Original Article

Quantile regression model on how logical and rewarding is learning mathematics in the new normal

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ABSTRACT

Learning mathematics through distance education can be challenging, with the "logical" and "rewarding" nature proving difficult to measure. This article aimed to articulate an argument explaining the "logical" and "rewarding" nature of online mathematics learning, elucidating their causal factors. Existing data from the literature that involving students at Visayas State University, Philippines, were utilized in this study. The study used statistical measures to capture descriptions from the data, and quantile regression analysis was employed to forecast the predictors of the logicality and rewarding nature of learning mathematics at a distance. Results indicate that learning mathematics in the new normal is perceived as "logical" and moderately "rewarding". The regression and correlation analyses revealed a significant positive association between the perceived "logical" nature and the rewarding experience of learning mathematics. The constructed statistical models depicted that the determinants of logicality in learning mathematics include family income, money spent on the internet, learning environment, household size, social status, and health. Moreover, causal factors such as family income, money spent on the internet, learning environment, leisure activities, social status, and health significantly determine the rewarding nature of learning mathematics online. Conclusively, institution must support college students with their online learning needs. Furthermore, mathematics instructors should create lively and exciting online discussions that boost their logical thinking. Providing problem-solving task that are intrinsically rewarding can contribute to a more fulfilling learning experience.

Keywords: college students, mathematics online, statistical model, state university

INTRODUCTION

The Coronavirus Disease 2019 (COVID-19) pandemic has adversely impacted the educational scheme, resulting to an unprecedented shift in teaching-learning methods. The abrupt transition from face-to-face learning to an online setup has posed challenges for students in comprehending their mathematics lessons (Dratva et al. 2020; El Firdoussi et al. 2020; Casinillo et al. 2022). It is worth noting that mathematics, being complex and abstract, requires excellent and clear discussions from teachers. Casinillo (2022) observed that learning mathematics during the pandemic is quite difficult because students struggle to remember lessons and comprehend mathematical facts, formulas, and concepts due to distractions from the unprecedented events. Irfan et al. (2020) and Valenzona et al. (2022) assert that students face challenges penetrating the core of mathematics lessons, resulting in low innovativeness and misuse of technologies. In that case, cognitive thinking during online classes is negatively affected (Irawan et al. 2020). Cassibba et al. (2021) and Ní Fhloinn and Fitzmaurice (2021) depicted the numerous challenges faced by teachers in imparting knowledge to students, as they struggle to interact with and monitor students effectively. This situation leads to uninteresting class discussions, proving tedious for both mathematics teachers and their students. Hence, logicality in learning mathematics does not prevail in the process, making it an unsatisfying or unrewarding experience for students.

A logical mind is imperative for mathematics problem-solving. Being a logical student involves critical thinking to analyze mathematical problems and formulate judgments (Darmayanti et al. 2022). The development of a logical mind requires formal training in the mathematics education process and continuous interaction and assessment by mathematics instructors. However, proper guidance and constant monitoring of students' academic progress become nearly impossible due to the barriers, high complexity, and uncertainty brought about by the world health crisis (Mendoza et al. 2021; Casinillo 2023). According to Kertiyani and Sarjana (2022), it is essential to maintain the critical learning process of students despite the challenges in distance learning, allowing students to develop reasoning related to the core ideas of mathematics. Progressing in the critical thinking process enables students in online learning to enhance their problem-solving skills (Braund 2021; Festiawan et al. 2021; Keener et al. 2021; Matthews et al. 2021). Once students improve and maintain their analytical and creative perspective in learning mathematics, they can find satisfaction and enjoyment in knowledge acquisition at a distance during the pandemic (Casinillo 2022). On the face of it, students with logical experience are more likely to experience a rewarding and stimulating feeling in learning mathematics online. Valenzona et al. (2022) stated that several factors are affecting the students' innovative thinking that weakens their logical and creative ideas during the pandemic. Additionally, the enjoyment and satisfaction of students are influenced by predictive determinants during this period (Casinillo 2022). Henceforth, the conceptual scheme of this article presumes that some determinants influence the “logical” and “rewarding” nature of learning mathematics in the new normal.

Although various articles in the literature explore learning experiences in online education during the pandemic, there is a relative scarcity of focus on mathematics students in higher institutions in rural areas. Additionally, the examination of the “logical” and “rewarding” experiences of students learning mathematics online remains unexplored in the literature. Moreover, employing a statistical model in determining the determinants of the “logical” and “rewarding” experiences of mathematics students has not been studied. Hence, this article aims to fill these gaps by elucidating students’ logicality and the rewarding experience of learning mathematics in the new normal. Specifically, the article seeks to achieve the following objectives: (i) present a descriptive analysis of the profiles of students and their learning experiences; and (ii) determine the statistical predictors of the “logical” and “rewarding” experiences of students using a regression model. The study aims to underscore the significance of the “logical” and “rewarding” nature of learning mathematics, which is crucial to students' cognitive behavior and well-being. Furthermore, the results may serve as benchmarks and guides for mathematics educators and students to improve their teaching and learning activities, respectively. Finally, the study’s findings may contribute to global baseline information for researchers.

METHODS

Research Design

This research article employed with a correlational design to articulate an argument that depicts the students' perception of how logical and rewarding learning mathematics online is during the pandemic. A *correlational design* is a method of research focusing on exploring association between variables (Seeram 2019). To address the study's objectives, the article used secondary data from ongoing research in the literature, specifically, a cross-sectional survey. Additionally, this study used standard statistical measures and employed quantile regression modeling as tools to extract valuable information.

Participants and Data

This study utilized secondary data from a recent research work by Casinillo et al. (2022) titled "How challenging it is to learn mathematics online.” The study focus on Mathematics in the Modern World (MMW) students at Visayas State University (VSU) during the pandemic. As VSU fully implemented online (distance) learning during this period, the survey was conducted using Google Forms, employing availability sampling. A total of 135 MMW students actively participated in the survey, with extreme (outliers) responses excluded. Additionally, only students with low to middle family income, excluding those with a family income above PHP

65,000, were considered. In that case, the study attained more or less homogeneous participants group of 129 individuals. It is worth noting that the sample sized in this article, surpassing the minimum requirement for constructing a statistically sound multiple regression model, aligns with established guidelines (Jenkins and Quintana-Ascencio 2020).

The dependent variable Casinillo (2022) study involved a challenge questionnaire featuring 3-item questions with a 1-10 scaling, addressing the logically, reward, and difficulty of learning mathematics online during the pandemic. The questionnaire underwent validation by three experts in mathematics education each holding at least a master's degree. Furthermore, a reliability test (Cronbach's alpha) yielded a coefficient of 0.91, confirming that the questionnaire is reliable to use (Cronbach 1951). This study specifically considered two dependent variables: the logical level and rewarding level. The logical level represents the students' reasoning and creative ideas in their problem-solving activities. On the other hand, the rewarding level signifies the satisfaction derived from motivation and challenge in learning mathematics. Table 1 presents the intervals for students' perception scores along with corresponding verbal descriptions of the logical and rewarding aspect of learning mathematics in the new normal.

Moreover, the independent variables considered in this current study are the following: age of MMW students (in years), sex (0 = female, 1 = male), hometown (0 = Rural, 1 = Urban), family members (count), availability of a laptop (0 = No, 1 = Yes), monthly family income (PHP), number of hours (h) spent in studying mathematics per week, and the amount of money spent on internet load (PHP per week). The study also considered questions related on a 1-10 scale that include internet signal, coping with anxieties, the conduciveness of the learning environment at home, leisure time, social relationships, and health status. These independent variables (students' demographic and learning profiles) are assumed to influence the logicality and rewarding nature of learning mathematics online during the health crisis.

Table 1. Students' perception score and its corresponding verbal description.

Students' perception score	Logical category	Rewarding category
1.00-2.80	Not logical	Not rewarding
2.81-4.60	Slightly logical	Slightly rewarding
4.61-6.40	Moderately logical	Moderately rewarding
6.41-8.20	Logical	Rewarding
8.21-10.00	Very logical	Very rewarding

Data Analysis and Statistical Model

After formatting the selected data in Microsoft Excel to fit the STATA statistical program, descriptive measures such as mean average (M), standard deviation (SD), minimum (x_{min}) value, and maximum (x_{max}) value were employed for summarization. This article also incorporated graphical representation including regression line graphs and scatter plots to enhance data interpretation. The association between the two dependent variables (logical and rewarding) was determined using Pearson correlation (r_p) and simple regression though ordinary least squares (OLS) analysis. The simple regression model is expressed as:

$$Rewarding_i = \alpha_1 + \alpha_2 Logical_i + \varepsilon_i \qquad \text{(Eq 1)}$$

Here, $Rewarding_i$ represents the level of how rewarding learning mathematics is (1 to 10 scaling), $Logical_i$ represents the level of how logical learning mathematics is (1 to 10 scaling), $i = 1, \ldots, 129$ students, α_1 and α_2 define the parameters in the model (1), and ε_i represents the random error. Quantile regression was then employed to determine causal factors affecting the logicality and rewarding nature of learning mathematics online. The quantile regression model provided vital insights into these aspects across different levels (quantiles) of distribution (Koenker and Bassett 1978). In that case, the logicality and rewarding level in learning mathematics were clustered into low, middle, and high to assess further the dynamics of student's learning experience in mathematics at a distance. Hence, the regression model is postulated in the following manner:

$$Y_i^Q = \lambda_0 + \lambda_1 P_{i1} + \lambda_2 P_{i2} + \cdots + \lambda_n P_{in} + e_i \quad \text{(Eq 2)}$$

where Y_i^Q represents the quantile division (25th, 50th, and 75th) of how logical and rewarding learning mathematics is, $i = 1, \ldots, 129$ students, λ_j ($\forall j \in \{0, 1, 2, \ldots, n\}$) represents the coefficients (parameters) of the model (2), where n refers to the number of independent variables, P_{ij} ($\forall j \in \{0, 1, 2, \ldots, n\}$) represents the independent variables and e_i represents the remaining random error term. The regression model is tested at 1%, 5%, and 10% levels of significance considering human subject involved in this study (Valenzona et al. 2022).

Findings from ordinary least square (OLS) regression served as a baseline comparison for the constructed quantile regression models. Post-estimation techniques including or diagnostic test for includes heteroscedastic, omitted variable bias, multicollinearity, and normality of residuals, were executed to validate the model's findings and test its significance at a 5% level or less.

RESULTS

Profile of Students

Table 2 shows the demographic and learning profiles of students. The mean average age of students is approximately 19.89 (±1.78) years, hanging from the youngest at 18 years old to the oldest at 33 years old. Gender distribution indicates that 29% of students are male, while 71% are female. Only 26% percent of the students live in urban areas, while the majority (74%) reside in rural areas. On average, these students belong to the families with nearly six members (± 2.25), ranging from a minimum of two to a maximum of 12. The monthly family income varies, averaging around 15,648.29 PHP (±15,953.91 PHP), ranging from a minimum income of 880 PHP and a maximum of 65,000 PHP. On a scale of 1-10, students rate their level of engagement in leisure activities during the pandemic at 5.79, their health status at 5.13, and their social relationship status at 6.67. Fifty-seven percent of the students used laptops, while 43% used mobile phones for their mathematics online classes. Students devote approximately 5.77 h (±7.33 h) per week to studying mathematics, and their average weekly expenditure on internet is PHP 187.85 (±PHP 179.73). Rating their internet connectivity on a scale of 1 to 10, students average 5.01 (±1.74). Students report coping with mathematics anxiety at a rating of 5.17 (±1.88), while their perception of the learning environment at home is rated at 4.26 (±1.68).

Logicality and Rewarding Level in Learning Mathematics

Table 3 reveals the nature of learning mathematics online in terms of logically and rewarding experiences. The data reveal that the learning experience online is "logical", with a mean of 6.59 (SD = 2.56). However, the degree of "rewarding" is observed to be moderately rated at 6.08 (SD = 2.51). Moreover, the Pearson correlation demonstrated a significant positive association $\left(r_p = 0.776, P < 0.001\right)$ between the "logical" and "rewarding" nature of learning mathematics online during the new normal. This implies that the relationship between how logical and how rewarding learning mathematics at a distance is directly proportional. In that case, as the logical level increases, students are more likely to feel a satisfying behavior in learning, and vice versa.

Table 2. Summary of students' demographic and learning profile. a-dummy (indicator); b-count; c-Philippine Peso (PHP); d-1 to 10 scaling.

Variables	Mean (M)	Std. dev. (SD)	x_{min}	x_{max}
Demographic profile				
Age (in years)	19.89	1.78	18	33
Sex: Male[a]	0.29	0.46	0	1
Hometown: Urban[a]	0.26	0.44	0	1
Household size[b]	6.11	2.25	2	12
Monthly Family Income[c]	15648.29	15953.91	880	65000
Leisure activities[d]	5.79	2.22	1	10
Health status[d]	5.13	2.19	1	10
Social relationship status[d]	6.67	2.11	1	10
Learning profile				
Availability of laptop for online class[a]	0.57	0.49	0	1
Number of hours (h) studying (per week)[b]	5.77	7.33	1	60
Money spent for internet load (per week)[c]	187.85	179.73	0	1000
Internet connection signal[d]	5.01	1.74	1	10
Coping strategies for anxiety[d]	5.17	1.88	1	10
Learning environment (at home)[d]	4.26	1.68	1	10

Table 3. Descriptive statistics and correlation for how logical and rewarding learning mathematics online. a-1 to 10 scaling; b-see Table 1 for details, ****P* < 0.01.

Variables	Mean	Std. dev.	Verbal interpretaion[b]	Correlation (r_p)	*P* (Two-tailed test)
Logical[a]	6.59	2.56	Logical	0.776***	< 0.001
Rewarding[a]	6.08	2.51	Moderately rewarding		

As seen in Table 4, the simple regression model ($F = 191.7, P < 0.001$) is significant at a 1% level. In addition, the model reveals a statistically sound coefficient of determination ($R^2 = 0.602$). This implies that about 60.2% of the differences in students' "rewarding" perception scores can be attributed to the students' "logical" perception scores. The model shows that for every one-unit increase in the "logical" perception score, there is a corresponding increase of 0.759 in the "rewarding" perception score, and it is significant at a 1% level. Moreover, Figure 1 shows that the regression line has an increasing trend, indicating that the slope of the line is positive.

Table 4. Simple regression on how logical and rewarding learning mathematics is (dependent variable: rewarding[a]). a-1 to 10 scaling; $^{***}P < 0.01$.

Regression	Coefficient	Std Error	T-test	*P* (Two-tailed test)
Logical[a]	0.759***	0.055	13.85	<0.001
Constant	1.072***	0.388	2.76	0.007
R^2	0.602			
F-test computed	191.70			
P (Two-tailed test)	< 0.001			

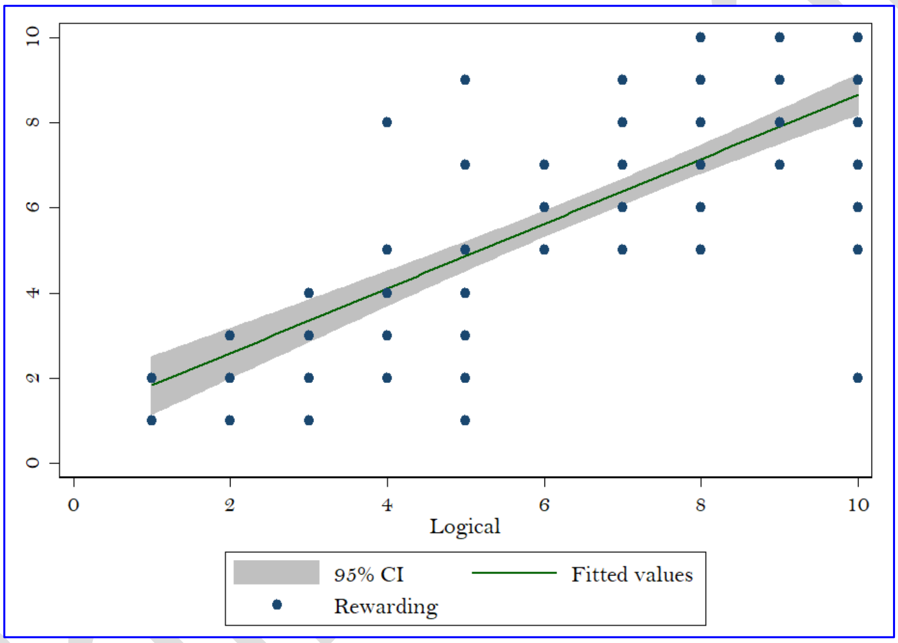

Figure 1. Regression line and scatter plot.

Regression Models for Logicality and Rewarding Level

The result of the Breusch-Pagan test reveals that the quantile and OLS models in Table 5 (dependent variable: Logical) are homoscedastic ($\chi^2 = 0.47$; $P = 0.494$), indicating constant variances. Additionally, no omitted variable bias ($F = 1.82$; $P = 0.148$) is found in quantile and OLS models based on the findings of the Ramsey RESET test. The model also does not involve multicollinearity between the independent variables, as the average variance inflation factor (VIF) is less than 10, specifically VIF=1.56. Moreover, the residuals of the models are found to be normal ($W = 0.983$; $P = 0.115$) based on the result of the Shapiro-Wilk W test. Thus, the outcome in Table 5 is considered valid for interpretation and prediction, free from misleading and biased results. It is worth noting that the OLS model in Table 5 reveals a significant construct at a 1% level, indicating substantial determinants that govern the student's logicality in learning mathematics at a distance. The quantile models (25[th] Quantile: $R^2 = 0.328$; 50[th] Quantile: $R^2 = 0.239$; 75[th] Quantile: $R^2 = 0.177$) and OLS model ($R^2 = 0.177$) have depicted a non-negligible coefficient of determination. The lower level (25[th] Quantile) of logicality in learning mathematics online has the following significant determinants: family monthly income (at a 10% level), social relationship status (at a 10% level), and learning environment (at a 10% level). No significant factors are found in the middle level (50th Quantile) of logicality. For the high level (75th Quantile) of logicality, it is depicted that the only significant determinant is the amount of money spent on internet load (at a 10% level). Moreover, the OLS model reveals that the following determinants of logicality are significant: household size (at a 5% level), health status (at a 10% level), money spent on internet load (at a 10% level), and learning environment (at a 10% level).

Table 5. Quantile and OLS regression models on how logical learning mathematics is and its predictors. a-dummy (indicator); b-count; c-Philippine Peso (PHP); d-1 to 10 scaling; Standard errors are enclosed with parenthesis; $*P < 0.10$; $**P < 0.05$; $***P < 0.01$; ns-not significant.

Independent Variables	**Regression Models (Dependent variable: Logical)**			
	25th Quantile	**50th Quantile**	**75th Quantile**	**OLS**
Age (in years)	-0.228^{ns} (0.218)	-0.105^{ns} (0.216)	0.002^{ns} (0.245)	-0.055^{ns} (0.123)
Sex: Male[a]	-0.081^{ns} (0.818)	-0.068^{ns} (0.814)	-0.915^{ns} (0.694)	-0.248^{ns} (0.486)
Hometown: Urban[a]	-0.106^{ns} (0.409)	0.366^{ns} (0.632)	1.018^{ns} (0.886)	0.199^{ns} (0.485)
Household size[b]	0.094^{ns} (0.109)	0.119^{ns} (0.183)	0.292^{ns} (0.203)	0.217** (0.096)
log (Monthly Family Income[c] +1)	1.264* (0.731)	0.759^{ns} (0.588)	0.308^{ns} (0.981)	0.784^{ns} (0.563)
Leisure activities[d]	0.079^{ns} (0.136)	0.301^{ns} (0.254)	0.121^{ns} (0.196)	0.129^{ns} (0.134)
Health status[d]	0.056^{ns} (0.227)	0.278^{ns} (0.231)	0.199^{ns} (0.240)	0.206* (0.135)
Social relationship status[d]	0.396* (0.228)	0.177^{ns} (0.299)	0.223^{ns} (0.351)	0.227^{ns} (0.162)
Availability of laptop for online class[a]	0.648^{ns} (0.711)	0.381^{ns} (0.583)	-0.503^{ns} (0.663)	0.105^{ns} (0.473)
Number of hours (h) studying (per week)[b]	0.017^{ns} (0.030)	-0.003^{ns} (0.048)	-0.028^{ns} (0.037)	-0.008^{ns} (0.028)
log (Money spent for internet load (per week)[c] +1)	-0.141^{ns} (0.412)	0.101^{ns} (0.519)	0.836* (0.537)	0.682* (0.484)
Internet connection signal[d]	0.116^{ns} (0.223)	-0.033^{ns} (0.147)	0.129^{ns} (0.197)	0.104^{ns} (0.134)
Coping strategies for anxiety[d]	0.083^{ns} (0.149)	0.138^{ns} (0.184)	0.053^{ns} (0.253)	0.141^{ns} (0.118)
Learning environment (at home)[d]	0.289* (0.149)	0.226^{ns} (0.161)	-0.033^{ns} (0.120)	0.192* (0.143)
Constant	-1.733^{ns} (5.701)	-1.691^{ns} (5.055)	-0.026^{ns} (6.150)	-3.607^{ns} (3.585)
Number of Participants	129	129	129	129
F-test	-	-	-	3.95***
P (Two-tailed test)	-	-	-	< 0.001
R-squared	-	-	-	0.327
Pseudo R-squared	0.328	0.239	0.177	-

The result of Breusch-Pagan test reveals that the quantile and OLS models in Table 6 (dependent variable: Rewarding) are not heteroscedastic ($\chi^2 = 3.31$; $P = 0.069$); hence, the variances are constant. In addition, no omitted variable bias ($F = 1.29$; $P = 282$) is detected for both quantile and OLS models based on the Ramsey RESET test findings. The average variance inflation factor (VIF) value indicated that the models (quantile and OLS) did not have a multicollinearity problem ($\text{VIF} = 1.56 < 10$) between the independent variables. The Shapiro-Wilk W test reveals that the residuals of the models (quantile and OLS) are normal ($W = 0.983$; $P = 0.103$). Conclusively, the results of the models in Table 6 are valid for interpretation and conclusion. The OLS model reveals a significant construct at a 1% level (Table 6), signaling significant factors affecting the students' reward level in learning mathematics online. Table 6 presents that the quantile models (25th Quantile: $R^2 = 0.345$; 50th Quantile: $R^2 = 0.270$; 75th Quantile: $R^2 = 0.126$) and OLS model ($R^2 = 0.336$) portray non-minimal goodness of fit. Hence, the lower level (25th Quantile) of rewarding level in learning mathematics online depicts the following significant determinants: family monthly income (at a 10% level), leisure activities (at a 5% level), health status (at a 10% level), social relationship status (at a 1% level), and money spent for internet load (at a 10% level). Health status (at a 10% level) and social relationship status (at a 1% level) are the significant factors found in the middle level (50th Quantile) of the rewarding level. Furthermore, in the high level (75th Quantile), it is depicted that only social relationship status (at a 10% level) is a significant factor. The OLS model discloses that the following determinants of rewarding level, which include leisure activities (at a 10% level), social relationship status (at a 1% level), money spent for internet load (at a 10% level), and learning environment (at a 10% level) are significant factors.

Table 6. Quantile and OLS regression models on how rewarding learning mathematics is and its predictors. a-dummy (indicator); b-count; c-Philippine Peso (PHP); d-1 to 10 scaling; Standard errors are enclosed with parenthesis; *$P < 0.10$; **$P < 0.05$; ***$P < 0.01$, ns-not significant.

Independent Variables	**Regression Models (Dependent variable: Rewarding)**			
	25th Quantile	**50th Quantile**	**75th Quantile**	**OLS**
Age (in years)	-0.024^{ns} (0.235)	-0.096^{ns} (0.287)	-0.029^{ns} (0.199)	-0.026^{ns} (0.119)
Sex: Male[a]	-0.351^{ns} (0.604)	0.114^{ns} (0.948)	0.363^{ns} (0.966)	-0.012^{ns} (0.473)
Hometown: Urban[a]	-0.454^{ns} (0.500)	0.447^{ns} (0.605)	0.457^{ns} (0.784)	0.116^{ns} (0.472)
Household size[b]	-0.089^{ns} (0.139)	-0.056^{ns} (0.109)	0.136^{ns} (0.179)	0.022^{ns} (0.093)
log (Monthly Family Income[c] +1)	1.079* (0.705)	0.995^{ns} (0.781)	0.208^{ns} (0.601)	0.642^{ns} (0.547)
Leisure activities[d]	-0.433** (0.201)	-0.317^{ns} (0.233)	-0.221^{ns} (0.177)	-0.226* (0.130)
Health status[d]	0.298* (0.192)	0.238* (0.122)	0.056^{ns} (0.187)	0.164^{ns} (0.131)
Social relationship status[d]	0.668*** (0.241)	0.827*** (0.279)	0.545* (0.345)	0.513*** (0.158)
Availability of laptop for online class[a]	-0.107^{ns} (0.573)	-0.397^{ns} (0.855)	-0.445^{ns} (1.089)	0.171^{ns} (0.461)
Number of hours (h) studying (per week)[b]	0.024^{ns} (0.032)	0.026^{ns} (0.039)	-0.002^{ns} (0.037)	0.003^{ns} (0.027)
log (Money spent for internet load (per week)[c] +1)	1.302* (0.855)	-0.049^{ns} (0.908)	-0.005^{ns} (0.599)	0.756* (0.471)
Internet connection signal[d]	0.094^{ns} (0.267)	-0.126^{ns} (0.167)	-0.109^{ns} (0.285)	0.072^{ns} (0.130)
Coping strategies for anxiety[d]	0.156^{ns} (0.134)	0.106^{ns} (0.145)	0.218^{ns} (0.163)	0.159^{ns} (0.115)
Learning environment (at home)[d]	0.194^{ns} (0.194)	0.220^{ns} (0.188)	0.128^{ns} (0.215)	0.261* (0.139)
Constant	-6.804^{ns} (5.923)	-1.457^{ns} (7.398)	2.802^{ns} (5.197)	-3.095^{ns} (3.488)
Number of Participants	129	129	129	129
F-test	-	-	-	4.12***
P (Two-tailed test)	-	-	-	< 0.001
R-squared	-	-	-	0.336
Pseudo R-squared	0.345	0.270	0.126	-

DISCUSSION

Profile of Students

The results indicated that the majority of MMW students are freshmen. According to Casinillo et al. (2022), MMW students are typically first-year students since the MMW course is designated to be taken in their first-year curriculum. The mean average age of first-year students was close to 20. The findings reveal that most MMW students are female. Balakrishnan and Low (2016) study suggested that addressing the shortage of female students in science and engineering careers could be achieved by increasing their enrollment in mathematical courses. Most students reside in rural areas, consistent with the study by Casinillo (2022), indicating that a number of students of VSU come from remote regions in the province of Leyte. Consequently, many of these students face challenges related to internet connectivity, contributing to struggles in coping with mathematical anxiety. Additionally, they experience a stressful learning environment at home due to distractions and boredom. Irfan et al. (2020) and Casinillo (2023) portray that students are challenged in doing their mathematics activities due to the limitations of the learning setup during the pandemic. Most of these students struggle to acquire advanced gadgets and financial support for online learning since they come from low-income families. Adhe et al. (2020) state that COVID-19 is also an economic crisis since most of the parent's income is decreasing due to job cuts resulting from the health protocol restrictions. Furthermore, due to the lockdowns and health restrictions, students' health and social status are declining due to inactivity and fewer leisure activities. Dratva et al. (2020) portray that the pandemic causes mental health problems, depression, stress, and anxiety in students due to difficulties and obstacles in distance education.

Logicality and Rewarding Level in Learning Mathematics

Learning mathematics at a distance is considered logical and moderately rewarding. In this case, students are somehow penetrating their lessons in mathematics applying reasoning and critical thinking in their learning activities. Kertiyani and Sarjana (2022) portray that logical and critical thinking are vital components that need to be developed during the pandemic to maintain excellent student problem-solving skills. In addition, students find learning mathematics online moderately satisfying and valuable in their student's life. Hence, they are still motivated and find the subject rewarding since it is part of their curriculum. However, the moderately rewarding result is a consequence of the barriers and limitations of distance education. The result above is parallel to the findings of Gustiani (2020) and Casinillo (2023), who found that students during the new normal have experienced moderate motivation, satisfaction, and self-efficacy in learning mathematics. The findings have revealed a positive correlation between how logical and rewarding learning mathematics is. Thus, as students are involved in creating logical ideas in mathematics activities, they feel satisfied and find mathematics exciting, and the other way around. The study by Spitzer and Musslick (2021) portray that it is necessary to give engaging activities in mathematics to motivate students to create new ideas that develop their cognitive thinking.

Regression Models for Logicality and Rewarding Level

The quantile regression revealed that the lower logical and rewarding level in learning mathematics are influenced by family income. Thus, students are motivated to learn mathematics during the pandemic if they do not have financial problems. In the study of Casinillo et al. (2022), students are eager and stimulated to study mathematics if they have the materials, suitable technology, and good internet connections needed for online learning. Social relationships also influence the lower logical and rewarding levels. So, chatting and spending time with co-students and loved ones will inspire them to learn mathematics despite the challenges brought by the pandemic. According to the studies of Elmer et al. (2020) and Baber (2021), students' social interaction will help them cope with anxiety, progress in their learning process, and positively influence their well-being.

Another significant determinant of how logical and rewarding learning mathematics is the students' learning environment at home. This result is consistent with the findings of Casinillo (2022), which stated that students' learning environment is a significant factor that influences concentration in an online class. Likewise, Bahian et al. (2020) portray that a conducive learning environment will give students a relaxing learning process that can enhance their cognitive thinking and be satisfied with learning at a distance. Family income and money spent on the internet load are causal factors of logicality and reward (both low and average) levels in learning mathematics online. Thus, students with enough financial assistance and resources in their online learning tend to perform better, penetrating their lessons more effectively, and are more likely to be satisfied. Adhe et al. (2020) and Casinillo et al. (2022) depict that most students are not performing well during online learning since they have difficulty acquiring suitable technologies and other vital needs.

On average, health is a significant factor in logicality in learning mathematics. Hence, if the student is healthy both mentally and physically, students tend to have more creative and logical ideas in the learning process. Also, the health aspect of a student positively influences the reward level of learning mathematics online. Holm-Hadulla et al. (2021) portray that mental health is a strong predictor of the well-being of students and their interest in learning online. Lastly, lower levels of leisure activities can impart a coping mechanism and positively influence their satisfaction with learning because students can focus and concentrate on their lessons. So, to give more time to education and avoid distraction, students may have to diminish leisure activities, resulting in peace of mind and a gratifying occurrence in learning mathematics online (Jaskulska et al. 2022).

Conclusively, the Philippine government must support college students by providing their needs and other resources for online learning. Additionally, mathematics teachers must encourage students to develop a good foundation of study habits and time management despite the challenges of stimulating cognitive and analytical thinking. Moreover, teachers must create a lively and motivating online class to boost their creative and logical thinking and give problem-solving tasks that are rewarding and suitable to accomplish in the required time. The study suggests that a similar study must be conducted with prominent participants in remote universities and incorporate variables in coping strategies and perceived stress as possible limitations of the current article.

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ETHICAL CONSIDERATIONS

For the students below 18 years old, a consent statement form was secured.

DECLARATION OF COMPETING INTEREST

The author declares that there is no competing interests exist.

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REFERENCES

Adhe KR, Maulidiya R, Al Ardha, MA, Saroinsong WP and Widayati S. 2020. Learning during the COVID-19 pandemic: correlation between income levels and parental roles. Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini, 5(1): 293-302. https://doi.org/10.31004/obsesi.v5i1.554

Baber H. 2021. Social interaction and effectiveness of the online learning–A moderating role of maintainingsocial distance during the pandemic COVID-19. Asian Education and Development Studies, 11(1): 159-171. https://doi.org/10.1108/AEDS-09-2020-0209

Bahian MEV, Agapito JJJ, Arradaza JT and Pita CC. 2020. Barriers to online learning amidst COVID-19 pandemic. Psychology and Education Journal, 57(9): 2252-2259.

Balakrishnan B and Low FS. 2016. Learning experience and socio-cultural influences on female engineering students' perspectives on engineering courses and careers. Minerva, 54(2): 219-239. https://doi.org/10.1007/s11024-016-9295-8

Braund M. 2021. Critical STEM literacy and the COVID-19 pandemic. Canadian Journal of Science, Mathematics and Technology Education, 21(2): 339-356. https://doi.org/10.1007/s42330-021-00150-w

Casinillo LF. 2023. Modeling students' self-efficacy in mathematics during the COVID-19 pandemic. Canadian Journal of Family and Youth/Le Journal Canadien de Famille et de la Jeunesse, 15(1): 77-89. https://doi.org/10.29173/cjfy29902

Casinillo L. 2022. Is learning mathematics still creative and enjoyable during the COVID-19 pandemic? Indonesian Journal of Social Research, 4(2): 124-138. https://doi.org/10.30997/ijsr.v4i2.208

Casinillo LF, Casinillo EL, Valenzona JV, Almonite MRC and Valenzona DL. 2022. How challenging it is to learn mathematics online. Philippine Social Science Journal, 5(1): 80-89. https://doi.org/10.52006/main.v5i1.447

Cassibba R, Ferrarello D, Mammana MF, Musso P, Pennisi M and Taranto E. 2021. Teaching mathematics at a distance: a challenge for universities. Education Sciences, 11(1): 1-20. https://doi.org/10.3390/educsci11010001

Cronbach LJ. 1951. Coefficient alpha and the internal structure of tests. Psychometrika, 16: 297-334. https://doi.org/10.1007/BF02310555

Darmayanti R, Sugianto R, Baiduri B, Choirudin C and Wawan W. 2022. Digital comic learning media based on character values on students' critical thinking in solving mathematical problems in terms of learning styles. Al-Jabar: Jurnal Pendidikan Matematika, 13(1): 49-66.

Dratva J, Zysset A, Schlatter N, von Wyl A, Huber M and Volken T. 2020. Swiss university students' risk perception and general anxiety during the COVID-19 pandemic. International Journal of Environmental Research and Public Health, 17(20): 7433. https://doi.org/10.3390/ijerph17207433

El Firdoussi S, Lachgar M, Kabaili H, Rochdi A, Goujdami D and El Firdoussi L. 2020. Assessing distance learning in higher education during the COVID-19 pandemic. Education Research International, 2020: 1-13. https://doi.org/10.1155/2020/8890633

Elmer T, Mepham K and Stadtfeld C. 2020. Students under lockdown: comparisons of students' social networks and mental health before and during the COVID-19 crisis in Switzerland. PloS ONE, 15(7): e0236337. https://doi.org/10.1371/journal.pone.0236337

Festiawan R, Hooi LB, Widiawati P, Yoda IK, Adi S, Antoni MS and Nugroho AI. 2021. The problem-based learning: how the effect on student critical thinking ability and learning motivation in COVID-19 pandemic? Journal Sport Area, 6(2): 231-243. https://doi.org/10.25299/sportarea.2021.vol6(2).6393

Gustiani S. 2020. Students' motivation in online learning during the covid-19 pandemic era: a case study. Holistics, 12(2): 23-40.

Holm-Hadulla RM, Klimov M, Juche T, Möltner A and Herpertz SC. 2021. Well-being and mental health of students during the COVID-19 pandemic. Psychopathology, 54(6): 291-297. https://doi.org/10.1159/000519366

Irawan AW, Dwisona D and Lestari M. 2020. Psychological impacts of students on online learning during the pandemic COVID-19. KONSELI: Jurnal Bimbingan dan Konseling (E-Journal), 7(1): 53-60. https://doi.org/10.24042/kons.v7i1.6389

Irfan M, Kusumaningrum B, Yulia Y and Widodo SA. 2020. Challenges during the pandemic: use of e-learning in mathematics learning in higher education. Infinity Journal, 9(2): 147-158. https://doi.org/10.22460/infinity.v9i2.p147-158

Jaskulska S, Jankowiak B, Marciniak M and Klichowski M. 2022. Assessment of physical well-being and leisure time of polish students during the COVID-19 outbreak. International Journal of Environmental Research and Public Health, 19(14): 8358. https://doi.org/10.3390/ijerph19148358

Jenkins DG and Quintana-Ascencio PF. 2020. A solution to minimum sample size for regressions. PloS ONE, 15(2): e0229345. https://doi.org/10.1371/journal.pone.0229345

Keener TA, Hall K, Wang K, Hulsey T and Piamjariyakul U. 2021. Quality of life, resilience, and related factors of nursing students during the COVID-19 pandemic. Nurse Educator, 46(3): 143-148. https://doi.org/10.1097/NNE.0000000000000969

Kertiyani NMI and Sarjana K. 2022. The critical thinking skill of mathematics education students during pandemic: a review. Jurnal Pijar Mipa, 17(2): 246-251. https://doi.org/10.29303/jpm.v17i2.3425

Koenker R and Bassett Jr G. 1978. Regression quantiles. Econometrica, 46(1): 33-50. https://doi.org/10.2307/1913643

Matthews LE, Jessup NA and Sears R. 2021. Looking for “us”: power reimagined in mathematics learning for Black communities in the pandemic. Educational Studies in Mathematics, 108(1): 333-350. https://link.springer.com/article/10.1007/s10649-021-10106-4

Mendoza VDJ, Cejas MMF, Varguillas CCS and Rivas UG. 2021. Anxiety as a prevailing factor of performance of university mathematics students during the COVID-19 pandemic. The Education and Science Journal, 23(2): 94-113.

Ní Fhloinn E and Fitzmaurice O. 2021. Challenges and opportunities: experiences of mathematics lecturers engaged in emergency remote teaching during the COVID-19 pandemic. Mathematics, 9(18): 2303. https://doi.org/10.3390/math9182303

Seeram E. 2019. An overview of correlational research. Radiologic technology, 91(2): 176-179.

Spitzer MWH, and Musslick S. 2021. Academic performance of K-12 students in an online-learning environment for mathematics increased during the shutdown of schools in wake of the COVID-19 pandemic. PloS ONE, 16(8): e0255629. https://doi.org/10.1371/journal.pone.0255629

Valenzona JV, Casinillo LF and Casinillo EL. 2022. Modeling students’ innovativeness and its factors in learning mathematics amidst COVID-19 pandemic. The Palawan Scientist, 14(1): 43-50.