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# Cognitive-Pedagogical Synergy in Cost Accounting: Mediating Effects of Intrinsic Motivation and Ability Belief in Business Education Students' Academic Achievement and Critical Skills Acquisition

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**Abstract**

The development of critical skills among Business Education students necessitates pedagogical approaches that transcend traditional instructional methods, fostering deeper engagement and academic proficiency. Given the fundamental role of Business Mathematics and Cost accounting in cultivating analytical reasoning for business-related disciplines, integrating effective instructional approaches is imperative for addressing persistent learning deficiencies. This study investigated the predictive role of intrinsic motivation and ability belief on students' critical skills development, with particular emphasis on the mediating role of computational thinking and problem-based learning in enhancing academic achievement. Employing a quasi-experimental research design, data were collected from 139 Business Education students across two universities in Southeast Nigeria: The University of Nigeria, Nsukka (UNN), and Nnamdi Azikiwe University, Awka (UNIZIK). Five standardized research instruments were utilized to measure key constructs, while Hierarchical Multiple Regression analysis was conducted to test five hypotheses. The findings indicated that computational thinking and problem-based learning significantly enhanced students' engagement in critical skills development, while intrinsic motivation and ability belief emerged as strong predictors of academic achievement and knowledge retention. The study contributes to the theoretical discourse on innovative pedagogical frameworks and provides empirical evidence to inform instructional practices in Business Mathematics and Cost accounting.

**Keywords**
Cost Accounting, Computational Thinking Pedagogy, Problem-Based Learning, Retention, Critical Skills, and Academic Achievement.

## Introduction

Education serves as a powerful catalyst for societal and economic advancement, continuously evolving to meet contemporary challenges. Across Nigeria, a significant transformation is underway, moving from traditional rote-based instruction toward dynamic teaching approaches that foster critical thinking and problem-solving abilities. The conventional "instructional paradigm" constrains creativity and analytical reasoning by prioritizing memorization over intellectual growth, underscoring the urgent need for a fundamental paradigm shift (Gwee, 2009; Yusal & Anggraini, 2024). Today's knowledge economy demands educational frameworks that develop both subject expertise and essential critical competencies (Koh et al., 2016). As Richardson and Blair (2015) highlight, meaningful intellectual engagement enables students to apply knowledge flexibly across diverse contexts. Recent research advocates for innovative teaching methods that enhance collaboration and engagement specifically within Business Mathematics education (Al Husaeni et al., 2024; Liu et al., 2023). Evidence demonstrates that approaches like Problem-Based Learning (PBL) and Computational Thinking Pedagogy (CTP) promote inquiry-driven learning, teamwork, and comprehensive skill development, thereby enhancing student motivation and academic achievement (Yusal & Anggraini, 2024; Agboola & Abe, 2017).

Computational Thinking Pedagogy (CTP) equips students to tackle complex challenges through systematic cognitive processes. These include applying logical reasoning, breaking down problems into manageable components, identifying patterns, and developing algorithmic solutions (Yusal & Anggraini, 2024; Wing, 2017). In business mathematics, CTP manifests through practical applications such as financial analysis, budgeting simulations, and market evaluations. These activities cultivate crucial analytical and decision-making skills that prepare students for increasingly data-driven business environments. CTP significantly enhances student engagement while promoting deeper conceptual understanding and critical thinking essential for future professional success (Yusal & Anggraini, 2024).

Problem-Based Learning (PBL) employs a constructivist approach characterized by self-direction and collaborative inquiry to develop vital skills including problem-solving, creativity, reflection, and teamwork (Yusal & Anggraini, 2024; Savery, 2022). This methodology immerses students in authentic, hands-on learning activities that enhance both theoretical understanding and practical skill development. Although LaForce et al. (2017) established connections between PBL and cognitive engagement, their research primarily addressed mental engagement while insufficiently exploring its impact on critical thinking and mathematical reasoning competencies.

The Cost accounting and Business Mathematics provides an ideal environment for investigating these innovative pedagogical approaches. This study examines fourth-year Business Education students enrolled in Cost accounting courses a distinctive research population with established mathematical foundations, offering an excellent context for assessing how modern teaching methodologies can enhance specialized skill development. Two key psychological constructs that significantly influence instructional effectiveness in educational settings are ability beliefs and intrinsic motivation. Ability beliefs, conceptualized within expectancy-value theory, represent a student's cognitive assessment of their competence to successfully execute specific academic tasks (Eccles & Wigfield, 2020). These self-evaluations form a critical component of academic self-concept and fundamentally shape how learners approach challenging material in quantitative disciplines. Students with positive ability beliefs demonstrate greater persistence when confronted with difficult problems, engage more deeply with complex mathematical concepts, and exhibit enhanced resilience following setbacks (Orji & Ogbuanya, 2020; LaForce et al., 2017; Marsh & Craven, 2016). Within the context of Business Mathematics, ability beliefs are particularly consequential, as students with stronger confidence in their mathematical capabilities tend to engage more readily with abstract concepts and demonstrate greater willingness to apply theoretical principles to novel problem-solving scenarios.

Complementing this cognitive dimension, intrinsic motivation represents a distinct psychological orientation characterized by engagement in learning activities for their inherent interest, challenge, or satisfaction rather than external contingencies such as grades or recognition (Ryan & Deci, 2017). This form of autonomous motivation manifests when students experience genuine enjoyment in the process of mathematical inquiry itself, finding intellectual stimulation in mastering complex concepts and deriving satisfaction from developing sophisticated analytical skills (Orji & Ogbuanya, 2020; Vansteenkiste et al., 2018). Research consistently demonstrates that intrinsically motivated students exhibit greater conceptual understanding, enhanced creativity in problem-solving approaches, and superior knowledge retention compared to those primarily motivated by external factors (Cerasoli et al., 2016).

The interrelationship between these psychological constructs creates a mutually reinforcing cycle particularly relevant to the implementation of innovative pedagogical approaches such as Problem-Based Learning and Computational Thinking Pedagogy. When educational environments support both competence beliefs and autonomous motivation, students demonstrate markedly improved engagement patterns characterized by deeper cognitive processing, sustained attention, and more sophisticated analytical reasoning (Jang, 2019). This dynamic becomes especially important in the context of Business Mathematics, where abstract theoretical concepts must be connected to practical applications in complex business scenarios.

Contemporary research indicates that pedagogical approaches like PBL and CTP can potentially enhance these psychological factors through their emphasis on authentic problem contexts, collaborative inquiry, and student autonomy (Orji & Ogbuanya, 2020; García-Martín & García-Sánchez, 2022). When students actively engage with meaningful mathematical challenges embedded within realistic business scenarios, they develop stronger ability beliefs through mastery experiences while simultaneously experiencing greater intrinsic satisfaction from the learning process itself. However, despite these promising theoretical connections, empirical investigation specifically examining how these psychological factors mediate the relationship between innovative pedagogical approaches and student performance outcomes in business courses remains surprisingly limited.

This research gap is particularly consequential because the effectiveness of any pedagogical innovation ultimately depends on its capacity to positively influence these underlying psychological processes. Understanding the precise mechanisms through which teaching approaches affect student motivation and self-beliefs provides essential insights for designing more effective instructional strategies and identifying potential moderating factors that may influence their effectiveness across diverse student populations (Ruzek & Schenke, 2019). The present study addresses this critical knowledge gap by systematically examining the mediating roles of ability beliefs and intrinsic motivation in the relationship between innovative teaching approaches and student performance in Cost accounting courses.

## Statement of the Problem

Business Education students face poor academic achievement in Business Mathematics which often affect their performances in Cost accounting courses. This is blamed against weak foundational skills and low engagement in teaching process. While CTP and PBL have shown promise in enhancing critical skills, this study examined how integrating them, alongside intrinsic motivation and ability beliefs, can improve engagement and critical skills development. We therefore, hypothesized that:

$H_1$: Combined CTP-PBL predicts high mean achievement scores (HMAS) between students exposed to the Combined CTP-PBL and those taught using LBM.

$H_2$: Intrinsic motivation and ability belief jointly predicts HMAS between students exposed to the Combined CTP-PBL and those taught using LBM.

$H_3$: Combined CTP-PBL significantly predicts Students Engagement in Critical Skill Acquisition (SECSA) and ability beliefs.

$H_4$: Combined CTP-PBL and intrinsic motivation significantly predicts SECSA.

$H_5$: Combined CTP-PBL and ability belief jointly mediate the relationship between intrinsic motivation and SECSA.

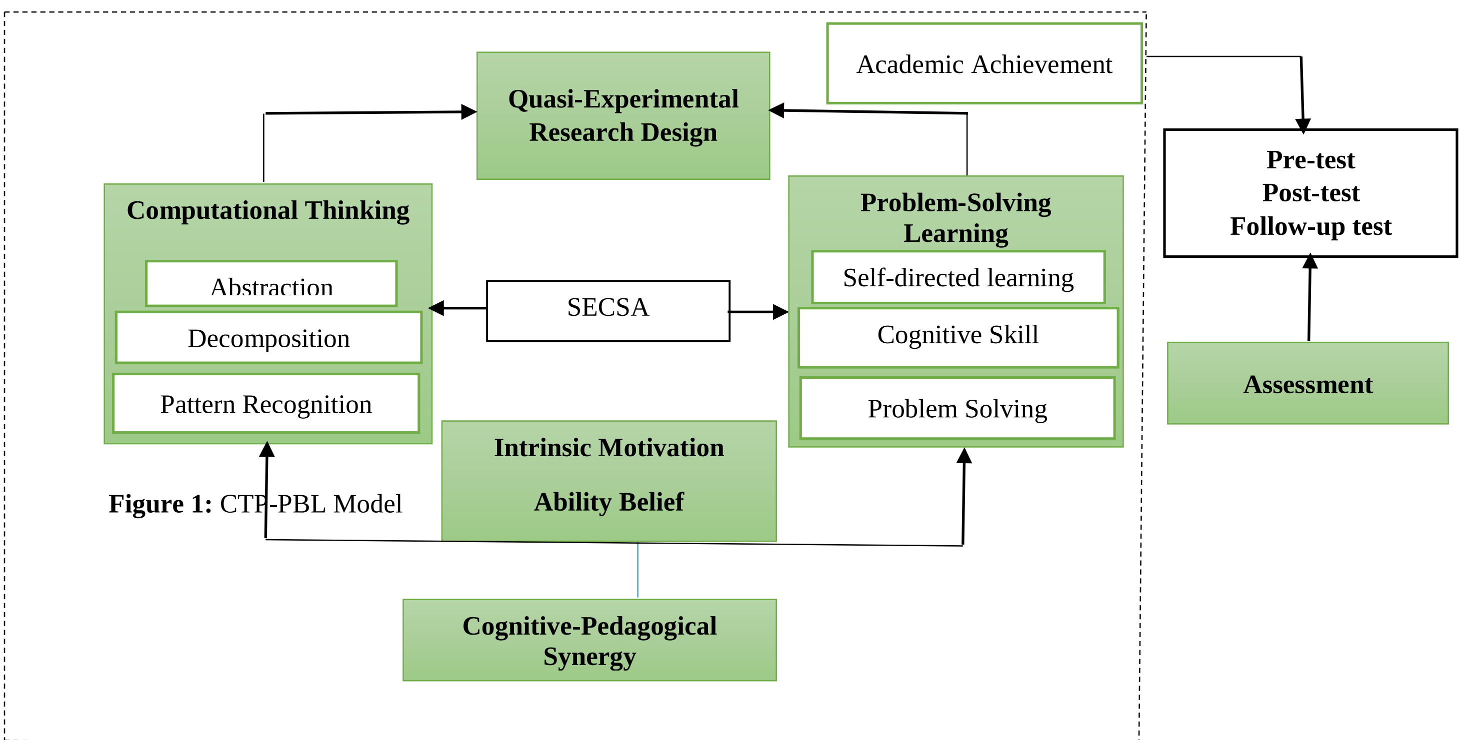


**Figure 1:** CTP-PBL Model

## Theoretical Framework

This study integrates Social Cognitive Career Theory (SCCT) and Self-Determination Theory (SDT) to examine relationships between innovative pedagogical approaches and student outcomes in Cost accounting. These complementary frameworks collectively illuminate psychological, motivational, and contextual factors influencing learning in quantitative business disciplines.

### Social Cognitive Career Theory (SCCT)

Social Cognitive Career Theory, developed by Lent, Brown, and Hackett (1994), explains how individuals develop academic interests, make educational choices, and achieve performance outcomes. SCCT posits that personal factors (self-efficacy beliefs, outcome expectations, and goals) interact with environmental variables to shape academic trajectories (Lent & Brown, 2019). Within this framework, self-efficacy plays a central role in determining engagement patterns, persistence, and achievement (Brown et al., 2023). SCCT provides an appropriate lens for examining Business Mathematics learning for three key reasons. First, it acknowledges the domain-specific nature of efficacy beliefs, recognizing that students' confidence in mathematical abilities constitutes a distinct psychological construct. Second, SCCT emphasizes how learning experiences shape efficacy beliefs, offering a framework for understanding how pedagogical approaches might enhance students' confidence. Finally, SCCT's focus on the relationship between efficacy beliefs and performance aligns with this study's examination of psychological mediators in educational outcomes. Recent research has successfully applied SCCT to understand academic performance in STEM disciplines. Jansen et al. (2021) employed the framework to investigate how learning experiences shape mathematics self-efficacy and subsequent achievement, validating SCCT's relevance for Business Mathematics education.

### Self-Determination Theory (SDT)

While SCCT addresses cognitive beliefs, Self-Determination Theory (Ryan & Deci, 2017) provides insights into motivational processes. SDT posits that optimal learning occurs when three psychological needs are satisfied: autonomy (experiencing volition), competence (feeling effective), and relatedness (experiencing meaningful connections) (Vansteenkiste et al., 2020). SDT distinguishes between different forms of motivation, particularly between intrinsic motivation (engaging in activities for inherent satisfaction) and various forms of extrinsic motivation (Ryan & Deci, 2020). This perspective illuminates how pedagogical approaches might foster deeper engagement with mathematical content. SDT offers several advantages for this investigation. Its emphasis on need-supportive environments aligns with student-centered pedagogies like PBL and CTP. Furthermore, its extensive research base demonstrates that autonomous motivation predicts deeper understanding and superior performance outcomes valued in Cost accounting courses.

### Integration of SCCT and SDT in Relation to PBL and CTP

Integrating these theories provides a more comprehensive framework than either alone. While SCCT illuminates cognitive beliefs influencing performance, SDT clarifies motivational processes that sustain engagement. This integration is particularly relevant for understanding Problem-Based Learning's impact. PBL's emphasis on authentic problems connects to SCCT's focus on building self-efficacy through mastery experiences. Simultaneously, its student-centered approach aligns with SDT's emphasis on autonomy support (Wijnia et al., 2022). The collaborative nature of PBL further satisfies relatedness needs, while scaffolded problem-solving builds competence. Similarly, Computational Thinking Pedagogy can be examined through this integrated lens. CTP's emphasis on logical reasoning provides structured approaches to problem-solving, potentially enhancing self-efficacy through specific cognitive strategies (Román-González et al., 2019). Simultaneously, CTP's focus on authentic learning experiences can satisfy autonomy and competence needs, fostering autonomous motivation (García-Martín & García-Sánchez, 2022). This theoretical integration shapes the study's hypotheses and methodology by suggesting that both pedagogical approaches should enhance ability beliefs and intrinsic motivation through complementary mechanisms, with these psychological factors serving as mediators between pedagogical approaches and learning outcomes.

## Method

### Design of the Study

This study adopted a quasi-experimental design, which is well-suited for educational research settings where random assignment is not feasible (Hayes, 2013). The intervention involved a single treatment group exposed to an instructional approach that combined Computational Thinking Pedagogy and Problem-Based Learning. This integrated method emphasized conceptual understanding through guided instruction while engaging students in problem-solving activities that reflected real-world applications. The control group received conventional instruction. To assess the effectiveness of the intervention, both groups completed pre-tests to establish baseline equivalence and post-tests to measure learning gains, ensuring that any observed differences could be attributed to the combined CTP-PBL approach.

## Participants and Selection Procedures

The participants of this study comprised a total of 139 Business Education students drawn from two universities in Southeast Nigeria: The University of Nigeria, Nsukka, Enugu State (UNN) and Nnamdi Azikiwe University, Awka, Anambra State (UNIZIK). The selection of these universities was based on their well-established Business Education programmes and their accreditation status by the National Universities Commission (NUC).

**Table 1: Demographic Variables of the Study Sample Depict Baseline Equivalence N = 139**

| Variables | | Treatment Groups (TP) (UNN) n = 69 | Waitlist Control Group (UNIZIK) n = 70 | $\chi^2$ | Sig. |
|---|---|---|---|---|---|
| Gender | Male | 30(57%) | 41(59%) | .483 | .597 |
| | Female | 39(43%) | 39(41%) | .501 | .538 |
| Average Age | X±SD | 18-33 | 18-33 | .618 | .636 |

**Note:** TG Treatment Group, UNN = University of Nigeria, Nsukka, UNIZIK = Nnamdi Azikiwe University.

The study sample was categorized into a treatment group, consisting of 69 students from UNN, and a waitlist control group, consisting of 70 students from UNIZIK. The demographic composition of the participants, as presented in Table 1, indicated that the treatment group included 30 (57%) male and 39 (43%) female students, while the waitlist control group comprised 41 (59%) male and 39 (41%) female students. The average age range of participants across both groups was 18 to 33 years, with no statistically significant difference in baseline demographic characteristics between the two groups ($\chi 2 = .483$, $p = .597$ for gender; $\chi 2 = .618$, $p = .636$ for age). The choice of these institutions was informed by the need to examine how computational thinking and problem-based learning influence Business Education students' development of critical skills in Business Mathematics, considering the crucial role of intrinsic motivation and ability belief in academic performance.

## Measures

Five instruments were utilized to evaluate the students' experiences and outcomes related to the interventions.

*Computational Thinking Experience and Problem-Based Learning Questionnaire (CTE-PBLQ):* The Computational Thinking Experience and Problem-Based Learning Questionnaire (CTE-PBLQ) was developed to assess the effectiveness of Problem-Based Learning (PBL) and Computational Thinking (CT) in enhancing business students' critical skills and academic achievement in Cost Accounting, considering the mediating role of intrinsic motivation and ability belief. The instrument integrates the Problem-Based Learning Experience Questionnaire (PBLEQ) and the Computational Thinking Experience Questionnaire (CTEQ) into a single 40-item instrument. The PBLEQ, adapted from Munshi et al. (2008) and Savery (2006), evaluates students' perceptions of PBL methodology, particularly its influence on ability beliefs, intrinsic motivation, and skill acquisition. The CTEQ, based on instruments by Upton & Upton (2006), measures students' confidence in computational problem-solving and motivation to develop critical skills. Both sections utilize a seven-point Likert scale, ranging from "very strongly disagree" (1) to "very strongly agree" (7) for PBL, and "poor" (1) to "best" (7) for CT. Higher scores indicate a positive perception of both pedagogies as engaging and effective in fostering critical thinking and academic success.

*Cost Accounting Achievement Test (CAAT):* The Cost Accounting Achievement Test was developed as a standardized assessment tool to measure the academic achievement of business education students in the Cost Accounting course. The instrument consists of thirty multiple-choice questions designed based on the prescribed curriculum for business education in Nigerian universities. It was used for pretest, posttest, and follow-up evaluations to determine students' comprehension and mastery of key Cost Accounting concepts. A table of specifications was prepared in alignment with Bloom's Taxonomy of the cognitive domain to ensure that the test items assess different levels of learning, including knowledge, comprehension, application, analysis, synthesis, and evaluation. To establish the instrument's suitability, an initial set of fifty questions was subjected to psychometric analysis. From this pool, thirty questions were selected based on their statistical properties, ensuring that the difficulty level ranged between 0.30 and 0.50, the discrimination index exceeded 0.40, and the distractor effectiveness fell within the range of 0.40 to 0.80. Each question was assigned two points for a correct answer, while incorrect responses received no points, resulting in a total possible score of sixty. The validity of the test content was verified by three senior lecturers with extensive experience in business education. To ensure the reliability of the instrument, a test–retest method was conducted over a two-week interval using a sample of thirty business education students. The reliability of the instrument was determined using the Kuder–Richardson Formula 20, which yielded a reliability coefficient of 0.91. This high reliability score confirmed the instrument's consistency in measuring students' achievement in Cost Accounting over time.

*Students' Engagement in Critical Skills Acquisition Questionnaire (SECSAQ):* The SECSAQ was a 25-item tool derived from the Watson-Glaser Critical Thinking Appraisal (Watson & Glaser, 1981) and the Course Engagement Questionnaire (Uçar & Sungur, 2018). It was used to measure the degree of students' engagement in acquiring critical skills, informed by their ability beliefs and intrinsic motivation. The SECSAQ employed a five-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5). Students with higher SECSAQ scores were considered to have exhibited greater engagement and higher academic achievement following the interventions.

*Students' Intrinsic Motivation Questionnaire (SIMQ):* Adapted from Glynn et al. (2011) and Alivernini & Lucidi (2008), the SIMQ was a 12-item instrument designed to evaluate students' intrinsic motivation. Responses were recorded on a five-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5). Higher scores reflected greater intrinsic motivation fostered by the learning environment or instructional approach.

*Ability Belief Questionnaire (ABQ):* The ABQ, a 12-item instrument adapted from Riopel (2019), was used to evaluate students' self-efficacy beliefs and their influence on intrinsic motivation and skill development. The ABQ employed a six-point scale ranging from "strongly disagree" to "strongly agree." Students with higher scores demonstrated stronger self-efficacy and a more positive self-assessment of their capabilities.

### Reliability of the Instruments

Each instrument underwent rigorous testing for internal consistency, yielding high reliability indices: *CTE-PBLQ* (0.84), CAAT (0.91), SECSAQ (0.89), SIMQ (0.88), and ABQ (0.86) with an overall reliability index of 0.88.

### Procedures

The study was conducted over a 17-week academic semester, with weekly two-hour sessions focusing on the application of Computational Thinking Pedagogy (CTP) and Problem-Based Learning (PBL) as an integrated instructional strategy for teaching Cost Accounting based on National Universities Commission standards. A one-week preparatory session was held before the intervention, during which researchers and course lecturers collaboratively discussed the lesson structures, real-world case study frameworks, and assessment instruments to ensure an effective and structured learning experience.

### Week 1: Baseline Assessment and Introduction of the CT-PBL Model

The first week focused on assessing prior knowledge and setting the foundation for the intervention. A pre-test was administered to evaluate students' understanding of cost classification, cost-volume-profit analysis, and cost allocation methods. Additionally, students completed a questionnaire designed to measure motivation, confidence, and anxiety levels regarding cost-related problem-solving. The lecturers introduced Computational Thinking Problem-Based Learning (CT-PBL) as the core instructional model, emphasizing active engagement with financial data and managerial decision-making.

### Weeks 2–8: Implementing Computational Thinking and Problem-Based Learning

This phase integrated CT principles into PBL-driven tasks, enabling students to develop logical problem-solving skills while engaging in real-world cost accounting scenarios.

*Breaking Down Cost Accounting Problems (Decomposition & Structuring)***:** Students worked in small teams to tackle complex cost analysis problems by breaking them into manageable components. They systematically identified, classified, and allocated costs, ensuring a structured approach to financial problem-solving.

*Recognizing Cost Trends and Patterns in Financial Data*: By examining historical cost records from local businesses, students identified trends in overhead, labor, and material costs. Using spreadsheet tools, they plotted financial data to forecast cost efficiency and overall business performance.

*Developing Algorithmic Thinking for Budgeting and Variance Analysis:* Instead of memorizing formulas, students developed systematic computational methods for budgeting and cost control. They created flexible budgets, analyzed standard cost variances, and proposed cost-reduction strategies using financial projections.

*Inquiry-Based Research and Decision-Making (PBL Component)*: Teams conducted independent research on real-world cost challenges, exploring concepts like activity-based costing and break-even analysis. They synthesized financial reports and proposed strategic solutions, simulating the decision-making process of financial managers.

*Collaborative Analysis and Business Decision Presentations:* Students built cost models, conducted financial simulations, and evaluated cost-cutting strategies for business scenarios. Each team presented their findings, receiving peer feedback that refined their analytical skills and deepened their understanding of financial decision-making.

**Weeks 9–15: Advanced Application and Integration**

This phase strengthened students' analytical skills through industry case studies, financial forecasting, and problem-solving. They analyzed real financial statements, created cost control models, and explored pricing strategies. Additionally, they kept learning journals to track their progress, challenges, and the development of their analytical abilities in cost accounting.

**Weeks 16–17: Final Evaluation and Assessment**

After the intervention, a post-test was conducted to evaluate students' improvement in cost accounting proficiency and analytical thinking, while a re-administered questionnaire assessed changes in motivation, problem-solving confidence, and cost-related anxiety. Additionally, each team submitted a comprehensive cost strategy report, showcasing their ability to apply CT-PBL principles to real-world financial challenges.

**Justification for the Integration of CTP and PBL**

Integrating Computational Thinking and Problem-Based Learning was essential due to the structured yet practical nature of Cost Accounting. While CTP strengthened students' logical thinking and computational problem-solving abilities, PBL contextualized these skills within real-world business applications (Yusal & Anggraini, 2024). This dual approach ensured that students not only understood cost accounting principles but could apply them to managerial decision-making, enhancing their preparedness for professional accounting roles.

## Data Analysis

Statistical analyses were conducted using SPSS version 25 with Hierarchical Multiple Regression and the PROCESS Macro for Multiple Mediation Analysis. Two regression models examined how PBL and CTP influenced ability belief and intrinsic motivation. A 5,000-sample bootstrapping method (Preacher & Hayes, 2008) evaluated total, direct, and indirect effects on critical skills and motivation.

## Results

The bivariate analysis (Table 1) showed significant positive correlations between SECSA and PBL ($r = 0.811$), CTP ($r = 0.730$), ability belief ($r = 0.735$), and intrinsic motivation ($r = 0.811$), with reliability coefficients ($\alpha > 0.7$). Study duration correlated positively ($r = 0.280$, $p < .05$), affirming Hayes' (2013) model robustness.

**Table 2: 2 Groups 3 Repeated Measure Analysis of Variance (ANOVA) Summary on Business Education Students' Academic Achievement by Experimental Conditions**

| | Combined CTP-PBL | | WCG (LBM) | | df | F | Sig |
|---|---|---|---|---|---|---|---|
| | M | SD | M | SD | | | |
| Pre-intervention | 48.17 | 10.53 | 46.97 | 8.50 | 1(138) | 2.164 | 0.184 |
| Post-intervention | 76.18 | 8.67 | 50.86 | 6.26 | 1(138) | 86.71 | 0.001 |
| Post Post-intervention | 88.51 | 7.38 | 48.53 | 8.31 | 1(138) | 119.26 | 0.001 |

**Note:** M = mean, SD = standard deviation.

To test if treatment predicts high mean achievement scores between students exposed to the Combined CTP-PBL and those taught using LBM, we conducted 3 repeated measure ANOVA. Results in Table 2 showed that at pre-intervention test there were baseline similarity in academic scores between the treatment and control groups: Treatment Group: 48.17±10.53, WCG: 46.97±8.50, ($F[138] = 2.164$, $p = 0.184$ (see Table 2). However, at post-intervention the results showed significant improvement in favour of the treatment group 76.18±8.67, ($F[138] = 86.71$, $p = 0.001$) but the waitlist control group had very insignificant change in the mean score (50.86±6.26). At follow-up test after two three weeks, result also revealed a remarkable and sustainable improvement in favour of the treatment group 88.51±7.38, ($F[138] = 119.26$, $p = 0.001$) but not in waitlist control group (48.53±8.31).

**Table 3: Total and Direct Effects of CTP-PBL on Students' Academic Achievement**

| | | | | | 95% CI | | |
|---|---|---|---|---|---|---|---|
| **Effects** | **Treatment** | **Estimate** | **SE** | **T** | **Lower** | **Upper** | **Decision** |
| Total | | .735 | .089 | 8.5393 | .593 | .883 | Significant |
| Direct | CTP-PBL | .318 | .078 | 3.4963 | .173 | .506 | Significant |
| Indirect | | .403 | .075 | - | .274 | .627 | Significant |
| Total | | .183 | .026 | 0.1169 | .018 | .133 | Not Significant |
| Direct | LBM | .094 | .018 | 0.0515 | .142 | .203 | Not Significant |
| Indirect | | .116 | .022 | - | .119 | .164 | Not Significant |

Table 4 shows that CTP-PBL significantly impact Students' Engagement in Critical Skills Acquisition (SECSA). The analysis confirmed the significant impact of Combined CTP-PBL on students' academic achievement, with a strong total effect ($\beta = 0.735$, $p < .001$). The direct effect ($\beta = 0.318$, $p < .001$) highlighted its independent influence, while the indirect effect ($\beta = 0.403$, $p < .001$) suggested mediation by intrinsic motivation, ability beliefs, and engagement. Assumptions of normality, multicollinearity, heteroscedasticity, and homogeneity were met. These findings validate CTP-PBL as an effective instructional strategy for enhancing academic success. This was not the case with the waitlist control group who were not exposed to treatment (Total: $\beta = 0.183$, Direct: $\beta = 0.094$, Indirect: $\beta = 0.116$, $p>.001$).

**Table 4: Indirect Mediation 5000 Re-samples BC Bootstrap Test Effects of CCTP-PBL, Ability Beliefs and Intrinsic Motivation**

| **Hypotheses** | **Path Relationship** | **CCTP-PBL** | | **95% CI** | | **Mediation** |
|---|---|---|---|---|---|---|
| | | **Estimate** | **SE** | **Lower** | **Upper** | **Remark** |
| $H_1$ | CTP-PBL→ HMAS | .193 | .083 | .069 | .316 | Partial |
| $H_2$ | IntrM↔AlB→ HMAS | .088 | .039 | .035 | .172 | Partial |
| $H_3$ | CTP-PBL→SECSA↔AlB | .187 | .067 | .074 | .348 | Partial |
| $H_4$ | CTP-PBL↔Intr.M→SECSA | .114 | .048 | .039 | .253 | Partial |
| $H_5$ | CTP-PBL↔AlB→IntrM→SECSA | .117 | .044 | .029 | .230 | Partial |

* PM = Partial Mediation, AlB = Ability Beliefs, IntrM = Intrinsic motivation, HMAS = High mean achievement scores

To examine the indirect mediation effects of the Combined CTP-PBL, ability beliefs, and intrinsic motivation, a bootstrap analysis with 5000 resamples and bias-corrected confidence intervals at 95% was conducted. The mediation analysis results demonstrated significant indirect effects, confirming partial mediation across all tested hypotheses. The findings indicated that the Combined CTP-PBL had a significant indirect positive effect on high mean achievement scores (HMAS) ($\beta = 0.193$, $SE = 0.083$, 95% CI: 0.069, 0.316). This result suggests that the implementation of the Combined CTP-PBL was instrumental in enhancing students' achievement scores, partially mediating the relationship. Thus, $H_1$ was supported. Similarly, the analysis revealed that intrinsic motivation and ability beliefs jointly contributed to high mean achievement scores (HMAS) ($\beta = 0.088$, $SE = 0.039$, 95% CI: 0.035, 0.172). This indicates that students' intrinsic drive and their belief in their ability played a crucial role in their academic success, providing partial mediation. Hence, $H_2$ was supported.

Furthermore, the results showed that the Combined CTP-PBL significantly influenced students' engagement in critical skill acquisition (SECSA) through ability beliefs ($\beta = 0.187$, $SE = 0.067$, 95% CI: 0.074, 0.348). This finding underscores the role of pedagogical strategies in fostering students' engagement and skill acquisition. Therefore, $H_3$ was supported with partial mediation. The analysis also demonstrated that the Combined CTP-PBL and intrinsic motivation significantly influenced SECSA ($\beta = 0.114$, SE = 0.048, 95% CI: 0.039, 0.253). This implies that students' motivation, when combined with an active learning strategy, positively impacted their engagement in acquiring critical skills. Consequently, $H_4$ was upheld. Lastly, the results revealed that ability beliefs and the Combined CTP-PBL jointly mediated the relationship between intrinsic motivation and SECSA ($\beta = 0.117$, SE = 0.044, 95% CI: 0.029, 0.230), further emphasizing the interconnectedness of students' motivational beliefs, instructional approach, and skill engagement. This confirms $H_5$ with partial mediation.

## Discussion

First, we tested the hypotheses one that combined CTP-PBL predicts high mean achievement scores (HMAS) between students exposed to treatment and those taught using LBM. The study found that students exposed to the treatment achieved significantly higher academic performance in cost accounting than those taught using the lecture-based method. The absence of a statistically significant difference in pre-intervention scores suggests that both groups had comparable prior knowledge. However, the substantial increase in post-intervention and post-post-intervention scores among the experimental group underscores the effectiveness of CTP-PBL in fostering deeper cognitive engagement and skill acquisition. These findings align with LaForce et al. (2017), who emphasised that problem-based learning enhances intrinsic motivation and ability beliefs, key drivers of academic success. The integration of computational thinking within problem-based learning likely reinforced students' problem-solving skills and analytical reasoning in cost accounting. The results also support Lent et al.'s (1994) social cognitive career theory, which posits that self-efficacy and ability beliefs mediate academic performance. Ogbuanya and Chukwuedo (2017) highlighted the role of experiential learning in skill acquisition, which aligns with the observed sustained improvement in achievement. Orji and Ogbuanya (2020) further demonstrated that ability beliefs and intrinsic motivation mediate the relationship between problem-based learning and student engagement. Recent studies also support the efficacy of computational thinking in enhancing analytical skills and problem-solving abilities (Tareq & Yusof, 2024; Zhang et al., 2024). The study reinforces that CTP-PBL enhances critical thinking, motivation, and long-term retention, making it a more effective instructional strategy than traditional methods.

The findings for hypothesis two revealed that intrinsic motivation and ability beliefs jointly predicted high mean achievement scores (HMAS), suggesting that students with stronger intrinsic motivation and ability beliefs performed better in cost accounting. The partial mediation observed implied that these psychological constructs played a significant role in enhancing academic achievement but were not the sole determinants. This result aligned with Consoli (2021), who highlighted the importance of motivation in shaping learning outcomes. Similarly, Lent et al. (1994) emphasised that ability beliefs mediated academic performance, reinforcing the assertion that students who believed in their capabilities were more likely to excel.

For hypothesis three, the study found that the combined CTP-PBL significantly predicted students' engagement in critical skill acquisition (SECSA) and ability beliefs. This suggested that CTP-PBL fostered an interactive learning environment that enhanced students' belief in their abilities, thereby promoting skill acquisition. The finding corroborated Orji and Ogbuanya (2020), who demonstrated that ability beliefs mediated the relationship between problem-based learning and student engagement. Furthermore, LaForce et al. (2017) emphasised that PBL encouraged active learning, improving students' motivation and self-confidence.

The results for hypothesis four indicated that CTP-PBL and intrinsic motivation significantly predicted SECSA, supporting the notion that motivation enhanced students' engagement in skill acquisition when integrated with problem-based learning. This outcome aligned with Ushioda (2021), who argued that motivation was a key factor in student engagement and skill acquisition. Valls et al. (2022) also noted that computational thinking in PBL strengthened students' problem-solving and decision-making skills, which were essential for skill acquisition.

For hypothesis five, the findings showed that ability beliefs and intrinsic motivation jointly mediated the relationship between CTP-PBL and SECSA, indicating that these psychological constructs served as pathways through which CTP-PBL influenced students' engagement in skill acquisition. This partial mediation suggested that while CTP-PBL directly enhanced skill development, students' beliefs in their abilities and intrinsic drive further facilitated the process. This finding aligned with Preacher and Hayes (2008), who noted that mediators played an essential role in understanding how interventions impacted outcomes. Ross and Scanes (2024) also highlighted the role of self-determination theory in explaining how intrinsic motivation drove sustained engagement in educational settings.

## Implications for Administrators and Researchers

The findings of this study have implications. University administrators should support innovative teaching by providing training and policies to enhance employability skills, while researchers should use advanced methods, such as multiple mediation models, to evaluate teaching practices' impact.

## Theoretical Contributions

This study contributed to Social Cognitive Career Theory (SCCT) by demonstrating how pedagogical interventions such as Computational Thinking Pedagogy (CTP) and Problem-Based Learning (PBL) enhance self-efficacy and ability beliefs, reinforcing SCCT's assertion that learning experiences shape confidence and academic choices. By establishing that self-efficacy and ability beliefs mediate the relationship between instructional strategies and skill acquisition, the study provided empirical support for SCCT's emphasis on cognitive mechanisms influencing academic performance. Regarding Self-Determination Theory (SDT), the study confirmed the significance of intrinsic motivation in sustaining student engagement and achievement, aligning with SDT's core principles that autonomy, competence, and relatedness are essential for effective learning. The integration of SCCT and SDT in this study highlighted the interaction between cognitive beliefs and motivational processes in shaping academic success, offering a strong theoretical foundation for future research on student-centred learning approaches in Cost Accounting and related disciplines.

## Limitations and Suggestion for Further Study

This study focused only on business education students, thus limiting generalizability. However, a 5,000-resample bootstrapping method and data from universities enhance reliability and applicability (Brydges, 2019).

## Conclusion

The findings of this study underscored the critical role of pedagogical strategies in shaping students' cognitive and motivational processes, ultimately influencing their academic achievement and skill development in Cost Accounting. By examining the impact of Computational Thinking Pedagogy (CTP) and Problem-Based Learning (PBL), the study revealed that these instructional approaches significantly enhance students' self-efficacy, intrinsic motivation, and problem-solving abilities, which are crucial for mastering complex accounting concepts. The results further validated the integration of Social Cognitive Career Theory (SCCT) and Self-Determination Theory (SDT), illustrating that cognitive beliefs and motivational factors work in tandem to foster deeper engagement and sustained academic performance. These insights offer valuable implications for educators, policymakers, and curriculum developers, emphasising the necessity of student-centred learning environments that cultivate autonomy, competence, and confidence. By reinforcing the importance of innovative teaching methodologies, this study contributes to the evolving discourse on educational transformation and provides a strong foundation for future research aimed at optimising instructional strategies to enhance learning outcomes in Cost Accounting and related disciplines.

## Recommendations

Based on the findings of the study, the following recommendations were made:

1. Educational policymakers should mandate the integration of Computational Thinking Pedagogy (CTP) and Problem-Based Learning (PBL) into Cost Accounting curricula to enhance students' cognitive and problem-solving skills.
2. University administrators should organise regular trainings to equip accounting lecturers with the necessary skills to effectively apply CTP and PBL in teaching Cost Accounting.
3. National University Commission should incorporate student-centred learning strategies that align with Social Cognitive Career Theory (SCCT) and Self-Determination Theory (SDT) to foster self-efficacy and intrinsic motivation.
4. Governments and educational institutions should provide adequate learning resources, including digital tools and real-world accounting case studies, to support active learning through CTP and PBL.
5. Periodic evaluations of pedagogical effectiveness should be conducted to refine teaching methodologies and ensure sustained academic engagement and performance in Cost Accounting.

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