BLENDED LEARNING PILLARS AND SENIOR HIGH SCHOOL PERFORMANCE IN STATISTICS HYPOTHESIS TESTING TOWARDS MATHEMATICS WORKSHEETS

JOHN MARVIN D. DELA CRUZ
https://orcid.org/0009-0000-4016-4681
Jehoshua Academy of Marikina Inc.
Marikina, Philippines

DOI: https://doi.org/10.54476/ioer-imrj/748644

ABSTRACT

This study investigates how blended learning pillars affect senior high school students' statistics hypothesis testing performance. While positive perceptions of blended learning pillars are noted, they show no significant correlation with post-test performance in Mathematics. However, significant improvements are seen in student performance from pretest to posttest, emphasizing the importance of addressing faculty attitudes and understanding students' learning capacity for effective instructional strategies within a blended learning environment. Recommendations include further research, educator professional development, and advocacy for policies supporting technology-enhanced learning approaches in mathematics education.

Keywords: Blended Learning, Statistics, Learning Capacity

INTRODUCTION

In the evolving educational landscape, technology integration has given rise to blended learning, an innovative method that combines traditional classroom pedagogy with digital platforms and app-based tools, as highlighted by Bhaduri (2023). This approach leverages technological advancements to enhance learning. However, the COVID-19 pandemic, as discussed by Pagaran (2022), introduced challenges, particularly in mathematics, where students struggled to retain lessons and showed subpar performance during the shift to online learning.

In the Philippines, blended learning is a relatively new and evolving concept, especially in emerging higher education institutions, and its growing demand brings challenges that need investigation (Alvarez, 2020). Understanding these challenges are crucial for effective implementation. Data-driven learning (DDL) is a tangible application of data-driven methods, supporting learners with diverse writing challenges (Muftah, 2023), though not all data-driven reforms address educational inequity. Personalized learning, rooted in individual interactions and experiences (Shemshack, 2020), can be enhanced through technology-enabled personalized systems of instruction (PSI), which streamline instructional strategies and accelerate learning (Hammerschmidt-Snidarich et al., 2019). Personalization also positively impacts students' engagement and comprehension (Starke, 2021). Student agency transforms classroom roles, with teachers as "expert facilitators" and strong student-teacher relationships fostering social-emotional skills and overall personal growth (Trust, 2021). Courses incorporating rigor stimulate critical thinking and appreciation for the subject (Culver et al., 2019). Relevance in mathematics education involves cultural responsiveness and practical applicability, making concepts more accessible and relatable (Glanfield & Sterenberg, 2020).

In addition, Blended Learning, which merges traditional teaching methods with digital tools, is transforming education by addressing diverse learning styles and adapting to disruptions like the COVID-19 pandemic. This study examines the relationship between blended learning pillars—data-driven instruction, personalized learning, student agency, relationships, rigor, and relevance—and students' performance in mathematics, as well as the role of mathematics worksheets. The research aims to optimize mathematics education within the blended learning framework and develop practical recommendations to improve performance, particularly during disruptions, by leveraging the key principles of blended learning.

OBJECTIVES OF THE STUDY

The study Blended Learning Pillars and Senior Highschool Performance in Statistics Hypothesis Testing Towards Mathematics Worksheets aimed 1) To know what extent the use of blended learning pillars is as assessed by respondents in terms of data-driven instruction, personalized learning, student agency, relationships, rigor, and relevance. 2) To know the performance level of students in statistics hypothesis testing before and after the use of blended learning pillars.3) To know if there is a significant relationship between the use of each Blended learning pillar and the mean performance level of students. 4) to know if there is a significant difference between statistical hypothesis testing performance levels before and after; decide of Blended Learning Pillars. This study also aimed to propose a blended statistic worksheet based on the implications derived from the study.

METHODOLOGY

The study focused on implementing Blended Learning in the pillars of data-driven instruction, personalized learning, student agency, relationships, rigor, and relevance. It also focused on the academic achievement of 33 students at Jehoshua Academy of Marikina Inc. study's findings 2022-2023.

This quantitative study aims to determine senior high school student's performance in mathematics to develop a mathematics worksheet. Utilizing a quasi-experimental design, the independent variable is the instructional method (face-to-face vs. blended learning), and the dependent variable is students' performance in statistical hypothesis testing. The control group will receive face-to-face instruction, while the experimental group will engage in blended learning activities. Pre-test and post-test scores will be compared between the groups to assess the effectiveness of blended learning on students' performance.

The research employed a Likert scale to assess blended learning alongside a five-point semantic differential scale evaluation checklist ranging from 'Highly manifested' to 'Not manifested.' Participants' performance in statistical hypothesis testing was measured using pre-tests and post-tests. Reliability and validity were evaluated using Cronbach's alpha for internal consistency during the pilot phase and the Shapiro-Wilk test to assess the normality of the data distribution. The researcher sought approval from the head of the organization before developing a Google Form to collect demographic information and assess elements in mathematics worksheets for statistics hypothesis testing in a blended learning setting. After pilot testing and refinement, the finalized questionnaire was distributed to participants via email or the school's learning management system with instructions emphasizing voluntary participation and confidentiality. Participants completed the questionnaire within a specified period.

The purpose of this study was to evaluate Blended Learning Pillars and Senior High School Performance in Mathematics Toward the Development of Mathematics Worksheets using the following tools: Weighted mean, Standard deviation, Pearson's R, and T-test. Moreover, the researchers took great care to safeguard the information she had been entrusted with and to comply with all relevant ethical regulations.

RESULTS AND DISCUSSION

1. Use of blended learning pillars by the respondents

Table 1
The Composite Mean Distribution of the Respondents' Perceived Use of Blended Learning Pillars in all six areas

Blended Learning Pillars	WM	VI
Data-Driven Instruction	3.87	M
Personalized Learning	3.99	M
Student Agency	3.81	M
Relationship	3.71	M
Rigor	3.56	M
Relevance	3.65	M
Grand Mean	**3.765**	**M**

Table 1 presents the composite mean distribution of respondents' perceived use of blended learning pillars across six areas. Each pillar, including data-driven instruction, personalized learning, student agency, relationships, rigor, and relevance, has been assessed based on its Weighted Mean (WM) and Variable Index (VI).

The Grand Mean, calculated at 3.765, represents the overall average manifestation level across all pillars, indicating a generally positive perception of the utilization of blended learning pillars among respondents. The study of Alvarez, 2020 supported these results, that blended learning is a relatively new and evolving concept, particularly in emerging higher education institutions. The growing demand for blended learning, while promising, brings forth challenges that merit investigation.

2. Performance level of students in statistics hypothesis testing before and after the use of blended learning pillars

Table 2
Performance Level of the Students

Levels	Pretest f	Pretest %	Posttest f	Posttest %
95-100 Distinguished	0	0.0	0	0.0
85-94 Proficient	0	0.0	1	3.0
75-84 Developing	7	21.1	25	75.8
60-74 Beginning	26	78.9	7	21.2
0-59 Failed	0	0.0	0	0.0
Mean	**71.67**		**77.21**	
Performance Level	**Beginning**		**Developing**	
s.d.	**3.25**		**4.23**	

The Pretest shows that most students (78.9%) fall into the "Beginning" category, followed by 21.1% in the "Developing" category. The post-test shows that the distribution shifts significantly after the intervention or learning period. These results were supported by the study of Acido, J. V., & Caballes, D. G., 2024, states that the comparative analysis between the PISA results in 2018 and 2022 in the Philippines suggests that there is a slight shift in results in the subjects of math and reading while science has decreased by a point only. This means educational progress from 2018 to 2022 has remained in the Philippines.

3. Relationship between the use of each Blended learning pillar and the mean performance level of students

Table 3
Correlation of Pillars to the Posttest Performance in Mathematics

Area	Median	Levels	rho-value	degree	p-value	decision	remarks
DD	4.0	M	0.027	Very Weak	0.881	Failed to Reject Ho	Not significant
PL	4.0	M	0.073	Very Weak	0.686	Failed to Reject Ho	Not significant
SA	4.0	M	-0.194	Negative Very Weak	0.278	Failed to Reject Ho	Not significant
Re	3.0	MM	0.035	Very Weak	0.845	Failed to Reject Ho	Not significant
Ri	3.0	MM	0.040	Very Weak	0.825	Failed to Reject Ho	Not significant
Rel	3.0	MM	0.003	Very Weak	0.987	Failed to Reject Ho	Not significant
Pillars	**4.0**	**M**	**0.039**	**Very Weak**	**0.828**	Failed to Reject Ho	Not significant

The rho-values indicate very weak correlates remained ions for each pillar, ranging from 0.003 to 0.073, with p-values above 0.05. Consequently, there's insufficient evidence to reject the null hypothesis, suggesting that the correlations are not significant. This implies that the Blended Learning Pillars do not exhibit a significant relationship with posttest performance in Mathematics at a 5% significance level.

The results were supported by the study of the importance of addressing faculty attitudes and perceptions, as highlighted by Singh (2021), to promote the successful integration of technology-enhanced learning approaches like blended learning. Additionally, understanding students' learning capacity, as demonstrated by Gumasing (2022), is crucial for designing effective instructional strategies that optimize academic performance.

4. Difference between statistical hypothesis testing performance level before and after the use of Blended Learning Pillars

Table 4
Comparison of Pretest and Posttest

Test	Average	Level	t-value	p-value	Decision	Remarks
Pre-test	71.67	Beginning	7.201**	0.000	Reject the Null Hypothesis	Significant

**Significant at 5%; **significant at 1%*

The table illustrates the mean distribution comparison between the Pre-test and Post-test scores. It shows significant improvements, as indicated by the rejection of the null hypothesis with a t-value of 7.201 and p-value of 0.000, significant at a 5% level of confidence. The Pre-test, with an average score of 71.67, represents the beginning level, while the Post-test, with an average score of 77.21, indicates a developing level. This significant improvement suggests a positive impact of the intervention or learning experience on the participants' performance.

These results are supported by a study by Ong, 2021 which stresses the importance of considering learner characteristics, abilities, and needs in the design of instructional materials, media utilization, interaction strategies, and the evaluation process within online distance learning.

Also, it aligns with the findings of the OECD, 2022, that in the Philippines, 16% of students attained at least Level 2 proficiency in mathematics, significantly less than on average across OECD countries (OECD average: 69%). At a minimum, these students can interpret and recognize, without direct instructions, how a simple situation can be represented mathematically (e.g. comparing the total distance across two alternative routes or converting prices into a different currency).

In addition, this result aligned with the report of Ignacio, 2022, which is the Program for International Student Assessment (PISA); the Philippines was ranked as one of the lowest in Mathematics, Science, and Reading Comprehension among 79 participating countries. Despite the educational reforms established to improve the Philippine Education System, the Philippines remains low and significantly below its neighboring countries in terms of quality education.

5. Proposed statistics worksheet for blended learning that incorporates various teaching strategies and considers students' learning capacities

Warm-up Activity

Engage students with a real-world scenario or problem that introduces key statistical concepts in a relatable context.

Peer Collaboration Activities

Facilitate peer collaboration through small discussions, problem-solving tasks, and collaborative projects.

Tiered Practice Problems

Present a series of tiered practice problems that scaffold learning and cater to different levels of student readiness.

Reflective Goal Setting

Conclude the worksheet with a reflection activity where students evaluate their learning experiences and set goals for future improvement.

The proposed actual Statistics Worksheet is based on the findings of the study. Drawing from the lowest mean indicators of every Blended Learning Pillars respectively. This is to identify the indicators that need to be addressed but not limited to as follows:

Data-Driven instruction

Tailor math problems based on the data to address identified areas of improvement.

Personalized Learning

Allow students to choose from a set of math problems based on their interests or real-world applications.

Student Agency

Include open-ended problems that allow for multiple solution pathways, promoting student choice.

Relationships

Create opportunities for students to discuss and share their problem-solving approaches with peers.

Rigor

Design math problems that require critical thinking and application of concepts beyond rote memorization.

Relevance

Include problems that showcase the practical applications of mathematical concepts in various fields.

CONCLUSIONS

Based on the findings mentioned above, the following conclusions are drawn:

1. The findings of the study reveal a generally positive perception of blended learning pillars among respondents, with a significant proportion demonstrating moderate to high manifestation levels across various pillars such as data-driven instruction, personalized learning, student agency, relationships, rigor, and relevance. The overall Grand Mean of 3.765 indicates an optimistic view of the utilization of blended learning strategies among participants.
2. Despite the positive perception of blended learning pillars, the correlation analysis suggests a non-significant relationship between these pillars and posttest performance in Mathematics. This implies that while respondents perceive blended learning positively and interventions show promising results in improving student performance, other factors may play a more significant role in influencing academic outcomes.
3. The study underscores the importance of addressing faculty attitudes and perceptions, as highlighted by Singh (2021**),** to promote the successful integration of technology-enhanced learning approaches like blended learning. Additionally, understanding students' learning capacity, as demonstrated by Gumasing (2022), is crucial for designing effective instructional strategies that optimize academic performance.
4. The proposed statistics worksheet draws from these insights, emphasizing warm-up activities, tiered practice problems, peer collaboration, and reflective goal setting to cater to student's individual needs and enhance their learning outcomes within a blended learning environment.
5. These conclusions provide valuable insights for educators and policymakers aiming to enhance educational practices and improve student performance through blended learning methodologies. By addressing faculty attitudes, understanding students' learning capacity, and implementing tailored instructional strategies, educators can optimize the effectiveness of blended learning approaches and foster successful learning outcomes in mathematics education.

RECOMMENDATIONS

Based on the findings and conclusions mentioned above, the following recommendations are drawn:

1. Conduct further research to explore additional factors that may influence academic outcomes in mathematics education within a blended learning environment. This could include investigating the role of teacher pedagogical practices, student motivation, and parental involvement.
2. Provide professional development opportunities for educators to improve their knowledge and skills in implementing blended learning approaches effectively. This training should focus on integrating technology into teaching practices, designing engaging learning activities, and addressing diverse student needs.
3. Develop guidelines and resources to support educators in incorporating personalized learning strategies into their mathematics instruction. This could include curriculum frameworks, instructional materials, and assessment tools tailored to individual student needs and learning preferences. Foster collaboration among educators, administrators, and educational researchers to share best practices and innovative approaches for integrating blended learning into mathematics education. This collaborative effort can facilitate the exchange of ideas and promote continuous improvement in teaching and learning practices.
4. Advocate for policies and funding initiatives that prioritize the integration of technology-enhanced learning approaches, such as blended learning, into mathematics education. This includes allocating resources for technology infrastructure, professional development, and research initiatives aimed at enhancing teaching and learning outcomes in mathematics.

REFERENCES

Acido, J. V., & Caballes, D. G. (2024). Assessing educational progress: A comparative analysis of PISA results (2018 vs. 2022) and HDI correlation in the Philippines. World Journal of Advanced Research and Reviews, 21(1), 462–474. https://doi.org/10.30574/wjarr.2024.21.1.0020

Alvarez, A., Jr. (2020). Learning from the problems and challenges in blended learning: basis for faculty development and program enhancement, *15*(2), 1347–9008. *Asian Journal of Distance Education*. https://files.eric.ed.gov/fulltext/EJ1285361.pdf

Bågenholm, L. T. (2020). *Experiences of mathematical relevance in project-based education among selected youths between 14-and-15-year-olds in Norway*. Inland Norway University. https://brage.inn.no/inn-xmlui/bitstream/handle/11250/3004498/Baagenholm.PDF?sequence=1&isAllowed=y

Bhaduri, K. (2023). How blended learning increases inclusivity in math classrooms. *eLearning Industry*. https://elearningindustry.com/how-blended-learning-increases-inclusivity-in-math-classrooms

Culver, K. C., Braxton, J. M., & Pascarella, E. (2019). Does teaching rigorously really enhance undergraduates' intellectual development? The relationship of academic rigor with critical thinking skills and lifelong learning motivations. *Higher Education*, *78*(4), 611–627. https://doi.org/10.1007/s10734-019-00361-z

Dekker, I., Schippers, M. C., & Van Schooten, E. (2023). Reflective goal setting Improves academic performance in teacher and business education: a large-scale field experiment. *Journal of Research on Educational Effectiveness*, 1–29. https://doi.org/10.1080/19345747.2023.2231440

Fatahi, S. (2019). An experimental study on an adaptive e-learning environment based on learner's personality and emotion. *Education and Information Technologies*, *24*(4), 2225–2241. https://doi.org/10.1007/s10639-019-09868-5

Glanfield, F., & Sterenberg, G. (2020). Understanding the landscape of culturally responsive education within a community-driven mathematics education research project. In C. Nicol, J. A. Xiiem, F. Glanfield, & A. J. Dawson, Living culturally responsive mathematics education with/in indigenous communities (pp. 71-90). Leiden: Brill | Sense. doi:10.1163/9789004415768_004

Gumasing, M. J. J., Villapando, K. D. C., Caday, L. T., & Draculan, K. a. E. (2022). Effects of learning capacity of students on the academic performance during online class. https://doi.org/10.1145/3524338.3524378

Hammerschmidt-Snidarich, S. M., Edwards, L. M., Christ, T. J., & Thayer, A. J. (2019). Leveraging technology: A multi-component personalized system of instruction to teach sight words. *Journal of School Psychology*, *72*, 150–171. https://doi.org/10.1016/j.jsp.2018.12.005

Ignacio, L. B., Cristobal, A. G. A., & David, P. C. (2022). Impact of policy implementation on education quality: a case study on Philippines' Low Ranking in International and Local Assessment Programs. *Asian Journal on Perspectives in Education,* 3, 41–54. https://ajpe.feu.edu.ph/index.php/ajpe/article/view/7663

Leverton, K. (2021). Building student agency by collaborating on learning standards. *Edutopia*. https://www.edutopia.org/article/building-student-agency-collaborating-learning-standards/

Lewis, K. (2019). *Effects of differentiating instruction through tiered lessons in special education secondary mathematics*. Rowan Digital Works. https://rdw.rowan.edu/etd/2710?utm_source=rdw.rowan.edu%2Fetd%2F2710&utm_medium=PDF&utm_campaign=PDFCoverPages

Lundgren, B. J. (n.d.), 2020 *The effects of math warm-ups on a student's number sense*. The Repository at St. Cloud State. https://repository.stcloudstate.edu/ed_etds/42?utm_source=repository.stcloudstate.edu%2Fed_etds%2F42&utm_medium=PDF&utm_campaign=PDFCoverPages

Moore, K. (2022). How to make math concepts feel relevant to students. *Edutopia*. https://www.edutopia.org/article/how-make-math-concepts-feel-relevant-students/

Muftah, M. (2023). Data-driven learning (DDL) activities: do they truly promote EFL students' writing skills development? Educ Inf Technol 28, 13179–13205 (2023). https://doi.org/10.1007/s10639-023-11620-z

OECD. (2019). *Student agency for 2030*. https://www.oecd.org/. https://www.oecd.org/education/2030-project/teaching-and-learning/learning/student-agency/Student_Agency_for_2030_concept_note.pdf.

OECD. (2022). PISA 2022 Results [Dataset]. PISA. https://www.oecd.org/publication/pisa-2022-results/country-notes/philippines-a0882a2d/

Pagaran, G. (2022). Mathematics performance of senior high school students in blended learning amidst the covid-19 pandemic. *Journal of Positive School Psychology*, *6*(10593–10613). https://journalppw.com/index.php/jpsp/article/download/9686/6321/11303

Rodriguez, E. (2023). 5 blended learning strategies to try. *Edutopia*. https://www.edutopia.org/article/5-blended-learning-strategies-middle-high-school/

Shemshack, A., & Spector, J. M. (2020). A systematic literature review of personalized learning terms. *Smart Learning Environments*, *7*(1). https://doi.org/10.1186/s40561-020-00140-9

Singh, J., Steele, K., & Singh, L. (2021). Combining the Best of Online and Face-to-Face Learning: Hybrid and Blended Learning Approach for COVID-19, Post Vaccine, & Post-Pandemic World. *Journal of Educational Technology Systems*, *50*(2), 140–171. https://doi.org/10.1177/00472395211047865

Tabuena, A. (2021), Preliminary methods and illustrative examples in formulating the research frameworks on theresearch Writing Process for Senior HighSchool Students. *Research Frameworks*, *7*(1), IJARIIE-ISSN(O)-2395-4396. https://ijariie.com/AdminUploadPdf/Preliminary_Methods_and_Illustrative_Examples_in_Formulating_the_Research_Frameworks_on_the_Research_Writing_Process_for_Senior_High_School_Students_ijariie13429.pdf

Trust, E. (2023, August 9). *The importance of strong relationships between teachers & students - The education trust*. The Education Trust. https://edtrust.org/resource/the-importance-of-strong-relationships/

Wen, Z., & Li, Y. (2022). A study of the effectiveness of peer collaboration in improving college students' English writing ability. In *Advances in Social Science, Education and Humanities Research/Advances in social science, education and humanities research* (pp. 928–936). https://doi.org/10.2991/978-2-494069-31-2_108

Wu, X., Wu, R., Chang, H. H., Kong, Q., & Zhang, Y. (2020). International comparative study on PISA mathematics achievement test based on cognitive diagnostic models. Frontiers in Psychology, 11. https://doi.org/10.3389/fpsyg.2020.02230

AUTHOR'S PROFILE

John Marvin D. Dela Cruz is a graduate with a degree in Bachelor's of Mathematics Education with a certificate in teaching in Junior High School at Philippine Normal University. He also finished a Master of Arts in Education major in Mathematics Education from Philippine Christian University in 2024. He also passed the Licensure Examination for Teachers given by the Professional Regulation Commission (PRC), the agency mandated to implement the regulatory laws and policies for the various regulated professions. Mr. Dela Cruz is one of the prominent researchers in the academy who can write research that is published in the international journal. Currently, he is a Senior High School teacher at Jehoshua Academy of Marikina Inc.

COPYRIGHTS