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Instructional Impact of Hybrid Learning in Mathematics

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Abstract

This study examined the instructional impact of hybrid learning on the mathematics performance of graduating Bachelor of Science in Information Systems (BSIS) students at Talibon Polytechnic College. Guided by blended learning theory, constructivist learning theory, cognitive load theory, the Community of Inquiry framework, self-regulated learning theory, and transactional distance theory, the research explored how hybrid learning influences academic performance, competency attainment, instructional strategies, availability of learning materials, assessment practices, and institutional support. A convergent embedded quantitative research design integrating quantitative and qualitative approaches was employed. Data were collected using survey questionnaires adapted from Albert Lagrimas (2022), semi-structured interviews, and analysis of students' academic records. Respondents included graduating BSIS students and a mathematics instructor who had experienced the hybrid learning system implemented at the institution. Quantitative data were analyzed using descriptive and inferential statistics, while qualitative data were examined through thematic analysis and triangulation. Results indicated that students demonstrated stronger performance in Statistics and Quantitative Methods, while Mathematics II showed lower performance due to the complexity of conceptual topics and limited face-to-face interaction. Students generally reported very positive experiences with hybrid learning, particularly in competency attainment, availability of learning materials, instructional strategies, assessment practices, and institutional support. However, challenges were identified in student engagement during synchronous sessions, understanding complex online materials, timely feedback in assessments, and access to counseling support. Overall, the study concludes that hybrid learning can effectively support mathematics education when supported by appropriate instructional strategies, accessible learning resources, and comprehensive academic support systems. The findings are relevant to Sustainable Development Goal 4 (Quality Education) by promoting innovative teaching practices that improve access and quality in higher education, and SDG 9 (Industry, Innovation and Infrastructure) by encouraging the integration of digital technologies in education. The study contributes to educational and socio-technological sustainability by providing evidence-based insights for improving hybrid learning systems and strengthening institutional capacity for technology-enabled instruction in higher education.

Keywords: academic performance, competency attainment, hybrid learning, instructional strategies, mathematics education, sustainability, technology-enhanced learning

1. Introduction

Hybrid learning, which integrates face-to-face instruction with online learning environments, has emerged as an important instructional model in modern higher education due to its flexibility, accessibility, and ability to support individualized learning. This approach enables students to study at their own pace while maintaining opportunities for instructor guidance and structured learning activities (Graham, 2006). Despite these advantages, the application of hybrid learning in subjects requiring continuous interaction and immediate feedback, such as mathematics, requires further examination. Mathematics plays a crucial role in higher education programs, particularly in technology-related fields where analytical thinking, logical reasoning, and algorithmic problem-solving are essential. However, the transition to hybrid learning environments may influence how students understand mathematical concepts, interact with instructors, and engage with learning materials. Online environments may limit real-time feedback and interaction, potentially affecting the learning of complex mathematical abstractions (Boaler, 2016). Talibon Polytechnic College implemented hybrid learning beginning in Academic Year 2020–2021 to maintain instructional continuity and address limitations in classroom availability and public health conditions. The hybrid model combined periodic face-to-face instruction with online learning resources to provide both structured learning experiences and flexible access to course materials. This study examined the instructional impact of hybrid learning on the academic performance of graduating Bachelor of Science in Information Systems (BSIS) students in mathematics at Talibon Polytechnic College. It explored students' experiences with hybrid learning in terms of competency attainment, instructional strategies, availability of learning materials, assessment practices, and academic support while determining whether hybrid learning significantly influenced students' mathematics performance.

1.1 Hybrid Learning Implementation in Mathematics Instruction for BSIS Students at Talibon Polytechnic College

Hybrid learning combines traditional classroom instruction with online learning tools to create a flexible learning environment that accommodates different learning needs. This instructional approach allows students to learn independently while still receiving instructor guidance during scheduled face-to-face sessions (Graham, 2006). Hybrid learning is increasingly adopted in higher education institutions as a strategy to improve access to education and address institutional constraints such as classroom shortages. Mathematics instruction in tertiary education requires structured guidance, opportunities for practice, and interactive engagement between students and instructors. Effective mathematics teaching involves providing a supportive learning environment and meaningful mathematical challenges that encourage problem-solving and conceptual understanding (Jaworski, 1992). In information technology programs, mathematics courses also develop algorithmic thinking and analytical reasoning skills necessary for computational problem solving (Sukhov, 2002). However, implementing mathematics instruction in hybrid learning environments may present challenges. Online learning environments can restrict immediate feedback and reduce opportunities for direct interaction between students and instructors. These limitations may make it difficult for students to fully grasp complex mathematical concepts (Boaler, 2016). Hybrid learning attempts to address these limitations by combining face-to-face instruction with digital learning tools such as simulations, independent modules, and interactive learning resources. At Talibon Polytechnic College, hybrid learning was introduced during the Academic Year 2020–2021 to ensure continuity of instruction and accommodate institutional constraints. The system combined intermittent face-to-face classes with online learning sessions, allowing students to access instructional materials while maintaining structured classroom interaction. Despite these efforts, instructors observed challenges related to student engagement, participation, and the effectiveness of presenting complex mathematical concepts in hybrid environments.

1.2 Hybrid Learning Experiences in Mathematics: Competency Attainment, Instructional Strategies, and Learning Support

Previous studies emphasize that the effectiveness of online and blended learning environments depends largely on instructional design, learner engagement, and the availability of appropriate learning resources. Research suggests that well-designed online learning environments can improve learning outcomes when students actively interact with course materials and participate in structured learning activities (Kebritchi, Lipschuetz, & Santiague, 2017). Blended learning models combine face-to-face and online instructional components to enhance learning experiences and provide flexible learning opportunities. When these components are properly integrated, blended learning can support deeper conceptual understanding in complex subjects such as mathematics (Graham, 2006; Garrison & Kanuka, 2004). Student engagement is another critical factor influencing learning outcomes in online mathematics education. Studies indicate that active participation, collaboration, and continuous feedback from instructors significantly enhance students' learning experiences and academic performance (Dabbagh & Bannan-Ritland, 2005). Interactive learning materials and structured instructional design also contribute to improved comprehension of mathematical concepts (Mupinga & Maughan, 2006). However, online mathematics instruction also presents challenges. Maintaining student motivation, providing timely feedback, and presenting complex mathematical concepts effectively remain significant concerns in online learning environments (Kumar, 2013; Tharp & Squires, 2013). These challenges highlight the need for effective instructional strategies and learning support mechanisms in hybrid learning systems. Student success in online mathematics courses is also influenced by self-regulated learning behaviors. Students who effectively manage their time, set learning goals, and monitor their progress tend to perform better in online learning environments (Artino, 2008). Similarly, course design, interactivity, and learner engagement significantly influence student achievement in online mathematics learning (Ally & Tsinakos, 2014). Student satisfaction with online learning is closely associated with the quality of course materials, instructor feedback, and interaction with digital resources (Ally, 2008).

1.3 Hybrid Learning in Mathematics Education within the Philippine Higher Education Context

The adoption of hybrid and online learning models has become increasingly common worldwide as higher education institutions integrate digital technologies into teaching and learning processes. These models offer opportunities for flexible instruction while addressing challenges related to infrastructure, accessibility, and resource availability. In the Philippines, educational policies support the integration of technology and alternative learning modalities to improve access to quality education. Republic Act 10655 promotes distance learning in higher education by encouraging the use of open educational resources and multiple instructional delivery formats. Similarly, Republic Act 10968 and the Philippine Qualifications Framework emphasize competency-based education and alignment with national educational standards (Republic of the Philippines, 2018). Republic Act 10533 further promotes the integration of information and communication technology in education to enhance teaching effectiveness and improve student learning outcomes. In addition, Republic Act 10931 and Republic Act 10650 emphasize expanding access to tertiary education and supporting alternative learning systems that accommodate diverse learner needs. These policies provide the institutional and legal foundation for implementing hybrid learning models in higher education institutions such as Talibon Polytechnic College, particularly in contexts where classroom availability and geographic conditions influence instructional delivery.

1.4 Theoretical Foundations of Hybrid Learning in Mathematics Instruction

This study was guided by several educational theories that explain how hybrid learning environments influence teaching practices and student learning outcomes. The Blended Learning Theory of Bonk and Cummings (2006) emphasizes integrating traditional face-to-face instruction with online learning technologies to create flexible and effective learning environments that combine the strengths of both instructional modes. Constructivist learning theory suggests that learners actively construct knowledge through experiences and social interaction. Scholars such as Piaget and Vygotsky emphasize the importance of collaboration and engagement in developing meaningful understanding (Piaget, 1976; Vygotsky, 1978; Woolfolk, 2021). Cognitive Load Theory explains how learning effectiveness depends on the learner's ability to process information without exceeding cognitive capacity. Subjects involving complex problem-solving, such as mathematics, require careful instructional design to manage cognitive load effectively (Sweller, 1988). The Community of Inquiry framework identifies cognitive presence, social presence, and teaching presence as key elements in creating effective online learning environments (Garrison, Anderson, & Archer, 2001). Maintaining these elements is particularly important in hybrid learning systems where face-to-face interaction is limited. Self-Regulated Learning theory highlights students' ability to manage their own learning processes, including goal setting, monitoring progress, and reflecting on learning outcomes (Zimmerman, 2002). These skills are particularly important in online learning environments where learners have greater autonomy. Transactional Distance Theory further explains that reduced communication and interaction between students and instructors may increase the difficulty of learning. Factors such as course structure, learner autonomy, and instructional communication influence this distance in online learning environments (Moore, 1993).

1.5 Research Gap on the Instructional Impact of Hybrid Learning on Mathematics Performance of BSIS Students

Although hybrid learning is widely implemented in higher education, limited research has specifically examined its instructional impact on mathematics learning outcomes among information systems students in Philippine higher education institutions. Mathematics learning requires active engagement, guided problem-solving, and timely instructor feedback. These instructional elements may be affected by hybrid learning environments that reduce direct interaction between instructors and students. While previous studies highlight the benefits of blended learning systems, they also identify challenges related to engagement, instructional design, and presentation of complex mathematical concepts (Kumar, 2013; Tharp & Squires, 2013). These findings highlight the need for further research examining how hybrid learning influences students' academic performance and learning experiences in mathematics courses. At Talibon Polytechnic College, hybrid learning has been implemented since Academic Year 2020–2021; however, its impact on students' mathematics competencies and academic performance has not been systematically evaluated. This study addressed this gap by examining students' academic performance and experiences with hybrid learning in mathematics courses.

1.6 Alignment with Sustainable Development Goals in Technology-Enabled Mathematics Education

This study contributes to several United Nations Sustainable Development Goals related to education and technological innovation. The research supports SDG 4 – Quality Education, which promotes inclusive and equitable access to quality education. Evaluating the effectiveness of hybrid learning in mathematics contributes to improving teaching practices and learning outcomes in higher education. The study also aligns with SDG 9 – Industry, Innovation and Infrastructure, as hybrid learning represents an innovative approach that integrates digital technologies into educational systems. Additionally, the research supports SDG 8 – Decent Work and Economic Growth by strengthening mathematics education within information systems programs, helping students develop analytical and technical skills necessary for modern technology-driven industries.

1.7 Importance of the Study to Educational and Socio-Technological Sustainability

This study contributes to multidisciplinary sustainability by strengthening hybrid learning systems in higher education. From an educational sustainability perspective, the study helps institutions refine hybrid learning strategies to ensure effective teaching and learning despite limitations in classroom space and instructional resources. From a technological sustainability perspective, the study evaluates how digital learning tools and online platforms support mathematics instruction, contributing to the continuous improvement of technology-integrated education. From a socio-economic sustainability perspective, improving mathematics instruction within information systems programs helps develop graduates equipped with critical thinking, analytical reasoning, and computational skills needed for modern digital industries. Finally, the findings provide evidence-based recommendations that can assist Talibon Polytechnic College in improving hybrid learning policies, instructional practices, and academic support systems to enhance student engagement and academic performance in mathematics.

2. Materials and methods

2.1 Research Design

The study utilized a convergent embedded quantitative research design in which quantitative and qualitative data were collected and integrated to provide a comprehensive understanding of the effectiveness and challenges of hybrid learning

in mathematics instruction. The quantitative component focused on describing students' and instructors' perceptions of hybrid learning using a survey questionnaire and examining students' academic performance in mathematics under the existing hybrid learning arrangement. The qualitative component involved semi-structured interviews conducted to validate and deepen the interpretation of the quantitative findings. The research examined the existing hybrid learning structure at Talibon Polytechnic College, where each academic program conducted one week of face-to-face classes per month while the remaining weeks were delivered online, with an additional week allocated for examinations. The study focused exclusively on teaching and learning activities in mathematics subjects and did not include other disciplines or instructional methods not implemented at the institution. Contextual factors such as the ongoing construction of the college building, which affected classroom availability, were also considered as part of the study setting.

2.2 Locale of the Study

The study was conducted at Talibon Polytechnic College located in San Isidro, Talibon, Bohol, Philippines. The institution is a higher education institution offering several undergraduate programs, including Bachelor of Science in Criminology, Bachelor of Science in Information Systems, Bachelor of Arts in Political Science, Bachelor of Science in Agriculture, Bachelor of Early Childhood Education, Bachelor of Science in Accounting Information System, and Bachelor of Arts in English Language. The college served as the setting where hybrid learning was implemented and where the data related to mathematics instruction were collected.

2.3 Respondents of the Study

The respondents of the study consisted of graduating Bachelor of Science in Information Systems (BSIS) students and the mathematics instructor at Talibon Polytechnic College. These participants were selected because they directly experienced the hybrid learning setup in mathematics courses and were therefore able to provide relevant information regarding the instructional impact of hybrid learning on mathematics education at the institution.

2.4 Sample and Sampling Procedure

The study involved the graduating BSIS students of Talibon Polytechnic College who were enrolled in mathematics subjects under the hybrid learning setup. These participants were chosen because they had experienced both face-to-face and online components of the hybrid learning system throughout their academic program. The mathematics instructor involved in teaching the course was also included to provide instructional perspectives on the effectiveness and challenges of hybrid learning in mathematics instruction.

2.5 Research Instrument

Data were collected primarily through survey questionnaires and semi-structured interviews. The survey questionnaire used in the study was modified and adapted from the instrument developed by Albert Lagrimas (2022), which investigated student attitudes toward online and blended learning before and after the pandemic in Philippine universities. The questionnaire consisted of closed-ended items measured using a Likert scale that assessed respondents' perceptions of the effectiveness, challenges, and experiences associated with hybrid learning in mathematics. The instrument also incorporated components related to competencies and learning outcomes identified in CHED Memorandum Order No. 25, series of 2015, to determine whether the hybrid learning approach facilitated the attainment of required mathematics competencies. The instrument was modified to align with the specific hybrid learning structure implemented at Talibon Polytechnic College to ensure contextual relevance. In addition to the questionnaire, semi-structured interviews were conducted to gather deeper insights into the experiences of students and instructors with hybrid mathematics learning.

2.6 Data Gathering Procedure

Data collection was conducted using a mixed-methods approach that combined survey questionnaires, interviews, and analysis of academic records. Survey questionnaires were distributed to students and instructors either through electronic media or in printed form when necessary. The survey collected information regarding perceptions of hybrid learning, including its benefits, challenges, and influence on students' academic performance in mathematics. Semi-structured interviews were conducted with selected students and instructors to supplement and clarify the survey results. These interviews were carried out either face-to-face or online depending on participant availability and convenience, allowing respondents to share detailed experiences related to hybrid mathematics instruction. Academic performance data were also obtained by examining students' grades in four mathematics subjects. Institutional permission was secured to access these academic records, which were used to analyze students' academic performance and explore possible relationships between perceptions of hybrid learning and mathematics achievement.

2.7 Data Analysis Techniques

The collected data were analyzed using both quantitative and qualitative analytical techniques. Quantitative data obtained from the survey questionnaires were analyzed using descriptive and inferential statistics. Descriptive statistics, including frequency distributions and measures of central tendency such as mean, median, and mode, were used to summarize respondents' perceptions of hybrid learning and academic performance in mathematics. Measures of variability, including

standard deviation, were also computed to determine the distribution of responses. Inferential statistical methods were applied to examine relationships and differences among variables. These included chi-square tests to determine associations between demographic variables and attitudes toward hybrid learning, as well as t-tests or analysis of variance to identify differences in perceptions among groups. Qualitative data obtained from interviews were analyzed through thematic analysis by coding responses, identifying patterns, and classifying themes related to students' and instructors' experiences with hybrid mathematics learning. Finally, triangulation was used to integrate quantitative and qualitative findings, enabling the comparison of results from multiple data sources to enhance the validity and reliability of the study.

3. Results and Discussion

3.1 Academic Performance of Students in Mathematics Under Hybrid Learning

3.1.1 Performance in Mathematics I and Mathematics II

The results showed varying levels of student performance across mathematics subjects under the hybrid learning modality. Mathematics I recorded a mean grade of 1.95 with moderate variation among students, indicating that learners generally managed the subject effectively despite differences in prior knowledge. In contrast, Mathematics II produced the lowest mean grade of 2.22 and the highest variability among students, suggesting greater difficulty in mastering the concepts taught in this subject. The lower performance in Mathematics II may be attributed to the subject's emphasis on higher-level concepts such as functions, inequalities, and analytical geometry, which require deeper conceptual understanding and interactive problem-solving. Limited face-to-face interaction in hybrid learning environments may have affected students' ability to grasp abstract mathematical concepts. This observation aligns with the findings of Baticulon et al. (2021), who reported that students in remote and blended learning settings often struggle with subjects requiring higher-order thinking skills due to reduced interaction, limited feedback, and technological constraints.

3.1.2 Performance in Statistics and Quantitative Methods

Students demonstrated stronger performance in Statistics and Quantitative Methods compared with other mathematics subjects. Statistics achieved the highest academic performance with a mean grade of 1.53 and low variability among students, indicating consistent achievement across the group. Quantitative Methods also showed strong performance with a mean grade of 1.84 and the lowest variation in scores. These findings suggest that hybrid learning environments may be more effective for subjects involving procedural or computation-based tasks. Practical topics such as statistical analysis and decision-making processes can be effectively demonstrated through digital tools and step-by-step explanations available in online platforms. This interpretation is consistent with the findings of Coman et al. (2020), which emphasized that subjects requiring procedural knowledge and structured problem-solving are well suited to online and hybrid learning environments because instructional demonstrations and practice activities can be easily delivered through digital resources.

3.2 Students' Experiences with Hybrid Learning in Mathematics

3.2.1 Attainment of Learning Competencies

The findings revealed that students strongly perceived hybrid learning as effective in supporting the attainment of competencies required in the Bachelor of Science in Information Systems program. The overall evaluation indicated a very high level of competency attainment across multiple areas, including modeling and designing information systems, applying technical tools and techniques, evaluating system performance, and recognizing legal and ethical issues related to technology. These results suggest that hybrid learning environments may enhance students' ability to apply theoretical knowledge in practical contexts. Access to digital resources, simulation tools, and flexible learning opportunities likely contributed to improved competency development. Bernard et al. (2014) similarly found that learners in hybrid or blended learning environments often demonstrate stronger academic outcomes compared with those in traditional settings because technology-mediated resources support active learning and higher-order thinking. However, some competencies related to communication and analytical problem-solving received slightly lower ratings, indicating that limited real-time interaction in hybrid environments may restrict opportunities for collaborative discussion and guided mentoring. Rasheed, Kamsin, and Abdullah (2020) also noted that although hybrid learning increases accessibility and flexibility, it may reduce direct interaction and collaborative learning experiences necessary for developing communication and analytical skills.

3.2.2 Availability of Learning Materials

Students reported a very positive experience regarding the availability and accessibility of learning materials in the hybrid learning environment. Learning resources were widely accessible both online and offline, and digital platforms such as Google Forms, Gmail, and Google Drive were considered effective tools for accessing instructional materials and submitting academic tasks. Multimedia resources such as videos, images, and audio materials also supported students' understanding of course content. These results indicate that digital learning platforms play a crucial role in supporting hybrid learning by improving access to educational resources and enabling students to learn independently. Garrison and Vaughan (2008) emphasized that blended learning environments enhance accessibility and participation by integrating digital tools with traditional instruction. Similarly, Redecker (2017) highlighted the importance of digital competence in supporting modern learning environments. However, some students reported difficulty understanding certain online

materials, suggesting that improvements in content design and multimedia integration may further enhance comprehension. Mayer (2009) noted that multimedia learning is most effective when instructional materials are designed to manage cognitive load and provide clear explanations of complex concepts.

3.2.3 Use of Instructional Strategies

Students perceived the use of instructional strategies in hybrid learning as highly effective. Group activities conducted during online sessions received the highest evaluation, indicating that collaborative learning opportunities were valued by students. Interactive activities, structured schedules for synchronous and asynchronous learning, and varied assessment strategies were also recognized as important elements of the hybrid learning experience. These findings demonstrate that strategic instructional planning is essential for maintaining student engagement in hybrid learning environments. Collaborative activities promote peer interaction, enhance participation, and support deeper understanding of complex subject matter. Johnson and Johnson (1994) emphasized that cooperative learning strengthens engagement and comprehension by encouraging peer support and shared problem-solving. Nevertheless, some students indicated that extended online sessions could lead to fatigue and reduced concentration. This observation corresponds with the findings of Mheidly, Fares, and Fares (2020), who reported that excessive exposure to digital environments may result in cognitive fatigue and decreased attention. Additionally, students perceived reduced interaction between instructors and learners in hybrid settings, reinforcing the findings of Martin and Bolliger (2018), who concluded that instructor–student interaction significantly influences student satisfaction and perceived learning in online and hybrid environments.

3.2.4 Conduct of Assessment

The implementation of assessment in hybrid learning environments was generally perceived positively by students. Online quizzes and examinations allowed flexible scheduling and efficient use of limited face-to-face class time. Students also appreciated the convenience of submitting tasks through digital platforms and accessing assessments online. Despite these advantages, students expressed concerns regarding the effectiveness of online assessments in accurately reflecting their mathematical abilities. Some respondents indicated that online assessments lacked detailed feedback, making it difficult to understand errors and improve performance. This finding supports the argument of Hattie and Timperley (2007), who emphasized that meaningful feedback is essential for improving student learning, particularly in subjects requiring conceptual understanding such as mathematics. Additionally, concerns about academic dishonesty in online assessments were raised, suggesting the need for more authentic assessment methods. Bishop-Clark and Dietz-Uhler (2012) highlighted that online learning environments may increase opportunities for academic dishonesty, while Rogers and Glifford (2008) recommended performance-based assessments and open-ended tasks to evaluate students' actual understanding. Herrington et al. also emphasized the importance of authentic assessments that encourage real-world problem-solving and deeper learning.

3.2.5 Provision of Institutional and Instructional Support

Students generally perceived institutional and instructional support in hybrid learning as effective. Library services providing access to digital resources received the highest evaluation, indicating the importance of accessible learning materials in supporting academic success. Instructor support, including monitoring student interaction, providing feedback, and facilitating communication during online classes, was also highly valued. These findings highlight the role of institutional support systems in ensuring successful hybrid learning implementation. Bawa (2016) emphasized that access to digital resources such as e-books and online journals enhances learning experiences in blended environments. Similarly, Allen and Seaman (2017) noted that access to digital content improves flexibility and accessibility in higher education. Bishop and Verleger (2013) further emphasized that institutional support mechanisms significantly influence the success of hybrid learning environments. However, some support services such as counseling services and device compatibility received relatively lower evaluations, suggesting the need for improved promotion of mental health support and better technical accessibility. Pianta (1999) also emphasized the importance of positive teacher–student relationships in promoting motivation and learning outcomes.

3.3 Overall Student Experience in Hybrid Learning

The overall evaluation of students' experiences in hybrid learning indicated a very high level of satisfaction across all components, including competency attainment, instructional strategies, availability of learning materials, assessment practices, and institutional support. Competency attainment received the highest evaluation, followed by instructional strategies, learning materials, assessment practices, and support systems. These findings demonstrate that hybrid learning effectively supported students' academic development and learning experiences. These results reinforce the idea that hybrid learning environments can enhance student engagement and academic performance when instructional strategies, learning resources, and support systems are effectively integrated. Garrison and Vaughan (2008) emphasized that blended learning environments improve student participation by combining the flexibility of online learning with the interaction of face-to-face instruction. Similarly, Bawa (2016) noted that access to digital resources strengthens student autonomy and academic achievement. Gikandi, Morrow, and Davis (2011) also found that flexible assessment strategies in blended environments

improve student satisfaction and perceived learning outcomes. Bean (2005) further highlighted the importance of maintaining strong emotional and academic support systems to ensure student success in hybrid learning contexts.

3.4 Differences in Academic Performance and Students' Experiences with Hybrid Learning

The statistical analysis revealed significant differences in both students' academic performance and their experiences with hybrid learning. The results indicated that variations among students' performance were statistically significant, suggesting that differences in academic achievement were influenced by multiple factors such as learning style, motivation, prior knowledge, and access to resources. These findings suggest that individual student characteristics and contextual factors may influence how learners adapt to hybrid learning environments. Tinto (1993) emphasized that academic success is strongly influenced by personal motivation, student characteristics, and institutional support systems. Similarly, Biggs (1999) argued that differences in learning outcomes may result from variations in instructional design, curriculum structure, and subject complexity. These results highlight the importance of implementing differentiated instructional strategies and targeted academic support to address diverse learning needs. Tomlinson (2001) emphasized that differentiated instruction is essential for accommodating diverse learners, while Darling-Hammond (2006) highlighted the importance of continuous curriculum evaluation and teacher development to improve educational quality and equity.

4. Conclusion & Recommendations

The study examined the instructional impact of hybrid learning on the mathematics performance of fourth-year Bachelor of Science in Information Systems students at Talibon Polytechnic College. The findings revealed that hybrid learning generally supported students' academic performance and competency attainment in mathematics, particularly in applied subjects such as statistics, while conceptual subjects such as Mathematics II presented greater difficulty due to limited face-to-face interaction and challenges in understanding abstract concepts. Students reported highly positive experiences in hybrid learning across several aspects, including competency attainment, accessibility of learning materials, use of instructional strategies, assessment practices, and institutional support. However, some areas require improvement, particularly in enhancing student engagement during synchronous sessions, strengthening communication and analytical skills, improving clarity of online learning materials, providing more timely feedback in assessments, and expanding emotional and counseling support services. Overall, the findings indicate that hybrid learning is an effective instructional approach for mathematics when supported by appropriate instructional strategies, accessible resources, and comprehensive academic support systems.

Based on the findings, it is recommended that instructors provide additional instructional support for Mathematics II and other conceptually demanding subjects through enhanced guidance, problem-solving activities, and interdisciplinary learning tasks to improve students' conceptual understanding. Educational administrators should strengthen programs that develop students' communication, technical writing, and professional skills while ensuring that learning materials are accessible and supported by interactive multimedia resources. Institutions should also promote professional development for instructors in innovative and technology-integrated teaching strategies to enhance hybrid learning implementation. Improvements in assessment practices are recommended, particularly by providing timely and detailed feedback to support deeper understanding of mathematical concepts. Furthermore, institutions should strengthen academic and emotional support systems, including counseling services and mentoring programs, to ensure that students receive comprehensive guidance throughout their hybrid learning experience.

This study was limited to graduating Bachelor of Science in Information Systems students and one mathematics instructor at Talibon Polytechnic College, focusing only on mathematics subjects delivered through the hybrid learning setup implemented during the period of classroom construction and limited physical learning facilities. The results therefore reflect the experiences and academic performance within this specific institutional context and may not fully represent other programs, institutions, or learning environments where hybrid learning is implemented differently.

Compliance with ethical standards

This study was conducted by the author at Talibon Polytechnic College and involved graduating Bachelor of Science in Information Systems students and a mathematics instructor who had direct experience with the hybrid learning setup in mathematics courses. Data were collected through survey questionnaires, semi-structured interviews, and analysis of students' academic records to examine the instructional impact of hybrid learning on mathematics performance. Institutional permission was obtained to access the academic records used in the analysis, and the information gathered was used solely for the purpose of evaluating hybrid learning implementation in mathematics instruction.

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