Blended Learning Approach: Its Implications for Students' Academic Performance in Physical Science

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ABSTRACT

This study examines the impact of blended learning on students' academic performance in Physical Science. Utilizing an experimental design, the research compares the achievement levels of two groups: a control group (modular learning) and an experimental group (blended learning). The document appears to determine the differences in pretest and post-test scores, as well as overall academic gains between the two learning strategies. A total of 178 Grade 12 students from Dr. Geronimo B. Zaldivar Memorial School of Fisheries, Albuera, Leyte participated in the study. The experimental group engaged in a combination of modular learning and online instructional support, while the control group relied solely on printed modules. Statistical analyses, including mean, standard deviation, and z-tests, were employed to assess differences in performance. Findings indicate that while both groups showed improvement from pretest to post-test, the blended learning group demonstrated significantly higher post-test scores and achievement gains compared to the modular learning group. The results suggest that blended learning enhances student comprehension and engagement, leading to improved academic outcomes. These findings align with previous research indicating the effectiveness of blended learning in facilitating student retention and understanding of science concepts. The study underscores the potential of blended learning as a superior instructional approach in science education.

Keywords: Blended Learning, Modular Learning, Academic Performance, Physical Science

INTRODUCTION

The method of instruction plays a crucial role in shaping learners' academic success. When educators adapt their teaching methods to align with students' individual learning preferences, it enhances their ability to grasp complex topics and engage more deeply with the subject matter. This alignment fosters a more meaningful and enriching learning experience. As Grasha (2002) noted, teaching is largely influenced by an educator's personal style. Therefore, instructors should thoughtfully design their approach to ensure it supports the cognitive and personal growth of learners. Selecting an effective instructional approach not only enriches the learning process but also contributes to higher teaching quality (Munna and Kalam, 2021).

The increasing integration of technology in education, along with the rise of remote learning platforms, has introduced new and dynamic methods of acquiring knowledge. Today's generation of students tends to be more engaged with these advanced approaches, as they align with how they interact with the modern world and society. Prensky (2010) pointed out that unlike previous generations, current learners are growing up in an era of constant and rapid change. This observation highlights the evolving responsibility of educators in facilitating knowledge transfer in an increasingly digital environment. Consequently, teachers must carefully consider their instructional methods and adopt strategies that not only suit the subject matter but also meet the diverse learning needs of their students in acquiring essential skills and knowledge.

The integration of technology into education, along with its widespread accessibility in everyday life, has significantly transformed the ways in which students learn. In this context, the blended learning approach — the central focus of this research — offers a promising method for enhancing instruction. By combining the technological innovations found in online learning with the interpersonal engagement typical of face-to-face instruction, this approach creates a more flexible and adaptive educational experience. Blended learning also enables the creation of modern, student-centered learning environments that foster greater participation and empower learners to take a more active role in their academic development.

Blended learning emerged as a response to the limitations of relying solely on either traditional or fully online instruction (Akkoyunlu & Soylu, 2008). According to Horn and Staker (2011), there are six recognized models of blended learning: (1) Face-to-face Driver. In this model, teachers deliver direct instruction in the classroom while incorporating technology to support students who need remediation or acceleration, allowing individualized learning paths.; (2) Rotation Model. Students cycle through a series of learning stations, which may include online tasks, group activities, and face-to-face instruction, following a structured schedule.; (3) Flex Model. Most of the content is delivered through an online platform, with teachers providing support and guidance as needed, typically in a more flexible classroom setup; (4) Online Lab. Students complete all coursework online but do so in a physical lab space at school, usually supervised by staff rather than subject teachers; (5) Self-Blend. This option allows students to independently enroll in online courses to supplement their in-school curriculum, giving them access to additional subjects or advanced content; and (6) Online Driver. Instruction is conducted entirely online, and students work remotely, often at their own pace, with minimal in-person interaction.

In a study conducted by Hoic-Bozic et al. (2008) on the design and application of blended learning in course delivery, it was revealed that students expressed a high level of satisfaction with this approach. Moreover, their academic performance surpassed expectations. Notably, the study also reported a significant reduction in dropout rates, which the authors attributed to the effective support provided by both the instructional system and the educators.

Demirkol and Kazu (2014) explored the impact of a blended learning model on high school students' academic performance in biology. Their findings indicated that students who were part of the blended learning group (experimental group) outperformed those in the traditional classroom setting (control group) in their final test scores.

Ceylan and Kesici (2017) reported that students in the experimental group, who engaged in a blended learning environment, demonstrated higher academic achievement compared to those in the control group who experienced traditional face-to-face instruction. These results are consistent with several other studies that have shown a positive effect of blended learning on students' academic performance (Sarıtepeci, 2012; Uluyol & Karadeniz, 2009; Yılmaz, 2011; Demirkol, 2012; Usta, 2007; Ilın, 2013; Yılmaz & Orhan, 2010; Bağcı, 2012; Robinson, 2004; Dziuban et al., 2004). Blended learning, as a mode of instructional delivery, has not only improved academic outcomes but also expanded access to lifelong, global education (Doorn, Judy & Doorn, John, 2014), with several reports noting its positive impact on schooling systems (DreamBox, 2013).

According to Bazelais and Doleck (2018), students who participated in a blended learning environment exhibited greater conceptual understanding and performed better academically than those in a traditional classroom setting. Similarly, the study by Vallée et al. (2020) revealed that, in the context of health education, blended learning consistently led to more favorable outcomes in terms of knowledge acquisition when compared to conventional instructional methods.

Driven by a commitment to improve instructional strategies, the teacher-researcher initiated this study to investigate the impact of the Blended Learning Approach on students' academic performance in Physical Science over a one-week lesson period. The study also sought to assess the effectiveness of this method by analyzing students' outcomes based on diagnostic and achievement test results.

Statement of the Problem

This study aims to evaluate the impact of blended learning on students' academic performance in Physical Science.

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Specifically, the study aims to address the following questions:

1. How do the two groups of participants perform in the pretest?

1.1. Control group; and

1.2. Experimental group?

2. How do the two groups of participants perform in the post-test?

1.1. Control group; and

1.2. Experimental group?

3. Is there a statistically significant difference between the pretest scores of the control and experimental groups?

4. Is there a statistically significant difference between the post-test scores of the control and experimental groups?

5. Is there a statistically significant difference between the pretest and post-test scores within the control and experimental groups?

Null Hypotheses

The following null hypotheses will be tested at the 0.05 level of significance:

1. There is no statistically significant difference between the pretest scores of the experimental and control groups.
2. There is no statistically significant difference between the post-test scores of the experimental and control groups.
3. There is no statistically significant difference between the pretest and post-test scores of the experimental and control groups.

METHODOLOGY

This study employed an experimental design to evaluate the impact of blended learning on students' academic performance, specifically focusing on how this approach affects the mean achievement scores of learners after a one-week lesson in Physical Science.

The participants were divided into two groups: the group of learners receiving modular learning (control group), and the group of learners using blended learning (experimental group). For the modular learner group, the researcher used the pre-prepared First Quarter Modules (Modules 1 to 3) for Physical Science from the Department of Education (Region V-Bicol) for the school year 2020-2021. Each module was designed to cover the equivalent of two weeks of classroom instruction, with two sub-sections per module. In addition to the modules, a group chat was set up on Messenger to facilitate communication, allowing students to ask questions and the researcher to send important updates or announcements related to the topic.

For the blended learner group, students received printed materials (the same First Quarter Modules), but in addition, they participated in a weekly one-hour online class. During these sessions, the researcher presented content for each week's sub-learning objective. The lessons were delivered using a combination of multimedia formats, including text, images, tables, audio, and video clips, to enhance engagement and comprehension. Furthermore, a Messenger group chat was created to share video links and resources, and a Google Classroom was set up where students could seek clarification or further details about the lesson content.

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Table 1. Comparison of Delivery Formats Between the Control and Experimental Groups.

GROUP RECEIVING MODULAR LEARNING	GROUP USING BLENDED LEARNING
• Distribution of ready-made modules. First Quarter Module 1 **Topic:** *Formation of Heavier Elements during Star Formation and Evolution.* First Quarter Module 2 **Topic:** *Transmutation* First Quarter Module 3 **Topic:** *Polarity of Molecules* First Quarter Module 4 **Topic:** *Polarity of Molecules and Its Properties* **Additional Strategies:** • Created a Group Chat using Messenger App. • Sending Links about the Topic / Learning Resources through Messenger Application.	• Distribution of ready-made modules. First Quarter Module 1 **Topic:** *Formation of Heavier Elements during Star Formation and Evolution.* First Quarter Module 2 **Topic:** *Transmutation* First Quarter Module 3 **Topic:** *Polarity of Molecules* First Quarter Module 4 **Topic:** *Polarity of Molecules and Its Properties* **Additional Strategies:** • Created a Group Chat using Messenger App. • Sending Links about the Topic / Learning Resources through Messenger Application. • Online discussion about the topic using Google Meet Application. • Creating Google Classroom where students can access to preview the next topic(s) and ask clarifications and/or further information about the present topic.

After receiving approval from the principal, the teacher-researcher conducted the one-week experiment. The scores from both the pretest and post-test were collected, coded, and then analyzed using statistical methods. Specifically, the mean and standard deviation were calculated to assess the performance levels of both the control and experimental groups, as well as to categorize students. Additionally, the t-test was applied to examine the statistical significance of the differences in the mean scores between the pretest and post-test results for both groups.

Presentation, Analysis, and Interpretation of Data

The following data represent the academic performance of 178 Grade 12 students from Dr. Geronimo B. Zaldivar Memorial School of Fisheries.

Table 2. Mean Scores for Pretest, Post-test, and Achievement

Strategies	Quizzes/Activities	Pretest	Post-test	Achievement
GROUP RECEIVING MODULAR LEARNING	154.70	14.404	27.483	13.079
GROUP USING BLENDED LEARNING	171.57	14.180	29.843	15.663

Table 2 displays the mean scores for quizzes/activities, pretest, post-test, and achievement for the Grade 12 students. The data reveals that the mean score for the pretest in the modular learning approach (control group) is 14.404, while the pretest score for the blended learning approach (experimental group) is 14.180. The relatively low performance in the pretest indicates that the students had difficulty mastering the specific topics or competencies from previous academic years. This outcome aligns with the findings of Valencia (2020), who noted that the low pretest scores were due to students' lack of mastery in the particular competency and their limited comprehension of science concepts from earlier years. Similarly, Samson (2014) highlighted that students had minimal prior knowledge of the subject matter. Furthermore, it is possible that these competencies had not yet been introduced or adequately covered in their prior learning materials or discussions.

Table 2 shows that for the Physical Science quizzes/activities, the experimental group using blended learning achieved a higher mean score of 171.57, compared to the control group using modular learning, which scored 154.70. This suggests that the blended learning approach is more effective than the modular learning approach, likely due to its integrated method. According to Mansour and Mupinga (2007), blended learning might be considered the optimal teaching format due to its combination of face-to-face (f2f) lectures and web-based learning environments. This idea is supported by Kenny and Newcombe (2011), who found that blended learning environments led to higher average scores compared to non-blended approaches.

Table 2 illustrates that there was an improvement in the mean scores of students in both learning strategies on the post-test. This indicates that the students' performance improved following their exposure to either the modular learning or blended learning strategies. However, the post-test mean score for the experimental group (blended learning), which stands at 29.843, surpasses the control group (modular learning), which scored 27.483. This suggests that the blended learning approach had a more positive effect on students' ability to grasp the concepts being taught. These findings align with the research of Garrison and Kanuka (2004), who noted that blended learning positively impacted student retention. Similarly, studies by Lin (2007) and Martyn (2003) have further confirmed that blended learning enhances students' understanding, engagement, and interaction within the learning environment.

Moreover, table 2 indicates that the experimental group (blended learning) achieved a higher mean gain of 15.663, compared to the control group (modular learning) with a mean gain of 13.079. This suggests that the implementation of blended learning in science positively influenced the academic performance of the experimental group after they were exposed to this approach. Similarly, a study by Alsalhi, Eltahir, and Al-Qatawneh (2019) demonstrated that blended learning had a beneficial impact on students' performance in science, showing a significant improvement in the experimental group compared to the traditional learning approach used by the control group.

Table 3. Z-test results comparing paired observations between the Modular Learning and Blended Learning groups.

Strategies	**Test**	**Number of Samples (n)**	**Mean**	**Probability Z-Value**	**Interpretation**
Modular Learning (Control Group)	**Pretest**	**89**	14.404	**0.000**	**Significant difference**
	Quizzes/Activities	**89**	154.697		
Blended Learning (Experimental Group)	**Pretest**	**89**	**14.180**	**0.000**	**Significant difference**
	Quizzes/Activities	**89**	**171.573**		
Modular Learning (Control Group)	**Pretest**	**89**	**14.404**	**0.000**	**Significant difference**
	Post Test	**89**	**27.483**		

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Blended Learning (Experimental Group)	**Pretest**	**89**	**14.18**	**0.000**	**Significant difference**
	Post Test	**89**	**29.84**		
Modular Learning (Control Group)	**Quizzes/Activities**	**89**	**154.697**	**0.000**	**Significant difference**
	Post Test	**89**	**27.483**		
Blended Learning (Experimental Group)	**Quizzes/Activities**	**89**	**171.57**	**0.000**	**Significant difference**
	Post Test	**89**	**29.84**		
Note: * -significant difference below 0.05 level					

Table 3 displays the results of the Z-test for paired observations comparing the performance of the control group (modular learning) and the experimental group (blended learning) across several assessments: pre-test vs quizzes/activities, pre-test vs post-test, and quizzes/activities vs post-test. The data indicates that there are significant differences between these comparisons in both groups, with the probability value approaching zero (0). This suggests that: the pretest significantly differs from the quizzes/activities; the pretest significantly differs from the post-test; and the post-test significantly differs from the quizzes/activities.

These findings align with Guido's (2014) study, as cited by Valencia (2020), which highlighted the effectiveness of using modules in improving students' comprehension of the subject matter. Similarly, the research conducted by Alsalhi, N.R., Eltahir, M.E., & Al-Qatawneh, S.S. (2019) supports the notion that blended learning has a positive impact on students' performance in science.

Table 4. Z-test for Independent Groups Results of the Pretest, Post Test, Achievement and Quizzes/Activities Groups between Modular Learning and Blended Learning

Test	**Strategies**	**Number of Samples (n)**	**Mean**	**Probability Z-Value**	**Interpretation**
Pretest	**Modular Learning (Control Group)**	**89**	14.404	**0.780**	**No significant difference**
	Blended Learning (Experimental Group)	**89**	14.180		
Post Test	**Modular Learning (Control Group)**	**89**	**27.483**	**0.030**	**Significant difference**
	Blended Learning (Experimental Group)	**89**	**29.843**		
Achievement (Mean Gain)	**Modular Learning (Control Group)**	**89**	**13.079**	**0.038**	**Significant difference**
	Blended Learning (Experimental Group)	**89**	**15.663**		
Quizzes /Activities	**Modular Learning (Control Group)**	**89**	**154.70**	**0.007**	**Significant difference**
	Blended Learning (Experimental Group)	**89**	**171.57**		
Note: * -significant difference below 0.05 level.					

Table 4 presents the results of the Z-test for Independent Groups, comparing the pretest, post-test, achievement, and quizzes/activities scores across the groups.

The table indicates that the mean score of the pretest for the control group (modular learning), which was 14.404, and the experimental group (blended learning), with a mean of 14.180, resulted in a p-value of 0.780. Since the p-value is greater than 0.05, the null hypothesis is accepted, meaning there is no significant difference between the pretest scores of the modular learning (control group) and the blended learning (experimental group). This suggests that the students were not yet exposed to either of the two teaching methods, leading to relatively low performance. These findings are consistent with Samson's (2014) study, cited by Valencia (2020), which noted that students had little prior knowledge of the subject. Furthermore, the students may not have encountered the competencies assessed in any previous discussions or materials. Consequently, it can be concluded that the students were at similar levels before the implementation of either modular or blended learning. This outcome aligns with the findings of Demirkol, M., & Kazu, I.Y. (2014), where no significant difference was observed between the two groups at the end of the pretest in the experimental (blended learning) and control (traditional learning) groups.

The table shows that the post-test mean score for the control group (modular learning), with a mean of 27.483, and the experimental group (blended learning), with a mean of 29.843, resulted in a p-value of 0.030. Since the p-value is less than 0.05, the null hypothesis is rejected, indicating a significant difference between the post-test scores of the modular learning (control group) and blended learning (experimental group). This suggests that the students were exposed to one of the two teaching strategies. Consequently, it can be concluded that both modular learning and blended learning have implications for the academic achievement of the students. However, the experimental group (blended learning) achieved higher mean scores on the post-test compared to the control group, indicating that blended learning is more effective than modular learning. This finding is in line with the study by Demirkol, M., & Kazu, I.Y. (2014), which showed that the experimental group outperformed the control group in final test grades. Furthermore, this result is supported by Alsalhi, N. R., Eltahir, M. E., & Al-Qatawneh, S. S. (2019), who reported that blended learning positively impacted students' academic achievement in science subjects.

Table 4 indicates that the achievement mean gain for the control group (modular learning), with a mean of 13.079, and the experimental group (blended learning), with a mean of 15.663, yielded a p-value of 0.038. Since the p-value is less than 0.05, the null hypothesis is rejected, suggesting a significant difference in the achievement scores between the modular learning (control group) and blended learning (experimental group). The table further reveals that the experimental group (blended learning) had a higher achievement mean gain of 15.663 compared to the control group (modular learning) with 13.079. This suggests that the use of blended learning in the science subject had a more positive impact on the academic performance of the experimental group after they were exposed to this approach. This finding is consistent with Kenny, J., & Newcombe, E. (2011), who found that blended learning produced higher average scores compared to traditional non-blended learning environments. Additionally, a study by the U.S. Department of Education (2010) indicated that blended learning classes yield statistically better results than their non-hybrid, face-to-face counterparts (DreamBox, 2013).

The table also highlights the significant difference in quizzes/activities between the control group (modular learning) and the experimental group (blended learning). The results show that the quizzes/activity mean score for the two groups yielded a p-value of 0.007, which is less than 0.05. This suggests that the null hypothesis is rejected, indicating a significant difference in the quizzes/activity mean scores between the modular learning (control group) and blended learning (experimental group). Furthermore, the experimental group (blended learning) achieved a higher mean score of 171.57, compared to the control group (modular learning) with 154.70. These results demonstrate that students who experienced blended learning performed better than those who learned through the modular approach. This implies that blended learning is more effective in enhancing students' academic performance in the science subject. This is supported by the study of Ceylan, V. K., & Elitok Kesici, A. (2017), which found that the experimental group in a blended learning environment performed better academically than the control group taught in traditional settings. These findings align with previous studies indicating that blended learning environments lead to increased academic achievement

(Sarıtepeci, 2012; Uluyol & Karadeniz, 2009; Yılmaz, 2011; Demirkol, 2012; Usta, 2007; Ilın, 2013; Yılmaz & Orhan, 2010; Bağcı, 2012; Robinson, 2004; Dziuban et al., 2004). Thus, the blended learning environment has significantly improved students' academic achievement.

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

Summary

Blended learning, as part of the new normal in education, combines online and offline classes, providing students with access to a wider range of learning resources. This approach has been shown to positively influence academic performance. In this study, blended learning was defined as the integration of online classes and modular learning (printed materials).

The study focused on the academic performance of 178 Grade 12 students enrolled in Physical Science at Dr. Geronimo B. Zaldivar Memorial School of Fisheries. A quasi-experimental design was employed, utilizing the pre-test and post-test method to assess the effects of blended learning. The findings revealed a significant difference between the performance of the control group and the experimental group, with the experimental group, which was taught using blended learning, showing more favorable results.

The researcher concluded that blended learning is an effective method for enhancing the academic performance of Grade 12 students in the Physical Science subject. The findings from the study support the positive impact of this teaching approach on student achievement.

Based on the study's results, the researcher recommends that the blended learning approach be applied to other subjects and across different educational levels. Science educators, in particular, should adopt blended learning strategies to foster improved academic outcomes for their students.

Furthermore, the researcher suggests that teachers should continue utilizing blended learning even beyond the pandemic to sustain and further enhance student performance in science. To make blended learning more effective, it is recommended that both teachers and students participate in webinars, seminars, and workshops focused on using supplementary applications and integrating them into the blended learning environment.

Findings

1. The pretest scores of Grade-12 students in Physical Science showed that the control group (modular learning) had a mean score of 14.405, while the experimental group (blended learning) had a mean score of 14.108.
2. The quizzes/activity scores of Grade-12 students in Physical Science revealed that the control group (modular learning) had a mean score of 154.70, while the experimental group (blended learning) had a mean score of 171.57.
3. The post-test scores of Grade-12 students in Physical Science indicated that the control group (modular learning) had a mean score of 27.483, while the experimental group (blended learning) achieved a mean score of 29.843.
4. The post-test scores of Grade-12 students in Physical Science indicated that the control group (modular learning) had a mean score of 27.483, while the experimental group (blended learning) achieved a mean score of 29.843.
5. A significant difference was found between pretest and quizzes/activities scores in both the control group (modular learning) and the experimental group (blended learning).
6. A significant difference was found between pretest and post-test scores in both the control group (modular learning) and the experimental group (blended learning).
7. A significant difference was observed between post-test and quizzes/activity scores in both the control group (modular learning) and the experimental group (blended learning).
8. There was no significant difference in the pretest scores between the control group (modular learning) and the experimental group (blended learning).

9. A significant difference was found in the post-test scores between the control group (modular learning) and the experimental group (blended learning).
10. A significant difference was observed in the achievement (mean gain) scores between the control group (modular learning) and the experimental group (blended learning)..
11. A significant difference was found in the quizzes/activity scores between the control group (modular learning) and the experimental group (blended learning).

Conclusions

From the results, the following conclusions can be made:

1. The Grade-12 students demonstrated low performance during the pretest in Physical Science, indicating a lack of mastery of the topics and limited understanding of science concepts from previous years. Additionally, students had not been exposed to either of the two delivery formats at this stage.
2. The Grade-12 students in the experimental group (blended learning) showed greater improvement in their academic performance in Physical Science compared to those in the control group (modular learnin).
3. There was a statistically significant difference between the performance of the experimental group and the control group, with the experimental group (blended learning) outperforming the control group (modular learning).

Recommendations

Considering the results and conclusions of this study, the following suggestions are proposed:

1. This study demonstrates that blended learning is a more effective instructional method for Physical Science compared to modular learning. Therefore, this approach should be implemented in other subjects and at various educational levels. Science teachers, in particular, should incorporate blended learning into their teaching practices to enhance students' academic performance.
2. Teacher should continue to use blended learning strategies to improve students' academic outcomes in science subjects.
3. Teachers and students should be encouraged to participate in webinars, seminars, and workshops focused on the use of supplemental applications for blended learning. This will help them maximize the potential of this teaching method.
4. The results from a single study are not enough to make definitive conclusions about the full implementation of blended learning in teaching Physical Science. Therefore, further research should be conducted in different contexts, with varied participants, and across different educational levels.
5. Future researchers are encouraged to expand on this study after the pandemic to further explore and refine the application of blended learning in education.

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