

Mathematics Academic Performance: It's Relationship to Attitudes and Engagement in Online Learning

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Abstract

The current study examined the relationship between students' attitudes and engagement and academic performance in mathematics online learning. The study used modified survey questionnaires adopted from Langat (2015), Davis (2014), Hart et al., (2011). The respondents are the 99 randomly selected pre-service teachers who are taking their Mathematics courses online. The respondents are moderately engaged in mathematics online learning. More specifically, students always have ready assignment and are cooperative and work with other students when doing online activities. However, it is found that respondents are somewhat disengaged and lack motivation whenever facing trouble in understanding a problem. The majority of respondents have a moderately positive attitude toward mathematics online learning. Students' engagement and attitude in mathematics online learning are significantly correlated with academic performance. The significant correlation between students' academic performance and attitude and engagement in mathematics online learning suggests that teachers may provide more opportunities for students to enable and extend their engagement and attitude in the teaching and learning process. It may allow to meet the positive effect that can contribute to an improvement of academic performance of students. Teachers may need to motivate their students to participate more in understanding math problems, to give their best, and to be more focused in class discussion. Teachers need to give more support to students who are very anxious in online classes and be more considerate to students who are having a hard time on this platform. Students may maximize the use of technology that could inspire them to become more academically motivated, engaged, and show positive attitude with regards to Mathematics online learning and to come up with their own relevant approaches.

Keywords: Online Learning Attitude, Online Learning Engagement, Mathematics Academic performance

Introduction

The persistent underachievement in mathematics has necessitated further research to determine what factors have been overlooked or given insufficient attention in the ongoing reform efforts.

Math is essential in today's world. Everyone uses mathematics in their daily lives, and most of the time they are unaware of it. Our world would be missing a critical component if math did not exist. Anthony & Walshaw (2009) pointed out that Mathematics like any other compulsory and examinable subject play a key role in shaping how individuals deal with various spheres of private, social and civil life. It is a subject taught in basic and higher education. It is one of the fundamental educational components that requires students to be skilled and comprehend the various methods used to structure their lives.

Due to pandemic, the educational system was forced to shift from face to face mode of learning to online. According to Salamat et al., (2018) "Online learning can refer to the situation where the interaction between the students and the teacher is done through online system. Students are re-

ceived training and taught through online system and teacher may also in the same building with them”.

The CHED’s response to this changes is the Memorandum Order No. 4, S 2020 - Guidelines on the Implementation of Flexible Learning (CHED, 2020). Everyone is called to be part of this transition and transformation towards the new normal and students has a major part in it. Learning activities that are usually routinely carried out in schools finally take place online. Regarding learning from home, the CHED emphasizes that online learning is carried out to provide meaningful learning experiences for students, without being burdened with the demands of completing all curriculum achievements for grade promotion or graduation. Online learning is education that takes place over the Internet. Online learning is just one type of distance learning for any learning that takes place across distance and not in a traditional classroom.

Most studies consider students’ attitudes as a vital role which affects student’s performance. Student’s attitude is one of the important keys impacting his performance in mathematics (Capuno et al., 2019; Peteros et al., 2019). Attitudes though not directly observable are inferred from observable responses and behaviors which reflect a pattern of beliefs and emotions.

Student engagement has been studied in various populations and educational settings

Trowler (2010) defined student engagement as the willingness and effort of students to effectively engage in school activities that contribute to successful outcomes. Student engagement is essential in the learning process. Moreover, the academic success of an entire school depends on the level of student engagement (Rimm-Kaufman et al., 2015). Student engagement has been studied in various populations and educational settings (Bear et al., 2018). Trowler (2010) defined student engagement as the willingness and effort of students to effectively engage in school activities that contribute to successful outcomes. Engaged students exhibit active attention, participation, motivation, and interest to study, whereas their disengaged counterparts’ manifest boredom, passiveness, poor motivation, and low grades. In addition, students with high engagement levels attend school routinely and attain higher grades than their colleagues with low engagement levels (Bear et al., 2018).

Though various research studies show that academic performance in mathematics is a function of many interrelated variables, Student attitudes and engagement are regarded by many researchers as key variables to be taken into account when attempting to understand and explain the student performance in mathematics. There is a need therefore, to further investigate how factors like student’s attitudes and engagement influence their own learning and achievement in the subject. The researchers considered the country’s transition into a new mode of learning as an opportunity to conduct this study to find out if the students’ engagement and attitude are correlated to their academic performance in Mathematics Online Learning.

Literature Review

Reviewed related studies and literatures relevant to current study provided enriching and substantial ideas which are very necessary for this research.

Several research studies support the fact that students’ success in Mathematics depends upon the learners’ attitude and engagement towards the subject as this determines their ability, willingness to learn, choice of action and response to challenges.

Ahn & Edwin (2018) indicated that mathematics plays a vital role in any country's educational and developmental aspirations worldwide, and the need to teach mathematical knowledge in a viable and efficient way to encourage learner productivity and applicability is still an ongoing challenge, especially for developing countries.

According to Maddison et al., (2017), online learning refers to communication that is provided electronically via multiple digital and web platforms and applications. Other concepts such as

web-based learning, e-learning, computer-assisted teaching, and Internet-based learning are used interchangeably. With the online mode of learning being used often nowadays, different mediums have been created to make learning materials more accessible for everyone such as students, and teacher itself. Different studies about online platforms providing help to students' and teachers have been conducted and in those research students and teachers find that such platforms really help in terms of supporting students with right learning materials, channel of communication, room for collaboration of ideas and a direct way of coaching platform (Al-Said, 2015).

According to Rajkumar & Hema (2019) there are e-learning ways of making students more interested in the subject of mathematics, and that E-learning is opening doors to a world of Mathematics being fun and exciting.

Within the academic community, student engagement is most usually characterized in terms of the degree to which students interact with their studies in terms of motivation, intellectual perception depth, or simply studiousness. Students who are engaged are seen as taking responsibility for their own learning, collaborating with faculty to ensure academic achievement, and adopting the role of a willing and engaged apprentice to an academic master (Velden, 2013)

A recent study conducted about student's engagement stated that in an online learning, engagement must be focused and should have more concern as it is being categorized in the learning platform such behavior engagement, cognitive engagement, and emotional engagement (Peng, 2017).

Attitudes are psychological orientations formed as a result of one's experiences that influence a person's perception of circumstances, objects, and people, as well as how to respond to them positively or negatively, favorably or unfavorably (Mensah & Okyere, 2019).

Because students learn to correlate positive experiences or events with Mathematics, a student can acquire a positive attitude towards subject. Good reinforcement also allows for the development of a positive attitude toward.

A Study on Attitude of Students Towards E-learning by Adewole-Odeshi (2014), found that the Students in southwest Nigeria's universities have a positive attitude toward e-learning because they believe it is simple to use and beneficial, especially for their course work, and concluded that if an e-learning system is easily accessible, there would be a more favorable attitude toward its use.

Another study that suggest that the students' attitude in E-learning is positive is presented in the study of (Zabadi & Al-Alawi, 2016), where they found out that the majority of students have positive attitude in e-learning. They also suggested that Teachers must use techniques to shift students' negative attitudes about e-learning by implementing more e-learning courses in lower years of study and encouraging students to use the internet in their education and contact with their teachers and peers.

In the study of Fu et al. (2020) with the use of the Pearson correlation coefficient analysis model, he found that the online engagement and attendance of students are positively correlated with academic performance but online engagement does not mean a significant causal variable for student performance.

In learning to any educational environment, attitudes towards learning plays an important role as according to Mensah & Okyere (2019) study, the academic performance of mathematics students is tightly correlated to the attitudes of students. Bhowmik & Banerjee (2016) and other researchers also supports this argument as they conclude that there is a positive correlation between attitude and accomplishment, that is if the attitude towards mathematics is strengthened, their achievement in mathematics will certainly increase.

The related literature and studies helped the researchers in analyzing and knowing the relationship between students' engagement and attitude, and their academic performance in Mathematics Online Learning.

Research Gaps

Most research on attitudes has found that attitude plays an important role in learning mathematics and thus determines the student's success in the subject. Research also supported the fact that a positive attitude toward the subject is an important educational outcome that should be constantly nurtured regardless of the achievement level of the learners who should be guided in order to bring out their best abilities and potentials.

However, there has not been a consistent finding about the relationships between attitudes and academic performance in mathematics online learning, nor has there been a proper recommendation about how to positively change attitudes for the benefit of the learners. Literature confirms that it should start from determining the root cause of attitudes and using that information to bring out the expected change which in most cases has remained elusive or not practicable in the school contexts. Bearing in mind various variables that play a role in determining the learner's attitude, the literature stresses the need for more understanding on the effect of these variables in the learning of the subject which has always received very little attention from the stakeholders.

Previous studies on student engagement as described in the foregoing literature summary focused on general internal and external factors in the school environment that affect performance. Student engagement is a useful indicator of examining the effect of these factors on student success. However, the relationship between the academic performance in math online learning and student engagement is unclear, and has yet to be clearly identified.

Research Questions

This study determined if the students' engagement and attitude are correlated to their academic performance in mathematics online learning.

Specifically, this sought answer to the following questions:

1. What is the students' level of engagement in Mathematics Online Learning?
2. What is the students' level of attitude in Mathematics Online Learning?
3. What is the students' academic performance in Mathematics online learning?
4. Is there a significant relationship between the students' engagement and attitude and academic performance in Mathematics Online Learning?

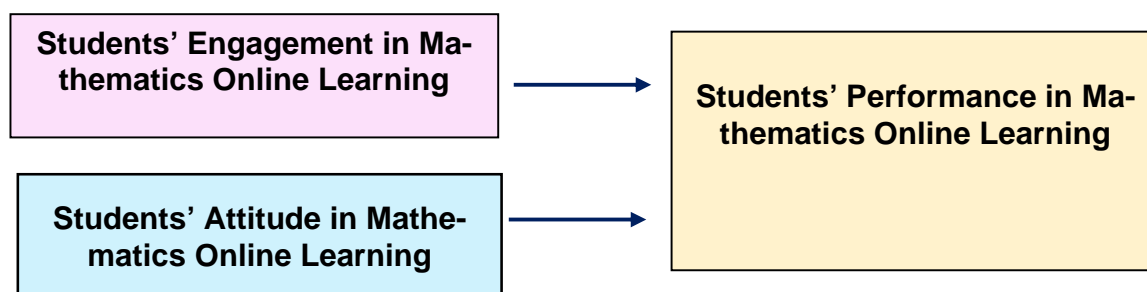
Theoretical and Conceptual Framework

The theoretical framework was primarily anchored on Student Involvement Theory of Astin (2014). Student involvement refers to the amount of physical and psychological energy that the student devotes to the academic experience. Thus, a highly involved student is one who, devotes considerable energy to studying, spends much time on campus, participates actively in student organizations, and interacts frequently with faculty members and other students. Conversely, a typical uninvolved student neglects studies, spends little time on campus, abstains from extracurricular activities, and has infrequent contact with faculty members or other students.

The involvement theory has five basic postulates: (1) Involvement refers to the investment of physical and psychological energy in various objects. The objects may be highly generalized (the student experience) or highly specific (preparing for a chemistry examination); (2) Regardless of its object, involvement occurs along a continuum; that is, different students manifest different degrees of involvement in a given object, and the same student manifests different degrees of involvement in different objects at different times; (3) Involvement has both quantitative and qualitative features. The extent of a student's involvement in academic work, for instance, can be measured quantitative-

ly (how many hours the student spends studying) and qualitatively (whether the student reviews and comprehends reading assignments or simply stares at the textbook and daydreams); (4) The amount of student learning and personal development associated with any educational program is directly proportional to the quality and quantity of student involvement in that program; and (5) The effectiveness of any educational policy or practice is directly related to the capacity of that policy or practice to increase student involvement.

This study is also anchored on The Theory of Reasoned Action (TRA) model by Fishbein and Azjen. It focuses on the construction of a system of observation of two groups of variables, which are: (1) attitudes defined as a positive or negative feeling in relation to the achievement of an objective; (2) subjective norms, which are the very representations of the individuals' perception in relation to the ability of reaching those goals with the product. The theory emphasized the importance of intention more than the reality of usage.



Based on the theories presented, the researchers conceptualized the framework shown above. Students' engagement and attitude in mathematics online learning may or may not have a significant relationship with the students' performance in math online learning. If correlation existed, as the students' engagement and attitude are high, the students' performance in math online learning will also be high.

Methodology

This study adopted a descriptive correlational design as it dealt with people's views and hence was relevant to the study area.

Descriptive method is often used to study people's feelings, thinking and attitudes about specific aspects hence was relevant for this study as attitudes could not be directly measured or observed but were inferred from certain cues which depicted the implicit nature of students' characteristics. The research aimed at capturing some of the student beliefs and perceptions which signified attitudes towards mathematics. The data was obtained through the use of student questionnaires representing various attitude variables or themes. The students' response was organized and analyzed both in qualitative and quantitative approaches then summed up in a descriptive manner according to the themes.

The purpose of this research is to determine if the students' engagement and attitude has a significant effect to their academic performance in Mathematics Online Learning

The method used by the researchers in this study is the correlational-survey research method. This approach entails determining whether or not there are any relationships between variables. Data are collected, then the relationships between them are analyzed. Since the magnitude of variables must be calculated, the correlational approach is defined by quantification. Correlational approaches

strike a good balance between accuracy and relevance. Precision is compromised since data was not obtained in a regulated environment considering that knowledge can be acquired in a number of ways, including observation, interviews, online surveys, questionnaires, and evaluation (MacKenzie, 2013).

The respondents were randomly selected 99 Bachelor of Secondary Education Major in Mathematics Students who are taking their Mathematics courses online and enrolled at Polytechnic University of the Philippines Sta. Mesa, Manila during the academic year 2020-2021.

The three (3)-page questionnaire/tool developed by the researchers was the main instrument used in gathering data. The draft of the researchers' questionnaires was drawn out from the related readings and literature that the researchers found, and previous instruments used by related studies, such as Students' Attitudes and Their Effects on Learning and Achievement in Mathematics of Langat (2011), Measuring Student Satisfaction in Online Math Courses of Davis (2014), National Survey of Student Engagement (NSSE), and The Student Engagement in Schools Questionnaire (SESQ) and the Teacher Engagement Report Form-New (TERF-N): Examining the Preliminary Evidence of Hart et al. (2011). All questionnaires used were assumed to be helpful in gaining additional information on the effects of the students' engagement and attitude to the academic performance in Mathematics Online Learning.

The survey questionnaire has three (3) parts. The first part involves personal data (including mathematics grades) of the students; the second part involves the students' level of engagement in online learning; and the final part involves the students' level of attitude in online learning.

The survey questionnaire is in Likert-Scale format to determine the level of engagement and attitude of the respondent. The researchers used a 4-point Likert scale to determine the responses of the respondents.

To be able to facilitate collection of data, the researchers wrote a letter to the officials of the college asking permission to conduct the study. After securing needed permission, the questionnaires were distributed to the respondents through google form. Upon retrieval, the questionnaires were tallied and given to the statistician for the statistical application/processing to be able to check for the validity of the results of the gathered data.

The gathered data were computed, interpreted, and analyzed. The method of analysis involved quantitative methods. The data was first captured in statistical package for social sciences (SPSS) from where analysis was done. The mean was used for calculating the degree of agreement between the engagement and attitude on mathematics online learning of the respondents. Summary, conclusions and recommendations was drawn depending on the findings and the analysis done. Pearson r was used to determine if the independent variables engagement and attitude are correlated with the students' academic performance in mathematics.

Results

1. *Students' Level of Engagement in Mathematics Online Learning*

Table 1. Students' Level of Engagement in Mathematics Online learning

Statement	Mean	Interpretation
In mathematics online learning...		
1. I usually ask questions and participate in class discussion.	2.59	Moderately Engaged
2. When I run into a difficult homework problem, I continue working at it and let it be solved.	2.98	Moderately Engaged

Statement	Mean	Interpretation
3. I spend significant amount of time studying and doing academic works.	2.80	Moderately Engaged
4. I cooperate and work with other students when doing online activities.	3.04	Moderately Engaged
5. If I have trouble understanding a problem, I do not proceed to the next one until I solved the current problem.	2.44	Somewhat Disengaged
6. I work hard to meet the teacher's standards and expectations.	2.97	Moderately Engaged
7. I always have ready assignment.	3.27	Moderately Engaged
8. I always work on all the activities given to us.	2.94	Moderately Engaged
9. I am always exerting much effort.	2.48	Somewhat Disengaged
10. My mind do not wanders and I'm focused on the lesson.	2.45	Somewhat Disengaged
Overall Mean	2.80	Moderately Engaged

Table 1 presents the students' level of engagement in mathematics online learning. Overall, the respondents are moderately engaged in mathematics online learning with mean ranging from 2.44(somewhat disengaged) to 3. 27(moderate engaged). More specifically, students always have ready assignment and are cooperative and work with other students when doing online activities. However, it is found that respondents are somewhat disengaged and lack motivation whenever facing trouble in understanding a problem. Nevertheless, majority of the respondents are moderately engaged in mathematics online learning.

2. *Students' Level of Attitude in Mathematics Online Learning*

Table 2. Students' Level of Attitude in Mathematics Online Learning

Statement	Mean	Interpretation
In mathematics online learning...		
1. I find concepts in Mathematics to be connected and related to activities in my environment.	2.94	Moderately Positive
2. I believe I have ability or talent to succeed in Mathematics.	2.93	Moderately Positive
3. I considered my previous failures in exam as challenge not just to pass but to obtain higher score.	2.92	Moderately Positive
4. I don't feel like skipping the lesson if it is Math time.	3.10	Moderately Positive
5. Mathematics assignments are fun and interesting.	3.37	Moderately Positive
6. I am motivated to learn.	2.62	Moderately Positive
7. I am not anxious even though I have limited time to think and draft responses for online discussions	2.22	Somewhat Negative
8. Online dialogue with my instructor/professor help me feel less "distant" in the online environment.	2.54	Moderately Positive
9. It promotes adequate relating in my Mathematics subjects, as well as caring among students.	2.66	Moderately Positive
10. My personal needs as a student are met.	2.01	Somewhat Negative
Overall Mean	2.73	Moderately Positive

In table 2, the mean and verbal interpretation of the students' level of engagement in mathematics online learning is presented. The respondents' attitude towards mathematics online learning is moderately positive with an overall mean of 2.73. The respondents find mathematics assignments fun and interesting obtaining a mean of 3.37. Meanwhile, when it comes to meeting personal needs, respondents have a slightly negative attitude toward mathematics online learning. Nonetheless, the majority of respondents have a moderately positive attitude toward mathematics online learning.

3. *Students' Academic Performance in Mathematics Online Learning*

Table 3. Students' Academic Performance in Mathematics Online Learning

	Mean	Verbal Interpretation
Over all Mean	1.202	Excellent

Table 3 shows the academic performance in Mathematics Online Learning of the students for school year 2020-2021. Most of the students from first year to third year obtained an excellent academic performance in mathematics online learning. Overall, the students' academic performance in Mathematics Online Learning for school year 2020-2021 was excellent with a mean of 1.202.

4. *Correlations between Students' Engagement and Academic Performance*

Table 4. Correlation of Students' Engagement and Attitude in Mathematics Online Learning and Academic Performance

	Pearson r	Strength of Relationship	p-value	Decision	Remarks
Academic Performance vs.					
Students' Engagement in Mathematics Online Learning	-0.270	Low relationship	0.007	Reject Ho	Significant
Students' Attitude in Mathematics Online Learning	-.0.259	Low Relationship	0.010	Reject Ho	Significant

Table 4 displays the correlation of engagement and attitude to academic performance in mathematics online learning of respondents. Academic performance of students in online mathematics learning when correlated with students' engagement and attitude, obtained a p-value of 0.007 and 0.010 respectively which are both less than the level of significance ($\alpha = 0.05$) which rejects the null hypotheses. Thus, students' engagement and attitude in mathematics online learning are significantly correlated with academic performance. With a Pearson - r of -0.270 and -0.259 respectively, these relationships imply that the students' academic performance will be higher if they have a highly positive attitude and are actively engaged in mathematics online learning.

Discussions

The current study examined the relationship between students' attitudes and engagement and academic performance in mathematics online learning. The findings revealed that the respondents are moderately engaged in mathematics online learning. More specifically, students always have ready assignment and are cooperative and work with other students when doing online activities. However, it is found that respondents are somewhat disengaged and lack motivation whenever fac-

ing trouble in understanding a problem. Nevertheless, majority of the respondents are moderately engaged in mathematics online learning. This result is supported by the study of Petty & Farinde (2013) where they found a higher percentage in the areas of engagement in asynchronous and synchronous platform of learning mathematics. Similar result were found by Fabian et al. (2018) where the response and experience of students using technology such as mobile devices have been positive and engagement has been developed.

Students find mathematics assignments fun and interesting. Meanwhile, when it comes to meeting personal needs, respondents have a slightly negative attitude toward mathematics online learning. Nonetheless, the majority of respondents have a moderately positive attitude toward mathematics online learning. This is supported by the study of Adewole-Odeshi (2014) on Attitude of Students Towards E-learning, which discovered that students in southwest Nigeria's universities have a positive attitude toward e-learning because they believe it is simple to use and beneficial, especially for their course work, and concluded that if an e-learning system is easily accessible, there would be a more favorable attitude toward its use.

The students' academic performance in Mathematics Online was excellent. The result is supported by the study of Cavanaugh & Jacquemin (2015) where students in online classes had higher academic GPAs, implying that they will do even better in online programs. Meanwhile it contradicts the findings of Xu & Jaggars (2013) and Bettinger et al. (2017), who found that taking an online course rather than an in-person course affects student success and advancement in college by lowering students General Performance Average (GPA).

Students' engagement and attitude in mathematics online learning are significantly correlated with academic performance. This implies that the students' academic performance will be higher if they have a highly positive attitude and are actively engaged in mathematics online learning.

This result of this study on correlation between students' engagement in mathematics online learning and academic performance is similar to the results of the study of Ran et al. (2021) where they found that a higher access of engagement to online learning can contribute to a higher improvement on students' academic achievement in mathematics. However, the findings of this study is in contradiction to the study of Fu et. al (2020) where they found that online engagement has a minimal effect on students' academic performance.

The significant relationship between students' attitude and academic performance in mathematics online learning found in this study is similar to the study of Okyere (2013), where he found that the academic performance of mathematics students is correlated to the attitudes of students. This is also further supported by the claim of Bhowmik & Banerjee (2016) as they conclude that there is a positive correlation between attitude and accomplishment, that is, if the attitude towards mathematics is strengthened, their achievement in mathematics will certainly increase.

Conclusions

This study determined the relationship between students' attitude and engagement and academic performance in online learning. Overall findings revealed that students are favorable to learning Mathematics in Online Learning platform as they are highly engaged in doing online activities, online quizzes, assignments, and doing online collaboration. Students also had an optimistic view or showing a positive attitude towards Mathematics Online Learning as they had a bright outlook in understanding and succeeding in a particular situation, such as online discussion, activities, assignments, and online collaboration. Students excellent academic performance in Mathematics Online learning, were also evident since they were highly engaged and shown a positive attitude towards

Mathematics Online Learning. The significant correlation between students' academic performance and attitude and engagement in mathematics online learning suggests that teachers may provide more opportunities for students to enable and extend their engagement and attitude in the teaching and learning process. It may allow to meet the positive effect that can contribute to an improvement of academic performance of students. Also, based on the researcher's findings in students' engagement, teachers may need to motivate their students to participate more in understanding math problems, to give their best, and to be more focused in class discussion. While in students' attitude, teachers need to give more support to students who are very anxious in online classes and be more considerate to students who are having a hard time on this platform. The researchers also recommend that students may maximize the use of technology that could inspire them to become more academically motivated, engaged, and show positive attitude with regards to Mathematics online learning and to come up with their own relevant approaches.

Limitations and Recommendations

The limitations of this study must be recognized and addressed in future research.

First, sample size of this study involved an intact group and is limited only to a specific program. To be able to come up with a more generalizable results, future studies may consider respondents from other education related programs. Second, future researchers may consider more specifications in variables such as affective, behavioral, and cognitive factors which affect one's attitude, and behavioral, cognitive, and emotional factors which affect one's engagement and its relation to academic performance be considered. Lastly, future studies may attempt to specify the engagement variable as to behavioral, cognitive, and emotional engagement to be able to come up with a more specific result and correlate each engagement classification to academic performance

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