

Original Article

Investigating Key Factors in Shaping Students' Mathematics Achievement in Blended Learning Instruction

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Abstract: The outbreak triggered new ways of teaching online. Most countries imposed restrictions, where the medium of education has shifted into either synchronous or asynchronous modes. More than 190 countries throughout the world have experienced the greatest disruption of their educational institutions in history. Up to 99% of the student population worldwide who come from lower-middle-income countries has been impacted by the closure of academic institutions. This study forced teachers to practice nimbleness and revise their methods of teaching to center students' understanding, care, and ease. Adjusting to a completely different rhythm of what is considered a normal teaching environment urges teachers to invent ingenious ways of community care, problem-solving, and managing resources. The COVID-19 pandemic has resulted in educational institutions across the world being compelled to suddenly harness and utilize the suite of available technological tools to create content for remote learning for students in all sectors. This research study conducted a survey to determine the variables and factors that affect the students' learning outcomes in blended learning instruction. The sample of this study was selected by the random method. According to the sample size needs to be considered in correlation with the number of parameter estimates, the sample size must be at least 100 to 150. Blended learning presents an increased opportunity for students to connect with their professors and teachers. This learning style promotes a number of effective means for teachers and students to become more engaged with one another. This factor facilitates the improvement of student's analytical and critical thinking and problem-solving skills. Course design on the other hand, includes structure, course design interface, testing and evaluation methods, and exchange forums between lecturers and learners. A good course design will attract and facilitate students to learn through online classes.

Keywords: factor, students, mathematics achievement, learning instruction

1. INTRODUCTION

The COVID-19 impacted all walks of life including education. It led to the closure of schools and universities. It has caused the academic institutions to cope with the unprecedented shift from traditional to online learning [1]. The outbreak triggered new ways of teaching online. Most countries imposed restrictions, where the medium of education has shifted into either synchronous or asynchronous modes. More than 190 countries throughout the world have experienced the greatest disruption of their educational institutions in history. Up to 99% of the student population worldwide who come from lower-middle-income countries has been impacted by the closure of academic institutions. The higher education institutions' closure demands online learning, where the course material is taught [2]. In the middle of this global pandemic, learning has innovated and adopted a new mode of instruction and delivery. In a short amount of time, students were able to adapt alongside with

their teachers in transitioning online with an incredible amount of resilience and responsiveness. The digital shift has encouraged teachers to experiment with different styles of pedagogy in order to still convey the same high-quality instruction in new and ever-developing mediums [3]. It has forced teachers to practice nimbleness and revise their methods of teaching to center students' understanding, care, and ease. Adjusting to a completely different rhythm of what is considered a normal teaching environment urges teachers to invent ingenious ways of community care, problem-solving, and managing resources [4]. The COVID-19 pandemic has resulted in educational institutions across the world being compelled to suddenly harness and utilize the suite of available technological tools to create content for remote learning for students in all sectors. Educators across the world are experiencing new possibilities to do things differently and with greater flexibility resulting in potential benefits in accessibility to education for students across the world. These are new modes of instruction that have previously been largely untapped [5]. In the Philippines, face-to-face instruction has been replaced with modular learning and online learning platforms to control the outbreak's spread [6]. The government had imposed a national lockdown, which resulted in universities' and schools' closure. Since 2020, the Commission on Higher Education (CHED) said that the country's education system has been trying to adjust to the realities of the coronavirus disease (COVID-19) pandemic. One of the responses of CHED to the challenges brought by COVID-19 is adopting a Flexible Learning policy. CHED Chairperson, Prospero De Vera described the concept of flexible learning as "more inclusive than online learning" a few months after the first backlash [7]. De Vera explains that while online learning requires internet access, flexible learning does not necessarily require connectivity. Instead, it "focuses on the design and delivery of programs, courses, and learning interventions that address the learners' unique needs in terms of pace, place, process, and products of learning". Due to the pandemic, De Vera said that the entire system was forced to adapt to various challenges. Higher Education Institutions (HEIs), in particular, have been preparing their campuses and faculty to ensure their operations even amid the ongoing pandemic [8]. "We will see a system where universities will have to determine the proper mix and match of learning delivery systems appropriate to the health situation on the ground, the capability of their faculty and students, connectivity, and their own capacity to do it," De Vera said. Flexible Learning, De Vera explained, is a combination of all live and limited face-to-face as well as online and physical classes in HEIs. School closures and the transition from face-to-face to online learning have created opportunities [9]. Universities and colleges have improved instructional platforms despite a lack of resources and contingency measures. Universities were able to move courses to the online, adapt curriculum, and train instructors/ professors through a series of webinars on online learning and module development, as well as implement the essential priority of reaching students and reopening classrooms at all levels [10]. There are shifting paradigms in teaching and learning, experimenting with innovative modes of delivery, and introducing lifelong education as the higher education sector moves into the new normal. The change to online in higher education entails reshaping our view regarding higher education, including institutions and students' needs [11]. For instance, theoretical courses can be taught online. In contrast, the practical courses should be conducted face to face to ensure best teaching practices in monitoring and guiding students. Therefore, technology can make larger classes' flexible and suiting students' needs. The shift into the techno-economic culture should associate with plans to reduce this shift's impact on the normal learning process [12]. Currently, blended synchronous learning "blend" of online and traditional approaches) mode is gaining and developing currency in higher education, while its effects on students' and instructors' experiences are yet to be fully explored. With the rapid expansion of the transnational education market, more and more universities join the ranks of transnational education providers or expand their transnational education offering, such as distance learning or blended learning, including in the Philippines. Most of the higher education institutions in the Philippines have been implementing blended learning delivery modes for the academic year (AY). Blended learning combines face-to-face (f2f) and online teaching and learning

modes. It expounded how blended or mixed methods allow greater flexibility for the University [13]. Blended learning fosters academic excellence, develops 21st-century competencies, and strengthens institutional resilience and learning continuity in the next normal during the COVID-19 pandemic and in preparation for other possible disruptions such as disasters and social crises (. Blended learning further improves the quality of teaching and learning by providing access to a wide range of learning resources in various media (text, video, audio, multimedia, interactive multimedia) [14]. It also enhances interaction using numerous technologies, expanding opportunities for collaborative learning online and f2f, and developing independent means to understanding and furthering one's digital skills. The teaching and learning environment is embracing a number of innovations and some of these involve the use of technology through blended learning. This innovative pedagogical approach has been embraced rapidly though it goes through a process. The focus of the study of Kintu & Kagambe is on examining the effectiveness of blended learning taking into consideration learner characteristics/background, blended learning design elements and learning outcomes and how the former are significant predictors of blended learning effectiveness. Blended learning effectiveness has quite a number of underlying factors that pose challenges [15]. One big challenge is about how users can successfully use the technology and ensuring participants' commitment given the individual learner characteristics and encounters with technology. In the blended learning environment, blending the online and face-to-face elements should be purposeful. Purposeful blending is defined as blending the tools, methods and technologies to accomplish educational purposes [16]. Most comparative studies have shown that blended learning is more effective than the face-to-face or online learning approaches. Successful use of the blended learning approach in the curriculum requires students' readiness to accept it. Therefore, it is important to identify the social, psychological, cultural and pedagogical factors that may influence the acceptance of blended learning [17]. Researchers have dealt with success factors for online learning or those for traditional face-to-face learning but little is known about factors that predict blended learning effectiveness in view of students' learning outcomes [19]. In order to ensure the effective implementation of blended learning, it is urgent to understand the attitude and capacity of colleges and universities in blended learning. This study sought to establish the factors of blended learning instruction that predict students' learning outcomes. It aimed to analyze the predictive factors on blended learning to provide suggestions for better implementation and promote to construct blended learning model to meet the demands of students in the University [20].

2. MATERIALS AND METHODS

The research design, subjects involved in the data gathering, instruments used, procedure by which data be gathered and statistical treatment of data. This research used the Descriptive Cross-sectional Survey Method. A cross-sectional study is a type of research method in which information was collected at one point in time. This research study conducted a survey to determine the variables and factors that affect the students' learning outcomes in blended learning instruction. The sample of this study was selected by the random method. According to the sample size needs to be considered in correlation with the number of parameter estimates, the sample size must be at least 100 to 150. Besides, the study of Bolin suggested that the ratio required for sample design is a minimum of 5 observations per parameter estimate This study has a total of 24 parameter estimates, so the minimum sample size must reach 120 observations. According to Anderson and Garbing, in practical research applications, a sample size of 150 or larger is often needed to obtain parameter estimates with sufficiently small standard errors. Thus, a sample size of 317 that was used in the study is acceptable. The sample of this research consists of the students enrolled in the different programs at Pangilinan State University Asingan Campus for the first semester.

3. RESULTS AND DISCUSSION

The distribution of the respondents by program was summarized by the table below.

Table 01: Sample Distribution by Program

Course	Frequency	Percent
Bachelor of Secondary Education	87	27.4
Bachelor of Elementary Education	40	12.6
Bachelor of Science in Business Administration	115	36.3
Bachelor of Science in Information Technology	47	14.8
Bachelor of Technology and Livelihood Education	9	2.8
Bachelor in Industrial Technology	19	6.0
Total	317	100

Preliminary survey was conducted with a small sample (30 students) to test the reliability of the scale with Cranach's Alpha coefficient and validity test using correlation of the total ratings. The resulting validity test shows that all the twenty four items were valid with a correlation coefficients having significance value less than 0.05 (see Appendix C). From the table of reliability statistics below, the Cranach's alpha computed was **0.971**, which indicates an excellent internal consistency of the instrument.

Table 02: Reliability Statistics

Cranach's Alpha	Cranach's Alpha Based on Standardized Items	N of Items
.971	.971	24

All statistical analyses were carried out using Statistical Package for Social Science (SPSS) Version 25. Frequency, average weighted mean, and ranking, were used to summarize the students' learning outcomes and the learners' level of agreement on the indicators in blended learning instruction. Principal component analysis (PCA) was used to determine the representative factors of the indicators in blended learning instruction. PCA is a variable-reduction technique that aims to reduce a larger set of variables into a smaller set of variables, called 'principal components', which account for most of the variance in the original variables. These will become the new representative factors of the original variables. Multiple regression analysis was utilized to determine the factors affecting students' learning outcomes in blended learning instruction.

Table 03: Learners' Level of Agreement on the Indicators in Blended Learning Instruction

Indicators	SA	A	N	D	SD	AWM	DE	Rank
1. Blended learning environment helps manage time more effectively.	92	137	76	12	-	3.97	Agree	8
2. Blended learning makes learning easier.	62	145	95	15	-	3.80	Agree	19
3. Blended learning saves costs	101	134	66	16	-	4.01	Agree	4.5
4. Blended learning creates more learning excitement	56	147	96	17	1	3.76	Agree	20

5. Faculty uses appropriate teaching methods in blended learning	82	165	66	3	1	4.02	Agree	3
6. Faculty has the ability to apply science and technology in blended learning	86	166	64	1	-	4.06	Agree	1
7. Faculty has the ability to form and combine different ideas and practices	79	179	57	1	1	4.05	Agree	2
8. Faculty possessed professional competence in blended learning.	69	174	70	3	1	3.97	Agree	8
9. Suitable course content and course materials are delivered in blended learning.	69	169	75	4	-	3.96	Agree	10
10. Blended learning support diverse learners.	64	173	75	5	-	3.93	Agree	11
11. Innovative and updated subject content is offered in blended learning.	59	178	76	4	-	3.92	Agree	12
12. There is practical and comprehensive subject content and structure in blended learning.	62	170	81	4	-	3.91	Agree	13
13. Blended learning offers appropriate course design structure and interface.	61	161	83	12	-	3.85	Agree	16.5
14. Blended learning has flexible time schedule.	83	151	72	11	-	3.97	Agree	8
15. There is an appropriate testing and evaluation methods in blended learning	70	149	88	10	-	3.88	Agree	14
16. There is a convenient exchange forums in blended learning.	60	155	90	12	-	3.83	Agree	18
17. Students have social interaction with instructors and collaborative interaction with classmates in blended learning.	85	160	62	10	-	4.01	Agree	4.5
18. In blended learning environment students can quickly adapt to changes	58	164	84	11	-	3.85	Agree	16.5

19. Students develop proactiveness and self-study ability in blended learning.	80	161	68	8	-	3.99	Agree	6
20. Students have develop sense of regulatory compliance in blended learning.	59	162	88	8	-	3.86	Agree	15
Total AWM	3.93			Agree				

Note: Highest frequencies in bold face; DE-Descriptive Equivalent

Legend: 1.00 – 1.49 SD-Strongly Disagree; 1.50 – 2.49 D-Disagree; 2.50 – 3.49 N-Neutral; 3.50 – 4.49 A-Agree; 4.50 – 5.00 SA-Strongly Agree The first twenty items of the survey had questions investigating learners' overall agreement to the effectiveness of blended learning context. Results of the study revealed that the blended mode combining online learning with f2f learning was generally agreed by the students to be an effective tool of instruction in all the indicators listed. The ability of the faculty to apply science and technology in blended learning ranked as the highest indicator in blended learning instruction in the perception of the students. Most of the students agreed that blended learning compelled faculty members to integrate science and technology in their methods of teaching. It is therefore pertinent that since the use of blended learning applies high usage of computers, computer competence is necessary to avoid failure in applying technology in education for learning effectiveness. Similarly, students agreed that faculty members has the ability to form and combine different ideas and practices and uses appropriate teaching methods in blended learning instruction. The top three indicators as perceived by the students to have been effectively emphasized in blended learning instruction characterized the capability of the faculty members in implementing blended learning instruction. The mean scores of items 3 and 17 ranked the same. Students agreed that they have experienced social interaction with instructors and collaborative interaction with classmates in blended learning and it have saves costs. A sense of community and social presence has been widely acknowledged to be a factor in enhancing both the quality of learning and the motivation to study. Blended learning presents an increased opportunity for students to connect with their professors and teachers. This learning style promotes a number of effective means for teachers and students to become more engaged with one another. Also, blended learning can often bring real cost savings, as there are minimal travel costs incurred by the students. At the eighth ranked were the mean scores of items 1, 8 and 14. Students agreed that blended learning environment helps manage time more effectively and has flexible time schedule, and faculty possessed professional competence in blended learning. Blended learning offers flexibility in terms of availability. In other words, blended learning enables the student to access the materials from anywhere at any time while enjoying the benefits of face-to-face support and instruction. Also, university instructors possess the competencies of blended education necessary to perform his/her profession to the fullest. The study of Al-Sayed shows that abilities, skills and knowledge possessed by the faculty member to employ blended education in the educational process contribute significantly to improving the learning and teaching process at the university. Students also believed that blended learning support diverse learners with a mean score ranked at 11th. Blended learning is expected to accommodate diverse students with different needs and interests and promote inclusion. Next in ranked is that innovative and updated subject content is offered in blended learning instruction? This is followed by the indicator that presence of practical and comprehensive subject content and structure in blended learning. Blended learning incorporates direct instruction, indirect instruction, collaborative teaching, individualized computer assisted learning of delivering subject content. Students get wide exposure and new perspectives of the course content in blended learning due to variety of experience students get. A wide exposure and their content

knowledge is enriched as they get to see various new dimensions of the content gain and practical useful knowledge. In the same way, students agreed that there is an appropriate testing and evaluation methods in blended learning. Also, they agreed that they have developed sense of regulatory compliance in the blended instruction. Alternative assessment techniques are essential for increasing student learning in blended courses. In a blended environment, an instructor can use a variety of digital technologies to provide diagnostic, formative, and summative assessment to students in a community of inquiry. Similarly, students agreed that blended learning offers appropriate course design structure and interface and they can quickly adapt to changes. Aside from the direct social interaction during face to face classes, during online classes, learners became skilled at navigating around the learning management system and it was easy for them to locate course content, tools and resources needed such as course works, lectures, recorded discussions and journal materials in a blended learning environment. These made them more adaptable to changes. Likewise, students agreed that there is a convenient exchange forums in blended learning. Students get ample of time to interact with their instructors and other students pursuing same course. They can interact with them inside college campus and also in virtual space. Blended learning approach provides student opportunity to communicate and share their views and feeling with the students in different modes, thus, it makes teaching-learning process more convenient. Further, students also believed that blended learning makes learning easier. Blended learning that uses apps, games, or measurable programs to teach concepts allows students to engage the material at their own pace. This helps to balance a classroom that contains both quick and slow learners. Every student can practice and tackle new material with timing that is perfect just for them. It can promote deeper learning, and lastly, students agreed that blended learning creates more learning excitement. The lengthy lectures and tedious seminars that made up a student's academic day in the mode of instruction used to make them dread going to class. Blended instruction made learning more enjoyable .The remaining four items in the survey refers to the attainment of the students' learning outcomes in the blended learning instruction. The following results shows on how blended learning can enhance learning outcomes in education.

Table 04: Students' Level of Agreement on the Attainment of Learning Outcomes in Blended Learning Instruction

Indicators	SA	A	N	D	SD	AWM	DE
1. Students gain a lot of knowledge in blended learning.	53	156	84	21	3	3.74	Agree
2. Students develop a variety of skills in blended learning	69	157	76	8	7	3.86	Agree
3. Students were able to apply subjects into practice in blended learning.	64	155	92	2	4	3.86	Agree
4. Blended learning improves overall satisfaction of students in the learning process	68	151	86	8	4	3.85	Agree
Total AWM	3.83			Agree			

Note: Highest frequencies in bold face; DE-Descriptive Equivalent

Legend: 1.00 – 1.49 SD-Strongly Disagree; 1.50 – 2.49 D-Disagree ; 2.50 – 3.49 N-Neutral; 3.50 – 4.49 A-Agree ; 4.50 – 5.00 SA-Strongly Agree The learning outcomes under scrutiny in this study include knowledge construction, development of skills, performance, application in real life situations, and student satisfaction. Generally, the results showed that the students agreed in the effectiveness of

blended learning instruction in the attainment of students' learning outcomes. Learning experience, development of skills, and performance are known to improve when traditional course delivery is integrated with online learning. Similarly, learner satisfaction was noted as a strong factor for effectiveness of blended courses. Regarding knowledge construction, it has been noted that effective learning occurs where learners are actively involved and this may be an indicator of learning environment effectiveness. The assumptions for the PCA must be met before the analysis. The study is composed of twenty indicators measured at a 5-point scale, thus, it has multiple variables. There is also a linear relationship among all variables as presented by the resulting correlation coefficients greater than 0.30 in the "Correlation Matrix" (see Appendix D).

Table 05: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.943
Bartlett's Test of Sphericity	Approx. Chi-Square	5821.795
	Df	190
	Sig.	.000

For the sampling adequacy condition, The **Kaiser-Meyer-Olkin (KMO)** needs to be at least **0.6** with values closer to 1.0 being better. The KMO value of 0.943 was interpreted by Kaiser as a marvelous sampling adequacy (Stephanie Glen). For the Bartlett's test, the p-value is less than 0.05 which means it is statistically significant. This means that the data is well suited for factor analysis.

Table 06: Initial Eigenvalues

Principal Components	Eigenvalue	Variance %	Cumulative %
Factor 1	11.415	57.077	57.077
Factor 2	1.546	7.729	64.806
Factor 3	1.163	5.815	70.621
Factor 4	1.128	5.641	76.263

Table 6 summarizes the "Total Variance Explained Table" (see Appendix D). There are only four that have an eigenvalue above 1.0. Hence, the total number of factors is four, as can be verified from the Scree plot in Figure 1. The percent variance column shows how much variance within the construct is accounted for by that factor. Factor 1 accounts for 57.08% amount of variance in the model, Factor 2 accounts for 7.73%, Factor 3 accounts for 5.82%, and Factor 4 accounts for 5.64%.

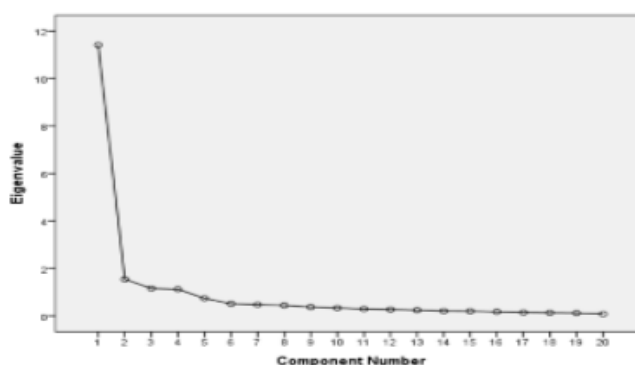


Figure 01: Screen Plot

The allocation of observed variables to each component is shown in Table 7. The results show that the matrix variance of each observed variable for its principal component has a value greater than 0.5. Hence, PCA extracted 4 factors and the observed variables in each factor had a factor loading coefficient greater than 0.5.

Table 07: Principal Component Matrix Variances

Indicators	Principal Components			
	1	2	3	4
1. Blended learning environment helps manage time more effectively.	.310	.210	.119	.795
2. Blended learning makes learning easier.	.254	.179	.247	.789
3. Blended learning saves costs	.251	.206	-	.760
4. Blended learning creates more learning excitement	.171	.197	.327	.717
5. Faculty uses appropriate teaching methods in blended learning	.212	.733	.314	.174
6. Faculty has the ability to apply science and technology in blended learning	.282	.701	.187	.132
7. Faculty has the ability to form and combine different ideas and practices	.205	.736	.311	.232
8. Faculty possessed professional competence in blended learning.	.195	.732	.302	.264
9. Suitable course content and course materials are delivered in blended learning.	.703	.508	.154	.217
10. Blended learning support diverse learners.	.722	.472	.136	.283
11. Innovative and updated subject content is offered in blended learning.	.706	.504	.189	.211
12. There is practical and comprehensive subject content and structure in blended learning.	.726	.476	.202	.252
13. Blended learning offers appropriate course design structure and interface.	.718	.142	.371	.326
14. Blended learning has flexible time schedule.	.666		.320	.420
15. There is an appropriate testing and evaluation methods in blended learning	.696	.165	.407	.251
16. There is a convenient exchange forums in blended learning.	.688	.198	.399	.230

17. Students have social interaction with instructors and collaborative interaction with classmates in blended learning.	.319	.348	.718	.127
18. In blended learning environment students can quickly adapt to changes	.373	.202	.745	.253
19. Students develop proactiveness and self-study ability in blended learning.	.223	.334	.800	.189
20. Students have develop sense of regulatory compliance in blended learning.	.256	.373	.742	.194

Table 08: Factors of the Indicators in Blended Learning Instruction Resulting from the Principal Component Analysis

Code	Indicator	Factor
CCD1	Suitable course content and course materials are delivered in blended learning.	Course content and design
CCD2	Blended learning support diverse learners.	
CCD3	Innovative and updated subject content is offered in blended learning.	
CCD4	There is practical and comprehensive subject content and structure in blended learning.	
CCD5	Blended learning offers appropriate course design structure and interface.	
CCD6	Blended learning has flexible time schedule.	
CCD7	There is an appropriate testing and evaluation methods in blended learning	
CCD8	There is a convenient exchange forums in blended learning.	
FC1	Faculty uses appropriate teaching methods in blended learning	Faculty capacity
FC2	Faculty has the ability to apply science and technology in blended learning	
FC3	Faculty has the ability to form and combine different ideas and practices	
FC4	Faculty possessed professional competence in blended learning.	
LC1	Students have social interaction with instructors and collaborative interaction with classmates in blended learning.	Learner characteristics
LC2	In blended learning environment students can quickly adapt to changes	
LC3	Students develop reactiveness and self-study ability in blended learning.	
LC4	Students have develop sense of regulatory compliance in blended learning.	

PU1	Blended learning environment helps manage time more effectively.	Perceived usefulness
PU2	Blended learning makes learning easier.	
PU3	Blended learning saves costs	
PU4	Blended learning creates more learning excitement	

Preliminary checks were completed to assess the assumptions of normality of the residuals, no significant outliers, no multicollinearity, and homoscedasticity before the conduct of multiple regression analysis.

Table 09: Normality of the Residuals

	Skewness	Std. Error	Kurtosis	Std. Error
Residual	-.092	.137	.514	.273

From the table above, the absolute value of the skewness and kurtosis of the data is less than twice the standard error, this indicates that the data is symmetric. Hence, the data is approximately with normal distribution. Also, no significant outliers were observed in the resulting box-plots.

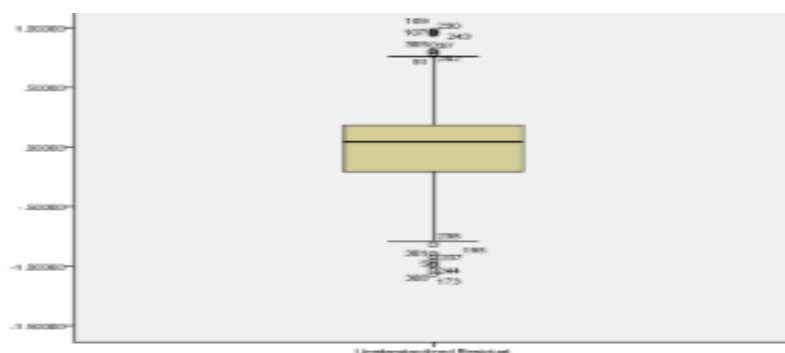


Figure 02: Box plot

There is no multicollinearity in the data since the resulting variance inflation factor (VIF) values in the following table, Table 10, are less than 5. This means that the predictors are not highly correlated with each other.

Table 10: Homoscedasticity Test

Model	Collinearity Statistics	
	Tolerance	VIF
Course content and design	.280	3.573
Faculty capacity	.365	2.743
Learner characteristics	.346	2.894
Perceived usefulness	.513	1.949

Homoscedasticity was satisfied since the variance of the residuals were approximately homogeneous as shown by the points evenly scattered in the Scatterplot in Figure 3.

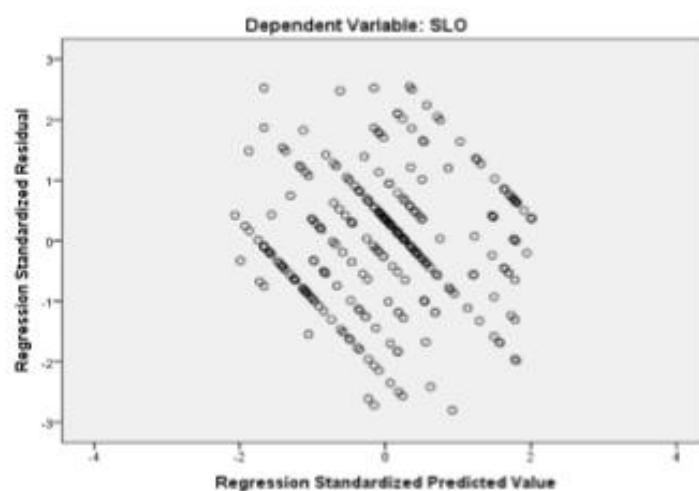


Figure 03: Scatterplot

Table 11: Factors Affecting Students' Learning Outcomes in Blended Learning Instruction

Code	Indicator	Factor	Coefficient	t-value	Sig.
CCD1	Suitable course content and course materials are delivered in blended learning.	Course content and design	.321	4.847	.000*
CCD2	Blended learning support diverse learners.				
CCD3	Innovative and updated subject content is offered in blended learning.				
CCD4	There is practical and comprehensive subject content and structure in blended learning.				
CCD5	Blended learning offers appropriate course design structure and interface.				
CCD6	Blended learning has flexible time schedule.				
CCD7	There is an appropriate testing and evaluation methods in blended learning				
CCD8	There is a convenient exchange forums in blended learning.				
FC1	Faculty uses appropriate teaching methods in blended learning	Faculty capacity	.126	2.047	.042*
FC2	Faculty has the ability to apply science and technology in blended learning				

FC3	Faculty has the ability to form and combine different ideas and practices				
FC4	Faculty possessed professional competence in blended learning.				
LC1	Students have social interaction with instructors and collaborative interaction with classmates in blended learning.	Learner characteristics	.267	4.505	.000*
LC2	In blended learning environment students can quickly adapt to changes				
LC3	Students develop proactiveness and self-study ability in blended learning.				
LC4	Students have develop sense of regulatory compliance in blended learning.				
PU1	Blended learning environment helps manage time more effectively.	Perceived usefulness	.198	4.264	.000*
PU2	Blended learning makes learning easier.				
PU3	Blended learning saves costs				
PU4	Blended learning creates more learning excitement				

Multiple Linear Regression results shows that the four factors were significant predictors of students' learning outcomes as shown in the coefficients of the four factors in Table 11 with corresponding significance less than 0.05. Further, for every 1 point increase in the Course content and design there is an increase of .321 or 32.1% in the students' learning outcomes. For every 1 point increase in Faculty capacity will result to a .126 or 12.6% increase in student learning outcomes. A 1 point increase in Learner characteristics will increase the student learning outcomes to 26.7%. And lastly, 1 point increase in the Perceived usefulness will result to a .198 or 19.8% increase in student learning outcomes. Finally, the standardized coefficients in Table 11 show that the order of impact of these factors on students' online learning outcomes from strong to weak is as follows: course content and design, learner characteristics, perceived usefulness, and faculty capacity. The regression model is a significant predictive model as resulted by $F=133.844$ and with a corresponding significance of .000 in the ANOVA table.

Table 12: ANOVA Table

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	77.889	4	19.472	133.844	.000 ^b
	Residual	45.391	312	.145		

	Total	123.281	316			
a. Dependent Variable: Students' Learning Outcomes						
b. Predictors: (Constant), FACTOR4, FACTOR2, FACTOR3, FACTOR1						

The resulting r^2 of .627 states that 62.7% of the variance in students' learning outcomes was being attributed by the four factors.

Table 13: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.795 ^a	.632	.627	.38143
a. Predictors: (Constant), FACTOR4, FACTOR2, FACTOR3, FACTOR1				
b. Dependent Variable: Students' Learning Outcomes				

The Regression Model is as follows:

$$Y = 0.302 + 0.321 X_1 + 0.126 X_2 + 0.267 X_3 + 0.198 X_4$$

Where

$Y = \text{Students' learning outcomes}$

$X_1 = \text{Factor 1 – Course content and design}$

$X_2 = \text{Factor 2 – Faculty capacity}$

$X_3 = \text{Factor 3 – Learner characteristics}$

$X_4 = \text{Factor 4 – Perceived usefulness}$

Discussion

Blended learning is the concept that includes framing teaching learning process that incorporates both face to face teaching and online teaching [21]. It has scope for collaborative learning; constructive learning and computer assisted learning this study discussed the concepts of blended learning, its main features and indicators of its implementation. The shift into the techno-economic culture should associate with plans to reduce this shift's impact on the normal learning process [22,23]. Currently, blended synchronous learning "blend" of online and traditional approaches) mode is gaining and developing currency in higher education, while its effects on students' and instructors' experiences are yet to be fully explored. With the rapid expansion of the transnational education market, more and more universities join the ranks of transnational education providers or expand their transnational education offering, such as distance learning or blended learning, including in the Philippines [24]. Most of the higher education institutions in the Philippines have been implementing blended learning delivery modes for the academic year (AY). Blended learning combines face-to-face (f2f) and online teaching and learning modes. It expounded how blended or mixed methods allow greater flexibility for the University. Blended learning fosters academic excellence, develops 21st-century competencies, and strengthens institutional resilience and learning continuity in the next normal during the COVID-19 pandemic and in preparation for other possible disruptions such as disasters and social crises [25].

4. CONCLUSION

The study was conducted using quantitative research methods with 317 respondents who are students of Panglilan State University – Asingan Campus using the random sampling method with detailed questionnaire consists of 24 parameters, 20 parameters for the indicators of blended learning instruction and 4 parameters for the students' learning outcomes. The study utilized PCA and Multiple regression analysis as the main statistical methods. Results proved that students' learning outcomes during the blended learning process are affected by the four factors in descending order, respectively, course content and design, learner characteristics, perceived usefulness, and faculty capacity. Engaging course content attracts lots of participation and reactivity among students, thereby influencing learning outcomes. The learning content includes the structure and content of chapters of learning materials. Besides, the learning content also includes additional materials to help students understand more clearly and deeply about the knowledge. This factor facilitates the improvement of student's analytical and critical thinking and problem-solving skills. Course design on the other hand, includes structure, course design interface, testing and evaluation methods, and exchange forums between lecturers and learners. A good course design will attract and facilitate students to learn through online classes. The course design interface is used to introduce course content, designed according to student's competence and level of understanding, and appropriate in terms of time and space to promote and support the self-study process. Based on the findings of the study course content and design has a positive effect on students' online learning outcomes. Social interaction with lecturers and with co-learners is imperative to achieve better learning quality in blended learning. Through strong interaction and consistent practice, the effectiveness of blended learning can be achieved. In addition, reactivity, self-study ability, and sense of compliance are important requirements for achieving better learning outcomes since regulations and requirements of online learning are more comfortable. The process is more difficult to control than traditional methods. In this study, the learner characteristics have a significant effect on students' learning outcomes in blended learning. Perceived usefulness is the degree to which learners believe that the use of online learning will help improve their performance. Many studies have shown that perceived usefulness positively impacts learners' attitudes and motivation, thereby improving learning outcomes. The findings of this study show that perceived usefulness has a positive effect on students' online learning outcomes. The approach in the blended learning process is learner-centered rather than teacher-centered as in traditional education. Pedagogical methods, professional competence, science and technology application level, the ability to form and combine different ideas, and practices in developing online course contents in higher education help students achieve better learning outcomes. The findings of the study show that faculty capacity has a positive effect on students' online learning outcomes. To conclude, it can be said that blended learning is to some extent the solution to problems prevailing in the educational system. If implemented in a well-planned design and organized way it can become the future of educational system. It is in the students benefit that steps for adapting blended learning are initiated.

REFERENCES

- [1] Al-Ayed, Sura & Al-Tit, Ahmad. (2021). Factors affecting the adoption of blended learning strategy. *International Journal of Data and Network Science*. 5. 267-274. 10.5267/j.ijdns.2021.6.007.
- [2] Alhumaid, Khadija & Ali, Sana & Waheed, Anbreen & Zahid, Erum & Habes, Mohammed. (2020). COVID-19 & Elearning: Perceptions & Attitudes Of Teachers Towards E-Learning Acceptance in The Developing Countries. 6. 10.5281/zenodo.4060121.
- [3] Ravi Kiran Karmacharya (2024). The Impact of School Culture on the Students Learning Experiences & Academic Achievement. *Dinkum Journal of Social Innovations*, 3(01):14-21.

- [4] Almahasees, Zakaryja. Mohsen, Khaled. Amin, Mohammad Omar. 2021. Faculty's and Students' Perceptions of Online Learning During Covid-19. <https://www.frontiersin.org/articles/10.3389/feduc.2021.638470/full>. Accessed 1 Oct. 2022.
- [5] Faith Ann Keith C. Fernandez (2024). Exploring the Use of Gamification in Classroom Management and Its Impact on Student Behavior. *Dinkum Journal of Social Innovations*, 3(02):79-89.
- [6] Ashraf, M. A., Tsegay, S. M., & Meijia, Y. (2021). Blended Learning for Diverse Classrooms: Qualitative Experimental Study With In-Service Teachers. *SAGE Open*, 11(3). <https://doi.org/10.1177/21582440211030623>
- [7] Azizi, S.M., Roozbahani, N. & Khatony, A. Factors affecting the acceptance of blended learning in medical education: application of UTAUT2 model. *BMC Med Educ* 20, 367 (2020). <https://doi.org/10.1186/s12909-020-02302-2>
- [8] Bringula, R., Reguyal, J.J., Tan, D.D. et al. (2021). Mathematics self-concept and challenges of learners in an online learning environment during COVID-19 pandemic. *Smart Learn. Environ.* 8, 22. <https://doi.org/10.1186/s40561-021-00168-5>
- [9] Ana Theresa P. Barba, Zairrah Mae A. Valeria, Ierine Joy L. Caserial & Derren Gaylo (2024). Alignment of General Mathematics Curriculum to the PISA 2022 Mathematics Framework. *Dinkum Journal of Social Innovations*, 3(03):152-161.
- [10] Cho MK, Kim MY. Factors Affecting Learning Satisfaction in Face-to-Face and Non-Face-to-Face Flipped Learning among Nursing Students. *Int J Environ Res Public Health*. 2021 Aug 16;18(16):8641. doi: 10.3390/ijerph18168641. PMID: 34444396; PMCID: PMC8391188.
- [11] Cooper, Bill. 2021. 10 Benefits of Blended Learning “from cost efficiency to increased engagement”. <https://www.freshpd.com/blended-learning/#:~:text=Blended%20learning%20can%20often%20bring,suits%20the%20trainer%20or%20employer.>
- [12] Dabu, Fred. 2022. UP adopts blended learning for AY 2022-2023. <https://up.edu.ph/up-adapts-blended-learning-for-ay-2022-2023/>.
- [13] EasyLMS (2021). Difference Synchronous vs Asynchronous Learning | Easy LMS. Available online at: <https://www.easy-lms.com/knowledge-center/lms-knowledge-center/synchronous-vs-asynchronous-learning/item10387> (accessed October 2, 2022).
- [14] Eksail, F. A. A. & Afari, E. 2020. Factors affecting trainee teachers' intention to use technology: a structural equation modeling approach. *Education and Information Technologies*, vol. 25, no. 4, pp. 2681–2697.
- [15] Cherry Anne P. Genovia (2024). Effects of Mathematics Relating to Real-World Connection to the Performance of Grade IX Students of MSU- Buug Laboratory High School, Buug, Philippines. *Dinkum Journal of Social Innovations*, 3(05):226-232.
- [16] Hernani, Ma. Rosita Ampoyas & Maria Nancy Quinco Cadosales (2022). Emerging Opportunities in the Philippine HEIs During COVID-19 Pandemic. *International Journal of Progressive Sciences and Technologies (IJPSAT)*. Vol. 31 No. 1 February 2022, pp. 99-109. https://www.researchgate.net/publication/359200046_Emerging_Opportunities_in_the_Philippine_Higher_Education_Institutions_during_the_COVID-19_Pandemic
- [17] Janmaimool, P. Nunsunanon, S. 2021. Online vs. Face-to-Face Lecture Courses: Factors Impacting the Effectiveness of Online Learning. Preprints, 2021070306 (doi: 10.20944/preprints202107.0306.v1).
- [18] Kulal, A., and Nayak, A. (2020). A study on perception of teachers and students toward online classes in Dakshina Kannada and Udupi District. *Asian Assoc. Open Univ. J.* 15, 285–296. doi: 10.1108/aaouj-07-2020-0047.

- [19] Mali, Dafydd & Lim, Hyoungjoo. 2021. How do students perceive face-to-face/blended learning as a result of the Covid-19 pandemic? <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8417584/>. Accessed 1 Oct. 2022.
- [20] Malipot, Merlina H. (2021). Flexible Learning is the Future of PH higher education. <https://mb.com.ph/2021/08/14/flexible-learning-is-the-future-of-ph-higher-education-ched-says/>.
- [21] Öztürk B, Akarsu R, Kayıhan H, Çelik Y, Kayhan SE. 2022. Investigation of the factors affecting the e-learning process in occupational therapy education during the pandemic with principal component analysis. *British Journal of Occupational Therapy*. ;85(9):694-703. doi:10.1177/03080226211070472
- [22] Parrocha, A. (2020). HEIs May Hold Limited Face-to-face Classes in MGCQ Areas. Quezon City, PH: Philippine News Agency.
- [23] Pema Wangdi (2024). Challenges faced by the primary science teacher while teaching elements and their symbols in two schools under Monger Dzongkhag. *Dinkum Journal of Social Innovations*, 3(06):340-348.
- [24] Salloum, S.A., M. Al-Emran, M. Habes, M. Alghizzawi, M. A. Ghani, and K. Shaalan. 2020. "Understanding the impact of social media practices on E-learning systems acceptance," in *Proceedings of the International Conference on Advanced Intelligent Systems and Informatics 2019* A. E. Hassanien, K. Shaalan, and M. F. Tolba, Eds., Springer International Publishing, NY, USA, pp. 360–369.
- [25] Siripongdee, K., Pimdee, P., and Tuntiwongwanich, S. (2020). A blended learning model with IoT-based technology: Effectively used when the COVID-19 pandemic? *J. Educ. Gift. Young Sci.* 8, 905–917. doi: 10.17478/JEGYS.69 8869.