieved April 26, 2023, from <https://light-it.net/blog/why-use-php-main-advantages-and-disadvantages/>

Sharma N. (2020). Asynchronous Programming In Node JS. Medium. <https://medium.com/codechef-vit/asynchronous-programming-in-node-js-d50c557e7be>

Senturk, Z. K., Senturk, A., Zavrak, S., & Kara, R. (2012).

Binary apple tree: A game approach to tree traversal

┌

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algorithms. Researchgate.net.

https://www.researchgate.net/publication/261456232_Binary_apple_tree_A_game_approach_to_tree_traversal_algorithms

Singhal U. (2022). Advantages And Disadvantages Of PHP: Why Should You Use PHP? UnStop.
<https://unstop.com/blog/advantages-and-disadvantages-of-php>

Sukendro, S., Habibi, A., Khaeruddin, K., Indrayana, B., Syahrudin, S., Makadada, F. A., & Hakim, H. (2020). Using an extended Technology Acceptance Model to understand students' use of e-learning during Covid-19: Indonesian sport science education context. *Heliyon*, 6(11), e05410.

Tan Ai Lin, D., Ganapathy, M., & Kaur, M. (2018). Kahoot! It: Gamification in higher education. *Pertanika Journal of Social Sciences & Humanities*, 26(1).

Understanding Roles and Responsibilities in Education and Training. Retrieved from
<https://thecriticalblog.wordpress.com/2013/09/11/understanding-roles-and-responsibilities-in-education-and-training/>

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Graduate School

Vanduhe, Vanye & Cemal Nat, Muesser & Al-Delawi, Hasan.

(2020). Continuance Intentions to Use Gamification for Training in Higher Education: Integrating the Technology Acceptance Model (TAM), Social Motivation, and Task Technology Fit (TTF). IEEE Access. PP. 1-1. 10.1109/ACCESS.2020.2966179.

Vartiainen, H., Toivonen, T., Jormanainen, I., Kahila, J., Tedre, M., & Valtonen, T. (2020, October). Machine learning for middle-schoolers: Children as designers of machine-learning apps. In 2020 IEEE Frontiers in Education Conference (FIE) (pp. 1-9). IEEE.

Verve Systems Pvt Ltd. (2023). Why Choose Node.js For Web Application Development? LinkedIn. <https://www.linkedin.com/pulse/why-choose-nodejs-web-application-development-verve-sys>

Werbach, K., & Hunter, D. (2012). For the win: How game thinking can revolutionize your business. Wharton Digital Press.

Wilson Chua (2017). PSIA Study: 52% of IT Students Are Not Hirable. Retrieved from

<https://technology.mb.com.ph/2017/01/27/psia-study-52-of-it-students-are-not-hirable/>

Zhan, Z., Tong, Y., Lan, X., & Zhong, B. (2022). A systematic literature review of game-based learning in Artificial Intelligence education. *Interactive Learning Environments*, pp. 1-22.

Zhang, D., Zhang, D., & Wu, Y. (2018). Gamification of online education: A review of empirical research. *Computers & Education*, 129, 14-27.

Zhao, Q., Chen, C. D., & Wang, J. L. (2016). The effects of psychological ownership and TAM on social media loyalty: An integrated model. *Telematics and Informatics*, 33(4), 959-972.