DESIGN and Evaluation of a Gamified Learning TOOL

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ABSTRACT

This study utilized a quantitative descriptive design to design and evaluate Quackademy, a gamified mobile learning tool aimed at enhancing computer programming education and supporting UN Sustainable Development Goal 4 (Quality Education) among public senior high school students in Region XI, Philippines. The research addressed four 'least mastered competencies'—Java syntax, package importing, loop constructs, and application development—by integrating specific gamification elements like points, badges, and the interactive 'Duck Race' game. Acceptance was measured using the Gamification Acceptance Model (GAM), with findings indicating high acceptance and strong user motivation. The study concludes with practical implications for teachers, administrators, and curriculum planners to facilitate the sustainable adoption of competency-based gamified learning across the Davao Region.

KEYWORDS: *Education, ITI, learning tool, computer programming, gamification mobile application.*

INTRODUCTION

The global educational landscape faces a critical challenge in computer programming instruction, characterized by three primary issues: a persistent technical skills gap that hinders industry employment (Balmes, 2017; Gallup & Lumina, 2014; Harms, 2024), widespread student disengagement due to the abstract nature of traditional teaching methods (Bukunova & Bukunova, 2017; Olipas, 2022; Songer & Brener, 2018), and significant socioeconomic disparities that limit access to quality coding resources (Alabi et al., 2023; Delos Santos & Manalo, 2021; Kasturirangan, 2020).

In the United States, the abstract nature of programming principles often leads to student disinterest in STEM fields (Songer & Brener, 2018). In countries like Brazil and India, obsolete instructional methods and rural access barriers remain major hurdles to acquiring necessary technical abilities (Freeman et al., 2014; Kasturirangan, 2020; Silva & Barros, 2019). These issues are mirrored in the Philippines, where conventional lecture-based approaches and obsolete curricula often fail to meet modern business demands (Alonzo, 2019; Gallup & Lumina, 2014; Sharma et al., 2018)

This study aligns with United Nations Sustainable Development Goal 4 (Quality Education), specifically Target 4.4, which aims to increase the number of youth with relevant technical skills for employment. By developing Quackademy, this research provides an inclusive digital tool that promotes lifelong learning opportunities. This is particularly significant given the persistent problem of the least mastered competencies, which negatively impact student achievement and human mobility.

While research into gamified learning has grown, a significant gap remains regarding localized studies that provide contextual adaptation for high school students in developing regions. Most existing literature focuses on higher education in North America or Europe, often utilizing general statistical analysis without exploring how specific localized competencies can be bridged through customized gamification elements. This study addresses this gap by evaluating a tool designed specifically for the DepEd curriculum in Region XI, Philippines.

Statement of the Problem

1. How to design and develop a mobile application gamified learning tool based on the least mastered competency in computer programming?
2. What is the level of acceptance of the developed mobile application gamified learning tool in terms of Perceived Usefulness; Perceived Ease of Use; attitude; skill engagement; interaction engagement; and functionality?
3. What is the implementation plan for the developed mobile application gamified learning tool for computer programming?

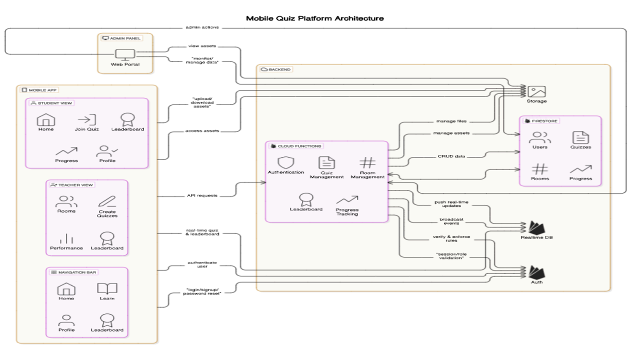
METHODOLOGY

Research Design **.** This study employed a quantitative descriptive design to systematically collect and analyze numerical data on students' acceptance of the Quackademy gamified learning tool. By employing structured surveys and descriptive statistical techniques—specifically mean and standard deviation—the research aimed to objectively measure user satisfaction across the various constructs of the Gamification Acceptance Model (GAM). This non-experimental approach was selected to provide a thorough, real-world assessment of the tool's effectiveness and usability in a natural educational setting, enabling a comprehensive evaluation of student attitudes and engagement without manipulating variables.

Software Development Methodology. Quackademy was developed using the Agile methodology, moving through iterative cycles of planning, design, development, testing, deployment, review, and retrospective. The process transitioned from Planning proficiency gaps in Java to design using Figma for wireframing, followed by Development with Flutter, the Flame engine, and Firebase for real-time data management. The Testing and Review phases used student and teacher feedback to refine the UI/UX and ensure cross-platform compatibility. This iterative approach ensured that the tool remained a learner-centered and technically sound platform for programming education.

System Architecture. The system architecture was designed to support a dynamic, cross-platform learning environment. The frontend was built using Flutter for responsiveness, while the Flame engine integrated real-time animations and interactive gamification elements. Firebase served as the backend solution for secure user authentication, real-time data storage, and analytics, allowing for personalized progress tracking and competitive leaderboards. Communication between the mobile application and backend services was facilitated via REST or GraphQL APIs, ensuring a seamless and motivating experience for the users

Figure 1
Architecture Diagram



Research Locale. The study was conducted in Region XI, specifically in Davao City and Davao del Sur, to capture diverse educational settings. Davao City, a highly urbanized center with advanced digital integration in schools, provided an ideal environment for assessing gamified learning tools. In contrast, Davao del Sur, with its mix of urban and rural schools gradually adopting educational technology, offered a broader context for evaluating the tool's applicability. This dual-site approach allowed the study to comprehensively assess the effectiveness and adaptability of the gamified learning tool across varied learning environments in the region.

The study selected public senior high schools based on specific inclusion and exclusion criteria to ensure relevance and validity. Schools were included if they offered the TVL track in computer programming, were DepEd-recognized, had at least 150 enrolled students, and demonstrated readiness for technology integration with trained, willing teachers. Schools were excluded if they lacked the relevant TVL track, did not meet the enrollment minimum, or lacked the infrastructure or faculty support needed for implementing gamified tools. This ensured a focused, capable, and representative sample for evaluating the impact of gamification on programming education.

Respondents of the Study. The sample size of 150 respondents was determined through quota sampling to ensure a balanced representation from both urban (Davao City) and rural (Davao del Sur) schools, capturing diverse technological readiness levels. To uphold research ethics, participant anonymity was strictly preserved through the codification of all data; no personal identifiers were used in analysis, and information was stored securely in compliance with the Data Privacy Act of 2012.

Research Instrument. This study utilized an adapted version of the Gamification Acceptance Model (GAM) survey instrument from Rahman et al. (2018) to measure student acceptance of the gamified learning tool. The survey assessed five key domains of engagement: skill engagement, participation/interaction, interaction engagement, measurement, and overall student engagement. Using a 5-point Likert scale, students rated their agreement with statements related to gamification's effectiveness and usability. The instrument demonstrated high internal consistency, with Cronbach's alpha values exceeding 0.7 across all constructs, confirming its validity and reliability for evaluating engagement in an educational context.

Data Gathering Procedure. To ensure ethical and systematic data collection, the researcher followed a multi-step process: the Dean of the Graduate School of the University of the Immaculate Conception (UIC) endorsed the study, followed by obtaining ethical clearance from the UIC Research Ethics Committee. Upon approval, permission was secured from the Department of Education, Region XI, and the Davao City Division to conduct the study and to access relevant data. An orientation session was held with participants to explain the study, introduce the gamified application, and obtain informed consent. Questionnaires were administered afterward, and all data were codified to maintain anonymity and confidentiality. The research strictly adhered to Republic Act No. 10173, the Data Privacy Act of 2012, ensuring that all personal information was handled securely and used solely for academic purposes.

*Statistical Tools***.** In analyzing and interpreting the data gathered from the TVL ICT students, several statistical tools were utilized to provide meaningful insights into students' engagement with gamification and technology:

Mean. The Mean was used to compute average scores of students' responses to the Gamified Acceptance Model in terms of perceived usefulness, perceived ease of use, attitude, skill engagement, interaction engagement, functionality, and the overall experience with the gamified learning tool.

*Standard Deviation***.** The Standard Deviation was utilized to measure the variability or dispersion of student feedback scores around the mean, indicating the consistency of their experiences with the gamified learning tool.

RESULTS AND DISCUSSION

The Design and Development of the Gamified Mobile Application Learning Tool

The design and development of Quackademy followed an Agile methodology, focusing on bridging four 'least mastered competencies' in Java programming through specific gamified interventions. The development process was characterized by the following technical and pedagogical integrations:

- Competency-Feature Linkage: To address Java syntax and package importing, the tool integrated a comprehensive resource library and interactive quizzes that provide immediate, non-penalizing feedback.

The more complex competencies—utilizing loop constructs and creating executable applications—were addressed through the 'Duck Race Game', a high-engagement module powered by the Flame engine that transforms abstract coding logic into competitive, visual challenges.

- Technical Architecture: The tool was built as a cross-platform mobile application using Flutter, supported by Firebase for real-time data tracking and secure authentication. Visual engagement was enhanced through Rive animations, which provided dynamic transitions and feedback, ensuring an immersive user experience.
- Iterative Refinement: Through a series of Agile sprints, wireframes were initially developed in Figma and refined based on usability feedback from both students and teachers. This iterative approach ensured that the final platform was not only technically robust but specifically tailored to the needs of low-proficiency learners, offering a supportive environment for gradual skill development

Level of Acceptance of the Gamified Mobile Application Learning Tool

The findings indicate a high level of acceptance (Mean = 3.956). While perceived usefulness was very high (4.198), the perceived ease of use was moderate (3.186), specifically regarding interface clarity. This suggests that while students value the pedagogical impact, future iterations should simplify the user interface. Recent literature by Alabi et al. (2023) and Tan et al. (2023) supports these findings, noting that immersive gamified environments significantly boost cognitive engagement.

Table 1
Level of Acceptance of the Gamified Mobile Application of the Learning Tool.

Dimension	Mean	SD	Description
Perceived Usefulness:	4.198	0.718	**High**
Perceived Ease of Use:	3.186	0.842	**Moderate**
Attitude:	4.166	0.803	**High**
Skill Engagement:	3.903	0.852	**High**
Interaction Engagement:	4.077	0.815	**High**
Functionality: General Weighted Mean	3.956	0.816	**High**

The Implementation Plan

The implementation strategy for Quackademy focuses on a multi-phased integration of the tool into the computer programming curriculum to bridge the least mastered competencies. It begins with the deployment of a fully functional, bug-free application developed alongside educators to ensure content relevance, followed by UI/UX refinements and dedicated training for teachers and students to facilitate effective classroom use. The plan emphasizes continuous monitoring of engagement for data-driven improvements, proactive technical troubleshooting, and securing sustainable funding to support the long-term adoption of this innovative learning environment.

CONCLUSION

Quackademy is widely accepted and pedagogically sound for enhancing programming education among senior high school students. The integration of gamification elements—points, badges, and leaderboards—successfully fosters student engagement and motivation. While the tool effectively addresses Java competencies, its moderate ease of use suggests that UI/UX refinements are needed to optimize the learner experience. Ultimately, gamified mobile learning offers a viable solution to bridge the gap between traditional instruction and the technical demands of the IT industry.

REFERENCES

Ab. Rahman et al. (2018). The effectiveness of gamification technique for higher education students' engagement in Polytechnic Muadzam Shah, Pahang, Malaysia. International Journal of Educational Technology in Higher Education, 15(41), 1-16.

Alabi, D., Adegbile, A., Afuye, L., Abel, P., & Monaco, A. (2023). NaijaCoder: Participatory Design for Early Algorithms Education in the Global South. arXiv preprint arXiv:2310.20488.

Alahäivälä, T., & Oinas-Kukkonen, H. (2016). Understanding persuasion contexts in health gamification: A systematic analysis of gamified health behavior change support systems literature. International Journal of Medical Informatics, 96, 62–70.

Albert, D., Nussbaumer, A., & Steiner, C. M. (2010). Towards generic visualization tools and techniques for adaptive e-learning. In

Proceedings of the 18th International Conference on Computers in Education ICCE (Vol. 2010).

Alhammad, M. M., & Moreno, A. (2018). A systematic review of the use of gamification in e-learning systems. International Journal of Advanced Computer Science and Applications, 9(12), 355–361.

Albert, D., Nussbaumer, A., & Steiner, C. M. (2010). Towards generic visualization tools and techniques for adaptive e-learning. In Proceedings of the 18th International Conference on Computers in Education ICCE (Vol. 2010).

Alhammad, M. M., & Moreno, A. (2018). A systematic review of the use of gamification in e-learning systems. International Journal of Advanced Computer Science and Applications, 9(12), 355–361.

Alharbi, A., & Balawi, A. (2021). Factors Influencing Students' Adoption of Learning Management Systems: A Systematic Review. *International Journal of Educational Technology in Higher Education*, 18(1), 1-20.

Bukunov, S. V., & Bukunova, O. V. (2017). Fundamentals of object-oriented programming. St. Petersburg State University of Architecture and Civil Engineering; EBS DIA

Butler, A. C., & Roediger, H. L. (2008). Feedback enhances the positive effects and reduces the negative effects of testing. *Frontiers in Psychology, 4*, 1-7. doi:10.3389/fpsyg.2013.00004

Butler, H., & Ahmed, A. (2016). Gamification in education: A systematic mapping study. Journal of Educational Technology & Society, 19(2), 75-88.

Calvo-Ferrer, J. R. (2020). Mobile-assisted gamification: User experience and learning outcomes in Spanish as a foreign language. Computer Assisted Language Learning, 33(1-2), 1–26.

Caponetto, I., Earp, J., & Ott, M. (2015). Gamification and education: A literature review. *European Conference on Games Based Learning*, 511–519.

Chen, I. J., & Huang, C. (2016). The Impact of Perceived Ease of Use on E-Learning Acceptance: An Empirical Study on Business Students. *International Journal of Management and Information Systems*, 20(1), 23-34.

Chen, Y., & Liu, Q. (2020). Integrating Programming Education into K12 Curricula: Benefits and Implications for Problem-Solving and Logical Thinking. Journal of Educational Technology, 15(2), 78-92.

Chen, Y., Zhang, Y., & Wang, L. (2017). The Effects of Collaborative Learning Using a Mobile Gamification Application on Students' Engagement and Learning Outcomes. *Educational Technology & Society*, 20(2), 256-267.

Cheong, C., Filippou, J., & Cheong, F. (2013). Towards an understanding of the challenges and benefits of gamification in K-12 education: A systematic literature review. World Conference on Educational Multimedia, Hypermedia and Telecommunications, 2013(1), 1803-1813.

Clark, D. B., Tanner-Smith, E. E., & Killingsworth, S. S. (2016). Digital games, design, and learning: a systematic review and meta-analysis. Review of Educational Research, 86(1), 79–122.

Creswell, J. W. (2014). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (4th ed.). SAGE Publications.

Cruz, M., & Santos, L. (2021). Socioeconomic and geographic disparities in access to programming education. Ateneo de Manila University.

Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, 13(3), 319-340.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (2020). User acceptance of computer technology: A comparison of two theoretical models. Management Science, 35(8), 982-1003.

Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. Psychological Inquiry, 11(4), 227-268.

Delos Santos, E., & Manalo, J. (2021). Socioeconomic disparities and access to resources in computer programming education. University of Mindanao.

De-Marcos, L., García-López, E., & García-Cabot, A. (2020). Social network analysis of a gamified e-learning course: A case study. *Computers in Human Behavior, 99*, 186–200.

Department of Education. (2010). Guidelines on the Implementation of the DepEd Computerization Program (DCP) (DepEd Order No. 78, s. 2010). Deterding, S. (2015). The lens of intrinsic skill atoms: A method for gameful design. Human–Computer Interaction, 30(3-4), 294–335.

Deterding, S. (2015). The lens of intrinsic skill atoms: A method for gameful design. Human–Computer Interaction, 30(3-4), 294–335.

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: defining "gamification". In Proceedings of the 15th International Academic MindTrek Conference: Envisioning

Future Media Environments (pp. 9-15). ACM.

Dobslaw, F., Angelin, K., Öberg, L.-M., & Ahmad, A. (2023). The Gap between Higher Education and the Software Industry -- A Case Study on Technology Differences. arXiv preprint arXiv:2303.15597.

Dobslaw, F., Angelin, K., Öberg, L.-M., & Ahmad, A. (2023). The Gap between Higher Education and the Software Industry -- A Case Study on Technology Differences. arXiv preprint arXiv:2303.15597.

Domingo, R., & Ferrer, J. (2020). Curriculum gaps in Philippine computer programming education. University of the Philippines.

Fathema, N., Shannon, D., & Ross, M. (2015). Exploiting gamification to enhance student engagement. Procedia Computer Science, 65, 104-113

Field, A. (2013). Discovering Statistics Using IBM SPSS Statistics (4th ed.). SAGE Publications.

Flores, J. F. F. (2018). Using gamification to enhance learning. *TechTrends, 62*(6), 598–606.

Fraser, S. (2013). Blockly: A visual programming editor. Google Inc.

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. Proceedings of the National Academy of Sciences, 111(23), 8410–8415.

Gallup & Lumina, (2014). Many Business Leaders Doubt U.S. Colleges Prepare Students. Gallup.

Garcia, L. M., & Cruz, R. S. (2019). Gamification in computer programming education: A local perspective in the Philippines. Philippine Journal of Educational Technology, 12(1), 25-37.

Garcia, M., et al. (2022). Gamified learning in STEM education: A systematic review. Journal of Research in Science Teaching, 49(1), 112-128.

Garcia, R., & Patel, S. (2019). Enhancing Student Engagement in Computer Programming Education through Authentic Assessments. International Journal of Computer Science Education, 5(1), 78-92.

Gentry, S. V., Gauthier, A., Ehrstrom, B. L., Wortley, D., Lilienthal, A., Tudor Car, L., ... & Car, J. (2019). Serious gaming and gamification education in health professions: Systematic review. *Journal of Medical Internet Research, 21*(3), e12994.

Grawemeyer, B., Halloran, J., England, M., & Croft, D. (2022). Feedback and Engagement on an Introductory Programming Module.

Hamari, J., Koivisto, J., & Sarsa, H. (2014). Does gamification work? A literature review of empirical studies on gamification. In 2014 47th Hawaii International Conference on System Sciences (pp. 3025–3034).

IEEE.

Hamari, J., Koivisto, J., & Sarsa, H. (2016). Does gamification work? A literature review of empirical studies on gamification. In *2014 47th Hawaii international conference on system sciences* (pp. 3025-3034). IEEE. doi:10.1109/HICSS.2014.377

Hamari, J., Shernoff, D. J., Rowe, E., Coller, B., Asbell-Clarke, J., & Edwards, T. (2016). Challenging games help students learn: An empirical study on engagement, flow, and immersion in game-based learning. Computers in Human Behavior, 54, 170–179.

Handelsman, M. M., Briggs, W. L., Sullivan, N., & Towler, A. (2005). A measure of college student course engagement. The Journal of Educational Research, 98(3), 184-192.

Hassan, L., Dias, A., & Hamari, J. (2019). How motivational feedback increases user engagement and goal attainment in gamification. *Computers in Human Behavior, 92*, 114–123.

Holman, C., Aguilar, S., Fishman, B., & Ross, L. (2020). Personalization and learner engagement: Examining the roles of choice and interest in a game-based learning environment. Computers & Education, 144, 103694.

Huang, W. H. Y., & Soman, D. (2020). *A practitioner's guide to gamification of education*. University of Toronto Press.

Huotari, K., & Hamari, J. (2012). Defining gamification: A service marketing perspective. In Proceeding of the 16th International Academic MindTrek Conference (pp. 17-22).

Hwang, G. J., & Chang, H. (2011). A List of Research Trends in Game-based Learning: A Historical Perspective. *Educational Technology & Society*, 14(4), 14-25.

Ibáñez, M. B., Di-Serio, Á., & Delgado-Kloos, C. (2014). Gamification for Engaging Computer Science Students in Learning Activities: A Case Study. IEEE Transactions on Learning Technologies, 7(3), 291–301.

Johnson, A., et al. (2018). The impact of gamified quizzes on student engagement and knowledge retention in high school science classrooms. Journal of Educational Technology, 42(3), 321-335.

Johnson, E., & White, L. (2018). Assessing Computer Programming Skills: Moving Beyond Memorization. Journal of Educational Technology, 12(2), 45-58.

Khalil, M., & Elkhider, I. A. (2016). Gamification in Higher Education: Learning Game Design as a Tool for Motivation and Engagement. *Education and Information Technologies*, 21(1), 299-319.

Klock, A. C. T., Gasparini, I., Pimenta, M. S., & Hamari, J. (2020). Tailored gamification: A review of literature. International Journal of Human-Computer Studies, 144, 102495.

Knutas, A., Ikonen, J., Nikula, U., & Porras, J. (2019). Increasing collaborative communications in a programming course with gamification: A case study. *Computer Science Education, 29*(2–3), 205–227.

Koivisto, J., & Hamari, J. (2019). The rise of motivational information systems: A review of gamification research. International Journal of Information Management, 45, 191–210.

Kuo, Y. C., & Chuang, H. H. (2016). Gamification and student motivation: A case study of Microsoft certification courses. *International Journal of Technology and Human Interaction, 12*(1), 1–14.

Landers, R. N., & Callan, R. C. (2014). Casual social games as serious games: The psychology of gamification in undergraduate education and employee training. In Serious games and edutainment applications (pp. 399-423). Springer, Cham.

Lantano, R., & Paredes, C. (2020). Teacher training and instructional methods in computer science education. Davao del Norte State College.

Li, X., & Zhang, L. (2022). Computational Thinking Skills in K12 Programming Education: Fostering Systematic Problem-Solving Approaches. Journal of STEM Education, 7(3), 112-125.

Liu, M., & Chen, X. (2021). The Impact of Interactive Elements on Student Engagement and Learning Outcomes in Educational Technology: A Meta-Analysis. *Journal of Computer Assisted Learning*, 37(3), 610-619.

Mekler, E. D., Brühlmann, F., Tuch, A. N., & Opwis, K. (2017). Towards understanding the effects of individual gamification elements on intrinsic motivation and performance. *Computers in Human Behavior, 71*, 525–534.

Mora, A., Riera, D., González, C., & Arnedo-Moreno, J. (2017). Gamification: A systematic review of design frameworks. Journal of Computing in Higher Education, 29(3), 516–548.

Morschheuser, B., Hamari, J., & Koivisto, J. (2017). Gamified crowdsourcing: Conceptualization, literature review, and future agenda. International Journal of Human-Computer Studies, 106, 26-43.

Murdock, J. L., & Keller-Mathers, S. D. (2008). The Torrance incubation model of teaching: A framework for teaching and learning. Journal of Creative Behavior, 42(3), 151-171.

Nacke, L. E., & Deterding, S. (2017). The maturing of gamification research.

Computers in Human Behavior, 71, 450–454.

Nacke, L. E., Bateman, C., & Mandryk, R. L. (2014). BrainHex: A neurobiological gamer typology survey. Entertainment Computing, 5(1), 55-62.

Nicholson, S. (2015). A RECIPE for meaningful gamification. In Gamification in education and business (pp. 1-20).

Olipas, C. N. (2022). A Phenomenological Study on the Feelings, Challenges and Difficulties Experienced by Information Technology Students in Learning Computer Programming. Traektoriâ Nauki = Path of Science, 8(7), 2001-2006.

Queirós, R. (2014). Innovative Teaching Strategies and New Learning Paradigms in Computer Programming. IGI Global. Retrieved from https://www.igi-global.com/book/innovative-teaching-strategies-new-learning/112202

Radošević, D., Dejanović, I., & Seljan, S. (2016). Gamification in e-learning: Introducing gamified design elements into e-learning systems. In Proceedings of the 39th International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO) (pp. 791–796). IEEE.

Reyes, J., & Garcia, A. (2019). Student Perceptions of Programming Education in the Philippines. International Journal of Computer Science Education, 6(2), 112-125.

Rivera, A., & Salazar, M. (2019). Curriculum alignment with industry standards in Mindanao's computer programming education. University of Southeastern Philippines.

Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. Contemporary Educational Psychology, 25(1), 54-67.

Smith, A., & Johnson, B. (2021). Gamification in Computer Programming Education: A Review of Coding Game Platforms. Journal of Educational Technology, 20(3), 112-125.

Smith, A., & Jones, B. (2018). "Challenges of traditional lecture-based methods in teaching computer programming." Journal of Computer Science Education, 20(2), 145-160.

Smith, B., & Brown, L. (2019). Effects of gamification on student learning outcomes: A meta-analysis. Educational Psychology Review, 31(4), 825-841.

Strmečki, D., Bernik, A., & Radošević, D. (2016). Gamification in E-Learning: Introducing Gamified Design Elements into E-Learning Systems.

Journal of Computer Sciences.

Surendeleg, G., Chen, K., & Zheng, W. (2019). Impact of gamification on active learning in higher education: A systematic review. *Educational Technology & Society, 22*(2), 28-40.

Tan, A., & Lim, K. (2018). Challenges in Computer Programming Education: A Review of Literature. Journal of Educational Technology Research, 20(3), 45-58.

Tan, M., Hew, K. F., & Koh, E. (2022). The effects of gamification on student motivation and engagement: A meta-analysis. *Educational Psychology Review, 34*, 1–30.

Tan, M., Hew, K. F., & Koh, E. (2023). Exploring flow and cognitive engagement in immersive gamified learning environments. *British Journal of Educational Technology, 54*(2), 213–230.

Toda, A. M., Valle, P. H. M., & Isotani, S. (2019). The dark side of gamification: An overview of negative effects of gamification in education. Communications in Computer and Information Science, 1001, 143–156.

Tondello, G. F., Wehbe, R. R., Orji, R., & Nacke, L. E. (2016). Effects of context and player motivation on game experience. *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play*, 317–329.

Tsai, C. C., & Tsai, M. J. (2019). Students' Attitudes, Self-efficacy, and Learning Outcomes in Online Learning. *Interactive Learning Environments*, 27(7), 1001-1015

Tuazon, IM.Q. (2019). Implementation of DepEd Computerization Program (DCP) for the Indigenous People. Surigao Del Sur State University.

Van Nuland, S. E., Roach, V. A., Wilson, T. D., & Belliveau, D. J. (2014). Head to head: the role of academic competition in undergraduate anatomical education. Anatomical Sciences Education, 8, 404–412.

Venkatesh, V., & Bala, H. (2008). Technology Acceptance Model 3 and a Research Agenda on Interventions. *Decision Sciences*, 39(2), 273-315.

Xi, N., & Hamari, J. (2021). Enhancing user engagement: The role of gamification in mobile apps. Journal of Business Research, 132, 170–185.

Zainuddin, Z., Chu, S. K. W., Shujahat, M., & Perera, C. J. (2022). The effectiveness of gamification in programming education: Evidence from a meta-analysis. Computers and Education: Artificial Intelligence, 3, 100067.