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Technology Integration and Student Engagement in Secondary Education: A Mixed-Methods Study

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Abstract

Despite substantial investments in classroom technology, evidence regarding its impact on student engagement and academic achievement remains inconsistent. This study examined the relationship between technology integration and student engagement, and the moderating role of teachers' technological pedagogical content knowledge (TPACK), in secondary classrooms. Using a mixed-methods sequential explanatory design, quantitative data were collected from 320 students and 40 teachers across six public secondary schools, while qualitative data were obtained through semi-structured interviews with 12 teachers. Pearson correlation and multiple regression analyses revealed a statistically significant positive relationship between technology integration and overall student engagement ($r = .62$, $p < .01$), with technology integration explaining 28% of the variance in academic achievement ($R^2 = .28$, $p < .01$). Thematic analysis of interview data identified three explanatory themes, namely pedagogical transformation, equity of access, and teacher professional confidence. The findings suggest that technology enhances learning when it is integrated through a TPACK-aligned pedagogy, supported by sustained professional development and equitable infrastructure. Implications for classroom practice, school leadership, and educational policy are discussed.

Keywords: - Technology Integration, Student Engagement, Academic Achievement, TPACK, Secondary Education, Mixed Methods

I. INTRODUCTION

The proliferation of digital tools, including interactive whiteboards, learning management systems, tablets, and adaptive applications, has transformed teaching and learning in the 21st-century classroom (Mishra & Koehler, 2006). Educational systems worldwide have responded by investing heavily in classroom technology, framing it as central to pedagogical innovation, equity, and lifelong learning (UNESCO, 2023). Yet the empirical evidence on its effectiveness remains divided. While some scholars report meaningful gains in motivation and achievement (Hattie, 2009; Tamim et al., 2011), others caution that technology, divorced from sound pedagogy, yields little measurable improvement in learning outcomes (Selwyn, 2016).

A persistent issue is that many teachers continue to use technology in superficial ways, primarily as a substitute for analog tools rather than as a means of pedagogical transformation (Puentedura, 2014). As a result, the anticipated gains in student engagement and achievement have not been universally realized. Few studies have systematically examined how teachers' pedagogical readiness mediates the relationship between technology integration and student outcomes, particularly in secondary classrooms in developing-country contexts. This gap is significant because secondary students are at a developmental stage in which engagement strongly predicts later academic trajectories and post-secondary aspirations (Fredricks et al., 2004).

The present study addresses this gap by investigating the relationship between technology integration, student engagement, and academic achievement in public secondary schools, while exploring the role of teacher pedagogical readiness as a moderating factor. The study is anchored on Vygotsky's (1978) sociocultural theory, which posits that learning

is mediated by tools and social interaction, and on the technological pedagogical content knowledge (TPACK) framework (Mishra & Koehler, 2006), which describes the knowledge teachers need to integrate technology meaningfully. Engagement is operationalized through Fredricks et al.'s (2004) tripartite model of behavioral, cognitive, and emotional engagement, widely regarded as a robust predictor of academic success. Hattie's (2009) synthesis of over 800 meta-analyses reports a moderate average effect size of technology on achievement ($d \approx 0.40$), with notably stronger effects when integration is paired with effective pedagogy and feedback. Tamim et al. (2011) similarly found positive but contextually variable outcomes, while Koehler et al. (2014) demonstrated that teachers' TPACK is a strong predictor of effective integration. The current study extends this body of work by focusing on the secondary-school level in a South Asian public-school context, where digital adoption is rapid but uneven.

II. OBJECTIVES OF THE STUDY

The general objective of the study was to examine the relationship between classroom technology integration, student engagement, and academic achievement in secondary education, and to identify the conditions under which this relationship is strengthened. Specifically, the study sought to:

- Determine the level of technology integration practiced by teachers in selected public secondary schools.
- Examine the relationship between technology integration and student engagement across its behavioral, cognitive, and emotional dimensions.
- Determine the extent to which technology integration predicts students' academic achievement when prior achievement and gender are statistically controlled.
- Identify the pedagogical, professional, and contextual factors that moderate the effectiveness of technology integration in the classroom.

III. METHODOLOGY

This study employed a mixed-methods sequential explanatory design, which combines quantitative and qualitative approaches in two successive phases (Creswell & Plano Clark, 2018). The first phase generated quantitative data to identify patterns of association between technology integration, engagement, and achievement, after which the second phase used qualitative interviews to interpret and explain those patterns in greater depth. This design was deemed appropriate because the research questions required both measurement of relationships and an understanding of the lived pedagogical experiences that produce them.

The study was conducted in six public secondary schools selected through stratified random sampling to ensure representation across urban, semi-urban, and rural settings. The quantitative sample comprised 320 students drawn proportionately from Grades 9 to 12, of whom 53% were female, and 40 classroom teachers with a mean teaching experience of 11.4 years. Sample size was determined using Cochran's (1977) formula at a 95% confidence level with a 5% margin of error. For the qualitative phase, 12 teachers were purposively selected on the basis of years of teaching experience and self-reported levels of technology integration, classified as low, moderate, or high, in order to capture variation in pedagogical practice.

Three instruments were used to gather data. The first was a Technology Integration Survey adapted from Schmidt et al.'s (2009) TPACK self-assessment instrument, which contained 24 items rated on a 5-point Likert scale ranging from "strongly disagree" to "strongly agree." The second was a Student Engagement Scale adapted from Fredricks et al. (2004), comprising 19 items measuring behavioral, cognitive, and emotional engagement on a 5-point scale. The third was a semi-structured interview guide developed by the researcher and refined after expert review. Academic achievement was operationalized through students' end-of-term grade point averages obtained from official school records. The instruments were content-validated by a panel of three educational research experts, and a pilot test with 30 students who did not participate in the main study yielded Cronbach's alpha values of .87 for the Student Engagement Scale and .91 for the Technology Integration Survey, indicating high internal consistency (Tavakol & Dennick, 2011).

Data collection followed institutional ethical clearance and obtained the informed consent of all participants and the parents of minor participants, in accordance with the ethical guidelines of the American Psychological Association (2017). Surveys were administered in person during regular class periods, with the researcher available to clarify items. Interviews lasted approximately 45 minutes each and were audio-recorded with the participants' written permission, then transcribed verbatim. Confidentiality was maintained through the use of pseudonyms, and participants were informed of their right to withdraw at any stage without consequence.

Quantitative data were analyzed using IBM SPSS Statistics Version 27. Descriptive statistics, including means, standard deviations, and percentages, were used to summarize the level of technology integration and student engagement. Pearson product-moment correlation coefficients were computed to examine relationships among the key variables. Multiple regression analysis was then conducted to determine the predictive value of technology integration on academic achievement, with prior achievement and gender entered as control variables. Assumptions of normality, linearity, multicollinearity, and homoscedasticity were checked and met. Qualitative data were analyzed using Braun and Clarke's (2006) six-phase reflexive thematic analysis, which involved familiarization with the data, generation of initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report. Trustworthiness of the qualitative analysis was strengthened through member checking with three participants, peer debriefing with a fellow researcher, and the maintenance of a detailed audit trail (Lincoln & Guba, 1985).

IV. RESULTS

Descriptive analysis indicated a moderate level of technology integration in classrooms, with a mean score of 3.21 (SD = 0.74) on the 5-point scale. Teachers most frequently used technology for content presentation (78%), assessment (51%), and student research (44%), but rarely for collaborative knowledge construction (19%) or higher-order problem-solving (16%). Pearson correlation revealed a strong positive relationship between technology integration and overall student engagement (r = .62, p < .01). Disaggregated by dimension, the strongest association was with cognitive engagement (r = .67), followed by behavioral engagement (r = .58) and emotional engagement (r = .54). Multiple regression analysis indicated that technology integration was a significant positive predictor of academic achievement (β = .34, p < .01), accounting for 28% of the variance in students' grade point averages (R^2 = .28, F(3, 316) = 41.07, p < .001), even after controlling for prior achievement and gender.

Thematic analysis of the interview transcripts produced three interrelated themes that helped explain the quantitative findings. The first theme, pedagogical transformation, emerged from the accounts of teachers who reported high TPACK and described a clear shift from teacher-centered instruction toward student-centered, inquiry-driven learning, in which technology served as a thinking and collaboration tool rather than a delivery channel. The second theme, equity and access, captured the disparities in students' device availability and home internet connectivity, with several teachers noting that integration strategies had to be adjusted to avoid disadvantaging lower-income learners. The third theme, professional confidence, reflected the consistent observation that sustained, school-based professional development was associated with greater willingness to attempt innovative integration, whereas one-off training sessions were viewed as ineffective.

V. DISCUSSION

The findings affirm that technology integration is positively associated with student engagement and academic achievement in secondary classrooms, consistent with prior research (Hattie, 2009; Tamim et al., 2011). The strong association with cognitive engagement is particularly noteworthy, as it suggests that, when used purposefully, digital tools can promote deeper learning processes such as elaboration, organization, and metacognitive monitoring (Mayer, 2009). At the same time, the findings echo Selwyn's (2016) caution that technology's value depends on pedagogical purpose. The qualitative data made clear that effective integration was not driven by the presence of devices but by the quality of teachers' pedagogical decisions, a result that strongly supports Mishra and Koehler's (2006) TPACK framework. Teachers who lacked sufficient TPACK tended to use technology in low-level, substitutive ways consistent with the lower stages of Puentedura's (2014) SAMR model.

The equity finding reinforces UNESCO's (2023) warning that the digital divide remains a critical concern. Without deliberate effort, technology integration can exacerbate rather than alleviate educational inequalities. Schools must therefore pair technology investments with structural support for under-resourced learners. This study makes two main contributions. Empirically, it provides quantitative and qualitative evidence from a South Asian public-school context, where research on technology integration remains limited. Theoretically, it integrates the TPACK framework with Fredricks et al.'s (2004) engagement model, demonstrating that the engagement and achievement pathway depends substantially on teacher pedagogical readiness. Three limitations should nonetheless be noted. First, the cross-sectional design limits causal inference. Second, the sample, while diverse, was drawn from a single region. Third, academic achievement was measured using grade point averages, which may not fully capture higher-order learning outcomes. Future longitudinal and multi-regional studies are therefore warranted.

VI. CONCLUSION

Technology integration, when grounded in pedagogically sound practice and supported by adequate infrastructure, significantly enhances student engagement and academic achievement in secondary education. Teacher pedagogical capacity, particularly TPACK, emerges as the most decisive factor. Schools and policymakers seeking to maximize the educational value of digital tools should therefore invest as much in teacher development and equitable access as in hardware procurement. Future research should employ longitudinal designs to trace effects over time and explore primary and rural-school contexts.

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