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Are Students Submitting their Mathematics Outputs on Time during the COVID-19 Pandemic?: A Statistical Modeling

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Abstract

During the pandemic, submitting students' outputs in mathematics is seldom on time because of a lack of focus on doing their activities before the deadline. In fact, several causal factors cause the students' submission process of mathematics outputs. Hence, this study focused on investigating the factors of outputs submission on time among students at Visayas State University taking a mathematics course online amid the new normal. The study involved statistical measures to summarize the variables of interest and employed binary logistic regression to model the causal factors affecting the students' submission on time. Results revealed that only 26.15% of the students are submitting their mathematics outputs on time. This means that during the pandemic, several students are having difficulty submitting their outputs on or before the given deadline. The logistic regression model showed that the significant factors that influence the students' submission on time include the availability of laptops (p-value=0.011), money spent on internet load (p-value=0.062), small household size (p-value=0.087), and internet signal strength (p-value=0.020). It is concluded that appropriate gadgets (technology) for online learning are a great help in accomplishing learning tasks on time. Additionally, less distraction at home, enough budget, and a good internet signal can progress their required mathematics activities and sustain an effective learning behavior amid the distance learning process. Hence, students must be supported by the Philippine government in terms of their need for learning tools that are suitable for online learning. Furthermore, teachers must provide attainable learning tasks given the deadline of submission and encourage their students to develop time scheduling management for their mathematics activities.

Keywords: Mathematics outputs, submission deadline, binary logit model, online learning, college students

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Introduction

Time management during the pandemic is very difficult to attain due to challenges and distractions brought on by a health crisis. Most of the students are struggling to work with their learning activities online because they lack motivation and interest due to the adverse effect of the pandemic (Bestiantono et al., 2020; Buba et al., 2020; Onyema et al., 2020). Especially in the subject of mathematics which contains complex topics, students suffered from barriers and limitations (Casinillo et al., 2022). Additionally, due to a lack of interaction with their mathematics teachers, some of them do not know how to do their learning tasks in mathematics (Wahyuningrum & Latifah, 2020; Ní Fhloinn & Fitzmaurice, 2021; Valenzona et al., 2022). Also, during the pandemic, there are obstacles and challenges that students are facing as they learn mathematics online. In that case, they cannot focus on their learning activities and most of the time they procrastinate their schedules (Tezer et al., 2020). Henceforth, most of the students cannot finish their mathematics outputs on time or before the deadline as they face the pandemic. In particular, there are a lot of problems existing in mathematics online learning that include internet problems, financial crises, mental health problems, distractions, and inappropriate use of technology, among others (Irfan et al., 2020; Cassibba et al., 2021; Casinillo et al., 2022). Thus, it is necessary to investigate the learning behavior of students amid online learning during the pandemic to acquire information on how to educate them to submit their outputs on time.

In the study of Dubey and Pandey (2020), it is found that in higher education, there are a lot of challenges in the implementation of distance learning students are experiencing. Particularly, students are having difficulty managing the use of technology which distracts their learning ability (Bestiantono et al., 2020; Dontre, 2021). On the face of it, students are having trouble managing their time and finishing the mathematics outputs on time. One of the significant reasons is that there is a lack of interaction between teachers and students in which lessons in mathematics are not comprehensively imparted to students' minds. According to Syafiq et al. (2021), less guidance from teachers will adversely affect students' learning behavior which results in procrastination, hesitation, and even class avoidance. Even on the teachers' side, they also have struggles in teaching the subject and reaching their students in an online class. Teachers are having difficulties monitoring the students' progress as the lessons go on and they have no accurate assessments of their students' learning (Cassiba et al., 2021; Francom et al., 2021). In addition to that, a low internet signal and insufficient technology for online learning can greatly affect the quality of teaching and learning mathematics (Irfan et al., 2020; Casinillo et al., 2022). In that case, most of the students cannot progress in their learning activities which results in the late submission of outputs. Moreover, a slow internet connection can cause barriers and limitations in interacting with their teachers and peers which results in low interest in learning mathematics online (Laksana et al., 2021). Hence, during the new normal setup, internet connection has a big role in students' submission process for their mathematics outputs.

Although several studies currently exist regarding mathematics online learning amid the pandemic (Balkist & Agustiani, 2020; Amelia et al., 2020; Wahyuningrum & Latifah, 2020; Ní Fhloinn & Fitzmaurice, 2021; Casinillo et al., 2022; Valenzona et al., 2022), student' mathematics output submission process has never been investigated

rigorously. Apparently, constructing a statistical model that elucidates the different factors influencing the students' submission of outputs on time is scarce in the literature. In light of the research gap, this study generally investigates the causal determinants that affect the students' submission process of their mathematics outputs amid the pandemic. The expected outcome of this study is to provide detailed information on why some students are submitting their outputs on time and others are not. This study also may fill in the gap between mathematics educators and learners to become effective in the teaching-learning process. Results may also provide a comprehensive idea of how the teacher will deal with their students to do the required mathematics class activities and assess their learning at a distance. In addition, the study may also supply a piece of the necessary information for mathematics teachers and students concerning how to cope with difficulties and challenges in online learning during the pandemic. Moreover, this study may give research ideas that might help experts in remote learning, may provide valuable knowledge to the body of literature, and serve as a benchmark for future research in mathematics education.

Objectives of the Study

The main aim of this study is to model the students' output submission on time and its determinants. In specific, it sought to answer the following research objectives:

1. to summarize the socio-demographic profile of students;
2. to estimate the proportion of students who submitted their outputs on time and beyond the deadline; and
3. to determine the significant factors affecting the students' output submission on time.

Methodology

Research Design

This study deals with a complex-correlational research design to investigate the causal factors affecting the students' mathematics outputs submission on time. In addition, the study considered a sizeable sample that focused on the survey response of students under online learning during the COVID-19 pandemic. Furthermore, the study utilized some descriptive techniques to summarize the gathered data and employed regression modeling to capture some significant factors that influence the students' outputs submission on or before the required deadline.

Respondents and Data Gathering Procedure

The study considered the students of Visayas State University (VSU), Baybay City, Leyte, who enrolled in Mathematics in the Modern World (MMW) in the second semester of the academic year (AY) 2020-2021. Secondary data were considered from

the paper of Casinillo and colleagues (2022) that deals with learning mathematics online during the pandemic. However, the study does not tackle the possible determinants of students' submission of outputs on time. In that case, this study was realized to model and capture the different factors affecting the student's ability to submit their outputs on or before the given deadlines.

After clearing (removal of outliers) of the existing data, this current study considered 130 MMW students as the subject of interest to achieve the assumption of the regression model that no strongly influential outliers exist. In addition, the following are the selected variables involved in the analysis: (1) age of students in years; (2) gender of students (dummy: 0=female, 1=male); (3) hometown (dummy: 0=Rural, 1=Urban); (4) number of family members; (5) availability of laptop (dummy: 0=No, 1=Yes); (6) hours studying mathematics lessons (per week); (7) family monthly income (in peso (PHP)); (8) learning environment at home (Scale of 1 to 10); (9) internet signal connectivity rating (Scale of 1 to 10); (10) amount spent for internet load (in peso (PHP)); (11) leisure activities (Scale of 1 to 10); (12) social relationship rating (Scale of 1 to 10); (13) health aspect rating (Scale of 1 to 10); and (14) submission of mathematics outputs (0=late submission, 1=on or before the deadline). The interval perception scores (Scale of 1 to 10) that the average (mean) might fall and its corresponding adjectival meaning are presented in Table 1.

Table 1: Average (Mean) Interval Perception Score and Adjectival Interpretation

Average (mean) perception score	Adjectival interpretation
1.00 - 2.80	Very poor
2.81 - 4.60	Poor
4.61 - 6.40	Fair
6.41 - 8.20	Satisfactory
8.21 - 10.00	Very satisfactory

Data Analysis and Empirical Model

In managing the data, descriptive techniques were used which include minimum value (min), maximum value (max), mean average (M), and standard deviation (SD) to summarize the variables and extract meaningful interpretation. A statistical model was employed in determining the significant factors that influence the students' submission process of mathematics outputs (0=late submission, 1=on or before the deadline). Since the dependent variable is binary in nature, the appropriate statistical model that is used in this study is the binary logistic regression model. So, the regression model can be written as:

$$S_i = a_0 + a_1 X_{i1} + \cdots + a_p X_{ip} + \varepsilon_i \qquad (1)$$

where S_i pertains to the student's submission of mathematics outputs (0=late submission, 1=on or before the deadline) and $i \in \{1, \ldots, n\}$, where n is the total number of students who participated in the survey, a_j ($\forall \mathrm{j} \in \{0, 1, \ldots, \mathrm{p}\}$) are the parameters to

be approximated where p is the number of predictors in the model, X_{ij} ($\forall$j $\in \{1, \ldots, \text{p}\}$) is the independent (predictor) variables, and ε_i is the remaining random error term.

It is worth noting that the logistic regression model is an inferential analysis, that is, predictive in nature. In that case, the logistic regression model is employed to depict data and to give an explanation of the association between one regressor binary variable. In particular, logistic regression is a method of modeling the likelihood (chance) of a discrete (binary) outcome. According to Stock and Watson (2007), the logistic regression model is founded on the logistic probability (likelihood) function (φ) and can be written as follows:

$$P_i = P_r\big(S_i = 1 \big| X_1, X_2, \ldots, X_p\big) = \varphi(a_0 + a_1 X_{i1} + \cdots + a_p X_{ip}) \tag{2}$$

where P_i is the probability (chance) that a student is submitting his/her mathematics outputs on or before the deadline gave the following predictors X_t ($\forall t \in \{1, 2, \ldots, p\}$). In that case, the logistic distribution function is given below:

$$P_r\big(S_i = 1 \big| X_1, X_2, \ldots, X_p\big) = \frac{1}{1 + exp\big[-(a_0 + a_1 X_{i1} + \cdots + a_p X_{ip})\big]} \tag{3}$$

where parameters a_j ($\forall j \in \{0, 1, 2, \ldots, p\}$) were approximated with the aid of the Maximum Likelihood Estimation (MLE) method (Mátyás & Sevestre, 2013). So, rewriting equation (3), the probability of a student submitting his/her mathematics outputs on or before the deadline is given by

$$P_i = \frac{exp\big[a_0 + a_1 X_{i1} + \cdots + a_p X_{ip}\big]}{1 + exp\big[a_0 + a_1 X_{i1} + \cdots + a_p X_{ip}\big]} \tag{4}$$

and the probability of a student submitting his/her mathematics outputs late is given as:

$$1 - P_i = \frac{1}{1 + exp\big[a_0 + a_1 X_{i1} + \cdots + a_p X_{ip}\big]} \ . \tag{5}$$

Taking the ratio of (4) and (5), and taking a logarithm on both sides, we obtain

$$\text{Log}\left(\frac{P_i}{1 - P_i}\right) = a_0 + a_1 X_{i1} + \cdots + a_p X_{ip} \tag{6}$$

In interpreting equation (6), the left-hand side can be represented as the log of odds that a student submitting his/her mathematics outputs on time or late. In addition, marginal effects were calculated to quantify and express how the predicted likelihood (probability) of the response variable (binary) changes given a change in a certain predictor (Norton et al., 2019). Moreover, to ensure that there is an absence of multicollinearity in the model, a variance inflation factor (VIF) was calculated and satisfies a value of lesser than 10 (Allison, 2012). All calculations were achieved using STATA version 14.0.

Results and Discussion

Profile of Students

The socio-demographic and learning profile of students is depicted in Table 2 using descriptive statistics. It is shown that the average age of these students was approximately 19.88 ($SD = 1.77$) years old with which the youngest being 18 and the oldest being 33 years old. There were 30% of these students were male and 70% were female. About 28% of them were living in urban places and 72% were living in rural areas. On average, the household size (family members) of each student was close to 6 (M=6.09, SD=2.25), having a minimum of two members (e.g., single parent) and a maximum of 12 members. During the whole semester, these students were studying their mathematics lessons for about 5.74 (SD=7.30) hours per week and spent about 190.44 PHP (SD=179.04 PHP) on internet load weekly.

Approximately, there were 58% of students possessed a laptop for their online learning and 42% of them are just using a mobile phone. On average, the family monthly income of these students was close to 19,051.00 PHP (SD=26,789.92 PHP). Students' rating for their internet signal strength was 5.08 (SD=1.70) and considered "fair" (Table 1). This suggests that these students are experiencing internet problems considering that most of them are living in rural areas (72%) where the internet signal is relatively low as opposed to urban areas. They also rated their coping with math anxiety (M=5.23, SD=1.84) as "fair" (Table 1) and suggested that sometimes they are having difficulty recovering from anxiety brought on by the crisis. In fact, the learning environment (M=4.24, SD=1.66) in their respective homes is not conducive to learning as they have rated it as "poor" (Table 1).

In view of their leisure time (M=5.82, SD=2.21), they rated it as "fair" (Table 1), meaning, they don't have the opportunity most of the time to conduct relaxing activities due to the pandemic restrictions. In addition, they rated their social relationship (M=6.68, SD=2.07) as "satisfactory" (Table 1). This suggests that they have more time for family bonding since most of the household members are just working at home during the lockdown. However, these students are experiencing mental health problems (M=5.13, SD=2.16) due to boredom and less opportunity for active learning. Furthermore, only 26% of these students are able to submit their mathematics outputs on time and 74% of them are unable to submit them on or before the deadline. This implies that students are having difficulty finishing their required tasks on time due to barriers and limitations of online learning during the COVID-19 pandemic (Lynch, 2020; Biwer et al., 2021).

Table 2: Summary of Students' Profile

Variables	M(±SD)	min	max
Age[a]	19.88(±1.77)	18	33
Male[b]	0.30(±0.46)	0	1
Urban[b]	0.28(±0.45)	0	1
Household size[c]	6.09(±2.25)	2	12
Hours studying Statistics[c,d]	5.74(±7.30)	1	60
Money spent for internet load[d,e]	190.64(±179.04)	0	1000
Availability of laptop[b]	0.58(±0.50)	0	1
Monthly family income[e]	19051.00(±26789.92)	880	200000
Internet signal[f]	5.08(±1.70)	1	10

Learning environment[f]	4.24(±1.66)	1	10
Leisure time[f]	5.82(±2.21)	1	10
Social relationship[f]	6.68(±2.07)	1	10
Health[f]	5.13(±2.16)	1	10
Mathematics outputs' are submitted on time[b]	0.26(±0.44)	0	1

Note: a - in years; b - binary variable; c - count; d - per week; e - Philippine Peso (PHP); f - Scale 1 to 10

Logistic Regression

Before drawing an inference, the model has undergone some diagnostic tests. The model is considered heteroscedastic by the Breusch-Pagan test (χ^2=10.33, p-value=0.0013), hence, it is corrected to make the model's residuals have constant variance. It is revealed by the Ramsey RESET test (F=4.90, p-value=0.0031) that the model has omitted variable bias. However, the model does not suffer from the problem of multicollinearity between pairwise independent variables since the Variance Inflation Factor (VIF) is lesser than 10 (VIF=1.56<10) (Allison, 2012).

The Shapiro-Wilk test has revealed that the residuals of the model are not normal (W=0.89, p-value<0.001), however, the graph estimate using the k-density graph has shown that these residuals are almost normal in nature (Mátyás & Sevestre, 2013). The model (χ^2=28.24, p-value=0.0084) is significant at a 1% level, hence, it contains significant regressors that influence the submission process of their mathematics outputs during the pandemic. Plus, the goodness-of-fit has shown that there is a variation that is attributed ($Pseudo\ R^2 = 1890$) to the model implying that there are factors affecting the students' mathematics outputs submission on time.

Table 6: Binary Logistic Model for Students' Mathematics Outputs Submission on Time and its Determinants

Determinants (regressors)	Binary Logistic Model			
	Coefficient	*Standard Error*	*p-value*	*Marginal effects*
Constant	-6.138[ns]	3.814	0.108	-
Age[a]	0.172[ns]	0.138	0.214	0.028
Male[b]	-0.540[ns]	0.545	0.322	-0.084
Urban[b]	-0.648[ns]	0.579	0.263	-0.098
Household size[c]	-0.213*	0.124	0.087	-0.035
Hours studying Mathematics[c,d]	-0.013[ns]	0.031	0.671	-0.002
Money spent for internet load[d,e]	-0.004*	0.002	0.062	-0.001
Availability of laptop[b]	1.554**	0.608	0.011	0.240
log (Monthly family income[e]+1)	0.252[ns]	0.596	0.672	0.042
Internet signal[f]	0.404**	0.174	0.020	0.067
Learning environment[f]	0.158[ns]	0.173	0.361	0.026
Leisure time[f]	0.168[ns]	0.160	0.294	0.028
Social relationship[f]	-0.243[ns]	0.209	0.245	-0.040
Health[f]	-0.043[ns]	0.151	0.777	-0.007
Participants		130		
χ^2***-test***		28.24		
p-value		0.0084		
Log Likelihood		-60.59		
Goodness-of-fit ($Pseudo\ R^2$)		0.1890		

Note: a - in years; b - binary variable; c - count; d - per week; e - Philippine Peso (PHP); f - Scale 1 to 10
ns- not significant.
* - significant at 10% α level. ** - significant at 5% α level.

The logistic model revealed that variables that include age (p-value=0.214), gender (p-value=0.322), hometown (p-value=0.263), hours studying mathematics lessons (p-value=0.671), family monthly income (p-value=0.672), learning environment at home (p-value=0.361), leisure activities (p-value=0.294), social relationship (p-value=0.245), health aspect (p-value=0.777) are not significant predictors of students' submission on mathematics outputs on time. However, Table 6 revealed that a higher household size (p-value=0.087) has a negative impact on the student's submission of mathematics outputs on time. For every one member increase in the family, students are more likely cannot to submit their mathematics outputs on time. Additionally, it implies that the likelihood of students with lower family members submitting their mathematics outputs on time is higher by 3.5% as opposed to higher household sizes. This implies that more family members can distract the students from doing their learning tasks at home. In the study of Biwer et al. (2021), learning at home or in a family setting, students are exposed to a lot of distracting activities in the learning environment. In that case, students cannot concentrate and learn to their full potential and even cannot finish their required learning tasks. Likewise, the findings of Barrot and colleagues (2021) stated that learning with their family members is experiencing distractions like unnecessary noise, limitations of facilities, and learning space. Hence, students are challenged in submitting their tasks on time during the pandemic.

The model has shown that lower money spent on the internet is positively influencing the students' submission of mathematics outputs on time and it is significant at a 10% level. This goes to infer that for every 1 peso decrease in money spent on the internet, it is more likely students can submit their mathematics outputs on time. It further implies that the chance of students with lower money spent on the internet submitting their mathematics outputs on time is higher by 0.1% compared to higher money spent on the internet. This means that if the students spent lower money on their internet, they have a good internet connection and don't have to spend more on other expenses. In that case, the student can attend classes and work with their learning activities. Affordable and good internet connection during the health and economic crisis is what the students are needing for their online learning to progress with their learning assessments (Agung et al., 2020; Yuzulia, 2021; Casinillo, 2022). The study by Laksana et al. (2021) found that students with minimum access to the internet are experiencing difficulties in learning especially students with parents who have a low income during the pandemic.

In addition, the model revealed that the availability of laptops (p-value=0.011) for online learning is an advantage in submitting mathematics outputs on time. This means that a student that uses a laptop is more likely can submit their mathematics outputs on or before the given deadline. In other words, the probability of students who own a laptop submitting mathematics outputs on time is higher by 24% as opposed to students who don't own one. This goes to infer that a student with a laptop can work faster concerning their mathematics tasks compared to a student who is just using a mobile phone. Several studies have shown that students who use a laptop and other advanced learning resources for online education are an advantage and more likely to perform better in class (Adnan & Anwar, 2020; Bestiantono et al., 2020; Suprianto et al., 2020). In that case, the availability of laptops for online learning can progress the students’ learning tasks and is more likely to increase students' academic achievement.

Moreover, the logistic model has shown that a good internet signal (p-value=0.020) helps accomplish the mathematics task and submit it on time. This implies that a student who has a good internet signal at home is more likely can finish and submit their learning task in mathematics on the required deadline. By marginal effects, the chance of a student who has a good internet connection to submit their outputs on or before the deadline is higher by 6.7% compared to a student with a bad internet connection. This implies good internet connection is one of the vital resources for online learning. In the study by Casinillo et al. (2022), it is stated that students with good access to the internet can attend classes regularly and dig into their lessons. In that case, students have good learning behavior and there is a big chance they can finish their required mathematics outputs on time. On the other hand, students that do not have good access to the internet are more likely cannot submit their outputs by the required deadline (Nartiningrum & Nugroho, 2020; Lemay et al., 2021).

Conclusion

The study's objective is to determine the various factors that influence the students' submission of mathematics outputs on time. The result of this study has concluded that only a few (26.15%) of the students can submit their outputs on or before the deadline during the new normal setup. The binary logistic model has revealed that the significant determinants that positively influence the students' submission on time include small household size, a small amount of money spent on internet load, availability of laptops, and good internet connection. Conclusively, education at home is negatively impacted by a large number of family members since they can be a distraction to the student's learning attitude. Likewise, if the students are spending more money on the internet, it can stress their learning behavior because they become anxious about their learning needs amid the crisis. In that case, appropriate gadgets (technology) for online learning are a great help in finishing their learning assessments on or before the required submission deadline. Additionally, a good internet connection can progress their required mathematics online tasks and continue an effective learning attitude during the new normal. Hence, it is concluded that students must be supported by the government concerning their needs in learning that help them progress in online learning.

Recommendation

It is highly recommended that mathematics teachers must provide attainable mathematics activities that suit the given deadline and must encourage their students to develop good time management in accomplishing their duty as a student in the new normal. Furthermore, to supplement the information of this current study, one may consider studying coping strategies and self-efficacy in learning mathematics amid the COVID-19 pandemic as future research.

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