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Play to Place Physical Gameboard as Learning Tools of Engagement and Collaboration Towards Learning Outcomes

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ABSTRACT

Gamification offers new possibilities for architectural education by transforming site analysis from a passive, descriptive task into an active and collaborative learning experience. Traditional approaches often limit engagement and critical interpretation, whereas gamified methods can sustain motivation, usability, and peer collaboration while linking site data to meaningful learning outcomes. This study examines the Play to Place Physical Gameboards – Seri Iskandar (P2P–SI) module, designed to integrate local cultural narratives, tangible play mechanics, and storytelling into site exploration. Grounded in constructivist and experiential learning traditions and supported by gamification theory, the research focused on three dimensions: engagement and usability, social and collaborative impacts, and learning outcomes. The module was implemented with 101 second-year architecture students at Universiti Teknologi MARA, Perak Branch, during site analysis exercises. Data were collected through a structured questionnaire and analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM) to test the relationships between the three dimensions. The results show that engagement and usability directly influenced learning outcomes and strongly shaped social and collaborative impacts, while collaboration in turn enhanced learning outcomes. Students highlighted that clear rules, intuitive play, and immediate feedback supported sustained engagement, while collaborative play improved communication, teamwork, and shared site interpretation. These findings demonstrate that embedding usability and collaboration within gamified tools can produce stronger outcomes, including spatial reasoning, cultural understanding, and reflective thinking. The study positions P2P–SI as a student-centred and culturally relevant pedagogical innovation that bridges technical knowledge with social and reflective dimensions of architectural design education.

Keywords: *Architecture gamification, learning engagement, learning outcome, collaborative learning, site-based pedagogy*

1 INTRODUCTION

1.1 Background of Study

Site analysis is a critical stage in architectural education, shaping how students interpret spatial, cultural, and environmental contexts before design begins. Traditional methods such as lectures, guided tours, and inventories often reduce learners to passive observers, limiting active engagement and deeper connections with site data (Hilhorst, 2021). To address this, gamification has emerged as an innovative approach to increase motivation, usability, and collaboration, linking abstract knowledge with meaningful outcomes. The Play to Place Physical Gameboards (P2P–SI) module demonstrates this by combining board game mechanics with local cultural narratives, transforming site exploration into an interactive, student-centred process. Grounded in experiential learning theory (Kolb, 1984) and constructivist principles (Vygotsky, 1978), it encourages learning through doing and co-construction of knowledge. Structured play enhances retention, teamwork, and problem-solving as students negotiate meaning and co-create richer interpretations (Schnabel, Lo, & Aydin, 2014; Redondo et al., 2020). Engagement and usability remain central; clear rules, intuitive design, and feedback sustain focus and motivation (Deterding et al., 2011; Toda et al., 2019; El-Zeini, 2024). By embedding collaboration, engagement, and usability, P2P–SI fosters spatial reasoning, cultural understanding, and critical reflection (Ortiz-Rojas et al., 2025), while its integration of Malaysian handicraft aesthetics enhances inclusivity and contextual relevance (Mohd Nadzamuddin et al., 2025)

1.2 Problem Statement

In architectural education, site analysis is often reduced to a procedural task rather than a transformative learning experience. Conventional methods such as lectures, guided visits, and manual inventories position students as passive observers, limiting opportunities for engagement, collaboration, and critical interpretation of site data (Hilhorst, 2021). Gamification has emerged as a promising alternative, showing potential for enhancing motivation, contextual awareness, and teamwork (Schnabel et al. 2014; Redondo et al., 2020). However, challenges remain. Social and collaborative dimensions are often underdeveloped, with poorly structured mechanics or competitive biases restricting deeper peer interaction and shared meaning-making (El Mehelmy & El-Zeini, 2024). Engagement and usability also vary, as complex rules, unclear objectives, or culturally irrelevant designs can frustrate learners (Goli et al., 2022). Moreover, the connection between engagement and long-term learning outcomes such as spatial reasoning, cultural understanding, and critical reflection remains underexplored in Southeast Asian architectural contexts (Eltahir, Zulkifli, & Samad, 2023). In Malaysia, while gamified tools show promise, concerns persist regarding their cultural adaptation and effectiveness in studio-based learning. This study, therefore, examines the Play to Place Physical Gameboards – Seri Iskandar (P2P–SI) through three key questions:

1. What are the perceptions of architecture students regarding the engagement and usability of the Play to Place Physical Gameboards (P2P–SI) in the context of site analysis activities?
2. How effectively does the gameboard promote social and collaborative interactions among learners in a studio-based environment?
3. How do engagement, usability, and collaboration contribute to meaningful learning outcomes?

1.3 Literature Review

1.3.1 Gamified Learning in Architectural Education

Gamification in architectural education relies on constructivist and experiential learning theories, transforming passive students into active co-constructors of knowledge (Kolb, 1984; Vygotsky, 1978). By embedding site data into playful mechanics, game-based approaches shift site analysis from routine description to an active, social, and reflective process, enhancing motivation and contextual understanding (Schnabel et al. 2014; Redondo et al. 2020). Within the Malaysian higher education context, Saad and Mansor (2024) found that gamification revitalises static learning materials, significantly boosting student engagement. Furthermore, embedding local cultural narratives sustains learner interest while preserving heritage. Aligning with these findings, the P2P–SI module integrates Malaysian aesthetics, transitioning site analysis into a culturally resonant, collaborative, and highly engaging academic pursuit.

1.3.2 Social and Collaborative Impact

Collaboration is a cornerstone of architectural practice, and gamified environments provide structured opportunities for teamwork and peer learning. Studies confirm that collaborative play in design studios fosters co-created site interpretations, active participation, and mutual reflection (El Mehelmy & El-Zeini, 2024; Redondo et al., 2020). Within the developing collaborative pedagogy of Malaysian education, Yuhaniz et al. (2018) found that board game modules in architecture classes significantly heighten peer collaboration and critical thinking. Aligning with these findings, tools like the Play to Place Physical Gameboards offer a culturally resonant medium for peer-to-peer interaction. This enables learners to connect site data with cultural narratives, effectively operationalising the Community of Inquiry (CoI) framework to create meaningful, shared learning (Swan et al. 2009).

1.3.3 Engagement and Usability

While collaboration is vital, learning outcomes strongly depend on whether gamified tools are engaging and user-friendly. Usability ensures learners navigate mechanics without confusion, focusing on site data interpretation rather than struggling with gameplay (Deterding et al., 2011; Toda et al., 2019). Clear mechanics, intuitive design, and immediate feedback are key to sustaining this engagement (El-Zeini, 2024). Highlighting this in the Malaysian context, Azhar and Che Din (2025) emphasise that well-structured, user-centric gamification strategies are essential to bridge passive observation with active, consistent participation. Conversely, inadequately organised or culturally irrelevant mechanics can frustrate learners and diminish educational effectiveness (Goli et al., 2022). Consequently, engagement and usability serve as crucial intermediaries, determining the extent to which collaborative play yields significant learning outcomes.

1.3.4 Towards Learning Outcomes

The primary goal of incorporating gamified methods into site analysis is to enhance educational outcomes, especially in spatial reasoning, cultural awareness, and critical design thinking. The EDUGAME4CITY project demonstrated the effectiveness of gamification in enhancing students' ability to link abstract urban data to design choices (Redondo et al., 2020). Similarly, Ortiz-Rojas et al. (2025) found that gamification enhanced autonomy, competence, and relatedness, consistent with Self-Determination Theory (SDT), and promoted greater engagement in learning.

The Play to Place Physical Gameboards (P2P–SI) module addresses this by embedding local landmarks, storytelling, and cultural aesthetics into its mechanics, thereby linking cultural inclusivity with educational outcomes (Mohd Nadzamuddin et al., 2025). This demonstrates how thoughtful integration of social collaboration, engagement, and usability can elevate site analysis from a procedural task into a transformative learning experience.

Gamification in architectural site analysis offers a shift from passive data collection toward active, participatory, and culturally relevant learning. The Play to Place Physical Gameboards (P2P–SI) module demonstrates how social and collaborative impacts, combined with engagement and usability, can generate stronger learning outcomes. These outcomes extend beyond technical knowledge to include spatial reasoning, cultural awareness, reflective thinking, and teamwork. Figure 1 shows the proposed conceptual framework of P2P-SI, which illustrates the relationship of Social and Collaborative Impacts (SC), Engagement and Usability (EU) and Learning Outcomes (LO), summarising the central focus of this study, positioning gamified tools as powerful approaches to enrich architectural pedagogy through integration of cultural, social, and reflective dimensions.

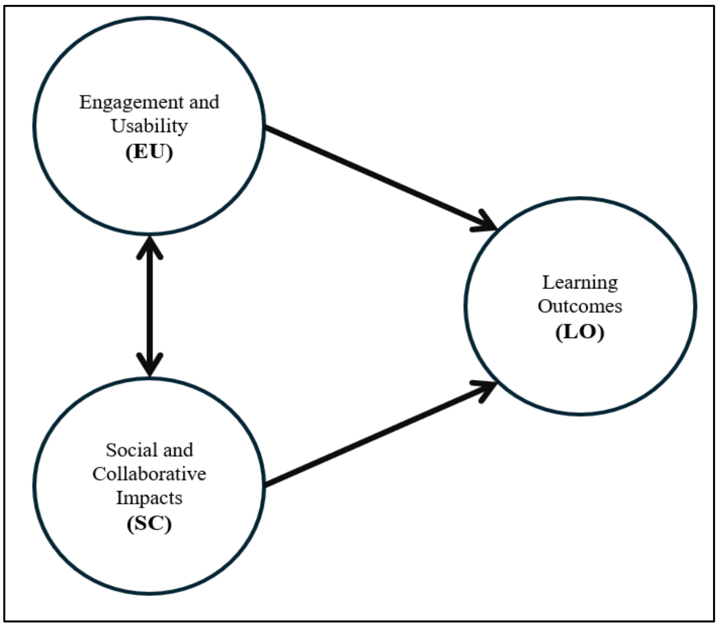

Figure 1 Proposed Conceptual Framework of Play to Place Physical Gameboard as Learning Tools of Engagement and Collaboration Towards Learning Outcomes
(Source: author)

1. METHODOLOGY

2.1 Research Design

This study utilised a quantitative research design, specifically employing Partial Least Squares Structural Equation Modelling (PLS-SEM), to investigate the relationships between Engagement and Usability (EU), Social and Collaborative Impact (SC), and Learning Outcomes (LO) within the framework of the Play to Place physical gameboard. PLS-SEM was chosen for its appropriateness in analysing models that include latent constructs, its capability to manage smaller sample sizes, and its focus on research that prioritises prediction (Hair, Hult, Ringle, & Sarstedt, 2017).

2.2 Population and Sampling

The participants in this study were students engaged with the Play to Place physical gameboard during their educational activities. A purposive sampling technique was employed to focus on 101 second-year undergraduate architecture students who had firsthand experience utilising the gameboard during their site exploration task. The final sample size was established in accordance with the minimum requirements for PLS-SEM analysis, adhering to the "10-times rule" (Hair et al., 2019) and validated through power analysis to guarantee adequate statistical power for identifying medium to large effect sizes (Cohen, 1988).

2.3 Research Instrument

The measurement tool utilised was a structured questionnaire aimed at gathering participants' perceptions of:

1. Engagement and Usability (EU): assessed using four (4) reflective indicators.
2. Learning Outcomes (LO): assessed via three (3) reflective indicators
3. Social and Collaborative Impact (SC): evaluated using two (2) reflective indicators.

A five-point Likert scale (1 = strongly disagree, 5 = strongly agree) was employed to assess responses.

2.4 Data Collection Procedure

Data collection occurred during the 10th week of the semester, following the introduction of the Play to Place gameboard in the design studio hours during the 3rd week. The students received an overview of the goals of the learning task prior to commencing their work. The questionnaire survey has been disseminated to the students via Google Form. Figure 2 illustrates the structure of the module and its innovation and operation compared to conventional learning tasks.

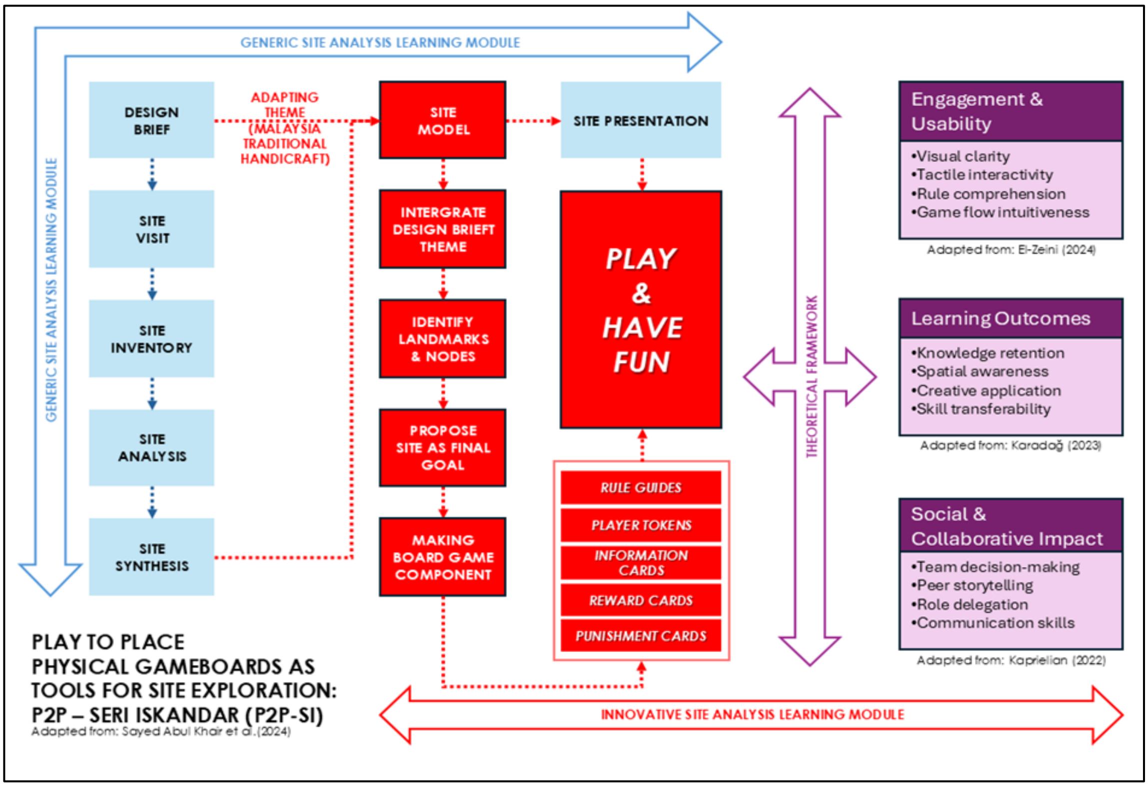

Figure 2 Play to Place Physical Gameboards as Tools for Site Exploration: P2P - Seri Iskandar (P2P-SI) framework
(Source: Mohd Nadzamuddin et al., 2025)

2.5 Data Analysis Technique

Data analysis followed a two-step approach in PLS-SEM:
The Measurement Model Assessment stage involved evaluating the following aspects:

1. Indicator Reliability: standardised loadings were examined, with values above 0.708 considered acceptable.
2. Internal Consistency Reliability: assessed using Cronbach's alpha and Composite Reliability (CR), with thresholds of 0.70 for acceptable reliability and >0.90 for excellent reliability (Nunnally & Bernstein, 1994; Hair et al., 2022).
3. Convergent Validity: evaluated through the Average Variance Extracted (AVE), where values greater than 0.50 were deemed adequate (Fornell & Larcker, 1981).
4. Construct Validity: examined using the Standardised Root Mean Square Residual (SRMR), d_ULS, d_G, Chi-square, and Normed Fit Index (NFI) to confirm overall model fit.
5. Collinearity Assessment: Variance Inflation Factor (VIF) values were checked to ensure the absence of multicollinearity, with thresholds of <5 (Diamantopoulos & Siguaw, 2006).

Structural Model Assessment – This stage tested the hypothesised relationships among EU, SC, and LO. Path coefficients (β), t-statistics, p-values, and confidence intervals were obtained using bootstrapping with 5,000 resamples (Hair et al., 2017). Significance was evaluated at both 5% and 1% levels using two-tailed tests. Effect sizes were interpreted using Cohen's (1988) guidelines (0.10 = small, 0.30 = moderate, 0.50 = strong).

3 RESULT AND DISCUSSION

3.1 Indicator Reliability

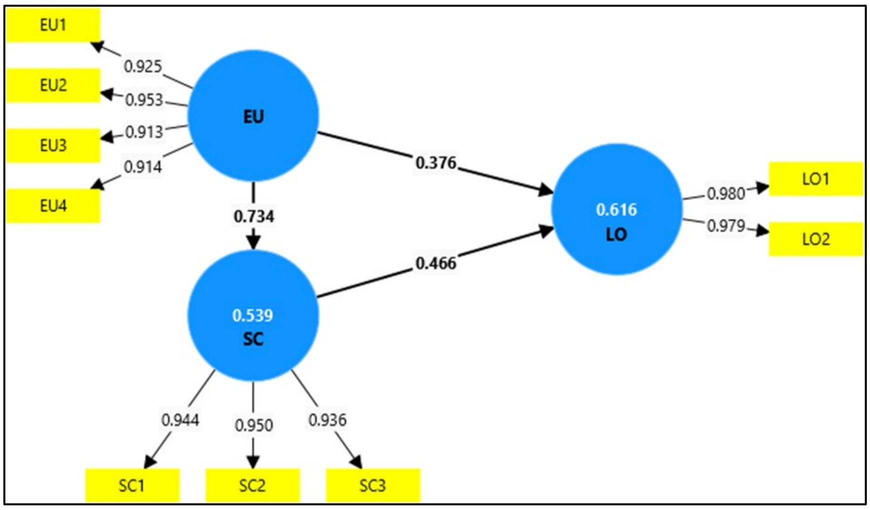

Figure 3 Measurement Model of Play to Place Physical Gameboard as Learning Tools of Engagement and Collaboration Towards Learning Outcomes

The findings presented in Table 1 indicate that every measurement item in this study meets or surpasses the suggested loading threshold. Indicators for Engagement and Usability (EU) varied from 0.913 to 0.953, indicators for Learning Outcomes (LO) were measured at 0.979 and 0.980, and indicators for Social and Collaborative Impact (SC) fell between 0.936 and 0.950. The results indicate that each indicator effectively reflects its corresponding latent construct, thus affirming a high level of reliability throughout the model.

The findings are consistent with earlier methodological guidelines that emphasise the importance of robust loadings to ensure construct validity in PLS-SEM models (Chin, 1998; Hair et al., 2019). Furthermore, the consistently high loadings noted in this analysis surpass the minimum threshold, demonstrating that the indicators are both reliable and significantly meaningful in reflecting the underlying constructs. This result enhances the reliability of the measurement model and guarantees that future evaluations of construct reliability, validity, and structural relationships are based on dependable indicators.

Table 1 Results of Indicator Loadings for the Measurement Model

Items/Constructs	EU	LO	SC
EU1	0.925		
EU2	0.953		
EU3	0.913		
EU4	0.914		
LO1		0.980	
LO2		0.979	
SC1			0.944
SC2			0.950
SC3			0.936

3.2 Internal Consistency (Composite Reliability) and Convergent Validity (AVE)

Table 2 indicates that all constructs in this study surpass the suggested thresholds for both Cronbach's alpha and CR. Engagement and Usability (EU) demonstrated a Cronbach's alpha of 0.945 and a CR of 0.960. Learning Outcomes (LO) achieved scores of 0.957 and 0.979, whereas Social and Collaborative Impact (SC) recorded values of 0.938 and 0.960. The findings demonstrate that the items reliably assess their respective constructs, offering robust support for internal consistency reliability. The results indicate AVE values of 0.858 for EU, 0.959 for LO, and 0.890 for SC. The findings provide robust evidence of convergent validity, demonstrating that each construct accounts for a significant amount of indicator variance beyond the influence of measurement error.

The findings collectively indicate that the constructs examined in this study show strong internal consistency and convergent validity. This enhances assurance in the measurement model and establishes a robust basis for assessing structural relationships. The results align with earlier suggestions in the PLS-SEM literature, indicating that assessments of reliability and validity are essential for a significant evaluation of the structural model (Hair et al., 2019; Sarstedt, Ringle, & Hair, 2020).

Table 2 Internal Consistency Reliability

	Cronbach's Alpha	Composite Reliability (rho_a)	Composite Reliability (rho_c)	Average Variance extracted (AVE)
EU	0.945	0.948	0.960	0.858
LO	0.957	0.958	0.979	0.959
SC	0.938	0.938	0.960	0.890

3.3 Construct Validity (Assessment of Goodness of Fit, GOF)

The findings presented in Table 3 indicate that the VIF values for the constructs examined in this study fall within the range of 1.000 to 2.171. Engagement and Usability (EU) documented a VIF

of 2.171, Learning Outcomes (LO) indicated 1.000, and Social and Collaborative Impact (SC) similarly noted 2.171. The values presented are significantly lower than the suggested cut-off points, indicating that there are no collinearity issues present in the structural model.
While values exceeding 0.90 are preferred, those near this threshold can still be deemed acceptable in PLS-SEM applications (Bentler & Bonett, 1980; Hair et al., 2022). This study presents an NFI value of 0.887, which, although slightly under the 0.90 threshold, suggests an adequate model fit considering the predictive focus of PLS-SEM. Ultimately, the reported Chi-square statistic (120.354) corresponds with expectations for intricate models, although in PLS-SEM, the interpretation of chi-square is approached with caution due to the method's lack of assumption regarding multivariate normality (Hair, Risher, Sarstedt, & Ringle, 2019).

Collectively, the GOF indices indicate that the measurement model shows robust construct validity. The extremely low SRMR and satisfactory values for d_ULS and d_G indicate that the model closely aligns with the empirical data. While the NFI is marginally under the optimal threshold, its closeness to 0.90, along with the predictive capabilities of PLS-SEM, reinforces the assertion that the model sufficiently aligns with the data. The findings correspond with contemporary suggestions that highlight a practical perspective on GOF in PLS-SEM, advocating for a focus on predictive accuracy and reliability instead of rigid compliance with CB-SEM standards (Henseler et al., 2016; Sarstedt, Ringle, & Hair, 2020).

Table 3 Construct Validity (Assessment of Goodness of Fit - GOF)

	Saturated model	Estimated model
SRMR	0.036	0.036
d_ULS	0.059	0.059
d_G	0.183	0.183
Chi-square	120.354	120.354
NFI	0.887	0.887

3.4 Assessment of Collinearity

The findings presented in Table 4 indicate that the VIF values for the constructs examined in this study fall within the range of 1.000 to 2.171. Engagement and Usability (EU) documented a VIF of 2.171, Learning Outcomes (LO) indicated 1.000, and Social and Collaborative Impact (SC) similarly noted 2.171. The values presented are significantly lower than the suggested cut-off points, indicating that there are no collinearity issues present in the structural model.

The absence of problematic collinearity reinforces the conclusion that the predictor constructs (EU and SC) account for variance in the dependent construct (LO) without redundancy. This reinforces the reliability of the estimated path coefficients and boosts confidence in the model's capacity to depict theoretically significant relationships. Furthermore, these findings are consistent with earlier methodological guidelines that highlight the importance of conducting regular collinearity assessments as a fundamental aspect of sound practice in PLS-SEM studies (Hair, Risher, Sarstedt, & Ringle, 2019; Sarstedt, Ringle, & Hair, 2020).

In conclusion, the results validate that collinearity does not distort the structural model, thereby guaranteeing that future assessments of path significance and effect sizes are both valid and reliable.

Table 4 Variance Inflation Construct (VIF) for Assessment of Collinearity

Construct/VIF Value	EU	LO	SC
EU		2.171	1.000
LO			
SC		2.171	

3.5 Assessment of Coefficients

The findings shown in Table 5 demonstrate that all three proposed relationships are statistically significant and align with the anticipated positive direction. Initially, the relationship between Engagement and Usability (EU) and Learning Outcomes (LO) demonstrated a moderate positive effect ($\beta = 0.376$, $t = 2.820$, $p = 0.005$, CI [0.142, 0.658]). This indicates that when learners view educational tools as more user-friendly, their academic results are notably improved. Second, the analysis of Engagement and Usability (EU) in relation to Social and Collaborative Impact (SC) demonstrated a significant positive correlation ($\beta = 0.734$, $t = 8.464$, $p < 0.001$, CI [0.539, 0.875]), highlighting that engagement and usability play a crucial role in enhancing collaborative behaviours among students. Ultimately, the relationship between Social and Collaborative Impact (SC) and Learning Outcomes (LO) showed a moderate positive effect ($\beta = 0.466$, $t = 3.352$, $p = 0.001$, CI [0.166, 0.711]), indicating that collaborative engagement among learners significantly enhances learning outcomes.

Table 5 Judgment of β

Step	Validity Type	Criteria	Acceptance Level
Significance and relevance of structural model	t-value	$P < 0.05$ $t > 1.96$ (Two tailed) $t > 1.645$ (One tailed) $P < 0.01$ $t > 2.58$ (Two tailed) $t > 2.33$ (One tailed)	Hair et al., (2017)
	Beta value (β)	0.10 – Small 0.30 – Moderate 0.50 – High	Cohen (1988)

3.6 Implication of Engagement, Usability, and Collaboration on Learning Outcomes

This study's findings offer strong empirical support that engagement and usability are crucial for improving learning outcomes, both directly and by affecting social and collaborative impact. The structural model reveals strong and significant path coefficients (EU → LO: $\beta = 0.376$, $p = .005$; EU → SC: $\beta = 0.734$, $p < .001$), indicating that students who perceived the Play to Place physical gameboard as engaging and user-friendly were more inclined to report meaningful learning experiences and demonstrate collaborative behaviours. The results support the current body of work, indicating that elements of gamification, including points, contextualised content, and storytelling, enhance intrinsic motivation and ongoing engagement, particularly when combined with well-defined mechanics and user-friendly design (Feng et al., 2025; Nguyen-Viet & Nguyen-Viet, 2023; Ismail et al., 2024). The robust indicator reliability and internal consistency values (all CR > .95) in this study reinforce the significance of these constructs in influencing learner outcomes.

The usability of the gameboard significantly diminished cognitive load, fostering a seamless learning atmosphere that maintained focus and promoted engagement. This is consistent with findings that prompt feedback, and well-organised interfaces enhance learner satisfaction and performance (Rey & Defensor, 2024; Jurgina et al., 2025). Through the integration of usability features into an engaging and culturally relevant gameboard, Play to Place established conditions that prioritised the learner, promoting deeper understanding and reducing disengagement (Fahlevi et al., 2024). The importance of the EU → SC relationship in the model further reinforces the claims made by Teo (2011) and Venkatesh and Davis (2000) that perceived ease of use and usefulness in educational technologies are strong predictors of user acceptance and collaborative behaviours.

This study further emphasises the importance of collaboration in enhancing learning outcomes, as evidenced by the findings (SC → LO: $\beta = 0.466$, $p = .001$). The findings align with the principles outlined in social interdependence theory (Johnson & Johnson, 2009), suggesting that collaboration among peers enhances the construction of shared meanings and promotes more profound cognitive involvement. Through organised team activities, students were motivated to engage in communication, negotiate site interpretations, and collaboratively build knowledge as essential components of architectural education. Additionally, the collaborative mechanics of the Play to Place module improved learners' sense of relatedness and engagement, consistent with recent studies indicating that cooperative gamification enhances attitudinal outcomes, social skills, and cognitive performance (Slamet & Meng, 2025; Dindar et al., 2021; Marinho et al., 2025).

The synthesis of quantitative data and theoretical frameworks indicates that the incorporation of engagement, usability, and collaboration within gamified tools has the potential to convert passive learning into dynamic, participatory experiences. In the realm of site analysis, where students are required to integrate spatial, cultural, and contextual data, these components are essential in promoting learning that transcends mere content absorption, fostering critical reflection and design reasoning. The Play to Place physical gameboard illustrates the intentional combination of game mechanics, accessible interfaces, and collaborative learning, which can enhance transferable skills like spatial reasoning, communication, and cultural sensitivity. This highlights the educational significance of gamified learning tools in architectural education and advocates for their wider implementation as drivers of transformative, student-focused learning.

4 CONCLUSION

The findings of this study show that engagement and usability (EU) and social and collaborative impacts (SC) play a significant role in shaping learning outcomes (LO) in architectural site analysis through the Play to Place Physical Gameboards (P2P–SI). EU directly enhanced LO and strongly influenced SC, while SC in turn positively affected LO. These results address the research questions by confirming that students perceive P2P–SI as engaging and easy to use, that collaborative play strengthens communication and shared interpretation, and that the combined effects of EU and SC lead to meaningful outcomes such as improved spatial reasoning, cultural understanding, and reflective thinking. From a pedagogical perspective, the study suggests that site analysis should move beyond being a descriptive task and instead be reframed as an interactive, collaborative, and culturally relevant activity. Educators can improve student learning by incorporating gamified tools that emphasise intuitive design, clear feedback, and structured opportunities for teamwork. Such approaches not only sustain engagement but also help students develop transferable skills needed in professional practice. For future research, there is value in examining the long-term impacts of gamified learning on design studio performance, exploring how cultural context shapes usability and engagement, and comparing different game mechanics such as collaborative versus competitive play. These directions can strengthen understanding of how gamification can be systematically integrated into architectural curricula, bridging technical learning with social, cultural, and reflective dimensions to better prepare students for real-world design challenges.

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AUTHOR CONTRIBUTIONS

All authors collaboratively conceived and designed the research within the team-teaching framework of the second-year architecture design studio. Ahmad Faiz Mohd Nadzamuddin and Sayed Muhammad Aiman Sayed Abul Khair led the overall study direction, developed the methodology, and conducted the formal data analysis. Muhammad Assyahmizi Mohd Yunus, Muhammad Faris Arman, Mohammad Nazrin Zainal Abidin, and Farid Al Hakeem Yuserrie facilitated the pedagogical implementation regarding the students' contextual analysis, conducted the literature evaluation, and proofread the manuscript. All authors have read and agreed to the published version of the manuscript.

CONFLICT OF INTEREST

The author declares no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

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