ISSN No:-2456-2165

Causal-Comparative Evaluation of Mathematical Achievement Relative to Learning Modalities Utilized in the New Normal Education

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Abstract:- The study aims to evaluate and compare the mathematical achievement of the respondents based on the two categories of learning modalities they utilized in the new normal education, those who utilized downloaded materials and at the same time attended online classes (category 1) and those who only downloaded the materials (category 2). This study utilizes quantitative causal-comparative research design. Based on the results, those who opted to utilized the category 1 has higher scores compared to category 2. Further, it is also evident with their average score for mathematical achievement which is approximately 10 points higher for those utilizing online materials and attending online classes. Hence, with sig. (2-tailed) of 0.003 less than the alpha level of 0.05, the null hypothesis was rejected. Therefore, there is a significant difference between the mathematical achievement in relation to the modalities utilized by the students.

Keywords:- *Mathematical Achievement, Learning Modalities, New Normal Education.*

I. INTRODUCTION

As evident as it could be, the COVID-19 pandemic has turned the world up to 180 degrees. Out of all the sectors that have been interrupted, the educational sector became the most affected. The government has no choice but to oblige the educational sector to live with the new normal. Educational institutions have been temporarily closed for learning activities to mitigate the situation (UNESCO, 2020). It must be noted that no one was prepared for this pandemic in terms of online learning and teaching. Many countries in the world are struggling to provide the necessary facilities needed for the implementation of the said type of learning. Not all learners have the opportunity to join virtual classes.

Today, the number of people infected is comparable to the number of students greatly affected by the temporary closure of educational institutions. According to Li & Lalani (2020), in Denmark, children aged up to 11 are able to return to their schools, however, in South Korea, both teachers and learners are utilizing virtual classes. Yet, easy as it may seem for people from other countries to adapt to the new normal, there are a lot of people at the bottom of the income bracket who struggle to live up with the new setup (WHO, 2020). According to Organization for Economic Co-operation and Development (OECD) data, only 34% in Indonesia have the means to use computers for their schoolwork compared to Switzerland, Norway, and Austria that have 95% of students who can (Li & Lalani, 2020). With that, the disruption of classes in Indonesia amplified the inequities of education across social-economic classes and regions (Lie, 2020). Li and Lalani (2020) added that in first countries like the US, there is also a significant gap between the privileged and people with disadvantaged backgrounds; while all 15-year old students have access to digital learning, nearly 25% of those from disadvantaged backgrounds did not. Further, they asserted that many countries, especially those who are struggling are concerned that this pandemic will widen the digital divide.

Angara (2020) enumerated two major concerns in the implementation of flexible learning in the Philippines. These are internet connectivity, and the issues on curriculum and educational materials. With that said, not all students have the opportunity to access the internet all the time. The implementation of flexible learning carries with it a lot of risks and challenges that both students and teachers are facing, especially in higher education institutions (HEIs) (Bao, 2020).

In Mindanao, as reported by SunStar Davao, the efficiency of its implementation was doubted as expressed by students and teachers, as they observed the unpreparedness of the country for the adaptation of the blended learning brought by the pandemic, as said by the College Editors Guild of the Philippines Mindanao President Grecian Asoy. Particularly, Alliance of Concerned teachers-Davao City (ACT-Davao City) division President Reynaldo Pardillo pointed out how the unpreparedness of the public schools in the region (sunstar.com.ph, 2020). With this said, the Compostela Valley State College (CVSC) is not exempted, given its geographical location, it also struggles in reaching out the students especially those who live in remote areas. Fortunately, with the college's stretched out initiatives, students were given sufficient assistance.

With that, how would courses like Mathematics be taught in the new normal? Mathematics, as it is known, is a subject best learned through collaborative and constructivist-based learning (DePriter, 2013). With the existing setup, a lot of concerns stem from the nature of learning Mathematics in the new normal. Mensch (2010) asserted that students learning Mathematics virtually face varied challenges such as higher attrition rates than those students taking other online courses. Further, studies showed

that student isolation and anxiety in the online classroom are potential concerns as well (Bird &Morgan, 2003; Conrad, 2002; Mayes 2011; DePriter, 2013).

Hence, this study would like to evaluate how would this new setup impacted the mathematical achievements of the students as face-to-face interaction is prohibited and choosing of modalities are in their hands. Nevertheless, this study aims to compare and evaluate the mathematical achievement of students as to their chosen learning modalities. The respondents will be divided into two, those who are utilizing modules and other instructional materials at the same time attending virtual classes and those who are only using downloaded modules and other instructional materials posted on various online platforms.

II. FRAMEWORK

This study is viewed from Charles Wedemeyer's Theory of Independent Study (1981), which is rooted in the idea of learners' freedom. Moore (2012) explained that independent study holds various forms of teaching-learning arrangements. Teachers and learners should carry out their essential tasks and responsibilities apart from one another, communicate in a variety of ways, free internal learners from inappropriate class pacing or patterns, or provide external learners the opportunity to continue learning in their environments, develop in all learners the capacity to carry on self-directed learning – the ultimate maturity required of the educated person. He added that it allows learners to enjoy a certain degree of freedom as to the self-paced learning experience. In addition, Moore (1994) emphasized from his European Theory of Independent Study that since there is a gap between teachers and students, students must accept a high degree of responsibility in their learning. Here, students have their autonomy and need little help from their teacher.

With the Equivalency Theory of Simonson (1995), he identified that learners should have learning experiences that are best suited to them under the environment that they have. In any form of learning environment, students should be provided with equal opportunity to have a quality learning experience. With this, in the 1960s, Otto Peter's (1971) theory of industrialization viewed the field of distance education as an industrialized form of teaching and learning. With the concept of industrialized, open, and unconventional learning it will change the practice of education (Keegan, 1986).

Hence, with all the means, platforms, and supplementary learning materials provided by the teachers, learning can now be accessed everywhere, not only in the traditional classroom. Learners now have the autonomy and responsibility as to their learning process. Whether which learning modalities they will utilize, the important thing is that they will strive for knowledge in order to enhance their performance with the guidance of their teacher.

III. METHODOLOGY

- *Research Design*

This quantitative study used a causal-comparative research design in which the researcher sought to identify if there is a difference in the mathematical achievement of the students in relation to the learning modalities utilized. The independent variable is defined as the varied learning modalities utilized by the respondents, namely, downloaded online materials-joining online classes and downloaded learning materials.

The dependent variable is defined as the mathematical achievement of the respondents. This design is appropriate as cited by York (2017) in his study, "Causal-comparative research is a type of non-experimental investigation in which researchers seek to identify cause and-effect relationships by forming groups of individuals in whom the independent variable is present or absent… and then determining whether the groups differ on the dependent variable" (Gall, Gall and Borg, 2007; p. 306).

- *Respondents of the Study*

This study was conducted in a class of first year students attending Compostela Valley State College – Main Campus and were enrolled in the course Mathematics in the Modern World. Specifically, the focus was on one section only. The respondents were chosen using stratified sampling. Stratified sampling involves dividing the population into subpopulation which differs in significant ways (McCombes, 2019). In this study, the researcher divided the population into two categories according to the learning modality utilized. Category 1 were those who utilized downloaded materials at the same time attended online classes and category 2 were those who only downloaded the learning materials. There is only a limitation on the number of respondents, since only one section was chosen and there were only 40 of them, only 30 students agreed to be the respondents of the study. In categorizing them based on their chosen modality, only 15 respondents were in category 1 and 15 respondents in category 2.

For the inclusion criteria of the respondents, first, they must have utilized the main two learning modalities of learning, namely, downloaded online materials-joining online classes and downloaded learning materials only. Second and lastly, they must be enrolled in Mathematics in the Modern World as this is a general education which their mathematical achievement will be measured.

For the exclusion criteria of respondents, first, they must not have enrolled in Mathematics in the Modern World previously since interaction must be with students who have not encountered the subject yet for richer information exchange. Second, students attending Compostela Valley State College Montevista, New Bataan or Maragusan Campuses or Laak Extension Class were excluded to focus on the Main Campus alone since it is the only convenient respondents for the researcher given the present situation.

➢ *Research Environment*

The locale of this study was in Compostela Valley State College – Main Campus which is located in Compostela, Davao de Oro. Due to the present situation brought by the COVID-19 pandemic, the researcher worked from home and the conduct of the study was done online. Communication between the researcher and respondents was done through various online platforms such as google forms, Facebook messenger, and email.

➢ *Research Instrument*

The key variables in this study is measured by researcher-made questionnaires. The research instrument was composed of two major parts. The first part dealt with questions on learning modalities, the data were gathered using self-assessment questionnaire while the second part dealt with the mathematical achievement of the respondents, researcher-made questionnaires were utilized.

Range	Scale	Interpretation
4.50 – 5.00	Strongly Agree	This means that the condition embodied in the item is always observed.
3.50 – 4.49	Agree	This means that the condition embodied in the item is oftentimes observed.
2.50 – 3.49	Moderately Agree	This means that the condition embodied in the item is somewhat observed.
1.50 – 2.49	Disagree	This means that the condition embodied in the item is slightly observed.
1.00 – 1.49	Strongly Disagree	This means that the condition embodied in the item is not observed.

Table 1. Scale of interpretation

➢ *Learning Modalities***.**

It refers to the modalities utilized by the respondents. It has two indicators, those who utilize downloaded online materials at the same time participating in online classes and those who only utilize downloaded online materials. Researcher-made self-assessment questionnaire was used. It utilized Likert scale measurement with one as the lowest and five as the highest. The questionnaire has two parts. Part I is for those who utilize downloaded online materials at the same time participating in online classes and the second part are those who only utilize downloaded online materials.

➢ *Mathematical Achievements.*

The respondents' mathematical achievement was assessed using a researcher-made test based on the module 3 of the course pack which is the last part of midterm. In this study, respondents answered a 20-item questionnaire.

➢ *Data Gathering Procedure*

The researcher observed the following steps in gathering the data to serve the purpose of this academic journey: the researcher had questionnaire validated by an external validator and conducted through pilot testing online. The pilot testing result was sent to the statistician who measured the questionnaire's validity and reliability.

Afterwards, a letter asking for permission to conduct the study was written to the College President, a letter asking for permission to gather data regarding the involved section undergoing the course, Mathematics in the Modern World, was written to the College Dean, and a consent form was secured from the participants.

After obtaining the necessary documents, the study was introduced to the respondents and explained the research tool and its purpose. The study was conducted for one (1) month which commenced on November 10, 2020 until December 10, 2020. For the first week, pre-assessment was conducted before the start of discussions of the module. For the rest of the weeks, classes were conducted. Afterwards, for the last week, after the last session of the module, post-assessment was done in a form of a long quiz. After, proving the reliability of the test items, summative test was done. Finally, upon retrieving the questionnaires online, the researcher downloaded all responses from the google forms and tallied their scores in a spreadsheet and submitted statistical analysis.

The results were analyzed and interpreted according to the research objectives. With the results, conclusions were drawn and recommendations were formulated based on the study's findings.

➢ *Data Analysis*

The data gathered was analyzed and interpreted using descriptive and inferential statistics. The researcher primarily employed SPSS (Statistical Package for the Social Sciences) tool for the analysis of data. Through the usage of this statistical system, different methods in analyzing data was retrieved. Particularly, in deriving the statistical data, mean and t-test was used.

According to Kim (2015), t-test is a type of statistical test that is used to compare the means of two groups. It tells you how significant the differences between groups are. In other words, it lets you know if those differences (measured in means) could have happened by chance (statisticshowto.com, 2020). The researcher utilized this type of statistical treatment in order to identify the difference between the mathematical achievement of students as to the modalities they utilized. Further, the mean was used to evaluate the level of perception of the respondents with regards to the learning modalities they utilized.

IV. RESULTS AND DISCUSSION

Below shows the table on the level of perception of the respondents utilizing the first category which is the utilization of online materials and attendance to online classes. From the table below, questions 1-6 has the mean ranging from 3.50-4.49 in which based from the scale of

interpretation in table 1 shows that the condition embodied in the items are oftentimes observed (agree). For question 7, it falls in the interval 2.503.49 in which it means that the condition embodied in the item is somewhat observed (moderately agree). The overall mean of 3.790 means that the conditions embodied in the items are oftentimes observed.

DOWNLOADED ONLINE MATERIALS AND ATTENDED ONLINE CLASSES (Category 1)	**Mean**	**Std. Deviation**	**Description**
1. I found the materials useful and free from errors.	3.733	0.573	Agree
2. Both the materials and my attendance in the online classes improved my performance in the course.	3.867	0.718	Agree
3. The combination of both modalities improved my acquisition of mathematical skills.	3.733	0.680	Agree
4. The combination of both modalities enhanced my effectiveness in solving problems.	3.933	0.680	Agree
5. The presentations of my instructor were clear and sequential.	4.333	0.471	Agree
6. The flow of the discussions was smooth because there were no class interruptions directly related to unstable internet connection.	3.600	0.800	Agree
7. The discussions were interactive and comparable to that of a face-to-face set-up.	3.333	0.699	Moderately Agree
	3.790		Agree

Table 2. Level of perception of students utilizing both online materials and online classes

On the other hand, the table below shows the level of perception of the respondents utilizing the second category which is the utilization of downloaded materials only. From the table below, question 1 has a mean belonging to the interval of 3.50-4.49 in which from the scale of interpretations means that the condition embodied in the item is oftentimes observed (agree). For questions 2-5, their mean belongs to the interval of 2.50-3.49 which means that the condition embodied in the item is somewhat observed (moderately agree). Judging from the overall mean of 3.307, the conditions embodied in the items are somewhat observed.

DOWNLOADED ONLINE MATERIALS ONLY (Category 2)	Mean	Std. Deviation	Description
1. I found the materials useful and free from errors.	3.600	0.800	Agree
2. The materials were sufficient and could stand alone even without the guidance of the instructor.	2.867	0.884	Moderately Agree
3. The materials supported me as a selfpaced learner.	3.400	0.879	Moderately Agree
4. The materials were interactive and interesting.	3.333	0.699	Moderately Agree
5. The materials contained all the elements that I need in understanding the lessons for me to answer all the activities/exercises given.	3.333	0.869	Moderately Agree
	3.307		Moderately Agree

Table 3. Level of perception of students utilizing downloaded materials only

As to the mean of the respondents' mathematical achievement per category, the following table shows the mean of both categories in the learning modalities utilized. Category 1 is for online materials and attendance to online classes while Category 2 is for downloaded materials only. The mean for category 1 is 36.53 and for category 2 is 26.93.

		Group Statistics			
	Category	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Scores	1	15	36.5333	2.32584	.60053
	2	15	26.9333	11.18332	2.88752

Table 4. Statistics of both categories of learning modalities

As we can see above in table 4, the average score of mathematical achievement of the respondents is approximately 10 points higher for those utilizing online materials and attending online classes. Hence, those who utilized and downloaded online materials at the same time

attended online classes had higher scores than those who only downloaded the learning materials.

Now let us see if this difference is large enough to reach statistical significance. The group means are statistically significantly different because in the *"Sig.(2-tailed)"* row it has values less than the alpha level of 0.05, hence, the null hypothesis which asserts that there is no significant difference between the mathematical achievement in relation to the modalities utilized by the students is rejected. In other words, the difference between the means in the two average scores of mathematical achievements of the respondents relative to which learning modality they utilized is extreme enough that it is unlikely to have occurred merely due to chance, therefore, it is a real difference.

	Independent Samples Test									
		Levene's Test for Equality of Variances		**t-test for Equality of Means**						
									95% Confidence Interval of the Difference	
		F	**Sig.**	**t**	**Df**	**Sig. (2tailed)**	**Mean Difference**	**Std. Error Difference**	**Lower**	**Upper**
Scores	Equal variances assumed	21.452	.000	3.255	28	.003	9.60000	2.94931	3.55862	15.64138
	Equal variances not assumed			3.255	15.209	.005	9.60000	2.94931	3.32121	15.87879

Table 5. Independent Samples Test

Modular approach may help students to have ample time in answering the questions given and might give them the chance to come up with better solutions given the sufficient thinking time than on the spot participation in a classroom setting (Sadiq & Zamir, 2014). However, the findings in this study was clearly supported by the studies done in the US Department of Education which revealed that "students in online conditions performed modestly better, on average, than those learning the same material through traditional face-to-face instruction". Further, they reported that blended instruction such as the combination of online and face-to-face elements had a larger advantage than purely online or offline alone (Means, Toyama, Murphy, Bakia& Jones, 2009).

V. CONCLUSIONS

The study evaluated the mathematical achievement of the respondents and compared it to the achievements of the respondents with the respective learning modality they belong to. Categories were made comprising those who utilized online classes and downloaded materials (category 1) and those who only utilized downloaded materials (category 2) throughout the sessions in Module 3 of the course Mathematics in the Modern World. Quantitative Causal-comparison was used in this approach anchored to the theories of independent study by Wedemeyer and Moore as well as the Equivalency Theory of Simonson. The research questions of this study were aimed towards determining the significant difference in the mathematical achievement of students utilizing downloaded online materials- attendance in online classes and downloaded learning materials.

Based on the results, those who utilized downloaded materials and at the same time attended online classes, they agreed that the learning materials were useful, free from errors, improved their performance, and aided in better acquisition of learning. This was supported by Zhang (2005) as mentioned by Kemp (2020) in his study that "online learning results in greater student performance and satisfaction…". However, the respondents moderately agreed on the comparison on the level of interaction between the current and face to face setup. Kemp (2020) also presented that there is slightly higher student achievement in those who interact with face-to-face groups (Zacharis, 2010).

On the other hand, there are those who only utilized downloaded online materials since it was difficult for them to access the internet for the online classes. On how they viewed the learning materials given to them, they agreed that the learning materials were useful and free from errors. However, they only moderately agreed that the materials were sufficient to help them as a self-paced learner.

Based on the difference of the mean of the scores of the respondents, those who downloaded materials and at the same time attended online classes had higher scores compared to those who only downloaded the learning materials.

With sig. (2-tailed) of 0.003 less than the alpha level of 0.05, the null hypothesis was rejected. Therefore, there is a significant difference between the mathematical achievement in relation to the modalities utilized by the students.

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