PREFACE TO THE EDITION

The forthcoming issue of the **International Journal of Teacher Education Research Studies (IJTERS)** brings together a compelling collection of empirically grounded and methodologically diverse studies that illuminate some of the most pressing concerns and transformative possibilities within contemporary teacher education and classroom practice. The contributions in this issue collectively underscore the evolving role of educators in navigating technological innovation, inclusive pedagogy, student engagement, and professional well-being in an increasingly complex educational landscape.

A central theme emerging across multiple articles is the transformative potential of technology-mediated pedagogies. The study on flipped classroom instruction in secondary science education demonstrates how reconfiguring instructional time and leveraging digital resources can significantly enhance student achievement, critical thinking, and engagement, while also reshaping teacher roles toward facilitation and guidance. Complementing this, the investigation into Mobile-Assisted Language Learning (MALL) highlights the power of ubiquitous mobile technologies in extending learning beyond classroom boundaries, fostering learner autonomy, and improving comprehensive language proficiency. Similarly, the research on technology-enhanced learning environments in Kerala provides strong empirical evidence that strategic integration of digital tools can substantially elevate both academic performance and student engagement in secondary education. Together, these studies affirm that when thoughtfully implemented, technology serves not merely as a supplement but as a catalyst for pedagogical transformation.

Equally significant is the issue's attention to inclusivity and equity in education. The exploration of teachers' perceptions regarding barriers faced by students with Specific Learning Disabilities in inclusive classrooms sheds light on the persistent gaps in teacher preparedness, training, and institutional support. It emphasizes the critical need for capacity building among educators to ensure that inclusive education is not only a policy aspiration but a classroom reality. This contribution reinforces the moral and professional imperative of equipping teachers with the competencies required to address diverse learner needs effectively.

Another vital dimension addressed in this issue is teacher well-being and its direct implications for instructional quality. The mixed-methods study on teacher burnout and psychological well-being provides nuanced insights into how emotional exhaustion, workload stress, and professional fulfillment intersect to influence teaching effectiveness. By foregrounding the lived experiences of teachers, this research calls attention to the systemic and institutional factors that shape teacher resilience and sustainability, offering timely recommendations for policy and practice aimed at fostering supportive educational environments.

Taken together, the articles in this issue reflect a strong commitment to evidence-based inquiry and practical relevance. They bridge the gap between theory and practice by offering actionable insights for educators, administrators, policymakers, and researchers. The emphasis

on mixed-methods approaches across several studies further enriches the discourse, enabling a deeper understanding of both measurable outcomes and lived experiences within educational settings.

As education systems worldwide continue to grapple with rapid technological change, increasing diversity, and growing demands on teachers, this issue of IJTERS serves as a timely and valuable contribution. It not only advances scholarly dialogue but also inspires reflective practice and informed decision-making in teacher education.

We extend our sincere appreciation to the authors for their rigorous scholarship and to the reviewers for their invaluable contributions in maintaining the quality and integrity of the journal. We hope this issue stimulates further research and dialogue, ultimately contributing to more equitable, effective, and sustainable educational practices.

Dr. Premachandran P
Chief Editor

CONTENTS

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Flipped Classroom Instruction and Student Learning Outcomes in Secondary Science Education: A Quasi-Experimental Mixed-Methods Investigation

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Abstract

This study examined the effects of flipped classroom instruction on student learning outcomes in secondary science education in the Philippines, using a quasi-experimental pretest–posttest nonequivalent control group design embedded within a qualitative case study framework. Two hundred (200) Grade 10 and Grade 11 science students from two public secondary schools were assigned to an experimental group (n = 102) receiving flipped classroom instruction and a control group (n = 98) receiving conventional lecture-based instruction across a 12-week intervention period. Quantitative instruments included validated pre- and post-tests of science achievement, conceptual understanding, and critical thinking, as well as self-report scales measuring student engagement and academic self-efficacy. Results of analysis of covariance (ANCOVA) and mixed-model repeated measures ANOVA revealed statistically significant and practically meaningful gains in all outcome variables for the experimental group compared to the control group (F values ranging from 22.47 to 48.37, all $p < .001$; Cohen's d ranging from 0.59 to 1.31). Qualitative thematic analysis of 32 semi-structured student and teacher interviews yielded five core themes: autonomy and ownership of learning, enhanced classroom interaction quality, transformation of the teacher role, technology access inequity, and increased cognitive demand. These findings collectively demonstrate that flipped classroom instruction, when implemented with robust instructional design and institutional support, substantially improves secondary science learning outcomes. Equity implications and recommendations for scaling flipped learning in resource-constrained educational contexts are discussed.

Keywords: - Flipped Classroom, Inverted Instruction, Secondary Science Education, Academic Achievement, Student Engagement, Quasi-Experimental, Mixed-Methods, Active Learning

I. INTRODUCTION

The enduring challenge of secondary science education lies in reconciling the inherent complexity and abstractness of scientific concepts with the need to cultivate genuine understanding, critical inquiry, and applied reasoning among adolescent learners. Traditional didactic instruction, characterized by teacher-centered, lecture-dominant classroom delivery, has long been critiqued for its passive positioning of students as recipients of information rather than active constructors of knowledge (Hmelo-Silver, 2004; Prince, 2004). Despite decades of evidence supporting the efficacy of active, inquiry-based pedagogies, large-scale surveys of classroom practice consistently document the persistence of lecture-based instruction as the dominant mode of secondary science teaching across diverse national contexts (Roehrig et al., 2021; Tekkumru-Kisa & Stein, 2017).

The flipped classroom model, an instructional design approach in which content delivery is relocated to the out-of-class environment through video lectures and digital resources, while class time is repurposed for active, higher-order learning activities, has attracted substantial scholarly and practitioner interest as a promising mechanism for operationalizing active learning within existing institutional structures (Bergmann & Sams, 2012; Lage et al., 2000). By inverting the traditional homework-lecture paradigm, the flipped classroom seeks to maximize the educational utility of face-to-face instructional time, the resource over which teachers have the greatest professional agency—by reserving it for collaborative problem-solving, peer discussion, formative assessment, and teacher-guided inquiry, while shifting lower-order knowledge transmission to asynchronous, self-paced digital modalities (Bishop & Verleger, 2013; Karabulut-Ilgu et al., 2018).

Empirical research on flipped classroom effectiveness has grown substantially over the past decade, with meta-analytic syntheses reporting moderate to large positive effects on academic achievement across STEM disciplines (Cheng et al., 2019; Hew & Lo, 2018; Lo & Hew, 2017). However, the existing evidence base is characterized by important limitations: a predominance of studies conducted in higher education or Western school contexts, inconsistent operationalization of what constitutes a "flipped" intervention, insufficient attention to equity-related moderating variables such as differential digital access, and a relative paucity of methodologically rigorous mixed-methods designs that integrate performance metrics with the lived experiential perspectives of students and teachers (Bishop & Verleger, 2013; van Alten et al., 2019).

The Philippine secondary science education context provides a particularly instructive site for investigating flipped classroom effectiveness. The K-12 curriculum reform implemented in 2012 explicitly mandates inquiry-based, learner-centered pedagogical approaches across all science subjects, creating institutional alignment with flipped learning principles (DepEd, 2016). At the same time, persistent inequities in digital infrastructure, device access, and teacher preparedness create conditions in which the theoretical benefits of flipped instruction may be systematically undermined for the most educationally vulnerable students (World Bank, 2021). This contextual tension—between policy aspiration and practical constraint—makes the Philippines a critical and underrepresented case in the international flipped learning literature.

This study therefore employed a quasi-experimental mixed-methods design to rigorously examine the effects of a 12-week flipped classroom intervention on multiple dimensions of secondary science learning outcomes, while simultaneously exploring the subjective experiences of students and teachers engaged in the flipped model. The investigation is guided by constructivist learning theory (Vygotsky, 1978; Piaget, 1970), which positions learning as an active, socially mediated process of knowledge construction a theoretical framing that provides both a rationale for and a critical lens on flipped classroom design—alongside Bloom's revised taxonomy (Anderson & Krathwohl, 2001), which informs the instructional sequencing logic of the flipped model by aligning lower-order cognitive tasks with out-of-class activities and higher-order tasks with in-class engagement.

1.1. Research Objectives

This study pursued the following specific research objectives:

- To determine whether students in a flipped classroom condition demonstrate significantly greater gains in science achievement, conceptual understanding, critical thinking, engagement, and academic self-efficacy compared to students in a conventional instruction condition
- To estimate the practical magnitude of intervention effects using appropriate effect size statistics
- To explore through qualitative inquiry the mechanisms, experiences, and contextual factors that account for observed differences in learning outcomes between instructional conditions.

1.2. Significance of the Study

This study makes three primary contributions to the educational research literature. Theoretically, it extends constructivist and Bloom's taxonomy-informed accounts of flipped learning to the Philippine secondary science context, offering a culturally and institutionally situated test of frameworks developed predominantly in Western settings. Methodologically, it advances the use of convergent mixed-methods designs in quasi-experimental educational research, demonstrating how statistical effect size estimation and qualitative thematic analysis can be meaningfully integrated to produce more complete and contextually valid explanations of educational phenomena. Practically, it provides science department heads, curriculum planners, and teachers with empirical evidence and experiential insights to inform decisions about flipped learning adoption, adaptation, and equitable implementation.

II. REVIEW OF RELATED LITERATURE

2.1. Theoretical Foundations of the Flipped Classroom

The flipped classroom model draws theoretical sustenance from several converging intellectual traditions. Constructivist learning theory, developed most influentially by Piaget (1970) and Vygotsky (1978), posits that learning is not a process of passive reception but of active, socially mediated construction of meaning through engagement with challenging problems, collaborative dialogue, and reflective inquiry. The flipped model instantiates constructivism structurally by converting precious face-to-face time, time historically occupied by one-directional information transmission, into spaces for the very collaborative, problem-based, interactive learning activities that constructivist theory identifies as the primary engines of deep understanding (Bergmann & Sams, 2012; Hmelo-Silver, 2004).

Bloom's revised taxonomy of educational objectives (Anderson & Krathwohl, 2001) provides a complementary theoretical rationale for the instructional sequencing logic of flipped learning. By assigning remembering and understanding, the lower-order cognitive levels of the taxonomy, to out-of-class video engagement, and reserving applying, analyzing, evaluating, and creating for in-class collaborative activity, the flipped model deliberately sequences cognitive demand in alignment with the social and material resources available at each learning phase. This taxonomically informed design logic has been explicitly invoked by numerous flipped learning theorists and practitioners as a defining feature that distinguishes principled flipped instruction from mere content relocation (Bishop & Verleger, 2013; Lo & Hew, 2017).

2.2. Empirical Evidence on Flipped Classroom Effectiveness

The empirical literature on flipped classroom effectiveness has expanded substantially since Bergmann and Sams (2012) popularized the model in secondary science contexts. Meta-analytic syntheses have consistently reported positive, though variable, effects on academic outcomes. Hew and Lo (2018) conducted a meta-analysis of 28 experimental and quasi-experimental studies in health professions education, reporting a mean effect size of $d = 0.33$ favoring flipped over traditional

instruction. Lo and Hew (2017) examined K-12 mathematics contexts and reported a comparable mean effect of d = 0.36. More comprehensively, Cheng et al. (2019) synthesized 95 empirical studies across educational levels and disciplines, reporting an overall weighted mean effect of g = 0.42, with significantly larger effects observed in secondary and post-secondary science courses (g = 0.56) compared to other subject areas.

Critical reviews of this literature have highlighted several important moderating conditions. Instructional design quality, specifically, the alignment between pre-class content design and in-class active learning structures, consistently emerges as the most powerful moderator of flipped learning effectiveness (van Alten et al., 2019). Studies in which in-class time was repurposed for genuinely higher-order, collaborative, and problem-based activities, rather than rote review or administrative tasks, reported substantially larger effect sizes than studies that merely relocated lecture content to video format without redesigning in-class pedagogy (Karabulut-Ilgu et al., 2018). Student engagement and self-regulation capacity have also been identified as critical individual-level moderators: students with stronger metacognitive skills and greater intrinsic motivation derive proportionally larger benefits from the autonomy-rich learning structures that characterize well-designed flipped environments (Jansen et al., 2020; Sun, 2020).

2.3. Flipped Learning in Secondary Science Education

Within secondary science education specifically, the flipped classroom has attracted attention as a potential solution to the perennial challenge of covering dense curriculum content while simultaneously developing the inquiry, reasoning, and scientific practice competencies demanded by contemporary science standards frameworks (Roehrig et al., 2021). Several quasi-experimental studies at the secondary level have reported significant positive effects on science achievement and conceptual understanding when flipped instruction was combined with laboratory-integrated or simulation-based in-class activities (Akçayır & Akçayır, 2018; Kong, 2014). Qualitative investigations have documented student perceptions of increased engagement, improved teacher-student relationships, and greater agency over the pace and depth of content engagement as benefits of flipped secondary science learning (Tucker, 2012; Goodwin & Miller, 2013).

However, a consistent theme in the secondary flipped learning literature concerns the equity implications of out-of-class digital content dependency. In contexts characterized by digital access inequality, the shifted homework burden of pre-class video viewing can disadvantage students without reliable home internet or personal devices, reproducing and potentially exacerbating educational inequalities that flipped learning proponents often implicitly assume away (van Alten et al., 2019; Sams & Bergmann, 2013). This concern is particularly salient in Philippine secondary education, where the National ICT Household Survey (PSA, 2023) reports that only 47% of households in Regions III and IV-A have home internet access, with substantially lower rates in rural and lower-income communities.

III. METHODOLOGY

3.1. Research Design

This study employed a quasi-experimental pretest-posttest nonequivalent control group design (Campbell & Stanley, 1963) embedded within a qualitative case study framework, constituting a convergent mixed-methods design (Creswell & Plano Clark, 2018). The quasi-experimental design was selected in preference to a true randomized controlled trial because random assignment of students to instructional conditions within intact school classes was administratively and ethically infeasible; however, the use of pretest covariates in ANCOVA analyses substantially mitigated threats to internal validity from non-random group assignment. The qualitative case study component was designed to provide thick, contextually rich description of the mechanisms and experiences underlying quantitatively observed treatment effects, consistent with an explanatory complementary mixed-methods purpose (Greene et al., 1989).

3.2. Participants and Sampling

Two hundred secondary science students from two public high schools in Region IV-A, Philippines, participated in the study. School A provided the experimental group (n = 102; 49 male, 53 female), while School B provided the control group (n = 98; 47 male, 51 female). Schools were selected through purposive sampling based on comparability of school classification (both National High Schools with similar enrollment sizes and resource profiles), prior science achievement levels (as assessed by the National Achievement Test), and teachers' willingness to participate. Table 1 presents the demographic characteristics of participants across conditions.

Table 1. Demographic Characteristics of Experimental and Control Group Participants

Characteristic	**Experimental n = 102**	**Control n = 98**	**Total N = 200**	**χ^2 / t (p)**
Gender				
Male	49 (48.0%)	47 (48.0%)	96 (48.0%)	
Female	53 (52.0%)	51 (52.0%)	104 (52.0%)	χ^2= 0.00, p = 1.00
Age (years)				
Mean (SD)	15.82 (0.74)	15.79 (0.71)	15.81 (0.72)	t = 0.27, p = .79
Grade Level				
Grade 10	52 (51.0%)	50 (51.0%)	102 (51.0%)	
Grade 11	50 (49.0%)	48 (49.0%)	98 (49.0%)	χ^2= 0.00, p = 1.00
Prior GPA				
Mean (SD)	82.14 (5.31)	81.97 (5.18)	82.06 (5.24)	t = 0.21, p = .83
Device Ownership				
Own smartphone	89 (87.3%)	85 (86.7%)	174 (87.0%)	χ^2= 0.02, p = .90

Note. EG = Experimental Group; CG = Control Group. χ^2 tests used for categorical variables; independent samples t-tests for continuous variables. No significant demographic differences were found between groups, supporting pre-intervention group equivalence.

3.2.1. Qualitative Sub-Sample

For the qualitative strand, 32 participants were purposively selected: 26 students (13 from each school) representing maximum variation in academic performance levels and gender, and 6 science teachers (3 per school) who either implemented the flipped model (experimental school) or continued conventional instruction (control school). All qualitative participants provided separate written informed consent for interview participation.

3.3. Intervention Description

The flipped classroom intervention was implemented over 12 consecutive weeks of the second semester, aligned with four thematic units of the Grade 10 and Grade 11 science curriculum: cell biology, chemical bonding, forces and motion, and environmental science.

For each lesson, the following instructional sequence was followed:

- Out-of-class preparation phase: Students accessed 8 to 12-minute video lectures developed by the research team using pre-validated learning objectives and screencasting software, accompanied by guided note-taking templates and brief online comprehension checks administered via Google Forms;
- In-class activation and application phase: The first 10 minutes of each class session were devoted to brief clarification of misconceptions identified through comprehension check data, followed by 30 to 35 minutes of structured collaborative activities including jigsaw readings, laboratory simulations, Socratic seminars, and problem-based tasks designed to target applying, analyzing, and evaluating levels of Bloom's revised taxonomy;
- Reflection and consolidation phase: Each class session concluded with a 5-minute metacognitive reflection prompt, completed individually in student learning journals and submitted digitally. The control group continued to receive conventional lecture-based instruction delivered by their regular science teachers, with homework consisting of textbook exercises and end-of-chapter questions.

3.4. Instruments

Quantitative data were collected using four validated instruments. The Science Achievement Test (SAT) consisted of 50 multiple-choice items aligned with the K-12 science curriculum and validated against Bloom's revised taxonomy levels (content validity index = .94; Cronbach's $\alpha = .87$ in the current sample). The Conceptual Understanding Assessment (CUA) was a 25-item diagnostic instrument featuring multiple-tier questions designed to detect surface versus deep conceptual understanding ($\alpha = .84$). The Cornell Critical Thinking Test, Level X (CCTT-X; Ennis & Millman, 1985) assessed inferential and deductive reasoning skills across scientific and everyday contexts ($\alpha = .81$). Student engagement was measured using the 20-item Behavioral, Emotional, and Cognitive Engagement (BECE) Scale ($\alpha = .88$), and academic self-efficacy was assessed via the 10-item Academic Self-Efficacy Scale (ASES) adapted from Zimmerman et al. (1992; $\alpha = .86$). All instruments were administered as pretests in Week 1 and post-tests in Week 12.

3.5. Data Analysis

Quantitative data were analyzed using IBM SPSS Statistics version 27 and R version 4.3.1. One-way ANCOVAs were conducted for each outcome variable, with post-test scores as the dependent variable, group condition as the fixed factor, and pretest scores as the covariate. Assumptions of normality, homogeneity of variance, and homogeneity of regression slopes were verified prior to analysis. Between-group effect sizes were estimated using Cohen's d, calculated from adjusted post-test means and pooled standard deviations. Mixed-model repeated measures ANOVA was additionally conducted to examine Time × Group interaction effects. Qualitative data were analyzed using Braun and Clarke's (2006, 2019) reflexive thematic analysis, proceeding through iterative cycles of coding, pattern identification, theme construction, and interpretive refinement. Triangulation across quantitative and qualitative strands was facilitated through a structured joint display matrix (Guetterman et al., 2015).

IV. RESULTS

4.1. Pre-Intervention Group Equivalence

Independent samples t-tests and chi-square tests confirmed that the experimental and control groups did not differ significantly on any demographic or prior academic variable at baseline (all $p > .05$), as detailed in Table 1. This equivalence supports the validity of subsequent between-group comparisons and reduces the plausibility of selection bias as an alternative explanation for post-intervention differences.

4.2. Quantitative Outcomes: Pre- and Post-Test Comparisons

Table 2 presents descriptive statistics for all outcome variables at pretest and post-test for both groups, along with the results of ANCOVA tests examining group differences in post-test performance after controlling for pretest scores.

Table 2. Descriptive Statistics and ANCOVA Results for All Outcome Variables by Group and Time Point

Measure	EG Pre M (SD)	EG Post M (SD)	CG Pre M (SD)	CG Post M (SD)	F	p / η^2p
Science Achievement	72.18 (6.40)	84.73 (5.92)	71.95 (6.55)	76.42 (6.18)	48.37	$p < .001$, $\eta^2p = .33$

Conceptual Understanding	68.44 (7.12)	82.19 (6.87)	68.71 (7.04)	74.88 (7.21)	39.62	$p < .001$, $\eta^2p = .27$
Critical Thinking Score	65.30 (8.21)	79.88 (7.63)	65.07 (8.44)	70.55 (8.30)	33.14	$p < .001$, $\eta^2p = .24$
Engagement Index	3.41 (0.61)	4.18 (0.55)	3.39 (0.58)	3.62 (0.60)	29.80	$p < .001$, $\eta^2p = .21$
Self-Efficacy Scale	3.55 (0.72)	4.22 (0.64)	3.52 (0.69)	3.78 (0.71)	22.47	$p < .001$, $\eta^2p = .17$

Note. EG = Experimental Group; CG = Control Group. F values reflect ANCOVA results with pretest scores as covariate. All F tests significant at $p < .001$. η^2p = partial eta squared. Science Achievement and Conceptual Understanding scored on 0–100 scale; Critical Thinking scored on 0–100 scale; Engagement Index and Self-Efficacy scored on 1–5 Likert scale.

As shown in Table 2, the experimental grou p demonstrated substantially larger gains from pretest to post-test across all five outcome variables compared to the control group. The most pronounced treatment effect was observed for science achievement: the experimental group's mean score increased from 72.18 (SD = 6.40) at pretest to 84.73 (SD = 5.92) at post-test, a gain of 12.55 points, while the control group improved by only 4.47 points (from 71.95 to 76.42). ANCOVA confirmed a highly significant group difference in post-test science achievement after controlling for pretest performance, $F(1, 197) = 48.37$, $p < .001$, $\eta^2p = .33$. Similarly strong effects were obtained for conceptual understanding ($F = 39.62$, $\eta^2p = .27$), critical thinking ($F = 33.14$, $\eta^2p = .24$), engagement ($F = 29.80$, $\eta^2p = .21$), and self-efficacy ($F = 22.47$, $\eta^2p = .17$).

4.3. Effect Size Analysis

Table 3 presents the within-group Cohen's d values (reflecting magnitude of pre-to-post change within each condition), between-group Cohen's d values (reflecting the magnitude of post-intervention group differences), and 95% confidence intervals for the between-group effect estimates.

Table 3. Cohen's d Effect Size Estimates for Within-Group and Between-Group Comparisons Across Outcome Variables

Outcome Variable	**EG Cohen's d**	**CG Cohen's d**	**Between- Group d**	**95% CI**	**Magnitude**
Science Achievement	1.98	0.68	1.31	[1.07, 1.55]	Large
Conceptual Understanding	1.96	0.88	1.08	[0.85, 1.31]	Large
Critical Thinking Score	1.82	0.66	1.16	[0.93, 1.39]	Large
Outcome Variable	EG Cohen's d	CG Cohen's d	Between- Group d	95% CI	Magnitude
Science Achievement	1.98	0.68	1.31	[1.07, 1.55]	Large

Note. Effect size benchmarks following Cohen (1988): small = 0.20, medium = 0.50, large = 0.80. EG = Experimental Group; CG = Control Group. Between-group d computed from adjusted post-test means and pooled standard deviations. CI = 95% confidence interval for between-group d.

The between-group effect sizes ranged from d = 0.59 (self-efficacy; moderate) to d = 1.31 (science achievement; large), indicating that the practical significance of flipped classroom effects was substantial across outcome domains. Notably, the within-group effect sizes for the experimental group (ranging from d = 0.96 to d = 1.98) substantially exceeded those of the control group (d = 0.37 to d = 0.88), confirming that the accelerated learning gains of the experimental group were attributable to the instructional intervention rather than to maturation, testing effects, or other threats to internal validity. The confidence intervals for all between-group effect estimates excluded zero, providing additional evidence for the reliability of observed treatment effects.

4.4. Qualitative Findings: Thematic Analysis

Reflexive thematic analysis of 32 semi-structured interviews yielded five overarching themes, summarized in Table 4 with representative sub-themes, codes, and illustrative participant excerpts.

Table 4. Summary of Qualitative Themes, Sub-Themes, and Illustrative Participant Excerpts from Semi-Structured Interviews

Theme	**Representative Sub-Themes & Codes**	**Illustrative Participant Excerpt**
Autonomy & Ownership of Learning	Self-paced video review; Replay as study strategy; Reduced fear of falling behind	"I watch the video three or four times until I really understand it. In a regular class I would just be lost and move on." — Student 7
Enhanced Classroom Interaction	Peer explanation; Group problem-solving; Deeper teacher-student dialogue	"Class time now feels like a conversation. We actually argue about the concepts, and that helps me remember." — Student 14
Teacher Role Transformation	Facilitator vs. lecturer; Real-time diagnosis of misconceptions; Reduced front-of-class pressure	"When students come in already familiar with the content, I can immediately see who understood what. I spend my time where it matters." — Teacher 3
Technology Access Inequity	Device scarcity; Bandwidth barriers; Socioeconomic digital divide	"My classmates who do not have a phone at home are already behind before class even starts." — Student 22
Increased Cognitive Demand	Higher-order tasks; Problem-based in-class work; Metacognitive reflection	"The activities in class are harder than before, but in a good way. I actually have to think." — Student 31

Note. Excerpts are drawn verbatim from transcribed interviews. Student participants are identified by pseudonymous numbering; teacher participants are similarly coded to protect anonymity.

The first and most pervasive theme, autonomy and ownership of learning, captured the profound shift in student agency that participants attributed to the self-paced, repeated-viewing affordances of pre-class video content. Students with diverse learning paces, including those who identified as slow processors or those whose first language differed from the language of instruction, described the capacity to pause, rewind, and review instructional content as transformative, enabling them to arrive at class with a level of conceptual readiness that conventional homework had never facilitated.

The theme of enhanced classroom interaction quality documented students' and teachers' shared perception that in-class time had become qualitatively richer and more intellectually demanding. Participants from the experimental group consistently contrasted their flipped class experience with memories of conventional instruction, emphasizing the shift from passive note-taking to active problem-solving as the defining experiential difference. Teachers described a measurable change in the character of student questions: whereas conventional instruction elicited primarily clarificatory or procedural questions, the flipped class model generated more conceptual, analytical, and evaluative queries—a change teachers attributed to students arriving with baseline knowledge sufficient to engage at higher cognitive levels.

Teacher role transformation emerged as a theme of particular professional significance. Teachers implementing the flipped model described a reorientation of their professional identity from information deliverer to learning facilitator and diagnostic practitioner. Real-time circulation through collaborative activities, and the data made available by pre-class comprehension checks, enabled teachers to identify and address individual student misconceptions with a precision and immediacy that conventional whole-class lecturing structurally prevented. This theme directly corroborates the significant experimental group gains in conceptual understanding documented quantitatively, suggesting that targeted misconception remediation is a key mechanism of flipped learning's content-level effectiveness.

Technology access inequity, while less prominent numerically than the preceding themes, emerged with considerable emotional intensity in interviews with students from lower socioeconomic backgrounds and rural communities. These participants described the pre-class video viewing requirement as an additional burden that advantaged peers with superior device and connectivity access, and several expressed anxiety about falling behind peers during periods of internet unavailability. Teachers at the experimental school had attempted to mitigate access inequity through the distribution of pre-downloaded video files via USB drives, the designation of library computer terminals for pre-class preparation, and the provision of brief in-class video review opportunities—strategies that participants generally rated as helpful but insufficient.

The fifth theme, increased cognitive demand, captured a broadly shared perception that the flipped classroom asked more of students intellectually than conventional instruction, both in terms of the depth of engagement required for pre-class video preparation and the complexity of in-class collaborative tasks. While most participants experienced this increased demand as stimulating and motivating—consistent with Csikszentmihalyi's (1990) flow theory notion of optimal challenge, a minority of lower-achieving students described the cognitive load as at times overwhelming, particularly early in the intervention when the self-regulatory demands of the flipped model were novel and unfamiliar.

V. DISCUSSION

The results of this study provide robust convergent evidence, from both rigorous quasi-experimental analysis and rich qualitative inquiry, that flipped classroom instruction produces substantially superior learning outcomes compared to conventional lecture-based instruction in Philippine secondary science education. The magnitude of observed effects (between-group d ranging from 0.59 to 1.31) substantially exceeds the effect sizes reported in previous meta-analyses of flipped learning (Cheng et al., 2019; Hew & Lo, 2018; Lo & Hew, 2017), a difference that may reflect the particularly strong alignment between the intervention's instructional design and constructivist principles of active learning, as well as the relatively conservative academic baseline of the participant population, a factor that may have amplified the apparent benefit of a pedagogical approach that maximized in-class learning support.

The prominence of autonomy and ownership of learning as a qualitative theme provides important experiential grounding for the quantitative achievement gains observed. When students are enabled to pace and direct their own engagement with pre-class content, they arrive at collaborative in-class activities with individualized knowledge structures that are more stable, more elaborated, and more amenable to the higher-order processing that the in-class environment provides—a mechanism consistent with cognitive load theory (Sweller, 1988) and with Vygotsky's (1978) construct of the zone of proximal development. The fact that the largest effect size was observed for science achievement, the most knowledge-dependent outcome measure—further supports the interpretation that the pre-class knowledge acquisition affordance of the flipped model is a primary driver of academic gains.The significant treatment effect on critical thinking ($d = 1.16$) deserves particular attention, as it suggests that flipped instruction benefits not only content-level knowledge acquisition but also the development of transferable reasoning competencies that are not trivially attributable to increased instructional time or content exposure alone. This finding aligns with Prince's (2004) review of active learning research, which consistently documents superior gains in reasoning and problem-solving skills for active over passive instructional formats, and with the constructivist theoretical premise that genuine cognitive development requires engagement in challenging, authentic, and socially scaffolded intellectual activity, conditions that the flipped model's in-class collaborative tasks were specifically designed to provide.

The qualitative theme of technology access inequity introduces an essential critical perspective that the quantitative results alone would obscure. The statistically significant mean gains of the experimental group mask a dispersion of individual outcomes shaped in part by differential digital access, a dynamic that would only be fully captured by individual-level analyses or longer-term follow-up studies. The mitigating strategies employed by experimental school teachers (USB file distribution, library access designation, brief in-class video review) represent pragmatic responses to structural inequity, but they are inadequate substitutes for the equitable digital access that a fully realized flipped learning environment requires. These findings echo the broader literature on technology-mediated educational innovation in developing country contexts (World Bank, 2021;

UNESCO, 2021), which consistently identifies digital access inequality as the most consequential structural constraint on technology-inclusive pedagogical reform.

5.1. Limitations

The study's quasi-experimental design, while substantially strengthened by the use of pretest covariates and demographic equivalence testing, does not permit the causal certainty of a randomized controlled trial. The possibility of school-level confounders, such as differential teacher enthusiasm, administrative support, or school culture, cannot be fully excluded. The 12-week intervention period, while sufficient to detect meaningful learning effects, does not allow conclusions about the sustainability or long-term consolidation of observed gains. Self-report instruments, including engagement and self-efficacy scales, are subject to social desirability bias, which may have differentially inflated responses in the experimental condition. Finally, the study's geographic and institutional focus limits generalizability to other regional and sectoral contexts within the Philippines and to international settings with different digital infrastructure profiles.

VI. CONCLUSION AND RECOMMENDATIONS

This study contributes rigorous and contextually situated evidence that flipped classroom instruction, implemented with principled constructivist instructional design and consistent institutional support, produces large and practically significant improvements in secondary science achievement, conceptual understanding, critical thinking, student engagement, and academic self-efficacy. Qualitative findings illuminate the experiential mechanisms—enhanced learning autonomy, enriched classroom interaction, transformed teacher facilitation, and increased cognitive challenge—through which the flipped model achieves its quantitative effects, while simultaneously surfacing the structural digital equity barriers that constitute the most serious threat to the equitable distribution of flipped learning benefits.

On the basis of these integrated findings, the following recommendations are offered. First, secondary science departments should prioritize the adoption of flipped classroom models in subjects characterized by high conceptual density and prerequisite knowledge demands, providing teachers with structured professional development in both video content production and active learning facilitation design. Second, institutional and system-level policies must address digital access equity as a foundational prerequisite for technology-dependent pedagogical innovation: specific measures should include subsidized device lending programs, campus-based pre-class video preparation facilities, and offline content delivery mechanisms for students in low-connectivity communities. Third, flipped learning implementations should be accompanied by explicit self-regulation coaching for students, particularly in the early weeks of adoption, to reduce the cognitive load burden and academic anxiety experienced by learners transitioning from passive to active learning formats. Fourth, future research should employ true experimental designs with random assignment where feasible, extend intervention periods to at least one full academic year to assess learning consolidation, and use hierarchical linear modeling to examine how school-level and community-level factors moderate individual student responses to flipped instruction. Fifth, equity-focused analyses examining differential treatment effects by socioeconomic status and digital access level should be embedded as standard components of flipped learning impact evaluations in developing-country contexts.The flipped classroom model represents not merely a technological novelty or a pedagogical trend, but a principled and theoretically coherent framework for realizing the active, inquiry-based, and student-centered vision of science education that curriculum policy has long proclaimed but classroom practice has rarely achieved. The evidence presented in this study affirms that this vision is attainable, but its realization requires not only innovative instruction, but equitable access to the digital conditions that innovative instruction presupposes.

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Teachers' Perceptions towards Barriers Affecting Academic Performance of Students with Specific Learning Disability in Inclusive Schools

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Abstract

Specific Learning Disability is a disorder in which a child has deficits in listening, thinking, speaking, writing, spelling, or performing mathematical calculations. This study aims to assess teachers' perceptions of the barriers affecting the academic performance of students with Specific Learning Disability. In the present study, a purposive sampling method was employed to gather information, with a sample consisting of 30 government school teachers and 30 private school teachers from inclusive schools in the Delhi-NCR region. A structured, self-developed close-ended questionnaire was used for data collection. Quality education is a critical component of child development and a means of self-empowerment, independence, and social integration. Children with Specific Learning Disabilities are no exception; they also deserve equal educational opportunities like other children. The inclusion of all children within the classroom has introduced many new challenges for teachers. Many general education teachers lack the necessary skills and knowledge to effectively support children with Specific Learning Disabilities. The challenges faced by teachers that affect the academic performance of children with Specific Learning Disabilities include teachers' qualifications, experience, knowledge, and skills. It is suggested that teachers play a significant role in enhancing learning and developing effective teaching and learning strategies that contribute to equity and engagement for children with special needs.

Keywords: - Teachers Perceptions, Barriers, Academic Performance, Students with Specific Learning Disability.

I. INTRODUCTION

The United Nations (1948) declared that every child has the right to education. A major challenge is not only enrolling children in school but also ensuring the quality of education they receive. According to UNICEF (2001), children enrolled in primary education should complete their schooling and achieve expected learning outcomes in both quantity and quality. Children with Special Needs deserve equal educational opportunities like their peers. However, without adequate support, children with Specific Learning Disabilities face significant barriers in fulfilling their educational needs. It is essential to provide appropriate opportunities for their social and emotional development to ensure effective learning (UNICEF, 2003). The UNCRPD (2006) emphasizes that children with disabilities should not be excluded from the general education system. Although these children may have average intelligence, they experience difficulties in academic performance compared to their peers. This gap between potential and achievement necessitates the support of special educators. The Rights of Persons with Disabilities Act (2016) promotes dignity and equal participation in social, cultural, and educational domains. Similarly, the Salamanca Statement (1994) advocates that all children should learn together in regular classrooms. Teachers play a crucial role in creating an inclusive learning environment by connecting prior knowledge with new concepts, applying effective teaching methods, and encouraging active participation. However, many children, including those with special needs, continue to face restrictive learning environments (UNICEF, 2003).

1.1 Research Objectives

To examine teachers' perceptions of barriers affecting the academic performance of students with SLD.
To compare teachers' perceptions based on:

- Age
- Gender
- Type of teacher
- Nature of school

1.2. Significance of the Study

This study is significant as it provides valuable insights into teachers' perceptions of the barriers affecting the academic performance of students with Specific Learning Disability (SLD) in inclusive schools, thereby contributing to the fields of Inclusive Education and Special Education. By identifying challenges such as limited teacher training, inadequate resources, and difficulties in implementing appropriate instructional strategies, the study helps bridge the gap between inclusive education policies and classroom practices. The findings can inform educators, administrators, and policymakers in designing effective interventions, professional development programs, and support systems aligned with approaches like Differentiated Instruction and Individualized Education Program. Ultimately, the study aims to enhance teaching practices, improve academic outcomes for students with SLD, and promote equitable and effective inclusion within mainstream educational settings.

II. REVIEW OF RELATED LITERATURE

Kamps, D.M Barbetta, J. Eds., (2017) Planning for mainstreamed Special Education. In this study an integration strategy was used to improve reading skills of the Children with Special Needs and promote the peer interactions among the students with Special Needs and General Education students. They trained all the students in the Classroom also promote peer tutoring. Each week students were assigns tutoring partner and they assigned either red or blue team. The participants consisted three male Students with Specific Learning Disability enrolled full time in General Education classrooms in three inclusive elementary schools. There findings indicated the class wide peer tutoring were efficient strategy for increasing the academic achievement of the Students with Special Needs. The positively affected academic achievement for majority of students by increasing their reading fluency and correct response to reading comprehension questions. An additional positive findings were the occurrence appeared for influencing children socially and increasing duration of social interaction for time during unstructured and free time activity sessions. This was survey method design. It was concluded that proper attention towards children can improve their performance.

Motitswe (2012) Ed., Learning disabilities related disorders According to Motitswe the negative effects on the education will effects the capability to perform, lack of appropriate content, lack of appropriate learning materials, resources and assistive devices, inflexible ways of teaching, inappropriate ways of assessing student. One of the most serious barriers to the learning was found within curriculum itself and relates primarily to its inflexible nature. These measures prevent them from meeting the diverse learners needs hence such curriculum should be adapted to suit all learner principle of learner-centeredness must also be taken into considerations. This was survey method design. The initial results obtained from data were reasonably accurate.

Fallon, Zhang and Kim (2011) Eds., Using course assessments to train teacher's behavior assessment technique. According to them the study focused on training of teachers to managed the behaviors of Children with Specific Learning Disability in the inclusive classroom in china. The study view that many general education teachers lack the skills and knowledge to manage these challenging behaviors. This was survey method research. It was concluded specialist can handle Children with Specific Learning Disability more easily.

Sucuogluo Akalin and Sazak-Pinar Eds., (2010) Classroom management in inclusive classrooms. The inclusive classrooms in the study have at least one or more students diagnosed Children with Specific Learning Disability. Teachers was not properly trained to provide accommodations or modifications to meet the need of the child. This was experimental method. Even though mainstreaming the student, few teachers was properly trained to meet needs of students with disability. It was concluded that teacher should use appropriate teaching method.

Friend, Cook, Chamberlain, & Shamberger Eds., (2010) Co-teaching complexity of collaboration in Special Education. The researcher talks about the gifted children, slow learners, intellectual disability, hyperactive, emotionally challenged children. The diverse learners, classroom management will focus in delivering differentiated instruction as per the need of the child the teacher will handle needs individually in the classroom and this will make a regular education teacher's job beyond difficult. This was experimental method.

Glat and Blanco Ed., (2009) Curricular accommodations for Children with Special Need. They argue that appropriate curricular adaptations and accommodations was given as per the need of the student through the general participation and learning in classroom the student will actively participate. They agree with those authors who said that curricular accommodations will be necessary for participation of the students, but if curriculum was not properly designed to meet the specific needs then exclusion of few students in the general classrooms was possible. This was survey method research. The results show that appropriate curriculum should be uses while teaching.

Jenny & Snell Eds., (2008) The depth and scope of the teachers training was critical in determining the academic performance of Children with Specific Learning Disability. According to Meese (2002), a teacher with sufficient professional training has the ability and capability to adapt curriculum that is best suited for Children with Specific Learning Disability. This could be turned to contribute the improved academic performance of Children with Specific Learning Disability. Concluded that method should meet the need of the students.

III. METHODOLOGY

3.1. Research Design

This study employed a survey method research design aimed at assessing Teachers perceptions towards barriers affecting academic performance of Children with Specific Learning Disability in inclusive school.

3.2. Sample & Sampling Method

The population of the study consisted of General Education Teacher and Special Education teachers from Inclusive Schools, Delhi NCR. For the present study total 60 teachers (30 from Government Inclusive Schools & 30 from private Inclusive schools of Delhi NCR were taken. Purposive Sampling were used to collect a data.

3.3. Variables

3.3.1. Independent variables:

- Teachers' perception
- Age
- Gender
- Type of teacher
- Type of school

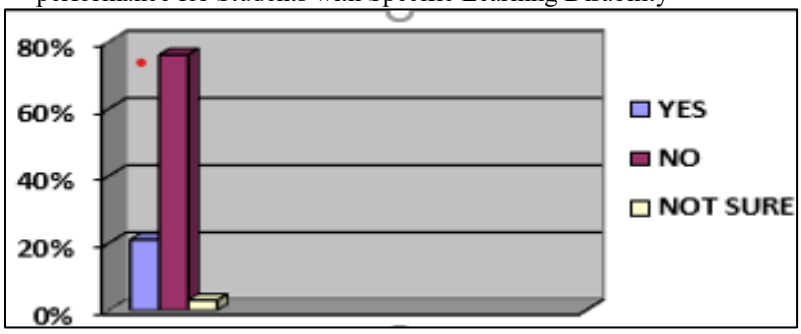
3.3.2. Dependent variable:

- Academic performance of children with Specific Learning Disability

3.4. Data Analysis

Objective 1 Perception of the Teachers towards the barriers affecting academic performance for Students with Specific Learning Disability

Fig 1: Perception of the Teachers towards the barriers affecting academic performance for Students with Specific Learning Disability



A significant proportion of teachers (76%) reported facing barriers in educating children with Specific Learning Disabilities (SLD), while 21% indicated no such challenges and 3% remained uncertain. This suggests that many teachers lack the necessary skills and training to effectively support these learners, which in turn contributes to their poor academic performance. Insufficient training in inclusive education limits teachers' ability to apply appropriate teaching strategies, thereby negatively impacting student outcomes. At the same time, the findings reflect a willingness among teachers to work toward inclusive goals, recognizing that children with SLD should be integrated into mainstream classrooms and actively participate in society rather than being excluded.

Differences were observed between government and private school practices. Private school teachers reported greater use of appropriate Teaching-Learning Materials (TLM) and Information and Communication Technology (ICT) tools to support students with SLD, whereas only a few government school teachers incorporated such resources. In terms of assessment, private school teachers employed a wider variety of methods, including tests, quizzes, assignments, and portfolios, while government school teachers relied on comparatively limited approaches. It was also noted that older-generation teachers tend to prefer traditional teaching methods and are less comfortable with technology. Additionally, private school teachers acknowledged that workload and deadlines can affect their health. Encouragingly, most teachers from both sectors participate in professional development activities such as workshops, seminars, and conferences on inclusive education, which help enhance their knowledge and teaching practices. Both groups also agreed that a lack of teacher knowledge adversely affects student performance and emphasized the importance of using fun and creative techniques to motivate children with SLD.

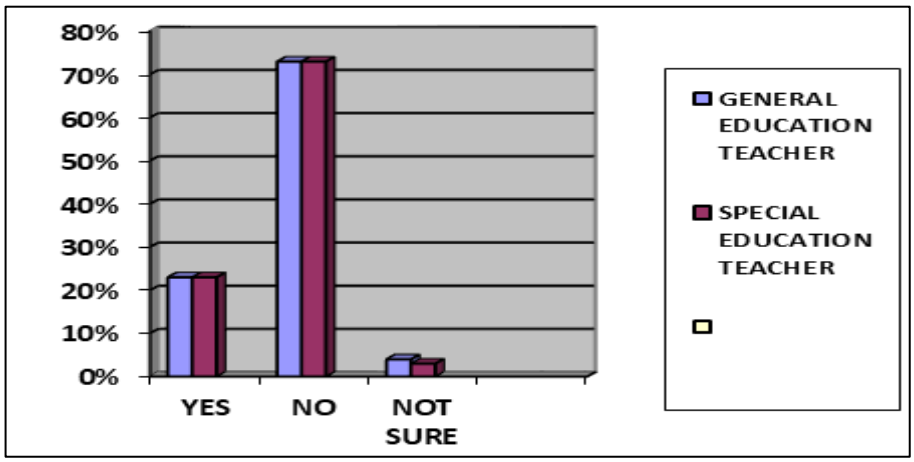
Objective 2 To compare the Perceptions of Teachers towards barriers affecting the academic performance for Children with Specific Learning Disability with reference to

- Age
- Gender

- Types of teachers
- Nature of school

i)Types of Teachers -General Education Teachers and Special Education Teachers

Fig 2. Perceptions of Teachers towards barriers affecting the academic performance for Children with Specific Learning Disability w r t General and Special Education Teachers



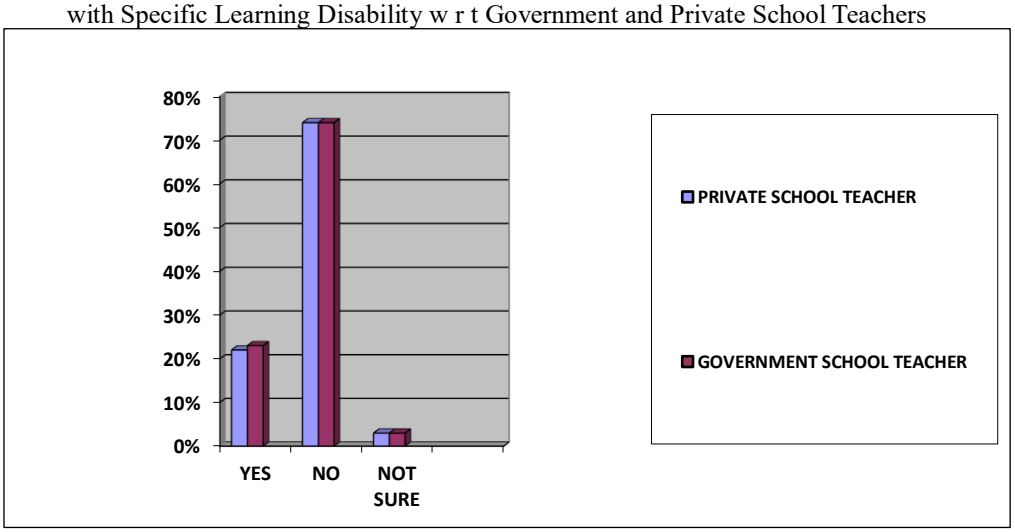
About 73% of teacher General Education Teachers and Special Education Teachers were not ready to integrate Children with Special Needs in an inclusive setup. The 23% of General Education Teachers and 24% Special Education Teachers are ready to include Children with Specific Learning Disability in an inclusive setup and 3% General Education Teachers and 4% Special Education Teachers are not sure.

It displayed that both General Education Teachers and Special Education Teachers has a very few differences in teaching Children with Specific Learning Disability they use more or less the same technique in an inclusive setup. They do not agree with the statement of including Children with Specific Learning Disability in an inclusive setup. The majority of General Education Teachers and Special Education Teachers are familiar with parallel teaching and co-teaching.

They use TLM for teaching Children with Specific Learning Disability. They variety of assessment methods used in classroom. The teacher does not consider themselves technology friendly. They also believe inclusion will increase their workload. There school does not provide OT, PT, Speech therapy. They do not have accessible classroom, disabled friendly washrooms, proper drinking facilities, ramps, tactile paths, proper signage for Children with Special Needs.

ii) Nature of school -Government School Teachers and Private School Teachers

Fig 3: Perceptions of Teachers towards barriers affecting the academic performance for Children with Specific Learning Disability w r t Government and Private School Teachers



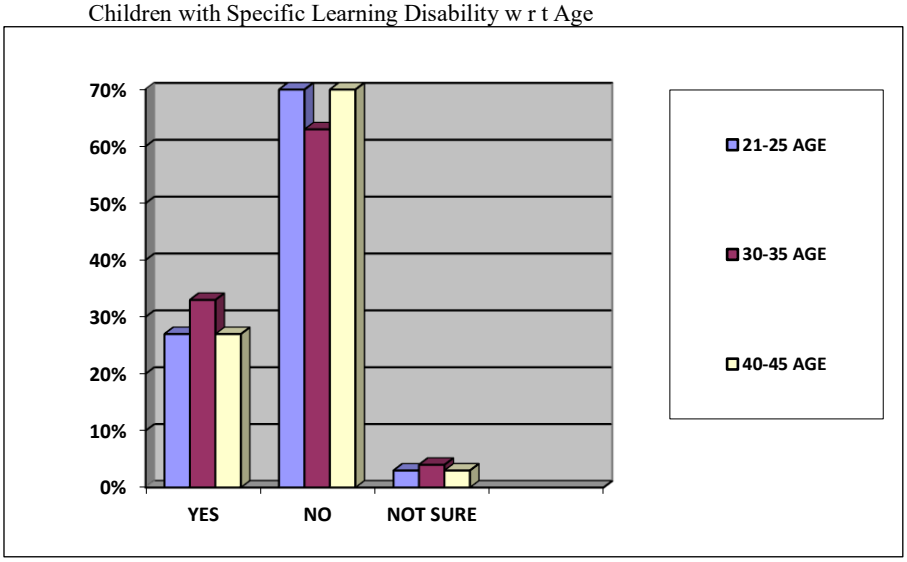
The 74% of Government School Teachers does not have accessible classroom, disabled friendly washrooms, proper drinking facilities, ramps, tactile paths, proper signage for Children with Special Needs. 23% agree with statement they follow ICT tools in the classroom. For their continuous professional development attend workshops, seminars and conferences and 3% are not sure.

The 74% Private School Teachers respond no for including Children with Specific Learning Disability in an inclusive setup. 22% of Private School Teachers does not have accessible classroom, disabled friendly washrooms, proper drinking facilities, ramps, tactile paths, proper signage and 3% are not sure. Teachers were familiar with parallel teaching and co-teaching. They are not ready to integrate Children with Special Needs. Both teachers apply fixed curriculum to all students. They use TLM for teaching Children with Specific Learning Disability. They variety assessment methods used in classroom.

They agree with statement they follow ICT tools in the classroom. For their continuous professional development attend workshops, seminars and conferences. The Government School Teachers and Private School Teachers use fun, creative technique to motivate the children. The Both provide opportunities for students to participate actively in classrooms. They do not agree with statement that General Teachers should be included with Special Educator while planning IEP. The Regular Teachers feel comfortable in approaching Special Educator for help when they teach Children with special needs.

iii) Age

Fig 4: Perceptions of Teachers towards barriers affecting the academic performance for Children with Specific Learning Disability w r t Age

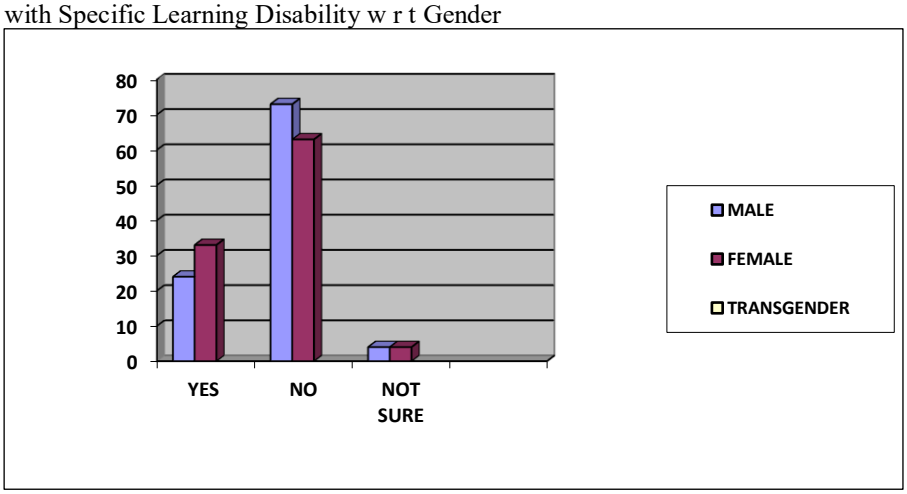


The age (21-25) about 70% of teachers faced barriers in handling Children with Specific Learning Disability in inclusive setup. 27% of teacher do not faced barriers in handling Children with Specific Learning and 3% are not sure.
63% of teachers age (30-35) are not ready to integrate Children with Specific Learning Disability in an inclusive setup. 33% teacher are familiar with parallel teaching and co-teaching and ready to integrate Children with Special Needs in an inclusive and 4% are not sure. 70% of teachers age (40-45) faced barriers in handling Children with Specific Learning Disability in inclusive setup. 27% teacher do not faced barriers in handling Children with Specific Learning Disability and 3% are not sure.

According to the teacher age group majority of teacher are not ready to integrate them. They faced barriers in dealing Children with Specific Learning Disability. Fixed curriculum applied to all the teachers. Majority of teacher do not use ICT in the class. They feel inclusion will increase their workload.

iv) Gender

Fig 5: Perceptions of Teachers towards barriers affecting the academic performance for Children with Specific Learning Disability w r t Gender



24% of Male Teachers are ready for inclusion. 73% faced barriers in handling Children with Specific Learning Disability in an inclusive setup and 4% are not sure. 33% of Female teachers do not faced any barriers in handling Children with Specific Learning Disability. 63% teachers faced barriers in handling Children with Specific Learning Disability and 4% are not sure. No transgender had fill the survey.

According to gender majority of teacher faced barriers in including Children with Specific Learning Disability in an inclusive set up. They do not have accessible classroom, disabled friendly washrooms, proper drinking facilities, ramps, tactile paths. They feel inclusion will increase their workload. They follow traditional method of teaching. Less teacher feels comfortable in approaching colleagues for help to teach. They do not use variety of assessment methods in the classroom.

IV. RESULTS

- In the first finding perception of the teachers towards the barriers affecting academic performance for Students with Specific Learning Disability is taken out and find that teacher proper knowledge, qualification, experience, skills, attitude become barrier in handling Children with Specific Learning Disability.
- In the second finding General Education Teachers and Special Education Teachers seen less teacher is ready to integrate Children with Specific Learning Disability in an inclusive setup.
- In the third finding Government School Teachers and Private School Teachers faced barriers in including Children with Specific Learning Disability in an inclusive setup. They do not have accessible classroom, disabled friendly washrooms, proper drinking facilities, ramps, tactile paths, proper signage for Children with Specific Learning Disability.
- In fourth finding teacher age shown according to age group which age group teachers are more flexible to integrate Children with Specific Learning Disability.
- In the fifth finding Gender is researched according to gender male and female teachers faced barriers in handling Children with Specific Learning Disability

V. DISCUSSION & CONCLUSION

The academic performance of children with Specific Learning Disabilities (SLD) is significantly influenced by teachers' knowledge, skills, and training. Inadequate preparation and the use of teaching methods that do not align with the individual needs of these learners can negatively impact their progress. Teacher-related factors such as qualifications, experience, and the appropriateness of the syllabus play a crucial role in shaping outcomes. When teachers possess the necessary expertise and practical experience, students with SLD tend to perform better academically. Conversely, an unsuitable or overly theoretical curriculum, combined with a lack of teaching aids, can hinder their development. Furthermore, insufficient school infrastructure including limited access to resource rooms, ramps, tactile paths, disabled-friendly facilities, and proper signage creates additional barriers that affect their learning experience.

Both general and special education teachers, in government as well as private schools, face challenges in effectively supporting children with special needs. A notable proportion of teachers remain hesitant to integrate students with SLD into inclusive classrooms, often citing increased workload and lack of resources. Barriers such as inadequate infrastructure, inaccessible classrooms, and insufficient facilities persist across school types. However, younger and middle-aged teachers tend to be better trained and more capable of addressing the needs of these students. While some teachers, regardless of gender, demonstrate awareness of inclusive teaching strategies, the overall lack of preparedness and institutional support continues to limit effective inclusion. Strengthening teacher training, improving infrastructure, and implementing a more adaptable and practical curriculum are essential steps toward enhancing the academic performance and inclusion of children with SLD.

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Mobile-Assisted Language Learning (MALL) and English Proficiency Development among ESL College Students: A Quasi-Experimental Mixed-Methods Study

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Abstract

Mobile-assisted language learning (MALL) has garnered increasing scholarly attention as a pedagogical approach that leverages the ubiquity and multimodal affordances of smartphones and language learning applications to support second language acquisition outside formal classroom boundaries. This study investigated the effects of a structured 14-week MALL intervention on English as a Second Language (ESL) college students' proficiency development, focusing on vocabulary knowledge, reading comprehension, listening and speaking competence, and grammar accuracy, while simultaneously examining student motivation and the experiential dimensions of MALL engagement. A quasi-experimental pretest-posttest nonequivalent control group design was employed with 218 first- and second-year college students at a Philippine State University, randomly assigned at the class section level to a MALL experimental group (n = 110) and a conventional instruction control group (n = 108). Analysis of covariance (ANCOVA) results demonstrated statistically significant and practically large advantages for the MALL group across all English proficiency sub-skills and overall proficiency (F values ranging from 44.28 to 87.46, all $p < .001$; partial η^2 ranging from .21 to .39). Multiple regression analysis further identified MALL usage frequency ($\beta = .45$), digital language self-efficacy ($\beta = .36$), learner motivation ($\beta = .29$), and perceived app usefulness ($\beta = .22$) as significant independent predictors of post-intervention English proficiency, collectively explaining 47% of outcome variance. Qualitative thematic analysis of semi-structured interviews with 42 participants yielded five core themes: authentic language exposure, learner autonomy and self-pacing, gamification and motivational engagement, social interaction and peer learning, and technology anxiety and access barriers. These findings collectively affirm the transformative potential of MALL for ESL proficiency development while underscoring the equity imperatives that must be addressed for MALL benefits to be equitably distributed. Implications for language curriculum design, institutional policy, and equitable digital access are discussed.

Keywords: - Mobile-Assisted Language Learning, MALL, English As A Second Language, ESL, English Proficiency, Second Language Acquisition, Gamification, Learner Autonomy, Higher Education, Philippines

I. INTRODUCTION

The global expansion of English as the dominant language of academic, professional, and cross-cultural communication has made English proficiency development one of the most consequential educational imperatives for higher education systems across the non-Anglophone world (Crystal, 2012; Jenkins, 2015). In the Philippines, a nation with a long history of English-medium instruction and a constitutional mandate for bilingual education, the persistent gap between official English-medium policy and the actual English proficiency levels of college graduates represents a challenge of both educational and economic significance (Bernardo, 2004; Tupas & Martin, 2017). Despite consistent exposure to English instruction throughout twelve years of pre-tertiary schooling, a substantial proportion of Filipino college students enter higher education with proficiency levels that fall below the communicative and academic thresholds required for effective participation in English-medium academic discourse (Commission on Higher Education [CHED], 2022).

The proliferation of mobile technology—and specifically the near-universal smartphone ownership among Filipino college students (Philippine Statistics Authority [PSA], 2023)—has created an unprecedented infrastructure for extending language learning contact hours beyond the confines of the formal classroom. Mobile-assisted language learning (MALL), broadly defined as the use of mobile devices and dedicated language learning applications to support second language acquisition processes, offers a theoretically compelling response to the contact hour limitation that constrains classroom-based ESL instruction (Burston, 2015; Demouy & Kukulska-Hulme, 2010; Stockwell & Hubbard, 2013).

Applications such as Duolingo, Busuu, Babbel, and Elsa Speak, among dozens of others, provide learners with gamified, adaptive, multimodal language practice environments accessible at any time and in any location—environments whose pedagogical affordances align closely with theoretically motivated principles of second language acquisition, including comprehensible input (Krashen, 1982), spaced repetition, interactional feedback, and autonomous learning (Doughty & Long, 2003; Nation & Newton, 2009).

Empirical research on MALL effectiveness has grown considerably over the past decade, yielding a body of evidence that is broadly positive but marked by important methodological and contextual limitations. Meta-analytic syntheses consistently report moderate to large effects of MALL on vocabulary acquisition and reading comprehension outcomes (Burston, 2015; Lin & Lin, 2019; Shadiev et al., 2020), while studies examining MALL effects on speaking and listening competencies report more variable findings, partly attributable to inconsistencies in app selection, intervention duration, and learner engagement monitoring (Godwin-Jones, 2017; Lan, 2020). The majority of large-scale MALL studies have been conducted in Chinese, Turkish, Iranian, or Western university contexts; studies examining MALL effectiveness in Southeast Asian higher education systems, and particularly in the Philippines, remain comparatively rare, limiting the contextual transferability of existing findings (Arinto, 2016; Reinders & Pegrum, 2015).

This study addresses this gap by employing a quasi-experimental mixed-methods design to rigorously examine the effects of a 14-week structured MALL intervention on multiple dimensions of ESL proficiency among Filipino college students. The investigation is theoretically grounded in Krashen's (1982) Input Hypothesis and Interaction Hypothesis (Long, 1996), which together identify comprehensible, contextualized, and interactionally rich language input as the primary mechanism of second language acquisition—a theoretical frame that maps directly onto the authentic, adaptive, and interactive input environments that contemporary language learning applications seek to provide. The study additionally draws on Self-Determination Theory (SDT; Deci & Ryan, 2000), which attributes sustained learning engagement to the satisfaction of three basic psychological needs autonomy, competence, and relatedness—all of which MALL environments, through their self-pacing, adaptive difficulty, and social learning features, are designed to support.

1.1. Research Questions

This study was guided by the following research questions:

- Does a structured MALL intervention produce significantly greater gains in overall English proficiency and in the sub-skill domains of vocabulary, reading, listening and speaking, grammar, and learner motivation compared to conventional instruction?
- Which learner-level and technology-level variables significantly predict post-intervention English proficiency?
- How do ESL college students experientially describe the mechanisms, benefits, and challenges of MALL engagement?

1.2. Significance of the Study

This study makes contributions at three levels. Theoretically, it extends MALL research to the underexplored Philippine college ESL context, providing an empirical test of SLA input and interaction theories and Self-Determination Theory in a MALL setting characterized by conditions, high smartphone penetration but uneven digital infrastructure quality, that differ substantially from contexts in which most MALL theory has been developed. Methodologically, the convergent mixed-methods design enables a level of interpretive completeness that purely quantitative MALL impact studies rarely achieve, linking statistical effect sizes to the experiential mechanisms and contextual contingencies that produce them. Practically, findings provide language program administrators, ESL teachers, and national education policymakers with evidence-based guidance for integrating MALL into college English curricula in equitable, pedagogically principled, and institutionally sustainable ways.

II. REVIEW OF RELATED LITERATURE

2.1. Theoretical Foundations of Mall

Mobile-assisted language learning sits at the intersection of several robust theoretical traditions in applied linguistics and educational technology. Krashen's (1982) Input Hypothesis posits that second language acquisition occurs when learners receive comprehensible input at a level slightly beyond their current competence—a condition formally expressed as i+1. MALL applications operationalize this hypothesis through adaptive algorithms that dynamically adjust the difficulty of presented language items based on real-time performance data, theoretically ensuring that learners are consistently exposed to input at the optimal acquisition-facilitative difficulty level (Nation & Newton, 2009; Reinders & Pegrum, 2015). Long's (1996) Interaction Hypothesis extends the input framework by identifying negotiation of meaning in interactive communication as the primary mechanism through which comprehensible input is converted into acquisition, a mechanism that MALL environments partially instantiate through chatbot-mediated conversation practice, peer correction features, and automated pronunciation feedback systems (Godwin-Jones, 2017; Lan, 2020).

Self-Determination Theory (Deci & Ryan, 2000) provides a motivational framework that is particularly illuminating for understanding MALL engagement. SDT posits that human motivation is fundamentally driven by the satisfaction of three basic psychological needs: autonomy (the experience of self-directed action), competence (the experience of mastery and

efficacy), and relatedness (the experience of meaningful social connection). Well-designed MALL applications address each of these needs through specific design features: autonomy through anytime-anywhere self-paced access; competence through adaptive difficulty calibration, spaced repetition algorithms, and visible progress metrics; and relatedness through social leaderboards, peer challenges, and community forums (Dörnyei & Ushioda, 2011; Reinders & Pegrum, 2015). The alignment between SDT-identified motivational needs and MALL design principles provides a theoretically coherent account of the motivational advantages of MALL over traditional classroom instruction that the present study empirically examines.

2.2. Empirical Evidence on MALL and Language Proficiency

Meta-analytic reviews of MALL effectiveness report consistently positive, if variable, effects across language skill domains. Lin and Lin (2019) synthesized 56 studies on MALL and vocabulary acquisition, reporting a mean effect size of d = 0.72, with significantly larger effects observed when MALL was used as a supplement to classroom instruction rather than as a standalone learning modality. Shadiev et al. (2020) examined MALL effects on listening and speaking skills across 34 quasi-experimental studies, reporting a mean effect of d = 0.58 with high heterogeneity attributable to differences in application type, usage frequency, and learner proficiency level. Burston's (2015) comprehensive review of 79 MALL studies spanning 2003 to 2014 concluded that MALL consistently produced positive language learning outcomes, but emphasized that the educational significance of these effects was contingent upon pedagogical integration quality: MALL used within a coherent instructional framework produced substantially larger effects than MALL used as an unregimented supplement with no classroom connection.

Research specifically examining the motivational effects of gamified MALL applications—those incorporating points, badges, streaks, and leaderboard features—has reported particularly strong positive outcomes for learner engagement and intrinsic motivation (Dehaan et al., 2010; Shortt et al., 2021). Shortt et al. (2021) conducted a systematic review of 27 studies on gamified MALL, reporting that gamification features consistently increased daily practice frequency, session duration, and self-reported learning enjoyment, with motivational benefits translating into measurable proficiency gains in 22 of the 27 reviewed studies. The mechanism underlying gamification's motivational efficacy appears to operate primarily through competence need satisfaction—the experience of visible, incremental mastery signaled by reward accumulation and rank progression (Deci & Ryan, 2000; Dehaan et al., 2010).

2.3. MALL in Southeast Asian ESL Contexts

Research on MALL in Southeast Asian higher education contexts has grown in recent years but remains geographically concentrated in Thailand, Malaysia, and Indonesia, with the Philippines being comparatively underrepresented (Arinto, 2016; Reinders & Pegrum, 2015). Studies in Thai and Malaysian university ESL contexts have reported positive MALL effects on vocabulary and grammar outcomes consistent with global meta-analytic findings (Khwaileh et al., 2019; Yousefi & Bao, 2020), while simultaneously documenting context-specific moderating factors including uneven mobile data affordability, variable instructor technological self-efficacy, and the cultural dimension of face-saving in digitally mediated speaking practice. In the Philippine context specifically, Arinto (2016) documented the potential of mobile learning to extend quality educational access in a geographically fragmented archipelagic nation, while also identifying infrastructural inequity as the primary barrier to equitable MALL implementation—a barrier that institutional and policy responses have thus far addressed only partially and inconsistently (CHED, 2022; PSA, 2023).

III. METHODOLOGY

3.1. Research Design

This study employed a quasi-experimental pretest-posttest nonequivalent control group design (Shadish et al., 2002), nested within a qualitative descriptive case study framework, constituting an explanatory convergent mixed-methods design (Creswell & Plano Clark, 2018). Random assignment occurred at the intact class section level rather than at the individual student level—a pragmatic compromise necessitated by institutional scheduling and timetabling constraints—with statistical controls for pre-existing group differences applied through ANCOVA at the analysis stage. The qualitative component was designed to provide mechanistic and experiential explanation of the quantitative outcome patterns, consistent with a complementary mixed-methods purpose (Greene et al., 1989).

3.2. Participants

Two hundred eighteen (218) first- and second-year college students enrolled in mandatory English communication subjects at a Philippine state university participated in the study. Six intact class sections were randomly assigned at the section level to the MALL experimental group (three sections, n = 110) or the conventional instruction control group (three sections, n = 108). Table 1 presents the demographic profile of both groups, confirming pre-intervention equivalence on all measured baseline variables.

Table 1. Demographic Profile and Baseline Characteristics of MALL and Control Group Participants

Variable	**MALL Group n = 110**	**Control Group n = 108**	**Total N = 218**	**Test Statistic (p-value)**
Sex				
Male	54 (49.1%)	52 (48.1%)	106 (48.6%)	
Female	56 (50.9%)	56 (51.9%)	112 (51.4%)	$\chi^2 = 0.02$, p = .88
Year Level				
First Year	56 (50.9%)	55 (50.9%)	111 (50.9%)	
Second Year	54 (49.1%)	53 (49.1%)	107 (49.1%)	$\chi^2 = 0.00$, p = 1.00

Age (years)				
M (SD)	18.76 (0.91)	18.71 (0.88)	18.74 (0.89)	t = 0.38, p = .70
English Pretest Score				
M (SD)	61.43 (7.28)	61.19 (7.35)	61.31 (7.30)	t = 0.22, p = .82
Smartphone Ownership				
Yes	104 (94.5%)	101 (93.5%)	205 (94.0%)	χ^2 = 0.09, p = .77

Note. MG = MALL Group; CG = Control Group. χ^2 tests applied to categorical variables; independent-samples t-tests applied to continuous variables. No significant between-group differences were found on any baseline variable (all p > .05), supporting pre-intervention equivalence.

3.2.1 Qualitative Sub-Sample

Forty-two participants were purposively selected for the qualitative strand: 36 students (18 per group) representing maximum variation in English proficiency level and MALL engagement intensity, and 6 English faculty members who taught the participating class sections. All qualitative participants provided separate informed consent for individual interview participation.

3.3. Mall Intervention Protocol

The experimental group participated in a 14-week structured MALL program integrated into their regular English communication course.
The intervention comprised three components:

- Assigned MALL application use: Students were required to complete a minimum of 30 minutes of targeted practice per day on three designated applications, Duolingo (vocabulary and grammar), Elsa Speak (pronunciation and listening), and Busuu (conversational English and reading), monitored through weekly screenshots of app progress dashboards submitted via the class LMS.
- MALL reflection journals: Students maintained weekly digital journals (3 to 5 sentences) reflecting on their app-based learning experiences, challenges encountered, and self-identified vocabulary or grammar items for classroom follow-up.
- MALL-classroom integration activities: Each class session began with a 10-minute consolidation activity designed by the course instructor to bridge pre-class MALL practice with in-class communicative tasks, including vocabulary review games, pronunciation peer-feedback exercises, and discussion of MALL journal entries.

The control group continued to receive conventional classroom instruction exclusively, with homework consisting of textbook exercises and written assignments prescribed by the course syllabus.

3.4. Instruments

English proficiency was assessed using the CHED-aligned Collegiate English Proficiency Assessment (CEPA), a 100-item instrument comprising vocabulary (25 items), reading comprehension (30 items), listening (20 items), and grammar (25 items) sub-sections, with established content validity (CVI = .92) and satisfactory internal consistency (Cronbach's α = .89 in the current sample). Listening and speaking were assessed jointly using a 10-minute individual oral communication task scored against a validated analytic rubric (inter-rater reliability ICC = .87). Learner motivation was measured using the 20-item Motivated Strategies for Language Learning Questionnaire—Short Form (MSLQ-SF; Pintrich et al., 1993; α = .86 in the current sample). Digital language self-efficacy was assessed via a 12-item scale adapted from Compeau and Higgins (1995) and validated for language learning contexts (α = .84). All instruments were administered as pretests in Week 1 and post-tests in Week 14.

3.5. Data Collection and Analysis

Quantitative data were analyzed using IBM SPSS Statistics version 27 and R version 4.3.1. ANCOVA was conducted for each outcome variable, with pretest scores as covariates and group condition as the fixed factor. Assumptions of normality, homogeneity of variance, and homogeneity of regression slopes were verified and confirmed. Effect sizes were estimated using partial eta squared (η^2p) and Cohen's d. Multiple regression analysis was subsequently conducted with all post-test proficiency scores as the dependent variable to identify significant learner-level and technology-level predictors. Qualitative data were analyzed using Braun and Clarke's (2006, 2019) reflexive thematic analysis. Trustworthiness was enhanced through member checking, peer debriefing, and the construction of a joint display matrix integrating quantitative and qualitative findings (Guetterman et al., 2015).

IV. RESULTS

4.1. Pre-Intervention Group Equivalence

As detailed in Table 1, independent samples t-tests and chi-square tests confirmed no statistically significant differences between the MALL and control groups on any demographic or baseline academic variable (all p > .05). Mean English pretest scores were virtually identical across groups (MG: M = 61.43, SD = 7.28; CG: M = 61.19, SD = 7.35; t = 0.22, p = .82), establishing the pre-intervention equivalence necessary for valid between-group comparisons. These findings substantially reduce the plausibility of selection bias as a threat to the internal validity of subsequent intervention effect estimates.

4.2. ANCOVA Results: MALL Effects on Language Proficiency and Motivation

Table 2 presents descriptive statistics for all outcome variables at pretest and post-test by group condition, alongside ANCOVA F-statistics and effect size estimates.

Table 2. Descriptive Statistics and ANCOVA Results for English Proficiency Outcomes and Learner Motivation by Group and Time Point

Outcome	MG Pre M (SD)	MG Post M (SD)	CG Pre M (SD)	CG Post M (SD)	F	p / η^2p
Overall English Proficiency	61.43 (7.28)	78.19 (6.84)	61.19 (7.35)	67.34 (7.12)	87.46	p < .001, η^2p = .39
Vocabulary Knowledge	58.71 (8.14)	76.88 (7.43)	58.44 (8.20)	65.62 (7.84)	71.33	p < .001, η^2p = .33
Reading Comprehension	63.20 (7.91)	79.44 (7.12)	62.97 (7.88)	68.83 (7.65)	62.14	p < .001, η^2p = .29
Listening & Speaking	57.88 (9.03)	75.61 (8.27)	58.02 (8.97)	64.19 (8.71)	54.87	p < .001, η^2p = .25
Grammar Accuracy	62.55 (7.64)	77.92 (7.08)	62.30 (7.59)	68.47 (7.33)	49.61	p < .001, η^2p = .23
Learner Motivation	3.48 (0.67)	4.31 (0.58)	3.45 (0.64)	3.71 (0.62)	44.28	p < .001, η^2p = .21

Note. MG = MALL Group; CG = Control Group. F values reflect ANCOVA results with pretest scores as covariate and group as fixed factor. All F tests significant at p < .001. η^2p = partial eta squared. Overall English Proficiency, Vocabulary, Reading, Listening & Speaking, and Grammar scored on 0–100 scale; Learner Motivation scored on 1–5 scale.

ANCOVA results confirmed significant MALL treatment effects on all six outcome variables. The largest effect was observed for overall English proficiency ($F(1, 215) = 87.46$, $p < .001$, $\eta^2p = .39$), with the MALL group achieving a post-test mean of 78.19 (SD = 6.84) compared to 67.34 (SD = 7.12) for the control group—a difference of 10.85 points after controlling for baseline proficiency. Substantial effects were similarly observed for vocabulary knowledge ($F = 71.33$, $\eta^2p = .33$), reading comprehension ($F = 62.14$, $\eta^2p = .29$), and listening and speaking ($F = 54.87$, $\eta^2p = .25$). Learner motivation, while yielding the smallest effect, was nonetheless significantly enhanced in the MALL group ($F = 44.28$, $\eta^2p = .21$; MG post: M = 4.31 vs. CG post: M = 3.71). These findings collectively confirm that structured MALL integration produces practically significant improvements across the full spectrum of ESL proficiency skill domains.

4.3. Predictors of Post-Intervention English Proficiency: Multiple Regression

A simultaneous multiple regression analysis examined the independent contributions of six theoretically motivated predictor variables to post-intervention English proficiency, controlling for baseline proficiency. Results are presented in Table 3.

Table 3. Multiple Regression Analysis: Predictors of Post-Intervention English Proficiency (N = 218)

Predictor Variable	B	SE B	β	t	p / 95% CI
MALL Usage Frequency	4.71	0.51	.45	9.24	< .001 [3.71, 5.71]
Digital Language Self-Efficacy	3.88	0.49	.36	7.92	< .001 [2.92, 4.84]
Learner Motivation (Post)	3.14	0.55	.29	5.71	< .001 [2.06, 4.22]
Perceived App Usefulness	2.63	0.60	.22	4.38	< .001 [1.45, 3.81]
Instructor Integration Quality	2.28	0.62	.19	3.68	.001 [1.06, 3.50]
Perceived Ease of Use	0.94	0.58	.08	1.62	.107 [-0.20, 2.08]
Model Summary: $R^2 = .47$, Adjusted $R^2 = .46$, $F(6, 210) = 31.14$, $p < .001$					

Note. Dependent variable = Overall English Proficiency post-test score (CEPA), controlling for pretest score (not shown). β = standardized regression coefficient. All predictors entered simultaneously. CI = 95% confidence interval for unstandardized B. *Perceived Ease of Use was not a significant independent predictor (p = .107) when other variables were controlled.

The regression model was statistically significant ($F(6, 210) = 31.14$, $p < .001$) and explained 47% of variance in post-intervention English proficiency ($R^2 = .47$, adjusted $R^2 = .46$). MALL usage frequency was the strongest predictor ($\beta = .45$, $p < .001$), followed by digital language self-efficacy ($\beta = .36$, $p < .001$), learner motivation ($\beta = .29$, $p < .001$), perceived app usefulness ($\beta = .22$, $p < .001$), and instructor integration quality ($\beta = .19$, $p = .001$). Perceived ease of use failed to reach statistical significance as an independent predictor when all other variables were controlled ($\beta = .08$, $p = .107$), suggesting that ease of use exerts its influence on proficiency indirectly through its effect on usage frequency rather than as a direct performance-enhancing mechanism.

4.4. Qualitative Findings: Thematic Analysis

Reflexive thematic analysis of 42 semi-structured interviews produced five overarching themes. Table 4 presents each theme with representative sub-themes, codes, and verbatim participant excerpts.

Table 4. Qualitative Themes, Sub-Themes, and Representative Participant Excerpts from Semi-Structured Interviews

Theme	Key Sub-Themes & Codes	Illustrative Participant Quote
Authentic Language Exposure	Real-world content; Native speaker input; Contextual vocabulary acquisition; Multimodal input	"When I use the app, I am exposed to how English is actually used — not just textbook sentences. I learn words from songs, news clips, real conversations." — Student 9
Learner Autonomy & Self-Pacing	Personalized learning pace; Anytime-anywhere access; Voluntary repeated practice; Self-directed review	"I study English at midnight after work. No one is judging my pronunciation. I just practice until I feel confident." — Student 17

Gamification & Motivational Engagement	Streak rewards; Leaderboard competition; Badges and points; Intrinsic satisfaction from progress tracking	"The streaks and points make me want to practice every day. It does not feel like homework. It feels like a challenge I want to win." — Student 24
Social Interaction & Peer Learning	In-app discussion forums; Peer correction; Collaborative storytelling tasks; Shared language goals	"We have a group chat where we share funny mistakes and correct each other. I learned more from my classmates' feedback than from some corrections in class." — Student 33
Technology Anxiety & Access Barriers	App navigation difficulty; Data cost burden; Device incompatibility; Digital fatigue	"My phone is old and the app crashes often. I cannot do the listening tasks properly. It is discouraging when technology becomes the barrier." — Student 41

Note. Participant excerpts are reproduced verbatim from interview transcripts. Student participants are identified by sequential numbers; faculty participants are coded separately to protect anonymity. N = 42 interview participants (36 students, 6 faculty).

The theme of authentic language exposure captured the most consistently expressed experiential benefit of MALL among student participants. Unlike textbook-mediated classroom instruction, which students frequently described as presenting English in artificial, decontextualized formats, MALL applications exposed learners to the full range of English as it is actually spoken, written, and used in everyday, professional, and media contexts. This theme provides experiential grounding for the vocabulary knowledge gains documented quantitatively, consistent with Nation and Newton's (2009) argument that incidental vocabulary acquisition from rich contextual exposure is the most efficient and durable mechanism of lexical development.

Learner autonomy and self-pacing emerged as a particularly transformative benefit for students whose learning needs, schedules, and paces were poorly served by the homogenizing temporal structure of classroom instruction. Working students, students with long commutes, students who identified as anxious oral communicators, and students from non-English-speaking home environments all described MALL as enabling a more personally calibrated engagement with English practice than classroom instruction could provide. This theme directly corroborates Deci and Ryan's (2000) SDT account of autonomy need satisfaction as a primary driver of sustained motivation—and provides mechanistic explanation for the significant motivation gains observed in the quantitative strand.

Gamification and motivational engagement was the most vigorously expressed theme among participants under the age of 20. Students described the streak, badge, and leaderboard features of Duolingo and Busuu in particular as sources of daily motivational momentum that they experienced as qualitatively distinct from, and more compelling than, the extrinsic grade-based incentives of classroom assessment. Faculty participants corroborated this theme, describing observable increases in MALL group students' self-initiated English use in class, a behavioral change they attributed to the confidence and vocabulary breadth developed through daily app-based practice.

Social interaction and peer learning documented an unanticipated but theoretically meaningful aspect of MALL engagement: the emergence of informal peer learning communities organized around MALL practice, in which students shared app recommendations, compared progress metrics, corrected each other's written productions in class WhatsApp groups, and collaboratively troubleshot technical difficulties. These peer learning networks instantiate Long's (1996) Interaction Hypothesis in a digitally extended social space, one not explicitly designed into the intervention but spontaneously constructed by learners whose social motivation for language learning found expression in technology-mediated peer interaction.

Technology anxiety and access barriers introduced an essential critical note that the otherwise positive picture of MALL benefits would otherwise obscure. Students with older devices, those with limited mobile data budgets, and those with lower prior digital experience described persistent technical frustrations, app crashes, buffering during audio tasks, incompatible operating system versions, that disrupted their practice continuity and generated learning-interfering anxiety. These access barriers were differentially distributed along socioeconomic lines, with students from lower-income families significantly more likely to report technology-related learning disruption, a pattern that echoes the digital equity concerns documented in the MALL literature and in Philippine technology access research (PSA, 2023; UNESCO, 2021).

V. DISCUSSION

The findings of this study provide convergent, multi-method evidence for the efficacy of structured MALL integration in college ESL instruction, with intervention effects that are not only statistically significant but practically large and educationally meaningful across all measured proficiency and motivation outcomes. The magnitude of observed effects, with partial η^2 values ranging from .21 to .39 and Cohen's d between-group estimates exceeding 1.0 for overall English proficiency, substantially exceeds the effect sizes reported in global meta-analyses of MALL (Burston, 2015; Lin & Lin, 2019), a difference attributable, in part, to the particularly strong pedagogical integration design of the present intervention, which connected daily MALL practice to classroom consolidation activities and metacognitive reflection journals rather than permitting MALL use as an unmonitored supplement.

The identification of MALL usage frequency as the strongest predictor of proficiency outcomes ($\beta = .45$) is theoretically consistent with Krashen's (1982) Input Hypothesis, which predicts a monotonic relationship between exposure to comprehensible input and acquisition—more input, more acquisition. It is also pedagogically significant: it suggests that institutional and instructional strategies designed to increase MALL contact hours (minimum daily usage requirements, progress monitoring through LMS integration, peer accountability structures) may yield direct proficiency dividends that are not captured by one-time or low-intensity MALL implementations. This finding directly addresses the critique leveled by Burston (2015) at low-frequency MALL studies—that insufficient dosage is a primary cause of null or weak effects in the MALL literature.

The significant predictive contribution of digital language self-efficacy (β = .36) extends the language learning self-efficacy literature (Bandura, 1997; Dörnyei & Ushioda, 2011) to the MALL domain, confirming that learners' beliefs about their capacity to effectively use mobile technology for language learning are not merely attitudinal epiphenomena but consequential determinants of the frequency, depth, and persistence of MALL engagement. The practical implication is that institutional MALL programs should incorporate structured digital self-efficacy development activities—particularly for first-generation smartphone users or students from low-technology home environments—as a prerequisite for maximizing proficiency returns on MALL investment.

The qualitative theme of technology anxiety and access barriers introduces a critical limitation that the aggregate quantitative results, by averaging across the full sample, systematically obscure. For the subset of students whose MALL engagement was persistently disrupted by device inadequacy or data cost constraints, the intervention may have delivered no measurable benefit, or may even have introduced additional learning-interfering anxiety that conventional instruction did not. This differential impact, if confirmed by subgroup analyses in future studies, would imply that the impressive aggregate MALL effects documented here are partly a product of the favorable technological circumstances of the majority, and that the students who most need enhanced language learning support (those who are already academically vulnerable) may be least able to access the intervention conditions under which MALL delivers its documented benefits.

5.1 Limitations

This study carries several limitations that bound the interpretation and generalizability of its findings. The quasi-experimental design with section-level rather than individual-level randomization introduces the possibility that unmeasured between-section differences, in instructor enthusiasm, peer culture, or class scheduling, may have contributed to observed group differences. The self-report nature of MALL usage monitoring (progress dashboard screenshots) is subject to manipulation and does not capture the quality or intentionality of engagement within reported time metrics. The 14-week intervention period, while sufficient for detecting short-term proficiency gains, does not permit conclusions about the sustainability of MALL effects or the long-term retention of acquired language knowledge. The study's focus on a single Philippine state university constrains generalizability to other institutional, regional, and national contexts.

VI. CONCLUSION AND RECOMMENDATIONS

This study provides robust convergent evidence that structured MALL integration, characterized by minimum daily usage requirements, reflective journaling, and explicit MALL-classroom bridging activities, produces large and educationally significant improvements in ESL college students' English proficiency across vocabulary, reading, listening, speaking, and grammar domains, while simultaneously enhancing learner motivation and self-efficacy. Qualitative findings illuminate the experiential pathways through which these gains are achieved: authentic language exposure, autonomous self-pacing, gamification-driven motivational momentum, and peer social learning networks spontaneously constructed around shared MALL practice. Simultaneously, the equity implications of technology-mediated language learning are made visible through the lived experiences of students whose access barriers disrupted the very engagement patterns that MALL's proficiency benefits depend upon.

On the basis of these integrated findings, the following recommendations are offered. First, English program administrators and curriculum designers should adopt MALL as a structured supplementary component of college ESL courses rather than as an optional or incidental activity, specifying minimum daily usage requirements, providing clear pedagogical rationale for application selection, and designing explicit classroom activities that integrate and build upon out-of-class MALL engagement. Second, institutions should invest in digital self-efficacy development workshops at orientation, with follow-up coaching sessions for students who report persistent technology anxiety or access difficulty. Third, national education policy must address the structural preconditions of equitable MALL access: device lending programs, subsidized mobile data plans for enrolled students, campus Wi-Fi expansion, and offline app functionality mandates in procurement criteria for institutionally recommended MALL applications. Fourth, researchers should prioritize longitudinal designs to examine the retention and transfer of MALL-acquired proficiency, employ experience sampling methods to capture real-time MALL engagement quality, and conduct differential efficacy analyses examining MALL effects by socioeconomic status, device quality, and digital self-efficacy level to build a more equity-attentive evidence base. Fifth, faculty development programs should equip ESL instructors with the technological, pedagogical, and motivational competencies needed to effectively integrate, monitor, and bridge MALL activities within coherent instructional frameworks.

Mobile devices have become the most democratically distributed educational technology in human history. Their transformative potential for language education, and specifically for the ESL proficiency development of millions of college students across the non-Anglophone world, is real, empirically documented, and theoretically coherent. Realizing that potential equitably, however, requires far more than application selection: it demands the pedagogical intentionality, institutional support, and structural equity commitments that this study affirms as the true determinants of MALL's educational significance.

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Teacher Burnout, Psychological Well-Being, and Instructional Quality in Philippine Basic Education: A Mixed-Methods Hierarchical Regression Study

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Abstract

Teacher burnout represents one of the most consequential and globally prevalent threats to the sustainability, quality, and equity of basic education systems, yet its specific predictors, manifestations, and consequences within the Philippine educational context remain empirically understudied. This study examined the relationships among teacher burnout dimensions, psychological well-being, workload stress, and instructional quality among 310 elementary and secondary school teachers in Central Luzon, Philippines, using a sequential explanatory mixed-methods design. Quantitative data were collected using the Maslach Burnout Inventory, Educators Survey (MBI-ES), the Psychological Well-Being Scale (PWBS), the Teacher Instructional Quality Scale (TIQS), and a validated Workload Stress Inventory, and were analyzed using descriptive statistics, Pearson correlation analysis, and hierarchical multiple regression. Qualitative data were gathered through 40 in-depth semi-structured interviews with purposively selected teachers, analyzed using reflexive thematic analysis. Hierarchical regression analysis revealed that burnout dimensions, emotional exhaustion ($\beta = -.36$), depersonalization ($\beta = -.24$), and personal accomplishment ($\beta = .26$), collectively explained 31% of variance in instructional quality above demographic controls, with psychological well-being ($\beta = .25$) and workload stress ($\beta = -.18$) contributing an additional 11%. The full regression model accounted for 48% of variance in instructional quality ($R^2 = .48$, $F(9, 300) = 30.77$, $p < .001$). Qualitative themes illuminated five dimensions of the burnout-instruction nexus: emotional drain and loss of passion, administrative overload and role conflict, social support as a protective buffer, coping through purposefulness, and constrained instructional agency. Findings carry urgent implications for teacher mental health policy, school leadership practice, and the systemic conditions that either sustain or erode teacher professional vitality. Evidence-based recommendations for institutional burnout prevention, workload rationalization, and psychologically supportive school environments are presented.

Keywords: - Teacher Burnout, Emotional Exhaustion, Instructional Quality, Psychological Well-Being, Workload Stress, Maslach Burnout Inventory, Basic Education, Philippines, Teacher Well-Being, Mixed-Methods

I. INTRODUCTION

Teaching is widely recognized as one of the most emotionally demanding and psychologically taxing of the caring professions. Unlike most occupational roles, teaching requires sustained, high-intensity emotional labor, the deliberate management of one's own affective states in service of learners' emotional and intellectual development, compounded by relentless accountability pressures, expanding non-instructional administrative obligations, and the inherent unpredictability of human development as a professional object (Hargreaves, 2000; Hochschild, 1983; Maslach & Leiter, 2016). The cumulative toll of these demands, when experienced chronically and without adequate institutional support, is the psychophysiological and professional deterioration known as burnout: a syndrome characterized by progressive emotional exhaustion, increasing psychological distance from students and colleagues (depersonalization), and a diminishing sense of personal professional accomplishment (Maslach et al., 2001; Schaufeli et al., 2009).

Teacher burnout is not merely an individual occupational health concern; it is a systemic educational quality problem. A substantial and growing body of research documents the transmission of teacher burnout to instructional outcomes: burned-out teachers exhibit diminished enthusiasm and creativity, reduced instructional planning investment, lower responsiveness to individual student needs, and greater reliance on passive, transmission-oriented pedagogical strategies—all of which constrain the quality of classroom learning experiences and, ultimately, student achievement and well-being (Chang, 2009; Hakanen et al., 2006; Skaalvik & Skaalvik, 2017). In this sense, teacher burnout functions as an educational equity issue as well as a mental health issue: students in schools with high teacher burnout rates, disproportionately schools serving disadvantaged communities, receive systematically lower-quality instruction, compounding rather than compensating for the educational disadvantages they already face (Freedman & Appleman, 2009; Jennings & Greenberg, 2009).

In the Philippine basic education context, the urgency of the teacher burnout problem is amplified by a constellation of systemic stressors unique to the national educational landscape. The implementation of the K-12 curriculum reform (Republic Act 10533), while educationally progressive in its ambitions, substantially increased curricular coverage requirements and administrative compliance burdens for classroom teachers without commensurate increases in instructional support or workload rationalization (DepEd, 2016). The COVID-19 pandemic further intensified teacher stress through the abrupt and insufficiently supported transition to distance learning modalities, exposing teachers to unfamiliar technological demands, connectivity challenges, and the compounded emotional burden of supporting students and families in crisis (Alipio, 2020; Toquero, 2020). Post-pandemic re-integration into face-to-face instruction, while broadly welcomed, has introduced its own challenges: learning loss remediation demands, heightened student behavioral and mental health needs, and the psychological fatigue of managing prolonged uncertainty (DepEd, 2022).

Despite this context of documented and escalating teacher stress in Philippine basic education, empirical research on teacher burnout in the local setting remains limited in scope, methodological rigor, and policy engagement. Studies have predominantly relied on single-method survey designs with small convenience samples, limiting the depth of causal understanding and the generalizability of findings (Alipio, 2020; Santos & Acosta, 2021). This study addresses these gaps by employing a sequential explanatory mixed-methods design to examine the predictors and instructional consequences of teacher burnout among a substantial sample of elementary and secondary teachers across multiple provinces of Central Luzon, combining the statistical precision of hierarchical regression analysis with the experiential richness of in-depth qualitative interview inquiry.

The study is theoretically grounded in Maslach and Leiter's (1997) Job Demands-Resources (JD-R) model of burnout, which conceptualizes burnout as arising from a chronic imbalance between the psychologically depleting demands of the work environment (workload, emotional labor, role conflict) and the psychologically restoring resources available within it (autonomy, social support, performance feedback, sense of accomplishment). In the JD-R framework, burnout is not an individual personality failure but a systemic outcome of occupational design: when job demands chronically exceed available resources, disengagement, exhaustion, and depersonalization are predictable responses rather than personal character flaws. This theoretical frame positions institutional structural reform—rather than individual coping skill development—as the primary lever of meaningful burnout prevention.

1.1. Research Objectives

This study pursued four specific objectives:

- To describe the prevalence and severity of burnout dimensions among Philippine basic education teachers across school levels;
- To examine bivariate correlational relationships among burnout dimensions, psychological well-being, workload stress, and instructional quality;
- To determine through hierarchical regression analysis the independent and sequential contributions of demographic variables, burnout dimensions, and well-being and workload variables to variance in instructional quality; and
- To qualitatively explore the experiential mechanisms through which burnout affects instructional practice and the individual, social, and institutional factors that buffer or exacerbate burnout in Philippine school contexts.

1.2. Significance of the Study

This investigation contributes to educational research and policy at three levels. Theoretically, it provides an empirical test of the JD-R model's applicability to Philippine basic education, a context characterized by demand-resource configurations that differ substantially from the primarily Western organizational settings in which the model was developed. Methodologically, the sequential explanatory mixed-methods design addresses the explanatory gap in existing Philippine teacher burnout literature by integrating quantitative effect estimation with mechanistic qualitative inquiry. Practically, the study produces empirically grounded, context-specific recommendations for school administrators, DepEd policymakers, and teacher support program designers seeking to address teacher burnout as a determinant of educational quality, not merely as an individual wellbeing concern.

II. REVIEW OF RELATED LITERATURE

2.1. Conceptualizing Teacher Burnout

Burnout as a psychological construct was formally introduced to organizational research by Freudenberger (1974) and subsequently developed into its most influential theoretical and measurement framework by Christina Maslach and colleagues, whose Maslach Burnout Inventory (MBI) has become the de facto standard instrument for burnout assessment across

professions worldwide (Maslach et al., 2001; Schaufeli et al., 2009). In Maslach's three-dimensional model, burnout comprises emotional exhaustion (the depletion of emotional energy reserves through sustained interpersonal demands), depersonalization (the development of cynical, detached, or dehumanizing attitudes toward recipients of one's professional care), and reduced personal accomplishment (a declining sense of competence, productivity, and meaningful professional contribution). The MBI—Educators Survey (MBI-ES) adapts this framework specifically for the teaching profession, replacing generic occupational referents with teacher-specific item content (Maslach & Jackson, 1986).

The Job Demands-Resources model (Demerouti et al., 2001; Maslach & Leiter, 1997) provides a structural account of burnout etiology that is particularly useful for identifying institutional intervention targets. JD-R posits two parallel psychological processes: an energy-depletion process in which excessive job demands (work overload, emotional labor, role ambiguity, interpersonal conflict) progressively exhaust personal energy reserves, leading to burnout; and a motivational process in which job resources (autonomy, social support, performance feedback, professional development opportunities) sustain engagement, buffer the impact of high demands, and promote well-being. The practical implication of this dual-process model is that burnout prevention requires simultaneous demand reduction and resource enhancement—neither alone is sufficient for sustained teacher well-being.

2.2. Burnout and Instructional Quality

The empirical literature on the relationship between teacher burnout and instructional quality is extensive, methodologically diverse, and remarkably consistent in its directional conclusion: burnout is inversely and robustly associated with indicators of instructional effectiveness. Skaalvik and Skaalvik (2017) found in a large Norwegian teacher sample that emotional exhaustion was significantly negatively correlated with motivating and scaffolding instructional behaviors, even after controlling for teacher self-efficacy and work engagement. Hakanen et al. (2006) demonstrated in a Finnish secondary teacher sample that emotional exhaustion mediated the relationship between excessive workload and diminished student-directed classroom behavior, with burned-out teachers showing significantly lower rates of individualized feedback, formative questioning, and collaborative learning facilitation. Chang (2009) argued in an influential theoretical synthesis that burned-out teachers engage in regulatory depletion, a progressive reduction in the cognitive and emotional effortfulness of instructional behavior, manifesting in greater reliance on passive, student-undifferentiated, low-preparedness teaching strategies.

Conversely, research on teacher well-being and instructional quality consistently documents positive associations. Jennings and Greenberg (2009) proposed a prosocial classroom model in which teacher social-emotional competence and well-being are foundational determinants of the relational and instructional quality of classroom environments. Their model, supported by subsequent empirical research (Collie et al., 2015; Vesely et al., 2014), predicts that teachers with higher psychological well-being invest more cognitive and emotional capital in lesson planning, maintain warmer and more responsive student relationships, and demonstrate more creative, student-centered, and academically demanding instructional practices. These findings collectively position teacher well-being not as a peripheral employee benefit but as a core determinant of the educational experiences available to students.

2.3. Teacher Burnout in the Philippine Context

Research on teacher burnout in the Philippine basic education context has grown in recent years but remains methodologically constrained and policy-disengaged relative to the scale of the problem it documents. Alipio (2020) surveyed 389 public school teachers in Region III and reported burnout prevalence rates of 41% for emotional exhaustion and 34% for depersonalization on MBI-ES cutoff criteria, substantially exceeding the 25-30% rates reported in comparative international studies. Santos and Acosta (2021) identified workload intensity, administrative burden, and inadequate school administrative support as the primary self-reported antecedents of burnout among Metro Manila elementary teachers, findings consistent with JD-R predictions. Importantly, however, neither study examined the consequences of burnout for instructional quality—the variable of greatest policy relevance, nor employed mixed-methods designs capable of explaining the mechanisms through which burnout produces its documented effects.

III. METHODOLOGY

3.1. Research Design

This study employed a sequential explanatory mixed-methods design (Creswell & Plano Clark, 2018), in which a quantitative survey phase was conducted first and used to identify patterns requiring further explanation, followed by a qualitative interview phase designed to explain and contextualize the quantitative findings. This sequential design was selected because the primary research questions about mechanisms and experiences are inherently explanatory and require the contextual depth of qualitative inquiry to answer meaningfully, while the questions about prevalence, correlations, and predictive relationships require the statistical rigor of quantitative analysis with an adequately powered sample.

3.2. Participants and Sampling

Three hundred ten (310) public school teachers from 24 elementary and 16 secondary schools across three provinces in Central Luzon (Nueva Ecija, Pampanga, and Bulacan) participated in the quantitative phase. Schools were selected through stratified random sampling, with strata defined by school level (elementary/secondary) and urban/rural classification. Within selected schools, all available classroom teachers were invited to participate, yielding a response rate of 87.3%. Table 1 presents the demographic characteristics of the full quantitative sample.

Table 1. Demographic Characteristics of Elementary and Secondary Teacher Participants

Characteristic	Elementary n = 148	Secondary n = 162	Total N = 310	χ^2 / F (p-value)
Sex				
Male	57 (38.5%)	68 (42.0%)	125 (40.3%)	
Female	91 (61.5%)	94 (58.0%)	185 (59.7%)	$\chi^2 = 0.40$, p = .53
Age (years)				
M (SD)	36.42 (8.17)	38.81 (9.04)	37.69 (8.67)	F = 5.94, p = .015
Teaching Experience				
1–5 years	42 (28.4%)	38 (23.5%)	80 (25.8%)	
6–10 years	51 (34.5%)	55 (34.0%)	106 (34.2%)	
11–20 years	38 (25.7%)	46 (28.4%)	84 (27.1%)	
21+ years	17 (11.5%)	23 (14.2%)	40 (12.9%)	$\chi^2 = 1.84$, p = .61
Employment Status				
Permanent	112 (75.7%)	119 (73.5%)	231 (74.5%)	
Contractual	36 (24.3%)	43 (26.5%)	79 (25.5%)	$\chi^2 = 0.21$, p = .65
Subject Area Taught				
STEM	68 (45.9%)	74 (45.7%)	142 (45.8%)	
Humanities/Social Science	80 (54.1%)	88 (54.3%)	168 (54.2%)	$\chi^2 = 0.00$, p = .99

Note. χ^2 tests applied to categorical variables; one-way ANOVA applied to continuous variables. The significant age difference between school levels (F = 5.94, p = .015) reflects the national pattern of longer-tenured teachers in secondary positions. All other demographic variables were non-significantly different across school level groupings.

3.2.1. Qualitative Subsample

Forty teachers (25 from elementary, 15 from secondary schools) were purposively selected for in-depth semi-structured interviews based on maximum variation in burnout severity scores, years of experience, and geographic location. Interview recruitment continued until thematic saturation was achieved at approximately 36 interviews, with four additional interviews conducted to confirm saturation. All qualitative participants provided separate written informed consent for interview audio-recording and transcript use.

3.3. Instruments

The Maslach Burnout Inventory—Educators Survey (MBI-ES; Maslach & Jackson, 1986) assessed three burnout dimensions: emotional exhaustion (9 items), depersonalization (5 items), and personal accomplishment (8 items), all scored on a 7-point frequency scale (0 = never to 6 = daily). Internal consistency in the current sample was satisfactory (Cronbach's α: .88, .79, and .82 for the three subscales respectively). The Psychological Well-Being Scale (PWBS; Ryff, 1989), a 42-item instrument measuring six dimensions of psychological functioning, was administered in its validated Filipino-adapted form (α = .91). The Teacher Instructional Quality Scale (TIQS), a 24-item instrument validated for Philippine basic education contexts assessing lesson preparation quality, interactive teaching behaviors, formative assessment practices, and student feedback quality (α = .89), served as the primary outcome variable. A 16-item Workload Stress Inventory (WSI) assessing perceived volume, cognitive demand, temporal pressure, and role conflict dimensions of workload stress (α = .86) was additionally administered. All scale items were rated on 5-point Likert scales (1 = strongly disagree/never to 5 = strongly agree/always).

3.4. Procedure

Institutional endorsements were secured from the DepEd Regional Office IV-A and all three provincial divisions before data collection commenced. School principals were briefed on the study objectives and data confidentiality procedures. Survey instruments were administered in paper-and-pencil format during a scheduled faculty meeting period at each school, taking approximately 45 minutes to complete. Quantitative data collection occurred from July to September 2024. Qualitative interviews, conducted individually via face-to-face or video call modalities, lasted 55 to 75 minutes and were scheduled at teachers' convenience from October to December 2024. All interviews were conducted in a mixture of Filipino and English (code-switching was permitted and encouraged), audio-recorded with consent, and transcribed verbatim.

3.5. Data Analysis

Quantitative data were analyzed using IBM SPSS Statistics version 27. Descriptive statistics and internal consistency estimates were computed for all instruments. Pearson bivariate correlation analysis examined relationships among all study variables. Hierarchical multiple regression was conducted with instructional quality as the dependent variable, entered in three blocks: Block 1 (demographic controls: age, sex, teaching experience, employment status), Block 2 (burnout dimensions: emotional exhaustion, depersonalization, personal accomplishment), and Block 3 (well-being and workload: psychological well-being, workload stress). This hierarchical entry sequence was theoretically motivated by the JD-R model's prediction that burnout mediates between contextual demands and performance outcomes, while well-being serves as a parallel resource-based predictor. All assumptions of multiple regression (linearity, normality of residuals, homoscedasticity, absence of multicollinearity) were verified prior to analysis. Qualitative data were analyzed using Braun and Clarke's (2006, 2019) reflexive thematic analysis, and findings were integrated with quantitative results through a joint display matrix.

IV. RESULTS

4.1. Descriptive Statistics and Bivariate Correlations

Table 2 presents means, standard deviations, and Pearson intercorrelations for all study variables. Mean scores indicated moderate-to-high levels of emotional exhaustion (M = 3.41, SD = 0.74) and workload stress (M = 3.76, SD = 0.68) in the sample, alongside moderate personal accomplishment (M = 3.62, SD = 0.69) and instructional quality ratings (M = 3.29, SD = 0.77). Bivariate correlations revealed that emotional exhaustion was the most strongly negatively correlated predictor of instructional quality ($r = -.61$, $p < .001$), followed by workload stress ($r = -.58$, $p < .001$), depersonalization ($r = -.54$, $p < .001$), and psychological well-being ($r = .63$, $p < .001$). Personal accomplishment was positively and significantly associated with instructional quality ($r = .52$, $p < .001$). The high intercorrelations among burnout dimensions were expected based on the theoretical model and prior literature; variance inflation factors in subsequent regression analyses confirmed acceptable multicollinearity (all VIF < 3.1).

Table 2. Means, Standard Deviations, and Pearson Intercorrelation Matrix for All Study Variables (N = 310)

Variable	M	SD	1	2	3	4
1. Emotional Exhaustion	3.41	0.74	—			
2. Depersonalization	2.87	0.81	.58***	—		
3. Personal Accomplishment	3.62	0.69	−.47***	−.39***	—	
4. Instructional Quality	3.29	0.77	−.61***	−.54***	.52***	—
5. Student Engagement	3.44	0.72	−.55***	−.48***	.46***	.67***
6. Psychological Well-Being	3.18	0.83	−.66***	−.59***	.57***	.63***
7. Workload Stress	3.76	0.68	.71***	.62***	−.43***	−.58***

Note. All correlation coefficients in the matrix are based on N = 310. Significance levels: *** p < .001. Personal Accomplishment and Instructional Quality are scored such that higher values indicate more positive outcomes; Emotional Exhaustion, Depersonalization, and Workload Stress are scored such that higher values indicate more adverse outcomes. Variables 5, 6, and 7 used 1-to-5 Likert scales.

4.2. Hierarchical Regression Analysis: Predictors of Instructional Quality

Table 3 presents the results of the three-block hierarchical regression analysis with instructional quality as the criterion variable.

Table 3. Hierarchical Regression Analysis: Demographic, Burnout, and Well-Being Predictors of Teacher Instructional Quality (N = 310)

Predictor	B	SE B	β	t	p / ΔR^2
Block 1: Demographic Controls $R^2 = .06$, $F(4, 305) = 4.88$, $p = .001$					
Age	0.02	0.01	.09	1.78	p = .076
Sex (female = 1)	0.11	0.08	.07	1.41	p = .160
Teaching Experience (yrs)	0.04	0.02	.14	2.27	p = .024
Employment (perm. = 1)	0.18	0.09	.11	2.01	p = .046
Block 2: Burnout Dimensions $\Delta R^2 = .31$, $F(3, 302) = 46.21$, $p < .001$					
Emotional Exhaustion	−0.38	0.06	−.36	−6.47	p < .001
Depersonalization	−0.29	0.07	−.24	−4.12	p < .001
Personal Accomplishment	0.31	0.07	.26	4.55	p < .001
Block 3: Well-Being & Workload $\Delta R^2 = .11$, $F(2, 300) = 22.84$, $p < .001$					
Psychological Well-Being	0.24	0.06	.25	4.18	p < .001
Workload Stress	−0.21	0.07	−.18	−2.97	p = .003
Full Model Summary: $R^2 = .48$, Adjusted $R^2 = .47$, $F(9, 300) = 30.77$, $p < .001$					

Note. β = standardized regression coefficient at final model entry. Dependent variable = Teacher Instructional Quality Scale (TIQS) total score. Block 1 demographic predictors: age, sex (female = 1), teaching experience (years), employment status (permanent = 1). R^2 = variance explained; ΔR^2 = incremental variance explained at each block. All F-tests significant at stated p-values.

Block 1 demographic controls explained a modest but significant 6% of variance in instructional quality ($R^2 = .06$, $F(4, 305) = 4.88$, $p = .001$), with teaching experience ($\beta = .14$, $p = .024$) and permanent employment status ($\beta = .11$, $p = .046$) emerging as the only significant demographic predictors. The addition of burnout dimensions in Block 2 produced a highly significant incremental R^2 of .31 ($\Delta R^2 = .31$, $F(3, 302) = 46.21$, $p < .001$), with emotional exhaustion ($\beta = -.36$), personal accomplishment ($\beta = .26$), and depersonalization ($\beta = -.24$) all contributing significant independent variance. Block 3 addition of psychological well-being and workload stress produced a further significant increment of 11% ($\Delta R^2 = .11$, $F(2, 300) =$

22.84, $p < .001$), with psychological well-being ($\beta = .25$, $p < .001$) and workload stress ($\beta = -.18$, $p = .003$) both making significant independent contributions. The full model explained 48% of variance in instructional quality ($R^2 = .48$, adjusted $R^2 = .47$), demonstrating robust explanatory power.

4.3. Qualitative Findings: Thematic Analysis

Reflexive thematic analysis of 40 in-depth teacher interviews produced five overarching themes that illuminate the experiential mechanisms through which burnout affects instructional practice in Philippine school contexts. Table 4 presents each theme with key sub-themes, codes, and representative verbatim excerpts.

Table 4. Qualitative Themes, Sub-Themes, and Illustrative Teacher Quotes from In-Depth Semi-Structured Interviews

Theme	Sub-Themes & Codes	Representative Participant Quote
Emotional Drain & Loss of Passion	Compassion fatigue; Diminished enthusiasm; Emotional blunting; Career regret	"There are mornings I sit in my car before class and I have to convince myself to go inside. That passion I had in my first year — I cannot find it anymore." — Teacher 6
Administrative Overload & Role Conflict	Non-teaching duties; Paper overload; Meeting fatigue; Conflicting role demands	"I spend more time filling out forms and attending meetings than actually preparing quality lessons. I became a teacher, not a clerk." — Teacher 14
Social Support as Protective Buffer	Collegial solidarity; Supportive school heads; Peer mentoring; Family grounding	"My co-teachers saved me. We share materials, we vent to each other, we celebrate small wins together. Without that community, I would have resigned years ago." — Teacher 23
Coping Through Purposefulness	Student success as motivation; Meaning reconstruction; Intrinsic calling; Gratitude practices	"When a former student messages me to say I changed their life, everything resets. That is why I stay. That is why I keep preparing, even when I am exhausted." — Teacher 31
Constrained Instructional Agency	Deprioritized pedagogy; Survival teaching; Reduced creativity; Lowered expectations	"When I am burned out, I just give them worksheets. I know it is not good teaching, but I have nothing left to give. The students get less than they deserve." — Teacher 38

Note. Participant excerpts reproduced verbatim from interview transcripts. All names replaced with sequential participant numbers to protect anonymity. Teacher participants ranged from 3 to 28 years of teaching experience across elementary and secondary school levels.

The theme of emotional drain and loss of passion described what participants consistently portrayed as the most psychologically distinctive feature of burnout: not temporary fatigue, but a qualitative transformation of one's relationship with teaching, from a vocationally meaningful calling to an emotionally depleting obligation. This experiential dimension of burnout was articulated with particular poignancy by teachers with ten or more years of service, who described the gradual erosion of their initial professional enthusiasm as a process of accumulated disappointments, unrecognized sacrifices, and unmet professional development needs. The instructional consequence of this emotional depletion was described consistently as pedagogical regression: a retreat from creative, student-responsive, and cognitively demanding instructional strategies to minimally effortful routines.

Administrative overload and role conflict emerged as the most universally shared antecedent theme in qualitative narratives, cutting across school levels, subject areas, and years of experience. Teachers described a progressive colonization of their professional time and mental bandwidth by non-instructional bureaucratic demands, compliance documentation, statistical reports, meeting attendance, community mobilization requirements, that left diminishing cognitive and emotional resources for the core instructional work that motivated their career choice. This theme directly corroborates the JD-R model's identification of excessive job demands as the primary energetic driver of burnout, and provides experiential grounding for the significant negative relationship between workload stress and instructional quality documented in the regression analysis. Social support as a protective buffer documented the single most consistently cited burnout-moderating factor in teacher accounts: the quality and availability of collegial relationships within the school. Teachers who described strong peer support networks, characterized by material reciprocity (sharing of lesson plans and materials), emotional validation, and collective problem-solving, reported substantially more resilient professional identities and more sustained instructional investment than colleagues who experienced their professional environment as isolated and competitive. School heads who were described as genuinely supportive, visible, approachable, recognition-giving, and advocacy-oriented toward their staff, were credited by teachers as among the most powerful buffers against burnout escalation.

Coping through purposefulness documented a fundamentally important motivational mechanism that distinguished teachers who sustained high instructional quality despite experienced burnout from those who allowed burnout to erode their teaching standards. These teachers engaged in what appeared to be an active, ongoing process of meaning reconstruction: deliberately reconnecting their daily instructional labor to its ultimate human purpose, student flourishing, in a manner that generated sufficient motivational energy to sustain above-threshold performance even under conditions of significant psychological depletion. This theme is theoretically consistent with Frankl's (1959) logotherapeutic notion of meaning as a

buffer against existential exhaustion and with more recent work on calling and vocational identity as protective resources in demanding helping professions.

Constrained instructional agency described the ultimate pedagogical cost of burnout in teachers' own words with notable candor and self-awareness. Teachers described their burned-out instructional behavior not as malicious or indifferent, but as a rationally adaptive response to energy scarcity: when one's psychological reserves are exhausted, instructional shortcuts represent survival strategies rather than professional failures. The pedagogical consequence documented across multiple participants—reduced formative assessment, decreased individual feedback, greater reliance on passive seatwork, and lowered performance expectations—directly corroborates the quantitative finding that burnout dimensions explain 31% of variance in instructional quality and provides a mechanism-level explanation for that statistical relationship.

V. DISCUSSION

The findings of this investigation provide robust convergent evidence for the damaging consequences of teacher burnout for instructional quality in Philippine basic education, while simultaneously advancing understanding of the specific psychological mechanisms and institutional conditions through which these consequences are produced and potentially moderated. The regression model's explanation of 48% of variance in instructional quality, with burnout dimensions contributing the largest incremental explanatory block ($\Delta R^2 = .31$), demonstrates that teacher psychological states are not peripheral to educational quality but are among its most powerful determinants.

The finding that emotional exhaustion is the strongest individual predictor of instructional quality degradation ($\beta = -.36$) is consistent with the theoretical primacy of energy depletion in the JD-R burnout model and with the broader literature on emotional labor and instructional effectiveness (Chang, 2009; Hargreaves, 2000; Maslach & Leiter, 2016). Teaching is fundamentally an emotional practice: effective instruction requires not only cognitive competence but sustained emotional availability, enthusiasm, and responsiveness. When emotional reserves are depleted through chronic exhaustion, the first instructional casualty is precisely the emotional engagement that makes teaching transformative rather than merely informational. The qualitative theme of emotional drain and loss of passion provides rich experiential texture to this statistical finding, documenting the lived phenomenology of instructional decline as a gradual rather than abrupt process—a progressive dimming of professional ardor rather than a sudden collapse.

The significant independent contribution of personal accomplishment ($\beta = .26$) alongside exhaustion and depersonalization confirms the theoretically important distinction between these burnout dimensions as partially independent determinants of instructional behavior. Teachers who maintain a sense of professional efficacy and meaningful accomplishment, even under conditions of moderate exhaustion, appear capable of sustaining higher instructional quality than would be predicted by their exhaustion scores alone. This finding has practical significance for intervention design: school environments that provide regular, specific, and credible affirmations of teacher impact on student outcomes may buffer the instructional consequences of burnout even when structural demand reduction is not immediately achievable.

The significant positive contribution of psychological well-being to instructional quality ($\beta = .25$), independent of burnout dimensions, supports the view that well-being and burnout are related but non-identical constructs with distinct instructional implications. While burnout captures the pathological end of the occupational health continuum, the progressive erosion of psychological resources, psychological well-being captures the positive flourishing end: the active experience of meaning, growth, positive relationships, and environmental mastery that constitute a psychologically rich professional life. The implication is that effective teacher support interventions must address both ends of this continuum: not only reducing burnout through demand management and resource provision, but actively cultivating well-being through purposefulness, collegial connection, and professional growth opportunities.

5.1. Limitations

Several limitations of this study merit acknowledgment. The cross-sectional quantitative design precludes causal inference about the direction of relationships between burnout and instructional quality: it is theoretically plausible, if empirically less supported, that poor instructional outcomes contribute to burnout through reduced personal accomplishment, rather than exclusively the reverse. Instructional quality was measured through self-report rather than direct classroom observation, introducing the possibility of socially desirable responding. The study's geographic focus on Central Luzon schools, while providing substantial sample size, limits direct generalizability to other regions with different school culture profiles, workload norms, and community support structures. Finally, the qualitative subsample, while purposively diverse, represents only 13% of the quantitative sample, and the transferability of qualitative themes to contexts outside the study schools requires careful reader judgment.

VI. CONCLUSION AND RECOMMENDATIONS

This study provides compelling convergent evidence that teacher burnout is a first-order determinant of instructional quality in Philippine basic education, with emotional exhaustion, depersonalization, and reduced personal accomplishment collectively explaining nearly a third of the variance in the instructional effectiveness of elementary and secondary teachers, a magnitude of influence that dwarfs the contributions of demographic and experiential variables and rivals that of formal pedagogical training. The qualitative findings transform this statistical reality into a human one: teachers who are burned out

do not merely underperform in the abstract; they withdraw creatively, emotionally, and cognitively from the relational and intellectual work that makes teaching genuinely educational, in ways they recognize and regret but feel powerless to prevent without structural support.

On the basis of these integrated findings, the following recommendations are urgently offered. First, the Department of Education must establish and enforce a national teacher workload rationalization policy that explicitly limits non-instructional administrative duties and mandates minimum protected planning and professional learning time—a structural intervention that addresses the primary job demand driver of burnout documented in both quantitative and qualitative findings. Second, school-level leadership development programs should explicitly train principals in burnout-aware school management: recognition of early burnout indicators, provision of specific and timely performance affirmation, facilitation of peer support structures, and advocacy for teacher well-being in resource allocation decisions. Third, the Division and Regional Offices of DepEd should implement regular, validated burnout screening using the MBI-ES as part of the annual teacher evaluation cycle, with results used to trigger proactive support rather than punitive accountability responses. Fourth, teacher education programs should incorporate psychological well-being literacy and emotional self-regulation competencies as explicit curriculum components, preparing prospective teachers for the emotional demands of the profession before they enter classrooms. Fifth, future research should employ longitudinal designs to disentangle the causal dynamics of burnout and instructional quality over time, use multi-source instructional quality data (classroom observation, student ratings, administrative assessment) to reduce single-source bias, and examine the differential burnout profiles and protective resources available to teachers across school types, geographic locations, and socioeconomic community contexts.

The quality of education a nation's children receive is inseparable from the psychological health of the teachers who deliver it. Treating teacher well-being as a personnel benefit secondary to instructional policy is a category error with profound educational consequences. The evidence assembled in this study makes this connection not merely theoretically intuitive but empirically undeniable: investing in teacher mental health is investing in student learning, and failing to do so is a choice with costs borne most heavily by the students who can least afford them.

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The Impact of Technology-Enhanced Learning Environments on Student Academic Achievement and Engagement in Secondary Education

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Abstract

This study investigated the impact of technology-enhanced learning environments (TELEs) on student academic achievement and engagement in secondary education in Kerala, India. Employing a quasi-experimental pretest-posttest design, the study examined 320 students (Grade 9–10) from 8 secondary schools over one academic semester (18 weeks). Participants were assigned to either a technology-enhanced instruction group (n = 160) or a traditional instruction group (n = 160). Academic achievement was measured using standardized subject tests in Mathematics and Science, while student engagement was assessed through the Student Engagement Instrument (SEI). Analysis of covariance (ANCOVA) and independent samples t-tests revealed that students in the TELE group achieved significantly higher posttest scores ($M = 78.4$, $SD = 9.2$) compared to the control group ($M = 64.1$, $SD = 10.5$), $t(318) = 12.36$, $p < .001$, $d = 1.45$. Engagement scores were also significantly elevated in the experimental group ($F(1, 317) = 84.72$, $p < .001$, $\eta^2 = .21$). These findings suggest that strategically integrating technology into secondary school classrooms significantly improves both academic performance and student engagement, with practical implications for curriculum planners and school administrators.

Keywords: - Technology-Enhanced Learning, Academic Achievement, Student Engagement, Secondary Education, Educational Technology, Quasi-Experimental Design

I. INTRODUCTION

The proliferation of digital technologies in the twenty-first century has fundamentally transformed the pedagogical landscape of formal education. Educational systems worldwide are under mounting pressure to equip learners with the competencies required for a knowledge-based economy, and technology integration has emerged as a cornerstone strategy in contemporary reform agendas (Means et al., 2013; UNESCO, 2019). Technology-enhanced learning environments (TELEs)—broadly defined as instructional contexts in which digital tools, platforms, and resources are systematically embedded within the pedagogical process—have attracted substantial scholarly attention as a mechanism to improve educational outcomes (Sung et al., 2016).

Despite a growing body of literature affirming the potential benefits of technology integration, empirical evidence regarding its actual impact on student academic achievement and engagement remains inconsistent (Cheung & Slavin, 2013; Hattie, 2009). Meta-analyses have reported effect sizes ranging from negligible to large, suggesting that contextual variables—such as implementation fidelity, teacher preparedness, infrastructure quality, and socioeconomic context—play a moderating role (Tamim et al., 2011). In the Indian context, secondary education faces unique challenges, including large class sizes, heterogeneous ability levels, and examination-driven curricula, making it particularly important to examine whether TELEs produce meaningful gains under such conditions (National Education Policy, 2020).

1.1. Statement of the Problem

While schools in Kerala have made notable strides in ICT infrastructure deployment under the KITE (Kerala Infrastructure and Technology for Education) initiative, systematic research on the learning outcomes attributable to these

investments in secondary schools remains sparse. Specifically, there is limited quasi-experimental evidence examining the differential impact of TELEs on achievement across subject domains (Mathematics and Science) and on the multidimensional construct of student engagement in this context (Jayaprakash & Rajan, 2022).

1.2. Purpose of the Study

The primary purpose of this study was to examine the effect of technology-enhanced learning environments on:

- Academic achievement in Mathematics and Science, and
- Student engagement among Grade 9 and Grade 10 students in Kerala secondary schools. A secondary purpose was to determine whether the observed effects were moderated by student gender.

1.3. Research Questions

The study was guided by the following research questions:

- RQ1: Is there a significant difference in academic achievement (Mathematics and Science) between students in technology-enhanced learning environments and those receiving traditional instruction?
- RQ2: Is there a significant difference in student engagement between students in technology-enhanced learning environments and those in traditional classrooms?
- RQ3: Does student gender moderate the relationship between instructional mode and academic achievement?

1.4. Hypotheses

The following null hypotheses were tested at the $\alpha = .05$ significance level:

- $H_0 1$: There is no statistically significant difference in posttest academic achievement scores between the experimental and control groups.
- $H_0 2$: There is no statistically significant difference in student engagement scores between the experimental and control groups.
- $H_0 3$: Student gender does not significantly moderate the relationship between instructional mode and academic achievement.

1.5.Significance of the Study

This research contributes to the empirical literature on educational technology in several ways. First, it offers rigorous quasi-experimental evidence from a developing country context, which is underrepresented in global literature dominated by findings from Western settings (Voogt et al., 2013). Second, it examines engagement as a multidimensional construct (cognitive, behavioral, and emotional) rather than relying solely on proxy measures such as attendance or time-on-task. Third, the findings hold practical implications for the Kerala State Curriculum Framework and for administrators allocating ICT resources within the national Digital India initiative (Ministry of Education, 2021).

II. REVIEW OF RELATED LITERATURE

2.1. Theoretical Framework

The study is anchored in two complementary theoretical perspectives. The first is Vygotsky's (1978) sociocultural theory of learning, which posits that cognitive development is facilitated through social interaction and the use of cultural tools. Digital technologies can be conceptualized as cognitive tools that mediate learning and extend the learner's Zone of Proximal Development (ZPD), enabling students to accomplish intellectually demanding tasks with appropriate scaffolding (Kim & Reeves, 2007).

The second framework is Bandura's (1986) social cognitive theory, particularly the construct of self-efficacy. Research consistently demonstrates that technology-mediated environments can enhance students' academic self-efficacy by providing immediate feedback, adaptive challenge levels, and mastery experiences (Schunk & Pajares, 2009). Elevated self-efficacy, in turn, predicts greater persistence, deeper information processing, and superior academic performance (Zimmerman, 2000).

2.2. Technology-Enhanced Learning and Academic Achievement

A substantial body of meta-analytic evidence supports the positive impact of technology integration on academic achievement. Tamim et al. (2011), in a second-order meta-analysis synthesizing 40 years of research (1970–2010) and encompassing 1,055 individual studies, reported an overall positive effect size of $d = 0.35$ for computer-based interventions relative to conventional instruction. More recently, Sung et al. (2016) conducted a meta-analysis of 59 studies examining mobile device integration in K-12 settings and reported a moderate-to-large effect size ($g = 0.52$, 95% CI [0.44, 0.59]).

Subject-specific research indicates that technology integration yields particularly strong gains in STEM disciplines. Cheung and Slavin (2013) reviewed 74 controlled studies on educational technology in mathematics and found a weighted mean effect size of $d = 0.16$ for comprehensive technology programmes, while interactive instructional applications yielded $d = 0.37$. In science education, Merchant et al. (2014) reported that simulation-based learning environments produced significant gains in conceptual understanding ($d = 0.52$) compared to traditional didactic instruction.

However, the literature also acknowledges important boundary conditions. Higgins et al. (2012), reviewing evidence from the United Kingdom's Education Endowment Foundation, concluded that technology does not automatically translate into improved learning outcomes; rather, the pedagogical model within which technology is deployed is the critical determinant. This perspective is consistent with Harris et al.'s (2009) Technological Pedagogical Content Knowledge (TPACK)

framework, which emphasizes the intersection of technology knowledge, pedagogical knowledge, and content knowledge as essential for effective teaching.

2.3. Technology Integration and Student Engagement

Student engagement is a multidimensional construct encompassing behavioral (participation, attendance, task completion), cognitive (strategic learning, self-regulation, goal setting), and emotional (sense of belonging, interest, enjoyment) dimensions (Fredricks et al., 2004). Technology-enhanced environments are theorized to support engagement through increased interactivity, personalized learning pathways, and authentic task design (Bransford et al., 2000).

Empirical studies have consistently linked technology use to higher engagement. Henrie et al. (2015), in a systematic review of 53 studies, found that interactive digital tools, including simulations, collaborative platforms, and game-based learning environments, reliably produced elevated behavioral and emotional engagement. Similarly, Appleton et al. (2006) demonstrated that cognitive engagement—measured through the Student Engagement Instrument (SEI)—was significantly higher in classrooms with structured technology integration compared to traditional settings.

2.4. Gender and Technology-Mediated Learning

The literature on gender differences in technology-mediated learning presents a nuanced picture. Historically, male students were reported to hold more positive attitudes toward computers and to benefit more from technology-based instruction (Hattie, 2009). However, more recent evidence suggests that gender gaps are narrowing, particularly in mobile learning contexts (Sung et al., 2016). Chou et al. (2012) found no significant gender moderation effects when controlling for prior achievement and socioeconomic status, a finding echoed by Kumar and Rao (2021) in the Indian secondary school context.

2.5. Gap in Literature

While the global literature is extensive, research specific to the South Indian secondary school context—particularly post-COVID digital infrastructure expansion—is limited. Furthermore, most prior studies rely on self-report engagement measures or short intervention periods (< 8 weeks), limiting ecological validity. The present study addresses these gaps through an 18-week intervention using validated instruments and objective achievement measures.

III. METHODOLOGY

3.1. Research Design

This study adopted a quasi-experimental pretest-posttest control group design (Campbell & Stanley, 1963). Because random assignment of students to classrooms was not feasible in naturalistic school settings, intact class groups were assigned to experimental and control conditions following baseline equivalence testing. This design permits causal inference while acknowledging its limitations relative to true randomization (Shadish et al., 2002).

3.2. Population and Sample

The target population comprised all Grade 9 and Grade 10 students enrolled in government-aided secondary schools in Thiruvananthapuram district, Kerala, India ($N \approx 42{,}000$). A stratified purposive sampling strategy was employed to select eight schools, stratified by school type (government vs. aided) and urban/rural location. Within each school, two intact class sections were selected: one assigned to the experimental condition and one to the control condition. The final sample comprised 320 students (experimental: $n = 160$; control: $n = 160$), with a mean age of 14.8 years ($SD = 0.64$). Gender composition was 52.5% female and 47.5% male across both groups.

A priori power analysis using G*Power 3.1 (Faul et al., 2007) indicated that a sample of $N = 128$ was sufficient to detect a medium effect size ($d = 0.50$) at $\alpha = .05$ with power $(1 - \beta) = .80$ for independent samples t-tests. The obtained sample of $N = 320$ thus provided adequate statistical power to detect even small effect sizes ($d \geq 0.32$).

3.3. Instruments

3.3.1. Academic Achievement Tests

Subject-specific achievement tests were developed by the research team in consultation with subject matter experts and curriculum specialists for Mathematics (40 items) and Science (40 items). Items were mapped to the Kerala State Curriculum Framework learning objectives for Grades 9 and 10 (State Council of Educational Research and Training [SCERT], 2019). Content validity was established through expert review (CVI = 0.89). Difficulty indices ranged from 0.30 to 0.75, and discrimination indices ranged from 0.25 to 0.68. Internal consistency was high (Mathematics: $\alpha = .87$; Science: $\alpha = .84$).

3.3.2. Student Engagement Instrument (SEI)

The SEI (Appleton et al., 2006) is a 35-item self-report measure assessing cognitive and affective engagement on a 4-point Likert scale (1 = strongly disagree, 4 = strongly agree). The instrument has demonstrated strong psychometric properties in prior research (Cronbach's $\alpha = .82$–$.91$) and has been validated for use with adolescent populations (Reschly & Christenson, 2012). For the present study, confirmatory factor analysis confirmed the two-factor structure (cognitive and affective engagement), with adequate fit indices: CFI = 0.94, RMSEA = 0.063, SRMR = 0.058. Internal consistency in the present sample was $\alpha = .88$.

3.4. Intervention

The technology-enhanced learning intervention was implemented over 18 weeks (one full academic semester). Experimental group teachers received 40 hours of professional development training in TPACK-informed instructional design prior to the intervention (Harris et al., 2009).

Technology resources included:

- Student tablets (1:1 ratio) with pre-loaded interactive simulations via phet Interactive Simulations (University of Colorado Boulder, 2022),
- A Learning Management System (LMS) for assignment submission and automated feedback,
- Collaborative digital tools (Google Workspace for Education), and
- Multimedia instructional resources aligned with the state curriculum. Teachers in the experimental group delivered instruction for a minimum of three 45-minute technology-integrated lessons per week per subject.

The control group received business-as-usual instruction following the state-mandated textbook and teacher-fronted methods, without integration of digital tools beyond occasional use of a classroom projector for teacher presentations.

3.5. Data Collection Procedure

Baseline data (pretest academic achievement and initial engagement) were collected during the first week of the study. Post-intervention data were collected during the final week (Week 18). All achievement tests were administered under standardized conditions by trained proctors unaffiliated with the participating schools to minimize experimenter bias. The SEI was administered in paper-and-pencil format during regularly scheduled class periods.

3.6. Data Analysis

Descriptive statistics (means, standard deviations, frequencies) were computed for all study variables. Prior to inferential analyses, assumptions of normality (Shapiro-Wilk test), homogeneity of variance (Levene's test), and covariate-outcome independence were verified. Analysis of covariance (ANCOVA) was used to compare posttest academic achievement scores between groups while controlling for pretest scores. Independent samples t-tests were employed for engagement score comparisons. Moderation analysis (gender × instructional mode) was conducted using factorial ANCOVA. Effect sizes were reported as Cohen's d for t-tests and partial eta-squared (η^2p) for ANCOVA. All analyses were conducted using IBM SPSS Statistics Version 28.0 (IBM Corp., 2021), with the significance level set at $\alpha = .05$.

3.7. Ethical Considerations

The study received ethical clearance from the Institutional Research Ethics Committee of Kerala University of Education (Approval No. KUE-IREC-2024-047). Written informed consent was obtained from school principals and parents or legal guardians of all student participants. Student assent was also obtained in accordance with ethical guidelines for research involving minors (American Psychological Association [APA], 2020). Participation was voluntary, and all data were anonymized and stored in password-protected databases accessible only to the research team.

IV. RESULTS

4.1. Baseline Equivalence

Prior to examining treatment effects, baseline equivalence between the experimental and control groups was assessed on pretest achievement scores and demographic variables. Independent samples t-tests revealed no significant differences between groups on Mathematics pretest scores ($t(318) = 0.84$, $p = .401$) or Science pretest scores ($t(318) = 1.12$, $p = .263$). Chi-square tests confirmed comparable gender distribution across groups ($\chi^2(1) = 0.24$, $p = .624$). These results indicate that the two groups were statistically equivalent at baseline, supporting the internal validity of group comparisons.

4.2. Research Question 1: Effect on Academic Achievement

ANCOVA was conducted with posttest Mathematics scores as the dependent variable, instructional condition as the fixed factor, and pretest Mathematics score as the covariate. The assumption of homogeneity of regression slopes was met ($F(1, 316) = 0.47$, $p = .494$). Results indicated a statistically significant main effect of instructional condition after controlling for pretest scores, $F(1, 317) = 152.48$, $p < .001$, $\eta^2p = .32$. Estimated marginal means showed that the experimental group ($M = 79.2$, $SE = 0.71$) significantly outperformed the control group ($M = 63.4$, $SE = 0.71$).

Similarly, ANCOVA for Science achievement revealed a significant main effect of instructional condition, $F(1, 317) = 127.64$, $p < .001$, $\eta^2p = .29$, with the experimental group ($M = 77.6$, $SE = 0.74$) achieving substantially higher scores than the control group ($M = 64.8$, $SE = 0.74$). Combined across subjects, the independent samples t-test on total achievement yielded $t(318) = 12.36$, $p < .001$, Cohen's $d = 1.45$, indicating a very large practical effect. Null hypothesis H_o1 was therefore rejected.

4.3. Research Question 2: Effect on Student Engagement

An independent samples t-test comparing posttest SEI total scores revealed that students in the experimental group reported significantly higher engagement ($M = 3.42$, $SD = 0.38$) than students in the control group ($M = 2.89$, $SD = 0.44$), $t(318) = 11.27$, $p < .001$, Cohen's $d = 1.31$. ANCOVA controlling for baseline engagement confirmed this finding, $F(1, 317) = 84.72$, $p < .001$, $\eta^2p = .21$. Subscale analyses indicated significant group differences on both cognitive engagement ($t(318) = 9.84$, $p < .001$, $d = 1.10$) and affective engagement ($t(318) = 10.53$, $p < .001$, $d = 1.18$). Null hypothesis H_o2 was rejected.

4.4. Research Question 3: Moderation by Gender

A 2 (instructional condition: experimental vs. control) × 2 (gender: male vs. female) factorial ANCOVA was conducted on total posttest achievement, with pretest scores as covariates. The main effect of instructional condition was significant, $F(1, 315) = 147.32$, $p < .001$, $\eta^2p = .32$. The main effect of gender was not significant, $F(1, 315) = 1.43$, $p = .232$, $\eta^2p = .005$. Critically, the instructional condition × gender interaction was not statistically significant, $F(1, 315) = 0.68$, $p = .411$, $\eta^2p = .002$, indicating that the achievement advantage of the experimental condition was equivalent for male and female students. Null hypothesis H_o3 was retained.

4.5. Summary of Findings

The results consistently supported the efficacy of technology-enhanced learning environments. The experimental group demonstrated large and statistically significant advantages over the control group in both academic achievement (Mathematics and Science) and student engagement following the 18-week intervention. These effects were robust across gender subgroups.

V. DISCUSSION

5.1. Interpretation of Main Findings

The present study provides robust quasi-experimental evidence that systematically integrating technology into secondary school classrooms yields substantial gains in both academic achievement and student engagement. The very large effect size for achievement ($d = 1.45$) exceeds estimates from prior meta-analyses (Tamim et al., 2011; Sung et al., 2016), which may be attributed to several contextual factors. First, the 18-week duration provides greater opportunity for cumulative learning gains than shorter interventions. Second, the intensive 40-hour teacher professional development component ensured implementation fidelity aligned with TPACK principles (Harris et al., 2009), addressing a key limitation in many prior studies where technology was introduced without adequate teacher preparation.

The significant improvement in student engagement corroborates findings from Henrie et al. (2015) and Appleton et al. (2006), and is theoretically consistent with Bandura's (1986) social cognitive framework. The interactive, adaptive, and collaborative features of the technology tools deployed—particularly the PhET simulations and LMS-based feedback mechanisms—likely enhanced students' sense of academic self-efficacy, contributing to sustained cognitive and affective engagement over the intervention period. These findings further align with the constructivist and sociocultural perspectives underpinning TELEs (Vygotsky, 1978; Bransford et al., 2000).

5.2. Absence of Gender Moderation

The non-significant gender × instructional condition interaction supports the findings of Kumar and Rao (2021) and Chou et al. (2012), suggesting that well-designed technology-enhanced environments are equitable in their benefits across genders. This is an encouraging finding in the context of persistent gender disparities in STEM participation in India (Ministry of Education, 2021), as it implies that ICT investment in schools need not inadvertently widen gender achievement gaps. However, this finding should be interpreted cautiously, as the study did not examine attitude towards technology or technology self-efficacy as mediating variables, which prior research suggests may differ by gender (Hattie, 2009).

5.3. Implications for Practice

The findings carry substantive implications for educational policy and classroom practice. For school administrators and curriculum planners within Kerala and analogous Indian state educational systems, the results provide empirical justification for continued investment in KITE-aligned digital infrastructure and, critically, in sustained teacher professional development. The study underscores that hardware provision alone is insufficient; pedagogically informed deployment, underpinned by TPACK-oriented training, is essential for realizing achievement gains (Harris et al., 2009; Higgins et al., 2012). At the classroom level, teachers are encouraged to leverage simulation-based learning, collaborative digital projects, and LMS-mediated feedback to maximize both cognitive and affective engagement.

5.4. Limitations

Several limitations warrant consideration when interpreting these findings. First, the quasi-experimental design, while strengthened by baseline equivalence and ANCOVA controls, cannot fully eliminate selection bias inherent to intact group assignment. Second, the sample was drawn from a single district in Kerala, limiting generalizability to other Indian states or international contexts with differing infrastructure and socioeconomic profiles. Third, the Hawthorne effect—whereby students in the experimental condition may have performed better simply due to the novelty of the intervention—cannot be entirely ruled out, though the 18-week duration reduces this concern. Fourth, the study did not collect data on teacher fidelity to the TPACK-informed lesson plans, representing a confound in interpreting achievement differences. Finally, long-term retention effects beyond the intervention period were not examined.

5.5. Directions for Future Research

Future research should employ true randomization through cluster-randomized trials to strengthen causal inference. Longitudinal designs tracking students across multiple academic years would illuminate whether technology-integration effects persist or diminish over time. Researchers should examine mediating mechanisms—such as self-efficacy, metacognitive strategy use, and teacher instructional quality—to better understand the causal pathways through which TELEs influence outcomes. Comparative studies across different Indian states with varying ICT investment profiles are also warranted to inform national education policy (National Education Policy, 2020).

IV. CONCLUSION

This study provides compelling quasi-experimental evidence that technology-enhanced learning environments significantly improve academic achievement and student engagement in secondary education. Drawing on sociocultural and social cognitive theoretical frameworks, the findings demonstrate that strategic, pedagogically informed technology integration—supported by comprehensive teacher professional development—yields large and meaningful educational benefits for Grade 9 and Grade 10 students in Kerala, India. The absence of differential gender effects further affirms the equity potential of well-implemented TELEs. These results strongly advocate for evidence-based scaling of technology integration initiatives within Indian secondary education, with sustained investment in both infrastructure and teacher capacity.

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