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Students' Perspectives on TPACK-Enacted Pedagogy: A Quantitative Analysis of Its Impact on Engagement and Learning Outcomes in a Tertiary EFL Classroom

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Abstract

Research on Technological Pedagogical Content Knowledge (TPACK) has predominantly focused on teachers' knowledge, beliefs, and practices regarding technology integration, while the student perspective has received comparatively limited attention. This study addresses this gap by examining tertiary EFL students' perceptions of TPACK-enacted pedagogy and exploring its relationship with their academic engagement and self-reported learning outcomes. A quantitative cross-sectional survey design was employed. A total of 187 undergraduate EFL students enrolled in a public university in Oman participated in the study by completing a 15-item Likert-scale questionnaire encompassing three constructs: Student-Perceived TPACK Enactment, Student Engagement, and Self-Reported Learning Outcomes. Data were analyzed using SPSS through descriptive statistics, Pearson correlation, simple linear regression, and bootstrapped mediation analysis. The results revealed strong positive correlations between Student-Perceived TPACK Enactment and both Student Engagement ($r = .790$, $p < .001$) and Self-Reported Learning Outcomes ($r = .792$, $p < .001$). Regression analyses indicated that perceived TPACK quality explained approximately 62% of the variance in both outcome variables ($R^2 = .624$ and .627, respectively). Furthermore, a bootstrapped mediation analysis revealed that Student Engagement partially mediated the relationship between Student-Perceived TPACK Enactment and Self-Reported Learning Outcomes (indirect effect = 0.441, BootSE = 0.056, 95% BCa CI [.331, .551]). The indirect effect accounted for approximately 53.1% of the total effect, while a significant direct effect remained ($B = 0.389$, $p < .001$). These findings suggest that students' perceptions of effective technology integration are strongly associated with higher levels of academic engagement and enhanced learning outcomes. The partial mediation model further indicates that TPACK-enacted pedagogy influences learning outcomes through two complementary pathways: a direct pathway that enhances content comprehension and an indirect pathway that operates through increased student engagement. Overall, the study highlights the importance of incorporating students' perspectives when evaluating the effectiveness of technology integration in EFL instruction and

contributes to a more comprehensive understanding of TPACK implementation in higher education contexts.

1. Introduction

The integration of technology into higher education has become a regular part of contemporary teaching practice, rather than a peripheral innovation. Many teachers believe they are using technology effectively, yet students often perceive its impact differently and with greater nuance. This disconnect between teachers' understanding of their technology use and students' actual learning experiences lies at the heart of this study.

The Technological Pedagogical Content Knowledge (TPACK) framework, developed by Mishra and Koehler (2006), provides a widely used theoretical lens for understanding the complex, intersecting knowledge domains that teachers need to integrate technology effectively. The framework identifies seven knowledge components — Technological Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK), Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), Pedagogical Content Knowledge (PCK), and the overarching Technological Pedagogical Content Knowledge (TPACK) — each representing a unique intersection of these three domains. The framework has generated a substantial body of research over the past two decades, much of it focused on measuring and developing teacher competence.

The bulk of TPACK scholarship examines teacher self-efficacy, professional development, and instructional beliefs (Voogt et al., 2013; Zhang & Chen, 2022). This orientation marginalises the student, treating them as a passive beneficiary of good teaching rather than as an active participant in the learning process. However, students are not merely passive recipients of technology-enhanced instruction; instead, they actively interpret and respond to the ways in which technology is used in their learning. As Huang et al. (2023) have observed, even technically sophisticated and pedagogically thoughtful instruction can fail if it does not resonate with students.

This problem is particularly pressing in EFL settings, where technology can serve as a bridge to authentic language use, cultural exposure, and interactive practice that would otherwise be difficult to access. However, if students do not experience that technology as genuinely supportive of their language development, these potential benefits go unrealised. The present study therefore shifts focus from what teachers know about technology to how students experience technology-enhanced teaching and whether that experience shapes their engagement and learning.

The study was conducted at the University of Technology and Applied Sciences (UTAS), Salalah, Oman, a context that is underrepresented in the TPACK literature despite the country's substantial investment in educational technology. Working within one institution allows for a more focused and contextually coherent analysis, keeping institutional variation such as infrastructure, administrative culture, and curriculum design from obscuring the relationships of interest.

The study addresses the following research questions:

1. What is the relationship between student-perceived TPACK enactment, student engagement, and self-reported learning outcomes?
2. To what extent does student-perceived TPACK enactment predict student engagement and self-reported learning outcomes?
3. Does student engagement mediate the relationship between student-perceived TPACK enactment and self-reported learning outcomes?

2. Literature Review

2.1 The TPACK Framework

The TPACK framework builds on Shulman's (1986) foundational concept of Pedagogical Content Knowledge by positioning technology as a third, transformative knowledge domain. Its central argument is that effective technology integration is not achieved by simply adding tools to existing teaching but by weaving technological, pedagogical, and content knowledge together in ways that are mutually reinforcing (Mishra & Koehler, 2006).

Early empirical work concentrated on making TPACK measurable, most influentially through Schmidt et al.'s (2009) self-report instrument, which opened the door to large-scale comparative studies of teacher knowledge. More recent work has explored contextual factors that influence TPACK implementation, such as institutional policy support (Siyam et al., 2025) and professional learning communities (Tyarakanita et al., 2021). However, across these developments, the student remains a largely absent figure, treated as a passive beneficiary rather than an active evaluator of technology-enhanced instruction.

2.2 Student Perceptions and Educational Effectiveness

Research in educational psychology consistently shows that students' perceptions of their learning environment are not merely subjective impressions but are causally related to their motivation, engagement, and academic achievement (Scherer et al., 2018). The Technology Acceptance Model (Davis, 1989) provides a useful framework here, arguing that perceived usefulness and ease of use are the primary determinants of whether students engage meaningfully with technology. Rajeb et al. (2023) extend this by adding perceived relevance as a key factor, particularly in language learning contexts where students assess whether technology genuinely supports their linguistic development goals. This matters for TPACK research: a teacher's knowledge is only enacted when students perceive it as meaningful.

2.3 Technology Integration and EFL Learning Outcomes

The empirical record on technology use and EFL learning outcomes is encouraging but incomplete. Zhang and Fang (2022) demonstrate that EFL teachers with stronger TPACK report greater teacher efficacy in technology-integrated instruction, with positive implications for student learning experiences. Studies in STEM education have similarly linked TPACK to improved academic achievement (Voogt et al., 2013). However, these studies typically measure technology integration from the teacher's or observer's perspective, not from the student's. This matters more than it might initially appear. A teacher can deploy a technically sophisticated tool in a way that leaves students confused about its purpose or unconvinced of its value. Conversely, a straightforward application — such as an online quiz, a short video clip, or a collaborative document — can feel genuinely meaningful if it is woven into a lesson with clear pedagogical intent. What predicts student outcomes, this study argues, is not the technology per se but the student's constructed sense of how well it has been put to work in the service of their learning.

2.4 Student Engagement as a Mediating Variable

Student engagement is a multidimensional construct comprising behavioural, cognitive, and affective dimensions (Fredricks et al., 2004). This study focuses on behavioural and cognitive engagement — participation and depth of mental effort — as these are most directly observable in technology-enhanced classroom settings. Drawing on self-determination theory (Deci & Ryan, 1985), this study hypothesises that effective TPACK enactment satisfies students' needs for competence and autonomy, generating heightened engagement, which in turn facilitates deeper learning and greater perceived language gains.

3. Methodology

3.1 Research Design

This study employed a quantitative, cross-sectional correlational design, which is appropriate for measuring the strength of relationships between variables at a specific point in time without experimental manipulation. Correlational and regression analyses address the research questions directly, and the design is well-suited for survey-based educational research of this kind.

3.2 Participants and Sampling

The study was conducted in the Preparatory Studies Center, University of Technology and Applied Sciences (UTAS), Salalah, Oman. This institution was chosen for its sustained commitment to blended learning, its consistent technology infrastructure across teaching spaces, and its well-established EFL programme. These conditions make TPACK enactment observable and meaningful to students.

Surveys were distributed to 200 enrolled EFL students through Google Forms. A total of 187 valid and complete responses were returned, yielding a response rate of 93.5%. Of the 187 participants, 123 were female (65.8%) and 64 were male (34.2%). All participants were native speakers of Arabic studying English as a compulsory course, with varying levels of English proficiency. Informed written consent was obtained from all participants before data collection began, and the study received institutional ethical clearance.

3.3 Instrument

A 15-item survey instrument was developed for this study, structured around three five-item subscales, each using a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). The full item set is presented in Table 1. Item development drew on established TPACK measurement instruments (Schmidt et al., 2009), validated student engagement scales (Fredricks et al., 2004), and outcome measures adapted for EFL contexts.

Subscale 1 — Student-Perceived TPACK Enactment (5 items): Captured how well students felt their teacher integrated technology with appropriate content and pedagogy. A representative item: *"My teacher uses technology that helps me understand English better."* Cronbach's α = .932.

Subscale 2 — Student Engagement (5 items): Measured behavioural and cognitive engagement during technology-enhanced lessons. A representative item: *"I pay more attention when technology is used in class."* Cronbach's α = .940.

Subscale 3 — Self-Reported Learning Outcomes (5 items): Assessed perceived gains in English language skills. A representative item: *"Overall, I learn English more effectively when technology is appropriately used."* Cronbach's α = .946.

3.4 Data Analysis

All statistical analyses were conducted using SPSS. Mediation analysis was performed using the PROCESS macro for SPSS (Hayes, 2022), which produces bootstrapped confidence intervals and does not require the assumption of normality for the indirect effect. The analytical sequence was as follows:

(1) Descriptive statistics — means and standard deviations — were calculated for each individual item and for the three subscale composite scores.

(2) Internal consistency was assessed via Cronbach's alpha for each subscale.

(3) Pearson correlation coefficients were computed for all pairs of subscale composites to address RQ1.

(4) Two simple linear regression models were estimated to address RQ2, with TPACK Enactment as the predictor and, in turn, Student Engagement and Learning Outcomes as criterion variables.

(5) A bootstrapped mediation analysis using the PROCESS macro for SPSS (Model 4) was conducted to address RQ3, employing 5,000 bootstrap samples to generate bias-corrected and accelerated (BCa) 95% confidence intervals for the indirect effect.

Preliminary screening confirmed that skewness values fell between −1.09 and −1.07 and kurtosis values between 0.46 and 0.78, within acceptable limits for ordinal Likert data at this

sample size (Pallant, 2020). No influential outliers were identified, and all assumptions for the planned parametric tests were satisfied.

4. Results

4.1 Item-Level Descriptive Statistics and Reliability

Item-level means, standard deviations, and subscale reliability estimates are presented in Table 1. Every item mean exceeded the scale midpoint of 3.0, ranging from 3.88 (Technology helps me with English writing practice) to 4.11 (My teacher manages technical issues effectively during lessons). This pattern indicates that students, on balance, held favourable views of technology integration across all three domains measured. Reliability was strong throughout: α = .932 for TPACK Enactment, .940 for Student Engagement, and .946 for Self-Reported Learning Outcomes, all well above the .70 threshold considered adequate for research purposes.

Table 1

Item-Level Means, Standard Deviations, and Reliability Coefficients (N = 187)

Item	M	SD	Subscale α
TPACK Enactment Subscale			**.932**
T1. My teacher uses technology that helps me understand English better	4.00	1.20	
T2. The technology used matches well with my learning activities	4.03	1.09	
T3. Technology is used in ways that make English content more interesting	4.04	1.12	
T4. My teacher manages technical issues effectively during lessons	4.11	1.12	
T5. Technology feels like a natural part of our English lessons	3.97	1.20	
Student Engagement Subscale			**.940**
E1. I pay more attention when technology is used in class	4.01	1.17	
E2. Technology-based activities increase my interest in learning English	4.06	1.16	
E3. I participate more actively when we use technology	3.99	1.18	
E4. Technology helps me stay focused during lessons	3.89	1.21	
E5. I enjoy English classes more when technology is used	3.96	1.22	
Self-Reported Learning Outcomes Subscale			**.946**
L1. Technology helps me improve my English vocabulary	3.97	1.18	
L2. I learn English grammar better through technology activities	3.94	1.22	
L3. My English speaking skills improve with technology use	3.99	1.15	
L4. Technology helps me with English writing practice	3.88	1.21	
L5. Overall, I learn English more effectively when technology is used	4.05	1.12	

Note. All items rated on a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree).

4.2 Descriptive Statistics and Correlations (RQ1)

Table 2 presents subscale means, standard deviations, and intercorrelations. At the subscale level, means were similarly high across all three constructs: TPACK Enactment (M = 4.03, SD = 1.02), Student Engagement (M = 3.98, SD = 1.07), and Learning Outcomes (M = 3.96, SD = 1.07). The standard deviations, all close to 1.0, indicate reasonable spread around these means, suggesting genuine variability in student perceptions rather than ceiling clustering.

All three correlations were large and statistically significant ($p < .001$). The strongest correlation was between Engagement and Learning Outcomes ($r = .826$), followed by TPACK Enactment with Learning Outcomes ($r = .792$) and TPACK Enactment with Student Engagement ($r = .790$). In direct answer to RQ1, all three constructs are substantially and positively interrelated, with effect sizes that are large by any conventional benchmark (Cohen, 1988).

Table 2

Means, Standard Deviations, and Intercorrelations for Study Variables (N = 187)

Variable	M	SD	1	2	3
1. TPACK Enactment	4.03	1.02	—		
2. Student Engagement	3.98	1.07	.790***	—	
3. Learning Outcomes	3.96	1.07	.792***	.826***	—

Note. ***$p < .001$.

4.3 Regression Analyses (RQ2)

Two simple regression models were estimated to address RQ2, with results reported in Table 3.

The first model, predicting Student Engagement from TPACK Enactment, was highly significant, $F(1, 185) = 306.65$, $p < .001$. TPACK Enactment explained 62.4% of the variance in Engagement ($R^2 = .624$, adjusted $R^2 = .622$; $f^2 = 1.657$), indicating a very large effect according to Cohen's (1988) standards. The unstandardised coefficient ($B = 0.827$, $SE = 0.047$, $\beta = .790$, $t = 17.51$, $p < .001$) indicates that each one-point improvement in perceived TPACK quality was associated with roughly a 0.83-point increase in reported engagement. In essence, students who feel their teacher integrates technology well are markedly more engaged.

The second model, predicting Self-Reported Learning Outcomes, produced near-identical results: $F(1, 185) = 310.84$, $p < .001$, $R^2 = .627$, adjusted $R^2 = .625$ ($f^2 = 1.681$). TPACK Enactment was again the sole predictor ($B = 0.830$, $SE = 0.047$, $\beta = .792$, $t = 17.63$, $p < .001$). The near-perfect symmetry between the two models is itself informative. It suggests that perceived technology quality predicts both engagement and learning with essentially equal strength.

Table 3

Simple Regression Coefficients for Student-Perceived TPACK Enactment Predicting Engagement and Learning Outcomes

Outcome Variable	B	SE B	β	t	p
Student Engagement ($R^2 = .624$, $F(1,185) = 306.65$, $p < .001$)					
TPACK Enactment	0.827	0.047	.790***	17.51	< .001
Self-Reported Learning Outcomes ($R^2 = .627$, $F(1,185) = 310.84$, $p < .001$)					
TPACK Enactment	0.830	0.047	.792***	17.63	< .001

Note. ***$p < .001$. ***B*** *= unstandardized regression coefficient; SE* ***B*** *= standard error;* β *= standardized coefficient.*

4.4 Mediation Analysis (RQ3)

To examine whether Student Engagement mediated the TPACK–Learning Outcomes relationship (RQ3), a bootstrapped mediation analysis was conducted using the PROCESS macro for SPSS (Model 4) with TPACK Enactment as the independent variable (X), Student Engagement as the mediator (M), and Self-Reported Learning Outcomes as the dependent variable (Y). A total of 5,000 bootstrap samples were used to generate bias-corrected and accelerated (BCa) 95% confidence intervals for the indirect effect. The mediation analysis results are presented in Table 4.

The total effect of TPACK Enactment on Learning Outcomes (path c: B = 0.830, t = 17.63, p < .001) was clearly significant. The a path — TPACK Enactment predicting Engagement — was also significant (B = 0.827, SE = 0.047, t = 17.51, p < .001), as was the b path — Engagement predicting Outcomes after controlling for TPACK (B = 0.533, SE = 0.062, t = 8.58, p < .001). Crucially, when Engagement was added to the model, the direct effect of TPACK on Outcomes (path c') remained significant (B = 0.389, SE = 0.065, t = 5.99, p < .001). This rules out full mediation and confirms a partial mediation pattern.

The bootstrapped indirect effect through Engagement (ab = 0.441, BootSE = 0.056) was statistically significant, with a BCa 95% confidence interval of [.331, .551]. As this interval does not include zero, the mediated pathway is considered statistically reliable without reliance on normality assumptions. The proportion of mediation was .531, indicating that approximately 53.1% of TPACK's total effect on learning outcomes was channelled through students' heightened engagement, while the remaining 46.9% operated through a direct pathway.

Table 4

Simple Mediation Analysis: Effect of TPACK Enactment on Learning Outcomes Through Student Engagement

Effect	Estimate (B)	SE / BootSE	t	95% CI LL	95% CI UL
Total Effect (c): TPACK → Outcomes	0.830	0.047	17.63	0.737	0.923
Direct Effect (c'): TPACK → Outcomes	0.389	0.065	5.99	0.261	0.517
Indirect Effect (ab): via Engagement	0.441	0.056	—	0.331	0.551
a path: TPACK → Engagement	0.827	0.047	17.51	0.734	0.920
b path: Engagement → Outcomes	0.533	0.062	8.58	0.411	0.655

Note. Bias-corrected and accelerated (BCa) 95% CIs based on 5,000 bootstrap samples generated via the PROCESS macro. CI = confidence interval; LL = lower limit; UL = upper limit. Proportion of mediation (PM) = .531.

5. Discussion

Overall, the findings paint a consistent picture. When EFL students perceive their teachers as using technology in ways that are relevant, well-managed, and genuinely integrated with their language learning, they report being more engaged in class and feel they learn more effectively. The correlations are large, the regression models explain over 62% of variance in each outcome, and the mediation analysis reveals a partial mediation pattern.

5.1 TPACK Enactment and Student Engagement

The finding that perceived TPACK quality explains 62.4% of the variance in student engagement is noteworthy. It places TPACK enactment not as one among many influences on engagement but as a dominant one. For context, many educational studies regard 20–30% of explained variance in engagement as substantively important; accounting for more than 62% from a single perceptual variable indicates that how students experience technology integration is closely connected to how invested they feel in their learning.

This aligns with constructivist views of learning (Vygotsky, 1978), which suggest that students are most cognitively engaged when the material is challenging but still understandable, and when the tools used to explore it serve a clear purpose. When technology is smoothly integrated into a lesson, it gives students something meaningful to engage with, but when it is implemented inconsistently or without clear pedagogical purpose, its impact is reduced. From a self-determination theory perspective (Deci & Ryan, 1985), feelings of competence and autonomy within the learning environment support intrinsic motivation, and effective technology integration appears to foster both.

5.2 TPACK Enactment and Learning Outcomes

The regression result for Learning Outcomes ($R^2 = .627$) is virtually indistinguishable from that for Engagement. Students who perceive stronger TPACK enactment do not just engage more; they also feel they learn more. This aligns with and extends the existing EFL literature (Zhang & Fang, 2022) by showing that student perception, rather than objectively measured teacher behaviour, is itself a meaningful and independent predictor of perceived outcomes.

The direct effect that remained after controlling for engagement ($c' = 0.389$, representing 46.9% of the total effect) deserves some consideration. It indicates that TPACK enactment contributes to learning through channels other than heightened engagement. Multimedia representations that reduce cognitive load, digital feedback tools that support self-correction, and technology-aided vocabulary exposure may all improve students' perceived language development directly without necessarily going through the route of increased behavioural or cognitive engagement first.

5.3 The Mediating Role of Student Engagement

The partial mediation result is theoretically the most interesting finding of the study. Engagement transmitted approximately 53.1% of TPACK's total effect on learning outcomes, making it the single largest pathway through which technology integration appears to benefit students, but not the only one. This dual-pathway structure echoes Fredricks et al.'s (2004) account of how engagement functions: behavioural participation and cognitive effort are not ends in themselves, but they create the conditions in which learning becomes more likely.

This finding provides a more specific account of how TPACK contributes to effective technology integration. When technology is used well, it tends to draw students in, making them more attentive, participative, and cognitively engaged. This increased engagement, in turn, leads to stronger perceptions of learning. Effective integration also helps make content more accessible and easier to understand. Both pathways are important for explaining how technology supports learning, and neither should be overlooked in research or practice.

5.4 Implications

From a theoretical standpoint, the results make a case for expanding the TPACK framework to include student perception as a validating dimension of effective technology integration. A teacher can possess considerable TPACK and still fail to enact it in ways that students find meaningful. Conversely, a teacher whose technical toolkit is modest may achieve strong perceived enactment simply by integrating whatever tools they have with evident pedagogical purpose. The student's experience of teaching, beyond the teacher's knowledge alone, is where TPACK ultimately succeeds or fails.

Practically, institutions and language programme coordinators should incorporate systematic student feedback on technology integration into their quality assurance processes. This feedback should function not as a summative judgement of individual teachers, but as formative input to guide professional development. Professional development itself should

shift its emphasis from tool training toward experience design. This involves helping teachers think through how a given technology will feel from the learner's seat, and whether students are likely to experience it as purposeful, relevant, and supportive of their language goals.

5.5 Limitations

The study relies entirely on self-report data, which introduces the possibility of response bias. Future research would benefit from triangulating survey responses with more objective measures: LMS log data, standardised language test scores, or classroom observation. The cross-sectional design also limits causal inference; the correlational and mediation findings are consistent with the proposed model but cannot confirm it. Longitudinal designs would help clarify the long-term impact of TPACK on student engagement and establish the direction of effects more firmly. Additionally, the single-institution setting constrains the replicability of the findings; extending the study to other Omani universities and broader Gulf EFL contexts would provide a more robust validation.

6. Conclusion

This study placed students at the centre of an inquiry that has often overlooked their perspectives. The evidence is clear: when EFL students perceive their teachers as integrating technology in ways that feel relevant, coherent, and genuinely useful for language learning, they report higher engagement and stronger learning outcomes. Using statistical tools available in SPSS, the study demonstrates that perceived TPACK quality accounts for over 62% of the variance in both engagement and self-reported learning outcomes, with student engagement mediating a substantial portion of that relationship (53.1%).

None of this diminishes the importance of what teachers know, but it reframes the question of TPACK effectiveness by highlighting that a teacher's knowledge matters only when it is translated into classroom experiences that students find meaningful. That translation is neither automatic nor guaranteed by technical sophistication alone. Paying attention to how students experience technology-enhanced teaching — instead of focusing solely on whether tools are being used — is essential for understanding what makes technology integration effective.

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