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Hybrid Learning and Academic Performance: The Role of Cognitive Load, Social Interaction and Collaboration, Self-Determination, and Multimodal Learning

Wang Yuanyuan[1], Immanuel T. San Diego[2]

[1] Master. Candidates of Arts Sciences and Education, Trinity University of Asia. 275 E. Rodriguez Sr. Avenue Quezon City. 1102 NCR

[2] Professor. Department Head of College of Mathematical and Physical Sciences, Trinity University of Asia. 275 E. Rodriguez Sr. Avenue Quezon City. 1102 NCR

First Author Email: WANGNYUANYUNA@tua.edu.ph

Second Author Email: itsandiego@tua.edu.ph

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ABSTRACT

Background: Hybrid learning has become the most common delivery model since it integrates face-to-face online instructions. That is why its adoption, particularly during COVID-19, has attracted interest in the impact on students' performance.

Objectives: This study aimed to evaluate the impact of hybrid learning on (1) cognitive load, (2) social interaction and collaboration, and (3) students' self-determination and engagement in the learning process.

Methods: The study employed a descriptive correlational research design. A self-developed, expert-reviewed questionnaire was used to survey the students registered for a hybrid civil law Procedure course to evaluate the students' ideas. The statistical tools included Mann-Whitney U, Kruskal-Wallis, and Spearman's correlation tests for comparing and assessing the inter-variable associations.

Findings: Cognitive load (M = 2.98) and self-determination (M = 2.88) were rated as "effective", while social interaction and collaboration (M = 2.45) were "somewhat effective". Cognitive load and multimodal learning significantly correlated with academic performance ($p < 0.001$), while self-determination did not ($p = 0.166$). **Conclusion**: This study's findings indicate that hybrid learning enhances the cognitive process and encourages the use of multiple interfaces; however, there is still space for development in aspects that concern social affairs and in the fostering of the self-learning paradigm to academic performance.

Keywords: Hybrid Learning, Cognitive Load, Social Interaction, Collaboration, Self-Determination, Multimodal Learning.

INTRODUCTION

The rapid integration of digital technology into education has led to the emergence of various instructional models, one of the most prominent being hybrid learning. Hybrid or blended learning combines traditional face-to-face instruction with online learning components, offering students more flexibility in managing their studies. Hybrid learning was initially developed to address the growing need for flexibility in education, with early pioneers such as Graham and Bonk laying the groundwork

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for blended learning systems (Graham, 2021). This model has gained popularity in higher education mainly because it can enhance student engagement and accommodate diverse learning preferences (Means et al., 2013).

The COVID-19 pandemic has significantly reshaped the higher education landscape, with hybrid learning models emerging as a key response to the crisis. Before the pandemic, hybrid learning, combining traditional in-person instruction with online education, was already gaining popularity. However, the immediate need for social distancing and the rapid closure of educational institutions worldwide propelled its adoption at an unprecedented pace (McKinsey & Company, 2020; UNESCO, 2021). Hybrid learning became a necessary response to the challenges posed by social distancing measures and the abrupt shift to remote education during the pandemic (Xing & Saghaian, 2022). As institutions worldwide faced these unprecedented changes, hybrid learning emerged as a stopgap solution and a viable long-term strategy for enhancing educational flexibility and accessibility (K.A.A. Gamage, A. Gamage, & Dehideniya, 2022).

Recent studies have demonstrated that hybrid learning positively impacts student outcomes across various educational contexts. Blended learning significantly enhances academic achievement, indicating its effectiveness in higher education settings. Features like asynchronous video lessons and Google Form quizzes greatly enhance the students' proficiency, confidence, and motivation (Sadiq, 2022). It also enhanced the knowledge retention of the students. It offers flexibility in learning pace, enhanced peer collaboration, and access to 24/7 resources, ultimately improving student satisfaction and educational outcomes (Behzad, Adnan, & Merchant 2022). This significantly improves learning management and effectiveness during disruptions like the COVID-19 pandemic (Dakir & Fauzi 2022). It also transforms traditional class structures and effectively integrates multimedia tools, leading to a more engaging and supportive learning environment that enhances students' performance (Arsenal & Pinar-Pérez, 2021; L. Li & Wang, 2022). Moreover, blended learning significantly improves students' cognitive performance.

Research Objectives

- To evaluate the impact of hybrid learning on cognitive load among college students
- To investigate the role of hybrid learning in fostering social interaction and collaboration among college students
- To examine the influence of hybrid learning on students' self-determination and engagement in the learning process

This study investigates the effectiveness of hybrid learning by examining its impact on various factors critical to academic performance among college students, including cognitive load, social interaction and collaboration, self-determination, and multimodal learning. By assessing how these elements interact within a hybrid learning framework, the research aims to shed light on the comprehensive benefits of this educational approach in enhancing student outcomes.

Literature Review

Hybrid learning on cognitive load among college students

Research evidence and theoretical understanding of the Cognitive Load Theory show a change in Cognitive Load when applying a hybrid learning mode. According to Tashiro et al. (2015), the students' demands have determined the conditions contributing to lessening cognitive loads for adaptive learning more than or within a balanced face-to-face and online content environment. The analysis by Hu et al. (2022) revealed that students learning in hybrids, especially those learning online, had a low cognitive presence with those learning physically; therefore, authors noted that the online component of hybrid learning may contribute to cognitive load if well dealt with.

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On the other hand, the extension of scaffolding in the context of hybrid learning environments has been argued to play an important role in regulating cognitive load. Impelluso (2009) supported the fact of scaffolding, stating that when it is used with hybrid and distance learning technologies, it reduces cognitive loads for the learners by offering guided procedures.

METHODOLOGY

The research employed a descriptive correlational design to assess the effectiveness of hybrid learning on the academic performance of college students. The study's population comprised college students enrolled in the Civil Law Procedure course, which utilized a hybrid learning format. To gather data, the researcher developed a self-made instrument validated by experts and tested for reliability. The survey questionnaire comprised two sections: the first gathered students' academic grades in Class 1801 Civil Law Procedure during the hybrid course, while the second contained questions assessing the effectiveness of hybrid learning concerning cognitive load, social interaction and collaboration, self-determination, and multimodal learning. The research instrument was specifically designed to evaluate these factors. With students' written consent, their grades were obtained from the teacher's records. The instrument underwent validation by three experts, and a reliability test was conducted thereafter, with Cronbach's Alpha yielding above 0.70 for each dimension. The institutional ethics board committee obtained the study's approval to ensure adherence to ethical standards. Data normality was assessed using the Shapiro-Wilk test, confirming that the data did not follow a normal distribution. Since the data were not normally distributed, the Mann-Whitney U-test and Kruskal-Wallis H-test were employed to determine significant differences in the perceived effectiveness of hybrid learning based on students' profile variables. Additionally, Spearman's rank correlation coefficient was utilized to assess the effect of hybrid learning on students' academic performance. Statistical analysis was conducted using statistical software, with a significance level set at 0.05, ensuring rigorous data evaluation.

RESULTS

Below are four key factors: cognitive load, social interaction and collaboration, self-determination, and multimodal learning. These factors influence the effectiveness of hybrid learning based on student perceptions. Table 1 presents the respondents' assessment of the effectiveness of hybrid learning based on four key factors: cognitive load, social interaction and collaboration, self-determination, and multimodal learning. The results indicate that cognitive load (Mean = 2.98, SD = 0.588), self-determination (Mean = 2.88, SD = 0.608), and multimodal learning (Mean = 2.73, SD = 0.716) were perceived as "Effective," suggesting that hybrid learning adequately supports students in managing cognitive demands, fostering autonomy, and integrating diverse learning modalities. However, social interaction and collaboration (Mean = 2.45, SD = 0.742) were rated as "Somewhat Effective," implying that students may have faced challenges engaging with peers and instructors in a hybrid learning environment.

Table 1: Assessment of the respondents on the effectiveness of hybrid learning

Factors	Mean	Standard Deviation	Interpretation
Cognitive Load	2.98	0.588	Effective
Social Interaction and Collaboration	2.45	0.742	Somewhat Effective
Self-determination	2.88	0.608	Effective
Multimodal Learning	2.73	0.716	Effective

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The Mann-Whitney U test compared male and female students' perceptions of hybrid learning across four key factors: cognitive load, social interaction and collaboration, self-determination, and multimodal learning (Table 2).

Table 2: Comparison of the Assessment on Hybrid Learning

Factors	U	p	Significance
Cognitive Load	109	0.23	Not Significant
Social Interaction and Collaboration	103	0.02	Significant
Self-determination	159	0.601	Not Significant
Multimodal Learning	145	0.333	Not Significant

For Cognitive Load, the test results indicated no statistically significant difference between male and female students ($p = 0.23$), suggesting that both groups perceived the cognitive demands of hybrid learning similarly. Regarding Social Interaction and Collaboration, a significant difference was found between genders ($p = 0.02$), with females reporting a more favorable experience in this area. This indicates that female students perceived hybrid learning as more effective in facilitating social interaction and collaboration compared to their male counterparts. For both Self-Determination ($p = 0.601$) and Multimodal Learning ($p = 0.333$), no significant differences were observed, implying that male and female students had comparable views on their levels of self-motivation and the effectiveness of the various learning modes integrated into the hybrid learning model (Table 2). While perceptions were generally similar across most factors, social interaction and collaboration emerged as an area where female students reported significantly more positive experiences than males, highlighting a potential gender-related difference in collaborative learning within the hybrid model.

The Kruskal-Wallis test results (Table 3) showed no statistically significant differences in students' perceptions of hybrid learning across different year levels for all factors assessed. Specifically, there were no significant variations in cognitive load ($p = 0.264$), social interaction and collaboration ($p = 0.747$), self-determination ($p = 0.692$), and multimodal learning ($p = 0.406$). This indicates that students from the first, second, and third years generally experienced hybrid learning similarly in terms of these dimensions. These findings suggest that year level did not impact students' views on the effectiveness of hybrid learning.

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Table 3: Comparison of the effectiveness of hybrid learning according to year level of the students

Variables	χ^2	p	Significance
Cognitive Load	3.98	0.264	Not Significant
Social Interaction and Collaboration	1.23	0.747	Not Significant
Self-determination	1.46	0.692	Not Significant
Multimodal Learning	2.91	0.406	Not Significant

The correlation analysis between the dimensions of hybrid learning and academic performance showed varying degrees of significance. Cognitive Load demonstrated a strong positive correlation with academic performance (rho = 0.538, $p < 0.001$), indicating that as students effectively managed their cognitive load, their academic performance improved. Similarly, Multimodal Learning also had a strong positive correlation (rho = 0.576, $p < 0.001$), suggesting that students who engaged well with various learning formats tended to perform better academically. Social Interaction and Collaboration showed a moderate positive correlation (rho = 0.362, p = 0.022), highlighting the importance of peer collaboration and teacher interaction in academic success. However, Self-determination did not show a significant correlation with academic performance (rho = 0.166, p = 0.166), suggesting that individual motivation and autonomy in hybrid learning did not significantly impact academic outcomes in this context (Table 4).

Table 4: Correlation between assessment of the respondents in hybrid learning and their academic performance

Factors	Correlation Coefficient, rho	p	Significance
Cognitive Load	0.538	<0.001	Significant
Social Interaction and Collaboration	0.362	0.022	Significant
Self-determination	0.166	0.166	Not Significant
Multimodal Learning	0.576	<0.001	Significant

DISCUSSION

This study examined the success of the hybrid learning model for the cognitive load factor, producing a mean result of 2.98 and a standard deviation of 0.588. The findings provide evidence for the proposition of Korlan et al. (2020) that effective content and appropriate technology improve cognitive load since instructional messages are optimised. Thus, if architects of learning experiences distribute learning tasks wisely, reduce intrinsic and extraneous cognitive load, and increase germane

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ones, they will foster conditions for effective learning (Leon et al., 2021). Therefore, accepting the positive opinion about the role of cognitive load management in hybrid learning establishes that a planned design approach is required to assist students in their efforts to regulate their mental load and thus improve educational experiences.

The results of the current study underscore that despite students' beliefs of some level of social interaction and collaboration in the hybrid mode learning model, which gave an overall mean of 2.45, this area has the most significant potential for improvement. This idea is supported by recent literature studies that assert the significance of several forms of interaction in hybrid spaces. According to Deschênes (2024), understanding social computing provides engagement and collaboration by context through enhancing the learning environment. Also, Hussin et al. (2019) emphasize that using social collaboration as a significant component of online learning requires engagement creation focusing on learner-learner and learner-instructor interactions. Uukkivi et al. (2022) have highlighted proper communication tools and effective media utilization for improving engagement. In contrast, Brown (2020) supports that faculty design and real-time interaction can minimize the disadvantages of such deliver mode and foster critical thinking and communication skills. Thus, the key to improving the quality of the learning process and students' engagement is developing these elements further to support the formation of a meaningful learning environment and students' practice-based relations.

Self-determination received a mean of 2.88, SD = 0.608, which shows that hybrid learning supported students' motivation and self-directedness. Another demographic factor that is featured as an important determinant of hybrid learning is self-determination, as the studies showed. Chemsi et al. (2020) established that formative assessments supported by ICT increase the self-determination of students' motivation in online/hybrid settings by endorsing students' significance of goal state and appreciation of personal autonomy. This agrees with Rasheed et al. (2021), who highlighted that students' self-regulation in blended learning requires positive affect, autonomy, goal, time competencies, and parental and social context to support self-scaffolding. Moreover, Farikah (2023) points out that meeting the necessity for competence, autonomy, and relatedness leads to an increase in students' interest and motivation in collaboration within the framework of the team-based online environment. Besides, Glassner (2019) pointed out that applying Heutagogy, which promotes learners' ownership in education, dramatically increases self-determination in hybrid learning, autonomy, self-efficiency and engagement by adopting collaborative and individual approaches. These studies demonstrate the importance of designing an environment that addresses students' affective needs and facilitates their instrumental resources to support autonomy in blended learning arrangements.

The study's results concerning multisensory learning highlight the fact that learners are more focused and achieve more learning outcomes through multisensory learning activities in blended teaching-learning contexts. According to Kaldenbach and Tan (2023), multimodal learning means combining teaching techniques and technologies, which enhances learning and increases students' interest, especially evidenced in the pilot study on hyflex teaching. This accords with the research of Limone (2020), who explains that heterogeneous modes of communication in environments such as these support interaction and emphasize educational individualization, student engagement and teamwork. Furthermore, it can be interpreted that the works of Parashar et al. (2020) underline that visual modalities can facilitate learning faster and that writing abilities are crucial for knowledge retention and for abstract thinking that is necessary for effective acquisition of knowledge in hybrid formats. In addition, Jima et al. (2023) point out that the difference in learning style, whereby students more prefer visual-auditory and kinesthetic modes of learning should be enhanced adopting a number of strategies so as to maximize students' achievement and they should adopt hybrid models in a way that best suits the students. Combined, these works show that properly conducted multimodal

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approaches within a distributed teaching-learning environment can result in better student motivation, learning activity, and therefore academic outcomes.

The analysis of gender differences in perceptions of the effectiveness of hybrid learning reveals intriguing findings. While most variables did not exhibit significant gender differences, social interaction and collaboration emerged as a notable exception, with female students reporting a more positive experience compared to their male counterparts. This discrepancy suggests that gender may influence how students perceive collaborative and interactive elements of hybrid learning, warranting further investigation into the underlying factors at play. Yu (2021) established a relationship between gender and online learning, pointing out that females face challenges like childcare responsibilities that quash their performance in hybrid learning modes (Fazal et al., 2022). Furthermore, González (2021) argue that such gender disparities impact ordinary communication processes with online resources and determine the levels of interactions in the mixed environment. Yu (2021) concluded that gender does not significantly impact learners' performance and that course difficulty appears to be a much more influential factor to academic performance. However, the changes in the quantity and quality of interactions and collaborations when learning requires working in a group support the need for gender-sensitive interventions. Discussing these aspects can help create global effective hybrid learning environments that would meet any student's needs.

The Kruskal-Wallis test results indicated no significant differences in perceptions of hybrid learning across different year levels regarding cognitive load, interaction, self-determination, and multimodal learning. This finding suggests that students generally view hybrid learning similarly regardless of academic standing. However, some studies have pointed out specific tendencies based on year levels. For instance, Verma, Illés, and Kumar (2024) note that younger B.Sc. students felt more confident in hybrid learning, considering it a secure mode of education during the pandemic. Conversely, Yu (2021) found that students at lower levels did not find online learning satisfactory compared to traditional methods, as they tended to evaluate teachers and course content more positively. Additionally, Osaili et al. (2023) reported that sophomore students had a more favorable perception of hybrid learning compared to other year levels, indicating a potential variance in preferences. Widyastuti et al. (2022) highlighted the unique challenges faced by grade 12 students, including less material delivery and greater reliance on independent learning than their lower-year counterparts. Lastly, Pramila-Savukoski et al. (2023) emphasized that first-year health sciences students did not report significant year-level differences in their hybrid learning experiences. These nuances reveal that while overall perceptions may be similar, certain year-level characteristics can influence students' experiences and evaluations of hybrid learning.

The results of this study also demonstrate significant relationships between several dimensions of hybrid learning and academic performance, aligning with the existing literature on the positive impact of hybrid learning models. Cognitive Load was found to have a significant positive correlation with student outcomes, supporting previous findings that well-managed cognitive demands enhance academic achievement (B.P. Mahapatra et al., 2024). Hybrid learning models, which integrate both digital tools and traditional teaching methods, can reduce the cognitive overload of students by simplifying complex concepts and making content more accessible and digestible (Khan, Lakshmana Kumar, & Kadry, 2021). This balance between online and in-person learning helps students process information more effectively, leading to improved academic performance.

The significant association between Multimodal Learning and academic performance further validates the effectiveness of using various learning modes, such as case-based learning, flipped classrooms, and gamification, which have been shown to foster critical thinking and real-world problem-solving (S.K. Mahapatra, Pattanayak, and Pati 2022). By applying different instructional

approaches, hybrid learning caters to different learning styles and helps students grasp content more thoroughly (Mitchell et al., 2020), leading to higher academic success.

The relationship between Social Interaction Collaboration and academic performance in this study also mirrors findings from previous research. Increased interaction in hybrid learning environments supports collaborative learning, which has been shown to enhance students' engagement and performance (Song & Park, 2023). Rahayu et al. (2024) emphasized the importance of peer and instructional support, which significantly influences both learning satisfaction and academic outcomes in hybrid learning models. Collaborative efforts in hybrid settings give students with opportunities for meaningful peer interaction, deepening their understanding of the material.

However, Self-Determination did not have a significant correlation with academic performance, which differs with some studies suggesting that motivation and autonomy can enhance learning outcomes (Hasanah, 2022). It is possible that while hybrid learning allows for greater flexibility and independence, other factors like peer and instructional support play a more critical role in determining academic success in this context (Essadki & Fourtassi, 2024).

The positive effects of hybrid learning on academic performance can be attributed to its ability to blend instructional methods that reduce cognitive load, increase social interaction, and utilize multimodal learning strategies. These elements together build a learning environment that is not only flexible but also more engaging and effective in improving academic achievement (Korompot & Umyah, 2023; Hediansah & Surjono, 2020).

CONCLUSION

This study proves that hybrid learning positively impacts cognitive load management, self-determination theory, and multimodal learning. This shows that cognitive load and engagement are suppressed in hybrid pedagogy while interaction and collaboration are yet to be enhanced. Gender differences also point to the fact that there is a need to have better communication technology in contexts that foster the use of both face-to-face and online communication. These suggestions call for a paradigm shift in designing learning environments and teaching strategies that encourage learning relationships, regulate cognitive load, and facilitate learning among diversified students for improved performances.

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