

Predictors of Students' Mathematics Performance in Online Distance Learning

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Abstract: Students' academic performance in online learning can be affected by several factors. This study investigated the predictors of students' mathematics performance in online distance learning in terms of student engagement, instructional quality, online learning environment effectiveness, and parental involvement. The descriptive-correlational design was used in this study. A total of 223 Grade 11 Senior High School Students in the Basic Education Department of Misamis University served as respondents who were selected through stratified random sampling. Survey questionnaires were used in gathering the data from the respondents. Mean, Standard Deviation, Pearson Product – Moment Correlation Coefficient, and Stepwise Multiple Regression were used to analyze the study's data. Findings revealed that students were highly engaged and demonstrated outstanding performance in their mathematics subject. Students perceived a satisfactory level of teachers' instructional quality and effective use of MS teams as a learning platform. Parents were found to be highly involved in their children's education in dealing with online learning. Moreover, students' behavioral engagement, teachers' professional knowledge, and classroom management in online distance learning significantly correlated to students' mathematics performance. Multiple regression showed that students' behavioral engagement and teachers' professional knowledge significantly predicted the students' mathematics performance. This suggests that teachers' mastery of the course and students' direct participation affects students' mathematics performance in online distance learning. This study recommends investigating other significant predictors of students' mathematics performance in online distance learning.

Keywords:- behavioral engagement, instructional quality, mathematics performance, professional knowledge

I. INTRODUCTION

Education systems have faced a huge challenge over COVID – 19 pandemic. It has forced many educational institutions worldwide to shift from traditional face-to-face learning to distance learning (Reimers & Schleicher, 2020). In addition, most students transitioned to virtual or online learning as they continued their education (Chick et al., 2020). Thus, reassuring the students and parents of providing students' needs is crucial in institutional response (Daniel, 2020).

At present, most schools around the globe were shut down to contain the spread of the virus and to protect students and teachers from possible infection. As one of the most affected sectors, the education industry embraced distance learning as the modality in teaching at all levels

(Stambough et al., 2020). The Philippine Department of Education has prepared the Basic Education Learning Continuity Plan (BE LCP) for the academic year 2020-2021, which arrays several instructional delivery modalities, including distance learning, to ensure the continuity of learning with K-12 curriculum modifications (DepEd Order No.12, s2020). Distance learning is a planned teaching-learning experience that uses a wide variety of technology, offline and online, to meet distance learners and is designed to facilitate engagement and qualification of learning among learners (Schneider & Council, 2020).

Several works of literature advocated the use of online distance learning in relation to students' academic performance. A study on student success and satisfaction with online learning conducted in the United States revealed that students demonstrate flexibility and can adapt to online classes effectively. In addition, students found satisfaction with online courses (Kauffman, 2015; McDaniels, Pfund, & Barnicle, 2016). Another study in Indonesia that explored students' synchronous learning experience through the Zoom conference system resulted in overall success in student academic achievement (Rahayu, 2020). However, in a study conducted by 62 university students, the respondents agreed that conventional face-to-face modality is still superior in accessibility and convenience, especially when viewed from the low dimensions of social context (Rahmawati & Sujono, 2021).

Over the years, several researchers and educational practitioners have studied a variety of concepts pertinent to students' achievement to understand and improve learners' capabilities and unleash their potentials (Evans et al., 2020). As we further lean towards online learning, certain components need to be prioritized as it served as the fundamentals to its successful and effective implementation (Moore, 1993):

- **Learner Autonomy:** refers to a student's view of both autonomous and interdependent engagement in a course, and it is linked to their level of self-directed learning. It refers to a learner's ability to make decisions about educational objectives, instructional strategies, rate of progress, and evaluation methods.
- **Dialogue:** refers to interpersonal communication that takes place in a planned course, in which teachers and learners interact in a variety of ways to help learners create information.
- **Structure:** characterizes the rigidity and flexibility of a course organization in terms of instructional goals, teaching techniques, and evaluation system.

Nowadays, online distance learning is no longer a trend. Rather, it is mainstream (Kumar et al., 2017). As one of the pioneering private schools in Mindanao, the Basic

Education Department of Misamis University, specifically the Senior High School, has reached the mainstream of online distance learning. In this context that educators and researchers need, it is important to consider significant influences on students' academic success in this modern era of learning. This study will be beneficial to the improvement of adapting and sustaining distance education for the mathematics curriculum.

Though online distance learning has been operating in other schools abroad years before the pandemic, the implementation of such a learning modality is still premature in some countries, particularly in the Philippines. Because of this, there is a growing concern about the possible factors that contribute to students' academic performance in online learning. However, there were no existing studies that addressed student engagement, teachers' instructional quality, learning environment effectiveness, and parental involvement as predictors of students' academic performance. This has led to the development of the objective of the study, which is to explore the predictors of students' performance, particularly in mathematics, in online distance learning.

II. METHOD

The respondents of this study were 223 Grade 11 students of Misamis University, Philippines. They have experienced the online distance learning modality since SY 2020-2021. They were given a questionnaire link which determined their engagement, perceived instructional quality, Online Learning Environment effectiveness, and parental involvement. In determining, students' mathematics performance, Documentary Analysis was used in obtaining the students' final grade in General Mathematics course.

The data were collected and analyzed using descriptive and inferential statistics. Hence, this study is a descriptive-correlational study.

III. FINDINGS

A. Students' Mathematics Performance in Online Distance Learning

Table 1 revealed the students' mathematics performance in terms of their final grade in the General Mathematics course. Most of the students obtained an Outstanding performance in math, having the highest grade of 98. Only 4 percent of the respondents received a Satisfactory performance with the lowest grade of 80. This implies that most of the students perform excellently in the General Mathematics course.

Performance	Frequency	Percent	Min	Max
Outstanding	191	86.00	90	98
Very Satisfactory	23	10.00	85	89
Satisfactory	9	4.00	80	84

Table 1: Students' Mathematics Performance in Online

Note: Performance Scale: 90-100 (Outstanding); 85-89 (Very Satisfactory); 80-84 (Satisfactory); 75-79 (Fairly Satisfactory); Below 75 (Did Not Meet Expectations)

B. Student Engagement and their Mathematics Performance

Table 2 showed that there is a high (M=3.81; SD=0.69) level of engagement of students in online distance learning in the Senior High School Department of Misamis University. Among the three dimensions, behavioral engagement obtained the highest mean (M=4.00; SD=0.64),

followed by cognitive engagement (3.79; SD=0.68) and emotional engagement (M=3.65; SD=0.74). These imply that students were actively engaged in their online classes, demonstrated the willingness to learn their math lessons, and established a healthy relationship with their teachers and classmates in their online classes.

Variables	Mean	SD	Remarks
Behavioral Engagement	4.00	0.64	High
Cognitive Engagement	3.79	0.68	High
Emotional Engagement	3.65	0.74	High
<i>Overall Mean</i>	<i>3.81</i>	<i>0.69</i>	<i>High</i>

Table 2. Students' Level of Engagement in Online Distance Learning

Note. Engagement Scale: 4.20-5.00 (Very High); 3.40-4.19 (High); 2.60-3.39 (Moderately High); 1.80-2.59 (Low); 1.00-1.79 (Very Low)

The test of the relationship between student engagement and their mathematics performance showed that students' behavioral engagement was positively correlated to their performance in Mathematics (r=0.134; p=0.046). This suggests that students' extent of participation in the mathematics subject is directly associated with their Mathematics performance in online distance learning. This

finding supports the idea that when students increase their participation, particularly in synchronous sessions, they get better opportunities to improve their grades in Mathematics. This is consistent with the results from studies establishing increased engagement is likely associated with mathematics achievement (Watt, Carmichael, & Callingham, 2017; Imms & Byers, 2017).

Variables	r value	p value	Remarks
Behavioral Engagement and Mathematics Performance	0.134	*0.046	Significant
Cognitive Engagement and Mathematics Performance	0.052	0.438	Not Significant
Emotional Engagement and Mathematics Performance	0.114	0.090	Not Significant

Table 3: Test of Relationship between Student Engagement in Online Distance Learning and Students' Mathematics Performance

Note: ** $p < 0.01$ (Highly Significant); * $p < 0.05$ (Significant); $p > 0.05$ (Not significant)

C. Perceived Instructional Quality and Students' Mathematics Performance

Table 4 revealed the teachers' instructional quality in teaching General Mathematics in online distance learning. Students' perception on their teachers' professional knowledge obtained the highest mean (M=3.94; SD=0.74),

followed by classroom management (M=3.87; SD=0.85), learner assessment (M=3.82; SD=0.72), and pedagogical skills (M=3.57; SD=0.57). The students' overall perception of instructional quality got the mean of (M=3.80; SD=0.72) and interpreted as Good.

Variables	Mean	SD	Remarks
Professional Knowledge	3.94	0.74	Good
Pedagogical Skills	3.57	0.57	Good
Classroom Management	3.87	0.85	Good
Learner Assessment	3.82	0.71	Good
Overall Mean	3.80	0.72	Good

Table 4: Teachers' Instructional Quality in Online Distance Learning

Note. Instructional Quality Scale: 4.20-5.00 (Very Good); 3.40-4.19 (Good); 2.60-3.39 (Fair); 1.80-2.59 (Poor); 1.00-1.79 (Very Poor)

The data below displays the test of the relationship between the indicators of instructional quality and students' Mathematics performance. The study found out that teachers' professional knowledge and classroom management in teaching Mathematics subjects online are directly associated with their student's performance in Math ($r=0.160$; $p=0.017$). This means that teachers' wide and deep knowledge of the subject matter influences student learning.

Students learn better if they perceive their teachers as experts in their field (Caena & Redecker, 2019). A study from Germany revealed that teacher competence has a significant positive impact on student achievement (Konig et al., 2020). Thus, improving teachers' mastery on learning content will greatly affect students' higher achievement, especially in Mathematics.

Variables	r value	p value	Remarks
Professional Knowledge and Mathematics Performance	0.160	*0.017	Significant
Pedagogical Skills and Mathematics Performance	0.052	0.436	Not Significant
Classroom Management and Mathematics Performance	0.134	*0.046	Significant
Learner Assessment and Mathematics Performance	0.057	0.400	Not Significant

Table 5: Test of Relationship between Instructional Quality in Online Distance Learning and Students' Mathematics Performance

Note: ** $p < 0.01$ (Highly Significant); * $p < 0.05$ (Significant); $p > 0.05$ (Not significant)

D. Online Learning Environment Effectiveness and Students' Mathematics Performance

Table 6 presented the effectiveness of the online learning environment used by the university, which is the Microsoft Teams. Among the four constructs, communication obtained the highest mean (M=4.02; SD=0.75) followed by monitoring and evaluation (M=3.92; SD=0.68), content management (M=3.89; SD=0.73), and user management

(M=3.69; SD=0.62). Students perceive Microsoft Teams as an effective learning management system in learning General Mathematics as indicated in the overall mean (M=3.88; SD=0.70).

Variables	Mean	SD	Remarks
Content Management	3.89	0.73	Effective
User Management	3.69	0.62	Effective
Communication	4.02	0.75	Effective
Monitoring and Evaluation	3.92	0.68	Effective
Overall Mean	3.88	0.70	Effective

Table 6: Online Learning Environment Effectiveness

Note. Effectiveness Scale: 4.20-5.00 (Very Effective); 3.40-4.19 (Effective); 2.60-3.39 (Moderately Effective); 1.80-2.59 (Less Effective); 1.00-1.79 (Least Effective)

The test of the relationship between the effectiveness of the university online learning environment (MS Teams) and students' Mathematics performance revealed that all indicators have no significant correlation to students' performance in Math. This suggests that the convenience of students' experience in managing the content in MS Teams and accessibility of learning materials do not correlate with their performance in Mathematics. However, this result is

inconsistent with the study of Raza et al. (2021), who examined the efficiency of their Learning Management System (LMS) and found out that students' positive perception of their LMS is directly associated with their online class performance. In addition, the efficiency of communication with teachers and students within the online environment and presentation of assessments shows no significant relationship on students' Mathematics learning.

Variables	r value	p value	Remarks
Content Management and Mathematics Performance	0.041	0.547	Not Significant
User Management and Mathematics Performance	0.083	0.215	Not Significant
Communication and Mathematics Performance	0.022	0.743	Not Significant
Monitoring and Evaluation and Mathematics Performance	0.033	0.624	Not Significant

Table 7: Online Learning Environment Effectiveness and Students' Mathematics Performance

Note: ** $p < 0.01$ (Highly Significant); * $p < 0.05$ (Significant); $p > 0.05$ (Not significant)

E. Parental Involvement and Students' Mathematics Performance

Table 8 showed the students' level of parental involvement in their Mathematics course in online distance learning. Among the three indicators, promoting autonomy obtained the highest mean (M=3.79; SD=0.79) and was

interpreted as Highly Involved, while Learning Incentives received the lowest mean (M=3.30; SD=0.95), which is interpreted as Moderately Involved. The overall mean (M=3.57; SD=0.89) suggests that parents were highly involved in the learning process of their children, especially in Mathematics.

Variables	Mean	SD	Remarks
Promoting Autonomy	3.79	0.79	Highly Involved
Learning Control	3.61	0.93	Highly Involved
Learning Incentives	3.30	0.95	Moderately Involved
Overall Mean	3.57	0.89	Highly Involved

Table 8: Level of Parental Involvement in Online Distance Learning

Note. Involvement Scale: 4.20-5.00 (Very Highly Involved); 3.40-4.19 (Highly Involved); 2.60-3.39 (Moderately Involved); 1.80-2.59 (Less Involved); 1.00-1.79 (Least Involved)

Data in Table 9 displayed the test of the relationship between the indicators of Parental Involvement and students' Mathematics Performance. It showed that all indicators are not significantly associated with students' performance in Mathematics subject. Though parents are highly involved in the learning of their children, their involvement does not significantly influence students' performance in Math. However, several works of literature negate the result of the study. Local research on parental involvement and academic performance in Marikina reveals that parents' involvement positively influences students' academic performance

(Leander & Fabella, 2020). Further, students whose parents with higher educational attainment performed better in class. Another study at the University of Nebraska concluded that parental involvement such as volunteering, decision making, and giving incentives help improve students' achievement in Algebra (Garcia & de Guzman, 2020). This contrasting result with the relevant pieces of literature may be caused by the different groups of respondents in terms of age and grade level and the type of parental involvement being studied.

Variables	r value	p value	Remarks
Promoting Autonomy and Mathematics Performance	0.036	0.589	Not Significant
Learning Control and Mathematics Performance	0.016	0.807	Not Significant
Learning Incentives and Mathematics Performance	0.029	0.668	Not Significant

Table 9: Parental Involvement and Students' Mathematics Performance

Note: ** $p < 0.01$ (Highly Significant); * $p < 0.05$ (Significant); $p > 0.05$ (Not significant)

F. Predictors of Students' Mathematics Performance

Multiple regression analysis was used to test if professional knowledge, classroom management, and students' behavioral engagement are significant predictors of Mathematics performance. The result of the regression showed that two predictors explained 48% of the variance ($R^2=0.48$, $F=5.57$, $df=222$, $p < 0.01$) or the extent of the Mathematics performance of the students. It was revealed that teachers' professional knowledge is the highest of the

predictor variables, followed by students' behavioral engagement. The finding shows that 48 percent of the extent of Mathematics performance is explained by the two predictors, namely: professional knowledge and behavioral engagement. Moreover, it indicates that other factors outside of the predictors mentioned can further explain the students' Mathematics performance. Hence, it is one of the limitations of this study.

Stepwise Multiple Regression ($R^2=0.48$, $F=5.57$, $df=222$, $p < 0.01$)				
Predictors	β (Unstandardized)	Beta (Standardized)	t	p value
(Constant)	83.816		33.625	** < 0.01
Professional Knowledge	1.032	0.390	2.647	** < 0.01
Behavioral Engagement	1.026	0.448	2.290	*0.023

Table 10: Predictors of Students' Mathematics Performance

IV. DISCUSSIONS

Generally, the senior high students exhibited high engagement in Mathematics course as evidenced by the overall mean ($M=3.81$; $SD=0.69$) in Table 1. This indicates that students religiously attended their Mathematics class and participated in teachers' discussions by sharing their ideas and insights. Despite the challenges brought about by online distance learning, students have played their role as active learners by asking and answering questions relevant to achieving the course learning outcome. During synchronous sessions, students demonstrated active learning strategies such as note-taking. Taking notes during class lectures is a contributing factor to effective learning (Morehead et al., 2019). As a result, they were able to turn in their learning activities and assignments within the given period. Moreover, students performed admirably on a paper or assignment and applied what they have learned from their Mathematics class. They were adamant about learning and found ways to put what they had learned in class into practice. Students are more motivated to do their activities and performing tasks when they are in a group (Kohnke, 2020). In the context of online distance learning in Mathematics, online group activities allow students to work collaboratively and interdependently. This reinforces students in fostering relationships with their classmates and teachers. Further, they are more open in helping other students learn and in talking about their career plans with their teachers and advisers.

Findings revealed that students perceived good instructional quality from their teachers teaching Mathematics in online distance learning. This means that teachers showed an acceptable level of mastery in teaching General Mathematics by demonstrating sufficient knowledge of the subject matter. Mathematics teachers displayed profound understanding in explaining the concepts in Math than what is written in textbooks. Moreover, the teachers were able to answer questions with speed and accuracy, which led to students feel their 'expert power.'

In teaching Mathematics in an online context, there are several limitations on the learning activities to be given to students compared to face-to-face modality (Yang et al., 2018). In synchronous sessions, teachers usually opted to practice the lecture method as a teaching strategy, where teachers provide most of the discussions leaving students less active in the learning process. As a result, some students felt bored during the discussion as they listen to teachers' lectures on their devices.

Findings showed that students were convenient in using Microsoft Teams as their learning platform in online distance learning. They managed a variety of digital learning resources (text, links, audio, image, video, etc.) that supplement their learning experiences in the mathematics course. In addition, students found it efficient to upload and download these resource types using their smartphones and computers. Users feel safe in managing a learning platform where digital files and other resources are secured (Ouaoud

et al., 2017). In Microsoft Teams, users' files are automatically saved to the user's account in cloud storage. Thus, students can easily retrieve their schoolwork in their accounts when the Teams get fully corrupted. Moreover, learners used the Microsoft teams in the various gadget (smartphone, laptop, desktop, etc.), and they can sign in their MS Teams account simultaneously on multiple devices.

Students found MS Teams as an effective medium for interactive communication between their teachers and classmates. They were able to send messages of various types, as private messages or as a public post. Moreover, MS Teams has its own video conferencing feature where they can meet and have their classes exclusively. During synchronous sessions, students can use various icons to interact with the discussion with no time limit. In online distance learning, it is essential to have a real-time interaction between students and teachers in establishing the relationship and student engagement (Politis, 2016).

In terms of parental involvement, parents tend to help their children in their online classes by controlling distractions inside their homes and assuming household chores for students to focus on their classes. They encouraged their children to answer their learning activities and not by doing the activities for them. This parental support gives an opportunity for students to develop a sense of independence and responsibility in doing their schoolwork (Haskins & Jacobsen, 2017). A similar result from the study of Durisic and Bunijevac (2017), where they found out that effective parental involvement is an enabler of autonomy. Parents can help their children by creating conditions that make work more efficient, but it is up to the student to complete their schoolwork. Further, if the students have experienced difficulty in understanding some concepts in Mathematics, their parents allocated some time to tutor them. In this way, parents can ensure that their children will submit and turn in their activities within the given time.

V. CONCLUSION

Based on the findings of this study, it was concluded that students demonstrated appreciation in the teaching of Mathematics subject in online distance learning. Also, teachers exhibited sufficient understanding of learning content and acceptable classroom management in teaching Mathematics online. The use of LMS (Microsoft Teams) as a learning platform was effective in managing and accessing various types of digital learning materials. In terms of parental involvement, parents were serious and intentional in their involvement with their children's education in online distance learning by enabling them to be autonomous and responsible in their own learning. However, parents' direct involvement does not contribute to students' performance in Mathematics.

This study advances the idea that the higher the students' behavioral engagement in Mathematics in online distance learning, the greater their Mathematics performance is. Teachers' broad and deep understanding of the learning content enables students to perform better in Mathematics subject. The quality of instruction provided in an online learning environment is not significantly associated with students' Mathematics performance. Teachers' level of mastery on the subject matter and students' active engagement and participation in their Mathematics subject significantly predict students' Mathematics performance in online distance learning.

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