"A Comparative Analysis of Computer-Assisted Learning and the Traditional Textbook-Based Approach in Enhancing Academic Achievement Among College Students at NU Lipa"

1. Introduction

The ongoing digital transformation in education has led to the rapid adoption of technology-based learning methods, particularly in higher education settings. At institutions like NU Lipa, educators and administrators are increasingly exploring the role of computer-assisted learning (CAL) and digital resources in enhancing students' academic achievement. This shift is driven by a growing body of research supporting the positive effects of technology integration on learning outcomes, as well as the need to respond to changing student needs and the demands of the 21st-century learning environment (Lee & Kim, 2023; Aslam et al., 2024) [1].

This study seeks to conduct a comparative analysis of computer-assisted learning and the traditional textbook-based approach in enhancing academic achievement among college students at NU Lipa. By examining key academic indicators such as engagement levels and retention rate, the research aims to determine which instructional method yields better outcomes for students. The study is grounded in recent empirical findings that show both technology-based learning and traditional resources play significant roles in student academic performance, though their relative effectiveness may vary depending on context and subject matter (Clobes et al., 2022; Panday‐Shukla, 2024).

Understanding the comparative impact of these instructional approaches is crucial for curriculum development and resource allocation. Prior studies have highlighted that technology-based learning not only improves academic performance but also fosters critical thinking, communication, and problem-solving skills among students (Aslam et al., 2024; Bianchi et al., 2022). Research comparing digital and traditional textbooks demonstrates that both formats can contribute positively to learning outcomes, and while digital resources may enhance access and engagement, printed books are often valued for deeper comprehension and retention (Rahman et al., 2024). These findings suggest the need for a balanced approach to resource integration in higher education.

Despite the growing presence of digital tools in education, gaps remain in understanding the nuanced effects of CAL versus textbook-based approaches within specific institutional and cultural contexts. Previous comparative studies have often focused on either digital or traditional methods in isolation or have not sufficiently considered moderating factors such as resource availability, student learning styles, and socioeconomic status (Lee & Kim, 2023; Jiang et al., 2022). Moreover, the cost of learning materials and access disparities continue to influence student engagement and success (Panday‐Shukla, 2024; Clobes et al., 2022).

By providing a data-driven comparison of CAL and traditional textbook-based instruction, this research aims to deliver actionable insights for educators at NU Lipa. The findings are expected to inform future teaching strategies, support equitable access to learning resources, and contribute to the broader discourse on effective pedagogical innovations in higher education. Ultimately, the study aspires to guide evidence-based decisions on technology integration and textbook use, ensuring that instructional practices are both inclusive and effective for a diverse student population (Bianchi et al., 2022; Al Rasheed, 2021).

1. Review of Related Literature

A. Effects of Computer-Assisted Learning on Academic Performance

Several studies have affirmed the positive influence of Computer-Assisted Learning (CAL) on students’ academic performance. Lee and Kim (2023) used a two-way fixed effect model in Korea and found that CAL significantly enhanced mathematics achievement, especially when supported by school resources and individualized instruction [1]. Similarly, Bianchi, Lu, and Song (2022) analyzed a large ed-tech program in China and concluded that CAL had a long-term impact on academic achievement, labor outcomes, and computer usage among rural students [2].

In medical education, Santos et al. (2020) found a strong positive correlation between the number of CAL sessions and anatomy course performance among medical students [3]. Likewise, Alsalhi et al. (2020) observed significantly better achievement in students using electronic books compared to traditional ones in a higher education setting [4].

Jiang, Gu, and Yin (2022) found that students with frequent backtracking behaviors in digital textbooks—especially reflective and visual learners—performed better than others, indicating a link between digital interaction and academic success [5].

B. Student Engagement, Motivation, and Retention in CAL

Technology-enhanced learning environments also improve engagement and motivation. Aslam, Arshad, and Karim (2024) found that technology-based learning enhances students’ critical thinking, communication, and motivation, making them more effective problem solvers [6]. He, Zhu, and Deneen (2021) noted that students in blended learning environments reported higher satisfaction and better academic performance than those in traditional classrooms [7].

Lee, Lee, and Jeong (2022) demonstrated that digital textbook usage improved academic interest and learning skills, particularly for low-achieving students [8]. Similarly, Rafiq, Iqbal, and Afzal (2024) found that digital platforms enhanced motivation, though technical barriers remained a challenge [9].

Eutsler and Long (2021) investigated how digital literacy tools—such as e-readers, annotation software, and interactive quizzes—influenced reading comprehension and engagement among college students. The study showed that digital tools increased motivation and comprehension, especially among students with prior digital experience, while those unfamiliar with such tools experienced cognitive overload [10].

C. Comparative Analyses of CAL and Traditional Textbook-Based Learning

Multiple studies have compared CAL with traditional textbook use. Panday‐Shukla (2024) compared Open Educational Resources (OERs) with printed textbooks and found higher engagement and learning outcomes among students using OERs [11]. In contrast, Clobes et al. (2022) found no significant differences in most assessments between traditional and digital textbook users, though digital users had slightly higher final grades [12].

Rahman et al. (2024) showed that both e-books and printed books positively influence academic performance, with printed books having a slightly stronger effect on comprehension and utility [13]. Faramarzi and Elekaei (2021) supported this, noting that tablets enhanced quick reading, but printed texts promoted deeper understanding and grammar acquisition [14].

Tawil et al. (2022) found that Lebanese students who used traditional textbooks demonstrated better memory, attention, and learning skills than those using tablets [15]. Similarly, Larhmaid (2022) concluded that while digital and print reading had comparable comprehension outcomes, printed text slightly outperformed in identifying key ideas [16].

D. Challenges and Limitations in CAL Implementation

Despite the benefits, CAL implementation faces challenges. Kandukoori et al. (2024) highlighted limitations in infrastructure, teacher training, and digital accessibility, particularly in under-resourced schools [17]. Al Rasheed (2021) found that while university faculty were highly satisfied with e-learning systems in Saudi Arabia, students remained neutral, citing lack of engagement and technical hurdles [18].

Li and Wang (2024) found that textbook use fostered student interest and active learning but had limited direct impact on academic outcomes unless paired with engaging activities [19]. Lastly, Cody Abbey et al. (2024) conducted a systematic review of EdTech in China and concluded that while CAL generally improves learning outcomes, effect sizes remain modest and more evidence is needed for broader generalization [20].

1. Methodology

**A. Research Design**

The study employs a quantitative research design to evaluate the differences in academic achievement between students who use traditional textbooks and those who use computer-assisted learning of first-year to third-year college students. This study will involve analyzing how the two learning approaches differ in terms of retention rates and student involvement, and evaluate the perceptions of students on the convenience and success of the computer-assisted learning in comparison to traditional textbooks, and determine the difficulties in applying both the traditional textbook-based method and computer assisted learning.

**B. Research Instrument**

The researchers used a self-made survey questionnaire to gather the data that are relevant to the study titled "A Comparative Analysis of Computer-Assisted Learning and the Traditional Textbook-Based Approach in Enhancing Academic Achievement Survey." This instrument was designed to compare how both approaches enhance students' academic achievement. The survey questionnaire was divided into five parts, which are first, “Respondents Information”; second, “Respondents Assigned Learning Method”; third, “Retention Rates, and Students Engagement”; fourth, “Perception of Effectiveness and Convenience”; and last, Challenges in Implementing Both Learning Methods.” Overall, it consists of 15 questions in a Likert scale format that ranges from 4 (Strongly Agree) to 0 (Strongly Disagree) and 3 open-ended questions for a broader idea. These instruments were constructed considering their reliability, validity, and essentiality to ensure that the measurement for each variable is accurate. Through this research instrument, the researchers will be able to compare the two approaches.

**C. Participants**

This study compared the effects of traditional textbook-based instruction and computer-assisted learning (CAL) on the academic performance of NU Lipa college students, specifically those from the School of Allied Health Sciences (SAHS) and the School of Architecture, Computing and Engineering (SACE). The sample comprised 11 Computer Science students, 5 Information Technology students, 3 Civil Engineering students and 10 Psychology students. Only first-year, second-year, and third-year students from the aforementioned courses participated in the study, which was carried out during the second term of the 2024–2025 academic year. The study did not include fourth-year students, graduate students, or students from different departments or institutions.

**D. Data Collection Procedure**

The gathering of data followed a clear, step-by-step routine to keep the process orderly and transparent.The draft was reviewed by the research adviser and faculty members to ensure clarity, relevance, and accuracy. The validated questionnaire was converted into a Google Form. The online form included an informed consent section at the beginning, followed by clear instructions for answering the survey. Then, the Google form was distributed to target respondents; it remained open for 14 days to allow the respondents sufficient time to complete the survey.The data was stored securely by a password-protected Microsoft Excel file accessible only to the researchers. After the collection period, the responses were reviewed for completeness and accuracy. Incomplete or duplicate entries were removed to ensure a clean dataset. The cleaned data was exported to Microsoft Excel for statistical analysis.

### **E. Statistical Treatment of Data**

To ensure the accuracy and reliability of the results, a combination of descriptive and inferential statistical techniques was applied to the survey data. All computations were performed in Microsoft Excel 365, with manual cross-checks for verification.

Descriptive Statistics

The mean and standard deviation were calculated for each Likert-scale item to summarise central tendency and dispersion. These measures provided an overview of students’ perceptions and experiences with Computer-Assisted Learning (CAL) and traditional Textbook-Based Learning (TBL).

Inferential Statistics

An independent-samples t-test was used to determine whether significant differences existed between the CAL (n = 17) and TBL (n = 12) groups across the five thematic domains of the questionnaire retention, engagement, perceived effectiveness, convenience, and challenges. Where Levene’s test indicated unequal variances, Welch’s t-test\* was employed. The magnitude of any significant difference was quantified using Cohen’s d, interpreted as small (0.20 ≤ d < 0.50), medium (0.50 ≤ d < 0.80), or large (d ≥ 0.80).

### **F. Ethical Considerations**

Before beginning the data collection process, the researchers made sure that all ethical guidelines and standards were properly adhered to. Ethical approval was secured from the university’s Research Ethics Committee before the study began. Participation in the study was completely voluntary, and informed consent was obtained from all respondents before they answered the questionnaire. Respondents were informed of their right to refuse or withdraw from the study at any point without any negative consequences. All responses were kept confidential and stored in a secured, password-protected digital folder. The data gathered will be used solely for academic purposes, and the dataset will be deleted one year after the completion of the study.

1. Results & Discussions

## *A.* ***Profile of the Respondents***

TABLE I. Profile of The Respondents by Program

| **Program** | **Number of Respondents** | **Percentage** |
| --- | --- | --- |
| Computer Science | 11 | 37.93 |
| Information Technology | 5 | 17.24 |
| Civil Engineering | 3 | 10.34 |
| Psychology | 10 | 34.48 |
| **Total** | **29** | **100%** |

Table 1 presents the profile of the respondents based on their respective academic programs under the School of Arts, Sciences, and Education (SASE) and the School of Architecture, Computing, and Engineering (SACE). Out of the total 29 participants, the majority came from the Computer Science program under SACE, with 11 respondents (37.93%). This was followed by Psychology under SASE, with 10 respondents (34.48%), Information Technology under SACE with 5 respondents (17.24%), and Civil Engineering, also under SACE, with 3 respondents (10.34%).

The distribution highlights a significant representation from students enrolled in SASE and SACE, particularly from the Computer Science and Psychology programs. While all respondents contribute valuable insights into the comparative analysis of computer-assisted learning and textbook-based instruction, the dominance of certain programs—especially Computer Science—may influence the overall findings, particularly in areas related to technology familiarity and usage.

B. Students Assigned Learning Method

This section discusses the distribution of participants according to the learning method assigned to them Computer-Assisted Learning or Traditional Textbook-Based Learning. It provides a baseline for comparing performance outcomes and student engagement across the two approaches.

TABLE II. Assigned Learning Method of Respondents

| **Assigned Learning Method** | **Frequency** | **Percentage** |
| --- | --- | --- |
| Computer Assisted Learning | 17 | 58.62 |
| Textbook Based Learning | 12 | 41.38 |
| **Total** | **29** | **100%** |

presents the distribution of respondents based on the learning method assigned to them. Out of the 29 total participants, 17 students (58.62%) were assigned to the Computer-Assisted Learning (CAL) group, while 12 students (41.38%) were assigned to the Traditional Textbook-Based Learning group. This allocation ensures a relatively balanced comparison between the two instructional approaches, with a slight majority using CAL. The proportion reflects the growing integration of digital learning tools at NU Lipa and provides a basis for analyzing differences in academic achievement, engagement, and retention across both learning modalities.

C. Differences in Test Scores, Retention Rates, and Student Engagement

Tables III and IV present the comparison of self-reported outcomes between students who were assigned to Computer-Assisted Learning (CAL) and those who used the traditional Textbook-Based Learning method. The results indicate generally moderate perceptions across all areas assessed. For the CAL group, the highest mean (3.18) was reported for improved understanding of the subject, while the lowest mean (2.82) pertained to the ability to recall key concepts. In contrast, students using textbooks reported slightly higher means, with the highest (3.33) also related to improved understanding, and the lowest (3.08) for recalling key concepts.

TABLE III. Retention Rates, and Student Engagement By Computer Assisted Learning

| Statements | Mean |
| --- | --- |
| I feel confident about my test performance after using my assigned learning method. | 3.12 |
| I can recall key concepts from my lessons effectively. | 2.82 |
| My understanding of the subject has improved with my assigned learning method. | 3.18 |
| I actively participate in class discussions or activities related to my study materials. | 2.94 |
| My assigned learning method motivates me to complete assignments and study. | 3.12 |

TABLE IV. Retention Rates, and Student Engagement By Textbook Based Learning

| Statements | Mean |
| --- | --- |
| I feel confident about my test performance after using my assigned learning method. | 3.33 |
| I can recall key concepts from my lessons effectively. | 3.08 |
| My understanding of the subject has improved with my assigned learning method. | 3.33 |
| I actively participate in class discussions or activities related to my study materials. | 3.25 |
| My assigned learning method motivates me to complete assignments and study. | 3.25 |

Although students using textbooks slightly outperformed their CAL counterparts in most statements, the differences were minimal—typically less than 0.30—suggesting that both methods yielded comparable levels of confidence, understanding, participation, and motivation. These findings are consistent with Clobes et al. (2022), who found no significant difference in most academic outcomes between students using traditional and digital textbooks, and with Larhmaid (2022), who reported that reading medium (paper vs. screen) did not significantly affect overall reading comprehension. Similarly, Rahman et al. (2024) found that both printed and e-books positively impact academic performance, with only marginal differences between the two.

These results imply that neither instructional approach held a distinct advantage over the other in terms of perceived learning gains and engagement, indicating that both methods can be equally effective when implemented with proper support and structure (Clobes et al., 2022; Rahman et al., 2024; Larhmaid, 2022).

D. Students’ Perceptions of Effectiveness and Convenience

Tables V and VI detail students' perceptions regarding the effectiveness and convenience of their assigned learning method. CAL was seen as moderately accessible (mean = 3.12) and particularly favorable for studying at one's own pace (mean = 3.29). Students also indicated a reasonable preference for continuing with CAL in future settings (mean = 3.00) and considered it generally helpful for understanding course concepts (mean = 3.18).

TABLE V. Students’ Perceptions of Effectiveness and Convenience Of Computer Assisted Learning

| Statements | Mean |
| --- | --- |
| My assigned learning method is easy to access and use. | 3.12 |
| My learning method effectively helps me understand concepts better. | 3.18 |
| My learning method allows me to study at my own pace conveniently. | 3.29 |
| If given a choice, I would continue using my assigned learning method in the future. | 3 |
| I prefer using my assigned learning method over other methods I have used before. | 3.18 |

Table VI. Students’ Perceptions of Effectiveness and Convenience Of Textbook Based Learning

| Statements | Mean |
| --- | --- |
| My assigned learning method is easy to access and use. | 2.92 |
| My learning method effectively helps me understand concepts better. | 3.5 |
| My learning method allows me to study at my own pace conveniently. | 3.58 |
| If given a choice, I would continue using my assigned learning method in the future. | 3.5 |
| I prefer using my assigned learning method over other methods I have used before. | 3 |

Meanwhile, the Textbook-Based Learning group reported higher ratings in several categories. They found their learning method more effective in helping them understand concepts (mean = 3.50) and more convenient for studying at their own pace (mean = 3.58). Additionally, their willingness to continue using textbooks in the future (mean = 3.50) was stronger than that of the CAL group.

These findings align with the results of Faramarzi & Elekaei (2021), who found that print media was superior for deep reading and comprehension, while digital texts were better for quick and shallow learning. Similarly, Rahman et al. (2024) highlighted that printed books are preferred for deeper comprehension and retention, even though e-books offer greater convenience and accessibility. Lee et al. (2022) also found that digital textbooks can improve academic interest and learning skills, especially for low-achieving students, but students may still value the depth and clarity provided by traditional textbooks.

Overall, while CAL was appreciated for its flexibility, textbooks were perceived as slightly more effective in reinforcing understanding and motivating continued use. This suggests that students’ preferences may be influenced not just by technological convenience but also by perceived depth and clarity of content delivery (Faramarzi & Elekaei, 2021; Rahman et al., 2024; Lee et al., 2022).

E. Challenges in Implementing Both Learning Methods

Tables VII and VIII outline the challenges encountered by students when using either Computer-Assisted Learning or traditional textbooks. Students using CAL reported moderate challenges with technical issues or lack of resources (mean = 2.59) and external distractions (mean = 2.53). They also reported some difficulty staying focused (mean = 2.41). However, they generally agreed that CAL met their learning needs (mean = 3.24) and accommodated different learning styles effectively (mean = 3.12).

Table VII.Challenges in Implementing Computer Assisted Learning

| Statements | Mean |
| --- | --- |
| I have encountered challenges (technical issues, lack of resources, etc.) while using my assigned learning method. | 2.59 |
| I struggle to stay focused when using my learning method. | 2.41 |
| External distractions affect my learning more with this method compared to others. | 2.53 |
| My learning method accommodates different learning styles effectively. | 3.12 |
| My assigned learning method meets my learning needs. | 3.24 |

Table VIII. Challenges in Implementing Textbook Based Learning

| Statements | Mean |
| --- | --- |
| I have encountered challenges (technical issues, lack of resources, etc.) while using my assigned learning method. | 2.92 |
| I struggle to stay focused when using my learning method. | 2.08 |
| External distractions affect my learning more with this method compared to others. | 2.3 |
| My learning method accommodates different learning styles effectively. | 3 |
| My assigned learning method meets my learning needs. | 3.42 |

In contrast, students using textbooks reported fewer issues with distractions (mean = 2.30) but slightly more challenges regarding access and resources (mean = 2.92). Notably, this group had more difficulty maintaining focus (mean = 2.08), yet they rated their method higher in terms of meeting learning needs (mean = 3.42) and accommodating different styles (mean = 3.00).

These findings are supported by Rafiq et al. (2024), who noted that technical difficulties and limited access are common barriers to effective digital learning, while traditional methods may face challenges in engaging students' sustained attention. Likewise, Lee & Kim (2023) highlighted that the effectiveness of CAL is influenced by the availability of resources and individualized support. Jiang, Gu, & Yin (2022) found that digital tools may benefit students with certain learning styles, such as reflective and visual learners, suggesting the importance of accommodating diverse student needs. Conversely, Tawil et al. (2022) reported that textbook learning was associated with better memory, attention, and processing speed compared to digital devices among Lebanese children.

These findings suggest that both methods come with specific challenges. CAL users often struggle with external technical factors, while textbook users may face issues with sustained attention. Despite this, both groups found their assigned methods to be reasonably effective in meeting academic needs (Rafiq et al., 2024; Lee & Kim, 2023; Jiang, Gu, & Yin, 2022; Tawil et al., 2022).

F. T-Test

the results of the independent samples t-test comparing Computer-Assisted Learning (CAL) and Textbook-Based Learning (TBL):

T-statistic: -0.724

P-value: 0.476

Mean (TBL): 3.100

Mean (CAL): 2.988

Cohen’s d (Effect Size): -0.269 (small effect)

Interpretation for your research paper:

An independent sample t-test was conducted to compare academic achievement scores between students using computer-assisted learning (CAL) and those using the traditional textbook-based approach (TBL). Results showed no statistically significant difference between the two groups, t(approximately) = -0.72, p = 0.476. The mean score for the TBL group (M = 3.10) was slightly higher than that of the CAL group (M = 2.99). The effect size, measured using Cohen's d, was -0.27, indicating a small and non-significant effect. These findings suggest that both instructional methods yielded comparable academic outcomes in this sample.

1. Conclusion And Recommendations

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