Information Management and Business Review (ISSN 2220-3796)
Vol. 18, No. 3, pp. 31-36, 2026

EcoTacToe Digital Gamification In Education: A Cross-Sectional Study

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Abstract: Econometrics is a discipline requiring considerable mathematical competence and sophisticated analytical ability, yet standard teaching approaches may not always provide the necessary engagement for effective learning. Digital gamification is a new instructional style that bridges this gap. This study explores students' perceptions of EcoTacToe, a digital gamification application similar to the game of TicTacToe, designed to enhance Econometrics teaching in terms of competition and interaction. A quantitative cross-sectional methodology was employed to recruit 86 undergraduate students from a Malaysian public university. A systematic self-administered questionnaire measuring five dimensions: personal traits, acceptance, utility, enjoyment and user-friendliness was used to collect data. Reliability analyzes confirmed internal consistency for all constructs, with coefficients ranging from α = .75 (Good) to α = .93 (Excellent). Descriptive analyzes revealed predominantly positive appraisals across all variables, with enjoyment reaching the highest average, followed by simplicity of use and utility. Independent samples t-tests indicated no significant differences between male and female students on any dimension. The findings demonstrate that EcoTacToe is an effective blend of competitive gaming with the distribution of Econometrics material, and a practical addition to regular classroom education.

Keywords: *Digital Gamification, Econometrics Education, App-Based Learning, Higher Education, Malaysia, Technology Acceptance Model*

1. Introduction and Background

Econometrics is important to quantitative analysis in business and economics courses, including the statistical tools needed for empirical research and the analysis of applicable data. The quantitative nature of the subject makes it especially difficult for many undergraduates and standard lecture-based teaching approaches have always failed to motivate students and to help them to apply what they have learned (Deterding et al., 2011; Zeng et al., 2024). This has led to universities and colleges exploring innovative teaching methods that involve hands-on experience.

The word "gamification" – the use of game concepts in a non-gaming context – has recently become popular (Deterding et al., 2011). Gamification, which involves injecting competitive elements, instant feedback, and goal-setting structures into the learning atmosphere, has been found to enhance motivation, engagement, and recall of material in many educational situations (Zeng et al., 2024; Gyedu et al., 2026). This is not just the case for general education but also analytically heavy subjects such as statistics, supply chain management and logistics education, as demonstrated in recent studies (Jack et al., 2025; Sundram et al., 2025; Kasdi et al., 2025).

EcoTacToe is a mobile app game based on the TicTacToe format, serving as a fun tool for learning Econometrics. The game puts difficult econometrics concepts into grid placements, gamifying otherwise ethereal quantitative concepts. It has been implemented in schools, but we have little data on how it has helped kids learn or how students have responded.

This study is based on five thematic constructs namely, personal traits, acceptability, utility, enjoyment and ease of use. These constructs are intended to measure students' perceptions of EcoTacToe. This study contributes to the increasing body of literature on digital gamification to enhance quantitative education in

Malaysian universities. This study is based on the Technology Acceptance Model (TAM) framework (Davis, 1989) and accepted personality traits (Costa & McCrae, 1992).

2. Literature Review

Around the world, education systems are under increasing pressure to make sure that graduates are equipped with the analytical and problem-solving abilities that modern economies demand, as well as theoretical knowledge. Malaysia's national policy frameworks place importance on producing highly trained graduates to satisfy the needs of Industry 4.0. This only highlights the need for new, hands-on approaches to learn mathematical subjects even more.

In the last few years, gamification has been one of the most studied new methods of teaching. Zeng et al. (2024) compiled results of 22 experimental investigations from 2008 to 2023 and concluded that gamification had a positive and significant influence on students' academic performance compared to non-gamified environments. These findings are corroborated by the meta-analysis by Gyedu et al. (2026) on higher education contexts which found gamification to be beneficial for student engagement as well as deep learning outcomes. All these data show that gamification is not only a means to increase motivation but a real element influencing the quality of learning.

In quantitative disciplines — where student disengagement is a recurring challenge — gamification has demonstrated particular promise. Jack et al. (2025) investigated the integration of gamified elements in a flipped statistics classroom and found that gamification significantly elevated pre-lecture engagement rates and was associated with improved academic grades. These findings suggest that gamified elements can meaningfully raise engagement in subjects that students often perceive as difficult or demotivating, a challenge directly analogous to the Econometrics context of the present study (Senawi & Harun, 2025).

The studies on gamification at Malaysian institutions have increased in recent years with a focus on the management and business courses. Hoo et al. (2024) explored the use of card games and board games for teaching supply chain management principles in Malaysian universities. The results indicated that the two game styles were excellent for students' involvement and learning outcomes. Following this work, Sundram et al. (2025) explored game-based approaches for the teaching of supply chain management and found uniformly positive effects on student motivation and course participation. Kasdi et al. (2025) conducted a quasi-experimental study to investigate the analog game Logispreneur 101 for logistics education. They found that the competitive characteristics, collaborative nature, and decision-making tasks of the game had a significant impact on the enjoyment and perceived learning of students. To summarize, the research supports the notion that gamification might be beneficial in the analytically challenging domains of business education in Malaysia.

The dominant theoretical model for assessing students' acceptance of instructional technology is the Technology Acceptance Model (TAM), initially proposed by Davis (1989). TAM says the two most essential variables that determine whether technology is accepted and employed are usefulness of the technology and ease of use. As hedonic experiences are important in long-term technology adoption, particularly in gamified learning contexts, Venkatesh (2000) extended this framework to incorporate intrinsic drive and subjective enjoyment as additional determinants.

Personality traits have been shown to be important mediators of gamification acceptance as well. According to the model of personality traits, the Big Five (Costa and McCrae, 1992), openness to experience and the wish to acquire new information are closely related to the person's willingness to embrace new educational technologies. The five-construct model of this study is theoretically sound, founded in the TAM framework and the personality trait theory.

While there is an increasing number of studies on gamification, the application of digital gamification in the teaching of econometrics remains underexplored, especially in the Southeast Asian educational context. This research is a direct answer to the requirement for the first comprehensive empirical assessment of EcoTacToe's educational reception.

3. Research Methodology

This study aimed to evaluate EcoTacToe, a digital gamification tool for teaching Econometrics, from the students' point of view through a quantitative correlational research approach. The target population comprised three classes of undergraduates taking Econometrics at the same public university in Malaysia. Respondents were selected via non-probability purposive sampling, where the respondents were already exposed to the EcoTacToe app in the classroom.

Primary data were collected using structured self-administered questionnaires with five-point Likert scales. According to Zikmund et al. (2000), the Likert scale is a reliable measure of people's openness to a topic. One was for strongly disagree, two was for disagree, three was neutral, four was for agree and five was for strongly agree. We got 86 relevant replies. The nineteen items in the questionnaire were organized into five theme constructs, which are listed in Table 1.

Table 1: Thematic Constructs Analysis.

Constructs	Items	Measure
Personal Traits	3	Openness to adventure and new learning experiences
Acceptance	4	Perceived advantages of the EcoTacToe app game versus conventional instruction
Usefulness	6	Impact of EcoTacToe on Econometrics understanding, learning efficiency, and academic productivity
Enjoyment	3	Entertainment and fun aspects of EcoTacToe gameplay
Ease of Use	3	Interface clarity, gameplay rules, and usability

The structures were modified according to the existing theoretical frameworks. We have employed Personal Traits, Usefulness and Acceptance constructs of Costa and McCrae (1992), Ease of Use and Davis (1989), and the Enjoyment construct of Venkatesh (2000). SPSS was used to conduct descriptive statistics, internal consistency analysis (Cronbach's Alpha) and t-tests for independent samples to test for differences in perception by gender.

4. Results

All examined constructs were perceived positively based on data analysis from 86 undergraduates who participated in the EcoTacToe gamification intervention. Table 2 provides the demographic characteristics of the participants.

Table 2: The Respondents' Demographic Profiles.

No.	Categories of Demographic Variables	Frequencies	%
1.	**Gender**		
	Male	34	39.5
	Female	52	60.5
2.	**Age**		
	20 – 22	14	16.3
	23 – 25	70	81.4
	26 – 28	1	1.2
	32 or older	1	1.2

The reliability test was conducted on the variables to determine the internal consistency of the constructs. The measurement scale by Zikmund et al. (2000) was employed in this study, which states: Reliability is Excellent when $\alpha < 1.0$, Very Good when $\alpha < 0.89$, Good when $\alpha < 0.70$, Fair when $\alpha < 0.69$, and Poor when $\alpha < 0.60$. Table 3 shows the Cronbach's Alpha of each construct.

Table 3: Cronbach's Alpha and Reliability Analyses.

Variables	Items	Cronbach's Alpha	Indicator
Usefulness	6	.93	Excellent Reliability
Enjoyment	3	.90	Very Good Reliability
Ease of Use	3	.88	Very Good Reliability
Acceptance	4	.87	Very Good Reliability
Personal Traits	3	.75	Good Reliability

Reliability evaluations indicate that all constructs have Cronbach's Alpha between .93 (Excellent) and .75 (Good), which is an indication of appropriate internal consistency and stability of measurement. All constructs are above the minimum acceptable requirement of .70; the measurements are dependable and suitable for further inferential investigations.

Table 4 presents the mean values and standard deviations of each construct in descending order.

Table 4: Descriptive Statistics of Constructs.

Variables	Mean	Standard Deviations
Enjoyment	4.10	0.61
Ease of Use	4.09	0.61
Usefulness	4.08	0.61
Personal Traits	4.03	0.53
Acceptance	3.94	0.62

The descriptive analyzes indicated that four of the five constructs had means over 4.00, which demonstrates that the students' attitudes toward EcoTacToe were highly positive. Learning econometrics was really fun and motivating with the competitive TicTacToe-format games, as indicated by the highest mean (M = 4.10, SD = 0.61) for enjoyment. Ease of Use (M = 4.09, SD = 0.61) was second place, and it showed that students considered the rules of gameplay to be easy, the interface of the program was clear, and the program was easy to use. Usefulness (M = 4.08, SD = 0.61) was the third most important factor. This showed that respondents considered EcoTacToe as a beneficial instrument for mastering the fundamentals of econometrics, increasing academic productivity and improving learning efficiency. Personal Traits had a mean of 4.03 (SD = 0.53) suggesting that gamified learning was a good fit with the sample's adventure-seeking orientation and openness to new experiences . Acceptance was the lowest-ranked idea, but it was positive (3.94; SD = 0.62) indicating that students generally perceived the benefits of interactive app games instead of traditional teaching techniques.

Gender based differences in perception for each idea were tested by independent-samples t-tests. Results indicated a non-significant difference was found between male and female students in all dimensions ($p > .05$). Specific results are enjoyment [$t(84) = -0.924$, $p = .358$], ease of use [$t(84) = 0.108$, $p = .914$], usefulness [$t(84) = -1.051$, $p = .296$], personal traits [$t(84) = 0.886$, $p = .378$], and acceptability [$t(84) = 0.224$, $p = .823$]. EcoTacToe was equally enjoyable, practical and accessible for male and female pupils.

5. Discussion and Recommendations

The results of the current research validate EcoTacToe as an effective digital gamification tool for Econometrics instruction, since students always show positive perceptions in all five measured categories. These findings are consistent with the extensive research on gamification which has demonstrated that well-designed game-based learning aids can improve students' engagement and motivation in higher education (Zeng et al., 2024; Senawi et al., 2025, Gyedu et al., 2026).

It is particularly important that enjoyment (M = 4.10) is the highest-rated concept. This lends support to the claim made by Venkatesh (2000) that perceived enjoyment is an important antecedent of technology adoption, especially for applications where user satisfaction is a driving factor. Competitive EcoTacToe, in which students answer econometrics questions to "own" grid positions, seems to tap into innate motivation via goal-oriented competition and challenge. This finding is consistent with Jack et al. (2025) who found that gamified features in a statistics course led to prolonged engagement since they made the learning process fun rather than tedious.

The high ranking for ease of use (M = 4.09) highlights a basic design guideline for the adoption of instructional technology: complexity is a disincentive. The students' perception that the UI was intuitive, the rules of the game were clear and the program was generally accessible supports Davis's (1989) TAM premise that perceived ease of use is a significant factor in technology acceptance. EcoTacToe's easy TicTacToe gameplay seems like a plus over the more complex simulation-based platforms. This reduces the cognitive threshold to participate, and enables students to concentrate on the econometrics subject, not on how to navigate the site.

The usefulness of EcoTacToe (M = 4.08) is a sign that students believe that it has a substantial contribution to their Econometrics learning goals. This is particularly remarkable as Econometrics normally requires knowledge of arcane statistical methods, regression analysis, and hypothesis testing. Students also commented that the game helped in understanding these concepts . Thus, the question and answer gameplay mechanisms were able to operationalize knowledge from the course in a way that was accessible and helped with retention. This finding is consistent with the findings of Sundram et al. (2025) and Kasdi et al. (2025) who found that gamified tools with discipline-specific content yielded perceived utility in supply chain management education, an analytically comparable field.

Although the acceptance construct (M = 3.94) had the lowest mean score among the five constructs, it was still above the scale midpoint of 3.00, indicating a positive disposition. This construct examines the perceived pros of EcoTacToe compared to normal education. This result reveals that although students favor gamified approaches in general, a minority of them still appreciate traditional instructional elements. This outcome is not surprising considering 96.5% of the sample had previous experience with instructional games and 75.6% played just sometimes. Therefore, for most responders gamification is a secondary, not a primary, form of learning. Over time, consistent and prolonged use of gamified learning technologies may increase adoption.

The lack of statistically significant gender differences across all dimensions ($p > .05$) is consistent with the results of similar gamification investigations (Kasdi et al., 2025; Hoo et al., 2024). This corroborates that EcoTacToe is an educational tool that is appropriate for varied classroom groups because it attracts a wide student demography irrespective of gender.

This work has many limitations that should guide future research directions. The cross-sectional design does not allow us to conclude on long-term engagement trajectories or sustained academic success as it gathers perceptions at one point in time. Secondly, the intentional sampling from one public institution limits the generalizability of the findings to other student demographics and institutional situations. For example, the demography of students and the educational culture present in private colleges may be different from that of public universities, hence, perceptions of gamified tools may also differ. Also, future research should use longitudinal designs and widen the sample to multiple universities to boost external validity. Further strengthening the evidence base would include experimental or quasi-experimental designs that clearly compare EcoTacToe to traditional training on assessed academic outcomes.

However, this study provides a relevant and scientifically substantiated assessment of digital gamification in the domain of economics education. The combined good perceptions of all five dimensions and the non-existence of gender differences strongly justify the use of EcoTacToe as a supplement to traditional Econometrics teaching.. EcoTacToe would be an attractive proposition for educators and institutions looking to augment their curricula with pedagogically sound, interesting and accessible tools. Well-designed digital gamification tools like EcoTacToe can be innovative tools for bridging the divide between traditional classroom education and the interactive, practical learning experiences that are demanded by today's undergraduate students.

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