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Massive Open Online Course in Elementary Statistics: A Tool in Empowering Data Analysis for Philippine Pre – Service Educators

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A R T I C L E I N F O

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A B S T R A C T

This study aimed to determine the effectiveness of Massive Open Online Course in Elementary Statistics (MOOC – ES) in the performance of students in Statistics under the Bachelor of Secondary Education program. Using true experimental research design, this study described the performance of two groups of students in Statistics before and after a series of instruction using pre-test and post-test design and test whether there is significant difference between the post-test scores of the two groups of subjects. This study was conducted in Nueva Ecija University of Science and Technology and selected 1st Year BSE students (50) for A.Y 2020-2021 served as subjects. The subjects were statistically divided into the controlled and experimental group based on their problem-solving skills in General Mathematics. The experimental group used the MOOC while the controlled group used a series of module. Significant differences within and between groups were analyzed using T-test for dependent and independent sample respectively. After applying these statistical treatments, the following conclusions were drawn: a) There is no significant difference in the problem-solving skills of subjects under the Controlled group in the pre – test and post-test, and b) There is a significant difference in the problem-solving skills of subjects under the Experimental group in the pre – test and post-test. Also, There is a significant difference in the problem-solving skills of the students between the two groups after instruction. Furthermore, a specific and concrete format and guidelines of MOOCs to be developed by the College was crafted.

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INTRODUCTION

According to Andreas Schleicher (2020), as universities closed their facilities and countries closed their borders in response to lockdown measures, the COVID-19 pandemic also had a significant effect on higher education. Moreover, Universities will need to rethink their learning environments to remain relevant, such that digitalization extends and complements student-teacher relationships and other relationships. To continue the delivery of quality education, numerous higher education institutions have reinvented and innovated learning modalities to cater to the problems raised by the pandemic and distance learning.

One example of learning modality under blended learning is the use of massive open online courses commonly known as MOOCs. As discussed by Mehmet Kesima and Hakan Altınpulluka (2015), in the simplest definition, MOOCs are online education platforms accessed for free by great masses. Online courses taught by elite academics at elite universities attract a lot of attention through assignments, lectures, videos and other course materials, and provide a full distance learning environment.

In Massive Open Online Courses (MOOCs), the "massive" means that this education appeals to a broad mass of individuals. The framework is built to accommodate a broad student body 's involvement. "Open" refers to the fact that anyone willing to participate is free to access these courses. "Online" means that, through multimedia resources such as videos, presentations, and audio, these courses are held online.

The Massive Online Open Courses (MOOCs) are becoming widespread as a training tool in universities (Pomerol et al., 2015) and management institutions (Porter, 2015) and also for in-service teacher training, but not so much for mathematics teacher training.

Moreover, according to Lambert (2015), the decline of student and community mathematical abilities and the abolition of university entrance mathematics standards are both parts of a 'math skills crisis' that has been on the national education agenda of various European countries for some time.

As cited by Lambert (2015), “The mathematics skills crisis is creating a vicious cycle that is slowly impacting on mathematics education. That is, fewer high school students are studying advanced or intermediate mathematics, which means fewer students are enrolling in university mathematics classes leading to a reduction in the number of mathematics teaching staff in universities and leading to lower numbers of enthusiastic, mathematics qualified teachers in schools. The cycle will ultimately result in a shortage of skilled professionals in the fields requiring tertiary mathematics education, including engineering, science, finance and the actuarial profession, all of which are areas on which our society and economy depend for continued prosperity.” (Professions Australia 2008). This crisis was deeply widened upon the arousal of the COViD 19 pandemic.

To cater this crisis, different universities across the globe have conducted studies on how massive open online courses may help in the upliftment of the students’ mathematical abilities. Indeed, by emphasizing

ICT and the use of online education as part of the compulsory teaching-learning process at tertiary level, the Government of India began to think seriously about this matter. In addition, the preparation of a draft new education policy for 2019, which at the time of this pandemic was considered a constructive and highly techno-efficient phase, is reflected. Active-Learning Study Webs for Young Aspiring Minds (SWAYAM) is a Massive Open Online Courses (MOOC) program initiated by the Government of India that focuses on key disciplines such as English, Mathematics and Science as explained in an article by Mehmet Kesima and Hakan Altınpulluka (2015).

With the latter studies, the implementation of massive open online courses to attain mathematical competencies was realized. It is eminent that MOOC is considered as a tool and platform to give instruction in Mathematics.

Also, as stipulated in the CHED Memo. No. 4 s.2020, it has become an urgent need to explore other innovative learning modalities that will facilitate migration from traditional to the implementation of flexible teaching and learning options.

About this memorandum released by the Commission on Higher Education and as shown in the table of various modalities in the implementation of flexible learning and teaching, it was clearly shown that massive open online course falls under the category of medium level technology where the combination of online and offline activities was suggested as a learning approach. This modality is aligned with the suggested modality for the students of the University based on the result of the survey conducted among them.

This claim was supported by the claim of Manalack & Yuriev (2016) which identifies MOOC as a combination of both online and modular learning which will cater to the increase in the diversity of students brought by this pandemic.

Also, in the statement released by Dr. Ronald L. Adamat, the current CHED commissioner, he encourages the use of programs and hybrid learning interventions that will be a solution to address the learner's particular needs in terms of pace, location, method, and learning products.

Furthermore, According to Manalack & Yuriev (2016), the utilization of MOOCs does not require a large amount of data or internet connectivity since some resources included in MOOCs are available for download and once downloaded, can be accessed by the participants anytime.

In this study, the researchers will investigate the use of massive open online courses in instructing Elementary Statistics. The main aim of this study is to test the effectiveness of using a developed and validated massive open online course for Elementary Statistics to be utilized by different higher education institutions and to be proposed to the CHEDRO III Open Educational Resources as reflected in CHEDRO III Memorandum No. 17 series of 2021.

LITERATURE REVIEW

Massive Open Online Courses (MOOCs) have become a significant phenomenon in modern higher education. MOOCs are online courses that can be accessed by thousands to millions of participants from around the world. This study will elucidate the importance of MOOCs in elementary statistics education as a tool to empower prospective educators in the Philippines to analyze data.

MOOCs are a form of online education that provides open access to all individuals without geographical or financial barriers. These courses typically consist of video lectures, reading materials, interactive exercises, and online discussion forums. MOOCs offer participants the opportunity to learn new skills and knowledge flexibly.

Education is the key to empowering individuals and societies. In this context, MOOCs can act as an empowerment tool by granting access to elementary statistics knowledge to prospective educators in the Philippines. The increasing statistical literacy will assist them in data analysis, making better informed decisions, and integrating statistical concepts into their teaching.

METHODOLOGY

Research Design

This study utilized a quasi-experimental research design. Experimental research describes "what will be" when certain variables are carefully controlled and manipulated. It is the only method that can truly test hypotheses concerning cause and effect relationships. (Cortez, 2015)

The researchers divided the subjects into two groups; experimental and control groups. The effect of the difference in learning modality will be exposed using the problem-solving skills of the subjects. Their problem-solving skills described by the result of the assessment tool will be determined and compared thus, the use of this method of research is the most appropriate.

Locale of the Study

This study was conducted at College of Education, Nueva Ecija University of Science and Technology, Sumacab Campus. Nueva Ecija University of Science and Technology is located at Barangay Sumacab Este, Cabanatuan City, Nueva Ecija, Philippines.

Subjects of the Study

This study was implemented to 50 1st year BSE Students from Nueva Ecija University of Science and Technology, Sumacab Campus distributed as follows: BSE English – ten, BSE Mathematics – 10, BSE Filipino – 10, BSE Social Studies – 10, and BSE Science – 10 that were statistically distributed to the experimental and controlled groups and as shown in the table below, there is no significant difference between the scores of the two groups in the Mathematical Proficiency Test in General Mathematics (MPTGM) that was administered before the experiment.

Table 1. Significant Difference between the Performance of Groups in the MPTGM

	Control	Experimental
Mean	35.44	35.20
Sd	7.7231	7.7723
Df	25	25
level of confidence	5%, two-tailed	
t-crit	1.711	
t-comp	-1.179	
Decision	Accept Ho	
Interpretation	Not Significant	

As shown in the table above, it was clearly shown that the controlled group performed better with a mean score of 35.44 compared to the experimental group with a mean score of 35.20. Moreover, the experimental group is more disperse with a standard deviation of 7.7231 compared to the controlled group with a standard deviation of 7.7723. With these given data, it can be deduced that subjects under the controlled group obtained greater scores compared to the subjects under the experimental group.

However, after applying test of difference between the performance of the two groups in the given MPTGM, it was revealed that under 5% level of significance that there is no significant difference between the two groups considering the results of their MPTGM. Hence, the two groups are comparable in terms of the performance in MPTGM.

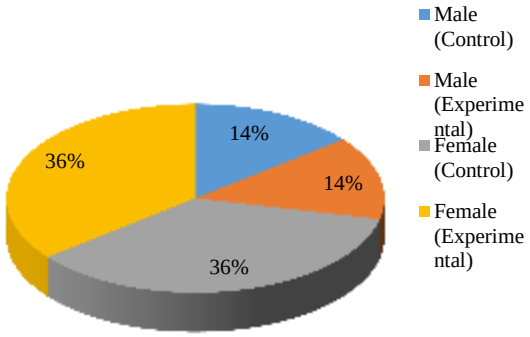

Figure 1. Distribution of Subjects According to Sex

The distribution of the subjects according to their sex is shown in the figure. The subjects were purposively selected and divided into two groups; the control group was exposed to Mathematics instruction using a Modular mode of learning while the experimental group was exposed to Mathematics instruction using the MOOC mode of learning.

Research Instruments and Validation

This study used instruments that were of great help to obtain data leading to the success of this study. This study used the following:

i.) ***Mathematical Proficiency Test in General Mathematics & Problem Solving Test in Elementary Statistics***

Description. These tests are teacher-made tests that contain items in selected topics in General Mathematics & Elementary Statistics respectively. A Table of Specification of Teacher-made Tests was prepared for this purpose. Each test composed of 50 items that underwent reliability testing.

Validation. The draft form of tests was checked by three experts in the field of Mathematics and was pilot-tested to a group of college students who have taken General Mathematics & Elementary Statistics and are not members of the sample. Pilot–testing and analysis of the internal consistency were conducted to test the reliability of the test through KR – 20 with a reliability index of 0.90 & 0.89 respectively.

ii. ***Module in Elementary Statistics***

Description. Module in Elementary Statistics is a teacher-made learning module that will serve as the guide and mode of instruction. The topics in the learning module are based on the syllabus of instruction for Elementary Statistics. Considering the process of validation of modules in the College of Education, this instrument underwent the following procedure: i) checking of grammar and technicalities of writing by an English Expert through the aid of Plagscan and Grammarly, ii) content validity by experts in the field of Mathematics, and iii) final checking by the College Dean.

iii. ***Massive Open Online Course in Elementary Statistics***

Description. Massive Open Online Course in Elementary Statistics is a teacher-made learning MOOC that served as the guide and mode of instruction. The topics in the learning MOOC are based on the syllabus of instruction for Elementary Statistics. The Massive Open Online Course in Elementary Statistics was validated by experts in the field of Mathematics and the field of MOOC Development. The development of the MOOC is another study conducted by the researchers.

Data Analysis

To describe students' performance in problem-solving skills in Elementary Statistics before and after the experiment in the two groups, scores, mean score, and standard deviation in each group were used. Also, Polya's Problem Solving Techniques was used as a basis in describing the improvement of the subjects' problem-solving skills. To further describe the scores and mean score of the subjects under each group, the interval below was used.

Interval	Verbal Interpretation
40.81 – 51.00	Excellent
30.61 – 40.80	Very satisfactory
20.41 – 30.60	Satisfactory
10.21 – 20.40	Fair
0.00 – 10.20	Needs improvement

To determine if there are significant differences between the pre-test and post-test in each group, a T-test for dependent samples was used. To determine if there is a significant difference in the problem-solving skills of the students between the two groups after the experiment, a t-test for independent samples was used.

RESULTS AND DISCUSSION

1. Problem – Solving Skills of the Subjects before the Experiment

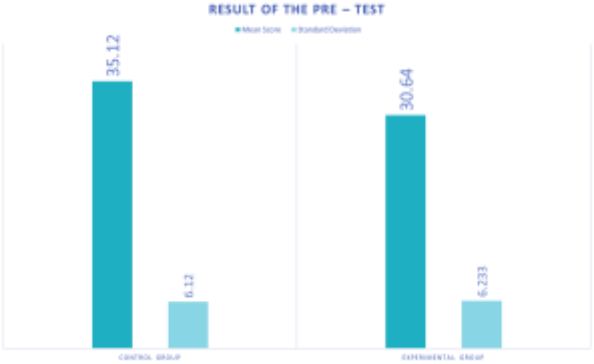

Figure 2. Mean Score and Standard Deviation of the Subjects in the Pre – Test

This figure shows the comparison between the controlled and experimental groups considering their mean score and standard deviation of the results of the pre-test. As shown in this figure, it was relevantly shown that the results of the pre-test conducted in the two groups show that subjects under the control group obtain a higher mean score of 35.12 than the subjects under the experimental group with a mean score of 30.64. However, the scores in the experimental group are much spread compared to the scores in the controlled group since the standard deviation of the control group is less than the standard deviation of the experimental group.

Table 2. Significant Difference between the Performance of Groups in the Pre - Test

	Control	Experimental
Mean	35.12	30.64
Sd	6.120	6.233
Df	25	25
level of confidence	5%, two-tailed	
t-crit	1.711	
t-comp	1.165	
Decision	Accept Ho	
Interpretation	Not Significant	

To assure that the subjects are statistically distributed, this table shows the result of the t-test applied to the scores in the pre-test in the two groups. It was evident that the two sets of scores are not significantly different from one another significant at 5% level of significance.

During the conduct of the pre-test, it was very eminent to observe that some students found it difficult to express their solutions to their answers as reflected by the way they frown during the examination period. Some were also observed to be unease while answering the same. Some even make some unnecessary movements to show discomfort.

It can be deduced from the above-mentioned results that there was room for further improvement of the students' problem-solving skills in Elementary Statistics.

2. Problem – Solving Skills of the Subjects after the Experiment

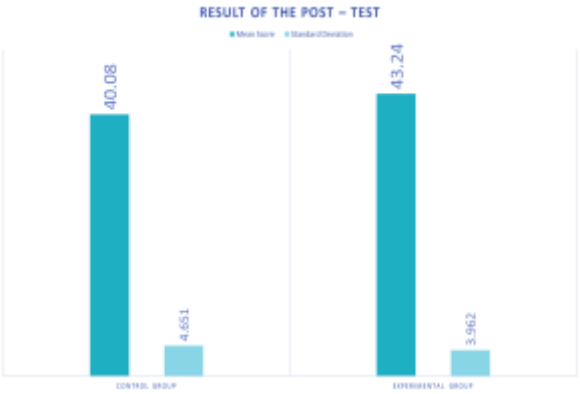

Figure 3. Mean Score and Standard Deviation of the Subjects in the Post – Test

This figure shows the comparison between the controlled and experimental groups considering their mean score and standard deviation of the results of the post-test. As shown in this figure, it was relevantly shown that the results of the post-test conducted in the two groups show that subjects under the experimental group obtain a higher mean score of 43.24 than the subjects under the controlled group with a mean score of 40.08. Moreover, the scores in the controlled group are much spread compared to the scores in the experimental group since the standard deviation of the control group is greater than the standard deviation of the experimental group.

Table 3. Comparison between Groups considering their Mean Scores

Groups	***Pre – Test***	***Post - Test***	***Difference***
Controlled	*35.12*	*40.08*	*4.96*
Experimental	*30.64*	*43.24*	*12.60*
Difference	***4.48****	***3.16****	***7.64****

** In favor to controlled group ** In favor to the experimental group*

The table above shows the comparison between the mean scores of the two groups before and after a series of instructions. With a mean score of 35.12 in the pre-test, the mean score of the controlled group increases to 40.08 making a difference of 4.96. On the other hand, the experimental group has the greater increase from a mean score of 30.64 to 43.24 making a difference of 12.60 exceeding the controlled group.

Comparing the mean scores of the two groups before the series of instructions, it was shown that the controlled group with a mean of 35.12 exceeded the mean score of the experimental group by 4.48. However, after the series of instructions, it clearly shows that the mean score of the experimental group has exceeded the mean score of the controlled group by 3.16.

Overall, the experimental group with an increase of 12.60 in the mean score exceeded the increase in the mean score of the control group by 4.96 concluding that the experimental group has performed better than the controlled group after the series of instructions.

Therefore, it can be deduced from the findings of the study that the students were able to grasp the skills necessary for them to solve the problems. Such skills can be described as critical for they knew then how to see every detail in the question and used the same in formulation their solutions and explanations.

3. Test of Difference Within Groups

3.1 Test of Difference in the Performance of Controlled Group before and after the experiment

Table 4. Test of Difference in the Pre – Test and Post – Test of the Controlled Group

	Pre - Test	Post - Test
Mean	35.12	40.08
Sd	6.120	4.651
Df	25	25
level of confidence	5%, two-tailed	
t-crit	1.711	
t-comp	-1.352	
Decision	Accept Ho	
Interpretation	Not Significant	

This table shows the t-test result of the significant difference between the scores in the pre-test and post-test of the subjects under the controlled group. The absolute value of the computed t-value of 1.352 is less than the t-critical value of 1.711. Hence, there is no enough statistical evidence to reject the null hypothesis and conclude that there is a significant difference between the test scores of the students under the controlled group in the pretest and post-test at a 5% level of significance.

3.2 Test of Difference in the Performance of Experimental Group before and after the experiment

Table 5. Test of Difference in the Pre – Test and Post – Test of the Experimental Group

	Pre - Test	Post - Test
Mean	30.64	43.24
Sd	6.233	3.962
Df	25	25
level of confidence	5%, two-tailed	
t-crit	1.711	
t-comp	2.985	
Decision	Reject Ho	
Interpretation	Significant	

Meanwhile, this table shows the t-test result of the significant difference between the scores in the pre-test and post-test of the subjects under the experimental group. The absolute value of the computed t-value of 2.985 is greater than the t-critical value of 1.711. Hence, there is enough statistical evidence to reject the null hypothesis and conclude that there is a significant difference between the test scores of the students under the experimental group in the pretest and post-test at a 5% level of significance.

4. Significant Difference in the Post – Test Results of the Two Groups

Table 6. T-Test Result and The Significant 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. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Scores	Equal variances assumed	7.557	.018	1.714	23	.676	1.28571	3.00227	-7.88483	10.45626
	Equal variances not assumed			1.714	21.496	.679	1.28571	3.00227	-8.61962	11.19105

This table shows the t-test result and the significant difference in the scores of the experimental and control group after a series of instructions. The computed sig of 0.018 is less than the sig critical value of 0.05. Hence, there is enough statistical evidence to reject the null hypothesis that *there is no significant difference between the test scores of the students under the two groups after the instruction at a 5% level of significance*. It is therefore concluded that there is a significant difference between the test scores of the students under the two groups after the instruction.

Based on the result of the t-test and significant differences, it shows that since there is a significant difference in the post-test scores of the two groups, it can be deduced based on the findings that the experimental group,

the subjects taught with MOOC as a learning modality in teaching Elementary Statistics performed better when compared to the control group. This is by the findings of Cook (2017) that students who utilize video discussions and MOOCs performed better compared to the students taught under a typical modular approach of learning modality.

5. Crafted General Guidelines and Policies on the Development of MOOC

Since the utilization of MOOC is compared to be more effective than the modular way of learning, the following policies used in crafting the MOOC – ES were suggested to the University.

1. The MOOCs that will be developed by the University in the future must be aligned with the set provisions of CHEd and most convenient platform to be used.
2. The MOOCs that will be developed must be designed to attain the objectives through the components and the compliance to the set policies and standards and as reflected in the result of a design solution.
3. The MOOCs to be developed must consider valid and evaluated content and the platform to be used will enable students to have a convenient and easier way to access the knowledge provided in the MOOC. Also, these MOOCs must comply with the set criteria for content development, and the components were aligned towards the achievement of the objectives of the course.
4. The quality and validity of MOOCs that will be developed must be established by a defined triangular assessment process by experts, teachers, and students.
5. The development and validation of instructional materials to be developed by the University like the Massive Open Online Course in Elementary Statistics is made possible using the ADDIE model.

CONCLUSION

In the light of the results, the following was concluded:

1. The students under the experimental group performed satisfactorily in solving problems in Elementary Statistics before a series of instruction using the MOOC and very satisfactorily after. On the other hand, the students under the controlled group performed very satisfactorily before and after the series of instructions with module as the mode of learning. There was an increase in the mean score of this group but very minimal compared to the experimental group.

2. There is no significant difference in the performance in solving problems in Elementary Statistics before and after a series of instructions with module as the mode of learning.
3. There is a significant difference in the performance in solving problems in Elementary Statistics before and after a series of instructions with MOOC as the mode of learning. The mean scores of the pre-test of the two groups increased after the series of instructions.
4. There is a significant difference in the problem-solving skills of the students between the two groups after instruction.
5. In this study, the use of MOOC as the mode of learning Elementary Statistics is effective.

RECOMMENDATIONS

In alignment with the results and conclusions, the following are hereby recommended:

1. Further analysis of different aspects that may contribute to the betterment of the MOOC-ES is greatly appreciated and encouraged.
2. The University may consider this study as a reference in formulating a standard format and design for the development of different Massive Open Online Courses in the University.
3. Future researchers may consider this study as a reference in developing Massive Open Online Courses considering a valid and evaluated content and procedure of development.
4. Future researchers may look over some external and internal factors that may influence the implementation of this MOOC - ES.
5. The University may consider hiring an IT expert that will create a program that will serve as the learning management system to be used in implementing this MOOC and other future MOOCs.
6. Further studies be conducted to determine the effect of using the MOOC-ES on students' achievement and affective behavior towards Mathematics.
7. The University with the aim of developing MOOCs to cater the needs of different clienteles may look on the possibility of formulating a core group for the construction, validation, and assessment of the MOOCs.
8. The University may consider this study in visualizing and planning the University's future endeavor. Also, the University may consider conducting other similar studies to come up with the idea of Open University.

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