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BOOK REVIEW

Investigating the Effects of Different Distance Learning Modalities on Student Academic Performance in Technology Education Programs

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ABSTRACT
The rise of online distance learning has necessitated investigations into its effectiveness across various educational contexts. This study examines the academic performance of students enrolled in technology education programs across three distinct learning modalities: synchronous, asynchronous, and blended. The study aims to determine if significant differences in academic performance exist among these modalities and how they vary across different assessment types (formative, performance-based, and examination). Forty-five students were equally divided into three groups, each experiencing one of the learning modalities. A non-parametric Kruskal-Wallis test was employed to analyze the academic performance data. The results indicated significant differences in student performance across the three learning modalities, particularly in formative assessments where blended learning yielded significantly higher scores compared to synchronous and asynchronous modalities. The superior performance in the blended learning modality was consistent across performance-based tests and examinations. Notably, the highest academic performance was observed in the students who engaged in blended learning and were assessed through performance-based tests. Asynchronous learning consistently resulted in lower performance across all assessment types. These findings suggest that blended learning may be a more effective pedagogical approach in technology education, facilitating enhanced academic performance compared to purely synchronous or asynchronous online learning environments.

1. INTRODUCTION

1.1. Overview

Distance learning (DL) is a type of education that enables students to study from the comfort of their own homes or any location in the world. Students can choose between synchronous and asynchronous learning modalities. Nowadays students choose online classes not because they will learn much from them but for convenience which can fit into their hectic schedules.

Among the known learning modalities, the synchronous learning modality is popular among the young ones since feedback is given immediately; however, it also has its drawback, especially potential unstable internet connectivity. Synchronous learning offers real-time feedback and interaction, which enhances student engagement (Lim, 2017; Watts, 2016). Students in synchronous online classes can communicate instantly, reducing the perceived distance

between them, their peers and the lecturer (Francescucci & Rohani, 2019). Nonetheless, synchronous distance learning requires adequate internet bandwidth. When internet connections are unstable or down, learners may lose out on critical information, unless there is an alternative way such as a backup connection. Students may become frustrated with scheduling if they are required to be online at a specific hour (Falloon, 2011), just like what other higher educational institutions are doing.

Another learning modality is the asynchronous online modality. Brierton et al. (2016) mention that with asynchronous online discussion boards, students feel more at ease and have greater freedom to express themselves. They are not under any obligation to answer immediately to queries or comments, and they have more time to consider how they would respond. Asynchronous distant learning classes can open new avenues for class development and delivery. New responsibilities for developing and delivering asynchronous distance learning courses can be identified because students and teachers can be separated in both time and space. Physical links are not needed, just a computer and the internet (Martin & Parker, 2014). Some advantages can be offered by this learning modality, but it could be difficult for learners who lack self-motivation. Students must be self-disciplined and must do what is asked of them however they can in their own learning style. Because social connections with instructors and peers are limited, learners may feel separated from the learning environment (Hrastinski, 2008).

Additional advantages of these distance learning modalities can be observed in the fact that learners' active participation can be promoted in the synchronous learning modality whereas the asynchronous online learning environments allow students to learn at their leisure (Lin & Gao, 2020). In comparison, Motteram (2011) claimed that synchronous tools are better for dealing with the social components of education while asynchronous tools are better for dealing with the academic parts. As we mentioned earlier, synchronous online learning allows students to communicate with their peers and instructors in real-time. The advantages of both online synchronous and asynchronous classes may be combined in a blended learning environment. This blended learning modality uses an application or a learning management system (LMS) platform that teaches students how to use their cellphones more intelligently. Hrastinski (2019) states that blended learning is used to describe other blends, such as integrating diverse instructional methods, pedagogical approaches, or technologies.

Based on the gathered literature, blended learning benefits both students and teachers since it enables them to be more versatile in their knowledge. This concept of blended learning is timely because there is a tremendous push in education today to have students exhibit their work online (Moore & Kearsley, 2011), ensuring that online learning will be just as effective as conventional learning in educating students.

The current study investigates synchronous, asynchronous, and blended learning modalities focusing on their effects on students' academic performance in a technology education program and also determines which modality yields better performance.

1.2. Objective and significance of the study

This research study focuses on the effect of three learning forms on students' academic performance within technology education. The study intends to explore students' performance within three assessment types: formative assessment, performance tasks, and examinations. By comparing student performance across various activities, the research focuses on identifying the learning modality where the students demonstrated better performance in technology education, thereby deepening existing understanding of effective teaching methods and learning outcomes as well as related theory.

This study is significant given its contribution to informed decision-making in education, particularly in the formulation of educational policies and intervention programs aimed at ensuring that students can receive effective technology education no matter what learning modality is used. It is of utmost importance in modern-day educational settings where various learning modalities are adopted to ensure that the learning process is maintained during unavoidable disruptions such as natural calamities or disease outbreaks. The researchers also aim to improve the capacity of technology education programs to withstand the challenges of varying learning modalities while achieving equality in learning opportunities for all students.

1.3. Limitation of the study

This study only examined the performance of 45 randomly selected technology education students comprising 1st year, 2nd year, and 3rd year students at a selected state university in Davao Region, Philippines, for the academic year 2021-2022. The respondent's performance was evaluated based on the formative assessment, performance task,

and examination results during the 1st semester and 2nd semester with synchronous, asynchronous, and blended learning modalities.

2. LITERATURE REVIEW

Distance education, as Moore (1993) noted, can be described as any situation of learning where teachers and learners are not in the same place and there is a technology that facilitates teaching. Because of this distance, there is a need to employ a number of technological devices in order to communicate as well as disseminate learning content. There are several ways in which distance learning can be put across, each of which has their own distinct features as well as pedagogical implications. Subsequently, the rapid evolution of online distance education has led to growing interest in its effectiveness across a variety of educational contexts (Allen & Seaman, 2014). Much research work has been conducted to examine the effect of learning modalities like synchronously, asynchronously and blended on academic performance (Bernard et al., 2014). On the other hand, literature exploring how effectively these modalities work in the context of technology education programs is still scarce. Consequently, this study fills in the existing void by comparing how various forms of modalities influence academic performance among students pursuing a technology education with assessment types as a source of variability.

As defined by Hrastinski (2008), asynchronous learning is a user-friendly mode of study in the sense that coursework and other course-related activities are available to students at their preferred time and speed. This mode of study is frequently characterized by advanced learning aids such as recorded lectures, web-based classrooms, and even emails without requiring the students' or teachers' physical or temporal presence (Anderson, 2008). Despite being flexible in approach, asynchronous learning may also mean that higher levels of self-control and management of time would be required from the students enrolled (Bernard et al., 2014). In contrast, learning in real-time also known as synchronous learning means the learning takes place in a classroom setting as in normal schooling (Hrastinski, 2008). Synchronous methods of instruction employ tools such as video connectivity, telephone chat, and online classrooms thus allowing participants to share ideas and carry out tasks at the same time (Simonson et al., 2006). Synchronous learning can help build a community of learners and allows immediate questions and discussions, however, it is usually structured such that everyone is called to be present at the same time which may reduce flexibility (Bernard et al., 2014).

Blended learning as Garrison and Vaughan (2008) contend encompasses some attributes of both synchronous and asynchronous modes of learning. This type of learning model is intended to use the benefits of both methods by incorporating traditional learning and conducting classes over the internet (Graham, 2006). Blended learning can allow for customization and flexibility but at the same time making it possible for interaction and sharing of thoughts at some points. Planning and integration of courses and other activities, which may involve mixed learning environments, must be done to facilitate the smooth functioning of blended learning (Osguthorpe & Graham, 2003).

Student academic performance is one of the important educational outcomes; it is often quantified by means of tasks that assess knowledge, skills, and understanding (Allen & Seaman, 2014). The level of academic achievements is affected by student engagement, motivation and learning strategies, instructional design (Means et al., 2010). Assessment of student academic outcomes achieved by various learning techniques is important in evaluating the usefulness of the techniques and technologies used in the process of learning (Bernard et al., 2014).

Technology education refers to the understanding of technological tools and processes including their relevance in the society of the learner (International Technology Education Association, 2000). It includes a focus on basic skills of problem-solving, critical thinking, and design, but in relation to technology (Sanders, 2009). Considering the rapid adoption of technology in all fields, technology education is an important aspect in ensuring a student is ready for the job market of the 21st century (National Research Council, 2012).

3. MATERIALS AND METHODS

The study employs a quasi-experimental design using pre-assigned groupings to establish a cause-and-effect between independent (modalities) and dependent (score) variables. The study investigates and compares the students' performances across the three learning modalities. The respondents of the study were students enrolled in technology education programs at a selected state university in Davao Region, the Philippines in the 1st and 2nd semester of the 2021-2022 academic year. The study consists of a sample of 45 students selected randomly from the said target

population; 15 student respondents were selected from synchronous modality, 15 student respondents from asynchronous modality, and 15 student respondents from blended learning modality (please see Appendix 1, Appendix 2 and Appendix 3 for the data score for each modality).

The learning platform used for the synchronous learning modality was Google Meet while the asynchronous learning modality made use of the University Virtual Environment (UVE) and Messenger. The Blended learning modality involved Google Meet, University Virtual Environment (UVE), Messenger, and Google Forms.

Moreover, the study used stratified random sampling with an equal allocation among year levels. After stratifying the target population, the researchers randomly selected a sample of 15 from each learning modality. The goal of stratified random sampling is to eliminate the possibility of human bias in selecting cases for inclusion in the study.

Furthermore, to establish the differences in academic performance among the three learning modalities, data were subjected to a normality test using first, an exploratory analysis with stem and leaf plot for the visual investigation of the distribution of the data and then statistical method using Shapiro-Wilk test for testing the normality of the data. If data is normally distributed, a one-way analysis of variance will be carried out. Subsequently, if significance exists, all pairwise comparisons will be tested using Tukey HSD test. On the other hand, if data is normally distributed, a nonparametric Kruskal Wallis test will be conducted; and if significance exists, all pairwise comparisons will be tested using median test. SPSS software version 23 (trial version) was used for the statistical calculations of the study.

4. RESULTS AND DISCUSSION

This study utilises the responses from a sample of forty-five (45) students recruited randomly from the three learning modalities namely synchronous, asynchronous, and blended in combination with three different forms of assessment including formative assessment, performance test, and examination results.

15 respondents were selected from the synchronous learning modality, 15 respondents from the asynchronous learning modality, and 15 respondents from the blended learning modality. Exploring the distribution of the data, the results show that formative assessment synchronous, performance blended, and examination blended were not normally distributed since their p-values are all less than 5% which means the hypothesis that they are normally distributed was rejected. Meanwhile, the remaining sub-categories were normally distributed as shown in Table 1. As for the sub-categories that were not normally distributed, a transformation was required. However, it was impossible to guarantee their normality, so rather than doing transformations, we adopted a nonparametric method which, though less efficient, does not require normality assumptions.

Table 1. Normality of the Data of each Modality (Shapiro-Wilk Test)

Type of Assessment	Modalities	Shapiro-Wilk		
		Statistic	df	p-value
Formative assessment	Synchronous	0.876	15	0.041*
	Asynchronous	0.937	15	0.347
	Blended	0.886	15	0.057
Performance test	Synchronous	0.923	15	0.214
	Asynchronous	0.904	15	0.111
	Blended	0.801	15	0.004*
Written Examination	Synchronous	0.884	15	0.054
	Asynchronous	0.939	15	0.375
	Blended	0.821	15	0.007*

**significant at 5 % level*

Using the Kruskal Wallis test, the analysis revealed that regarding formative assessment, there was a significant difference between the mean values of the respondents' scores across the three types of modalities (Chi-square=9.878, $p<0.05$). Similar results (highly significant) were also observed for the performance test (Chi-square=29.126, $p<0.01$) and the written examination (Chi-square=12.127, $p<0.01$) (Table 2).

Since all modalities observed significantly different students' performances among the three types of assessments, it can be seen in table 2 that formative assessment in the blended modality dominated in terms of their mean rank followed by the synchronous modality. Moreover, Picciano (2002) states that successful course completion, grades, and enhanced knowledge and abilities are all examples of how student performance can be defined and measured. Many researchers have analysed student performance using conventional evaluation and final course grades to dispute the efficiency of online learning (McFarland & Hamilton, 2005). This observation is also true for the performance test as well as in the examination. On the basis of performance comparing all assessment and learning modalities, we can see that the performance test in the blended learning modality demonstrated the best student performance in their technology education.

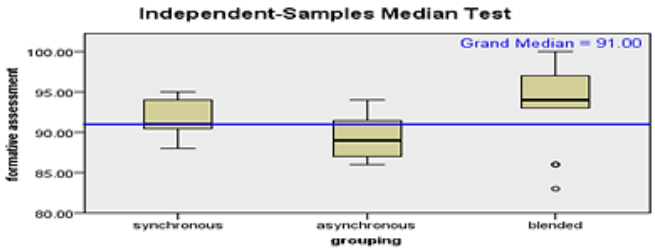
However, statistically, further investigation on which modalities have similar effects is needed using pairwise comparison median tests. Regarding the formative assessment, the results show that there was a highly significant median score among the modalities ($p<0.01$). Further analysis revealed that there were no significant differences in the medians between the synchronous and asynchronous modalities, with the median line hit both stem and leaf plots of the two modalities (see Figure 1), but both were significantly different from the blended modalities, where the median line did not hit blended modality (see Figure 1).

Table 2. Kruskal Wallis Test for the comparison of mean ranks among the three modalities

Type of Assessment	modalities	Sample size n	Mean Rank	Chi-square	df	p-value
Formative assessment	Synchronous	15	23.63	9.878	2	0.007*
	Asynchronous	15	15.20			
	Blended	15	30.17			
	Total	45				
Performance test	Synchronous	15	15.53	29.126	2	0.000*
	Asynchronous	15	15.70			
	Blended	15	37.77			
	Total	45				
Examination	Synchronous	15	21.83	12.127	2	0.002*
	Asynchronous	15	15.33			
	Blended	15	31.83			
	Total	45				

**significant at 5% level*

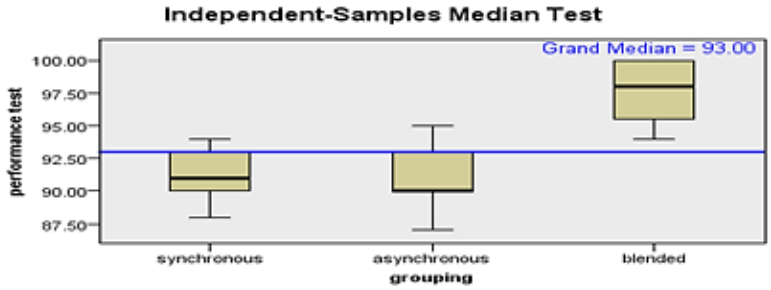
The median score in the blended modality group (94) was higher than the grand median of 91 and also both that of the synchronous (91) and asynchronous (89) modalities. The synchronous modality got the same median score as the grand median score while the asynchronous modalities the lowest median, lower than the grand median score (See Table 3 and Figure 1).



(n=45, test statistic=10.17, df=2, p<0.01)

Figure 1. Visualisation of Pairwise comparison among modalities in the formative assessment

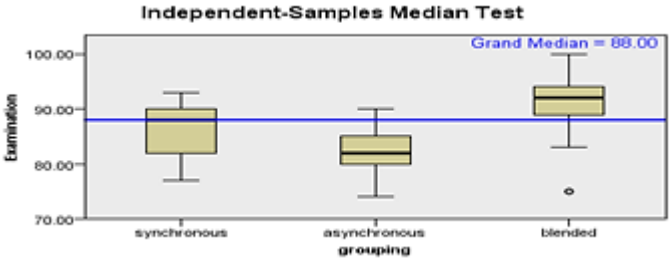
On the other hand, as for the performance test, it is shown that there was a highly significant median score across the modalities (p<0.01). However, there were no significant differences in the medians of the synchronous and asynchronous groups, both of which were significantly different from that of the blended modality (see figure 2). The median score in the blended modality group (98) was higher than those of both the synchronous (91) and asynchronous (90) modalities while the asynchronous modalities had the lowest median. The median score of the blended modality group was higher than the grand median of 93 and also those from both the synchronous and asynchronous modalities. The synchronous and asynchronous modalities had the median scores lower than the grand median score and the blended median score. The lowest median score belonged to the asynchronous modality group as seen in Table 3 and Figure 2.



(n=45, test statistic= 33.88, df=2, p<0.01)

Figure 2. Visualisation of Pairwise comparison among modalities in the performance assessment

Lastly, regarding written examination, the results showed that there were highly significant differences in the median score among the three modalities (p<0.01) as demonstrated by the median line (see Figure 3). Again, the median score of the blended modality group (92) was higher than those of both the synchronous (88) and asynchronous (82) modality groups while the asynchronous modalities had the lowest median. The median score of the blended group was higher than the grand median score of 88 and also higher for both the synchronous and asynchronous modalities. The synchronous and asynchronous modality groups had a median score lower than the grand median score and the blended median score. The lowest median score belonged to the asynchronous modality group as seen in Table 3 and Figure 3.



(n=45, test statistic=11.11, p<0.01)

Figure 3. Visualisation of pairwise comparison among modalities in the examination

Table 3. Results of Pairwise comparison among medians of the different modalities

Type of Assessment	modalities	n	Median	Median compared to grand median
Formative assessment	Synchronous	15	91	Equal
	Asynchronous	15	89	Lower
	Blended	15	94	Higher
	Grand median	45	91	

Performance test	Synchronous	15	91	Lower
	Asynchronous	15	90	Lower
	Blended	15	98	Higher
	Grand median	45	93	
Written Examination	Synchronous	15	88	Equal
	Asynchronous	15	82	Lower
	Blended	15	92	Higher
	Grand median	45	88	

As seen in Table 3, it was observed that the blended modality group got the best median scores among the respondents, followed by the synchronous modality while the asynchronous modality was the worst performing, even below the grand median score. It was further observed that the best median score among the three types of assessment was in the blended performance test. Overall, the performance test got the best results among the different modalities in terms of the median score.

On the basis of our results from this particular data set, the blended learning modality for all types of assessment resulted in a very good academic performance in the technology program. Given the recent experience with the COVID-19 pandemic where direct interactions were limited, some higher education institutions are considering the replacement of total face-to-face classroom instructions with a distance online learning environment or limited face-to-face instructions. That is where blended learning modality can place itself with instruction implemented online in synchronous or asynchronous modality in combination with a face to face learning instruction, especially on the actual laboratory classes. Blended learning transcends time, space, and culture to provide numerous new options for both students and teachers. In other words, blended learning intends to consciously and effectively merge online and conventional learning to develop a unique, innovative method with its own merits (Picciano, 2006). Moskal et al. (2013) also mentioned that blended learning, as viewed by higher education institutions, is the mixture of old and new methods, and in our present practice, a combination of online classes for theories and face-to-face classes for practice among the educational institutions in the Philippines. Furthermore, Moskal et al. (2013) further suggest that there must be a better definition of blended learning so that higher education institutions can align their goals to be successful in initiating a blended learning environment.

In this manner, blended learning has been found to enhance adaptability to individuals' learning and help organizations with productive utilization of time and workforce, which has previously been supported and mentioned by Holden and Westfall (2006).

5. CONCLUSION

In this study, it has been figured out that the blended learning modality yielded a better result in terms of the academic performance of the students in their technology education programs even with the different types of assessments. The performance test in the blended learning modality group showed a desirable result in the students' academic performance in the technology education programs. This finding can be justified with the fact that technology education requires hands-on experience while theories and lectures can be delivered online through a synchronous or asynchronous, thus the actual performance can be best implemented in a full or limited face-to-face modality. Thus, the blended learning modality can gain its adequate role and place in the educational learning environment.

The researchers recommend that this research design should probably be replicated in more general education programs like in Applied and Pure Sciences, Engineering and Mathematics, and perhaps Arts and Social Sciences in a much higher sample size to confirm the results in the conclusion.

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Appendix 1. Score data on 15 students' Academic Performance on Synchronous Learning modality among three types of assessment

Student(s)	Formative Assessment	Performance Test	Exam
1	91	90	82
2	91	90	82
3	89	88	89
4	91	90	90
5	91	90	77
6	95	93	82
7	94	93	88
8	95	93	88
9	95	93	82
10	94	88	78
11	91	91	90
12	91	94	93
13	88	91	90
14	90	92	90
15	90	91	88

Appendix 2. Score data on 15 students' Academic Performance on Asynchronous Learning Modality among three types of assessment

Student(s)	Formative Assessment	Performance Test	Exam
1	92	90	82
2	91	90	79
3	86	90	74
4	87	90	84
5	92	87	80
6	89	92	85
7	87	90	90
8	90	90	82
9	89	90	80
10	90	92	84
11	93	95	90
12	87	93	80
13	89	93	80
14	94	94	85
15	87	93	85

Appendix 3. Score data on 15 students' Academic Performance on Blended Learning modality among three types of assessment

Student(s)	Formative Assessment	Performance Test	Exam
1	94	95	94
2	93	95	95
3	97	100	94
4	97	95	92
5	93	100	88
6	96	96	94
7	93	94	90
8	100	98	92
9	100	96	92
10	100	97	92
11	86	100	83
12	94	100	75
13	97	100	75
14	86	100	92
15	83	100	100