How Challenging It Is to Learn Mathematics Online

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ABSTRACT. Distance education is an unprecedented form of instruction for most students, making it difficult to learn, especially in Mathematics. This study aimed to elucidate the students' level of challenge in learning mathematics and its influencing predictors amidst the COVID-19 pandemic. Primary data was gathered through a Google form questionnaire from 135 college students under a non-probabilistic sampling. Some descriptive statistical measures and a regression model were employed to summarize and analyze the data gathered. Results revealed that the mean challenge perception score was 6.45, which indicates that learning mathematics at a distance is "challenging". The regression models revealed that students have difficulty acquiring internet load due to the financial crisis. Due to anxiety brought by the pandemic and distractions through social media friends, students cannot focus on their mathematics activities. In addition, due to some limitations and barriers in remote learning, students have difficulty understanding their lessons. Hence, mathematics teachers need to have positive attitudes and encourage students to pursue despite all the challenges. Furthermore, teachers must also be considerate to their students regarding output deadlines and examinations.

1.0. Introduction

COVID-19 pandemic has adversely impacted the educational learning platform and resulted in a challenging situation for both teachers and students throughout the world. Despite the pandemic disruption, the educational system must continue to operate in the form of online classes and e-learning modules (Kanneganti et al., 2020; Talimodao & Madrigal, 2021). Elfirdoussi et al. (2020) stated that schools have been shut down and shifted to online learning, which is not interesting to the side of students compared to face-to-face learning due to some challenges. In that case, several adverse scenarios are encountered in the teaching-learning process (Dubey & Pandey, 2020; Kanneganti et al., 2020; Onyema et al., 2020). One of the courses that students highly avoid in higher education is mathematics due to its complexity and abstract difficulty (Casinillo, 2019). According to Ní Fhloinn and Fitzmaurice (2021), several challenges are experienced by mathematics lecturers and learners, such as limitations in communication, internet concerns, and difficulty in presenting mathematical symbols and equations, among other problems. Hence, several studies in literature deal with the challenges in mathematics education to understand and contribute some policy that is fit for pandemic and beyond (Bakker & Wagner, 2020; Carius, 2020; Mahmut, 2020; Wahyuningrum & Latifah, 2020; Francom et al., 2021).

One of the state universities in the region of Leyte, Philippines, namely Visayas State University (VSU), is experiencing the challenge brought by the pandemic in the aspect of delivering the lessons to students. Most of the birthplace of students are in rural areas wherein internet connectivity is relatively low compared to urban areas. Aside from low internet, students' families are also struggling to survive due to the economic crisis brought by the pandemic. In that case, students struggle to cope with their lessons, especially in doing some mathematical problem-solving. It is worthy to note that mathematics requires doing with the luxury of time and attention to teachers. However, due to barriers like health protocols, financial problems, and low internet connectivity, among other problems, the level of challenge in learning mathematics is higher than it used to be. Moreover, Irfan et al. (2020) and Cassibba et al. (2021) revealed that teaching mathematics at a university during the

pandemic is not easy due to some limitations and obstacles in imparting cognitive and analytical skills. Because of health emergencies and protocols, instructors and professors could not undergo some rigorous training regarding distance learning. Due to that, they face first-hand experience in online classes, which makes it difficult to discuss and present equations, mathematics symbols, and formulas. Thus, it is crucial to investigate the students' challenging moments in learning mathematics during the pandemic to formulate some policy that may improve the current mathematics education in the country and beyond.

Measuring the level of challenge in learning mathematics during the pandemic is not often in literature. Modeling the level of challenge and its predictors has never been done in rural areas in Leyte, Philippines. Hence, the current study is realized. To accomplish the goal of this study, it aspires to answer the two objectives: (1) to measure the level of challenge in learning mathematics amidst the COVID-19 pandemic; and (2) to document some significant determinants that influence the students' level of challenge in learning mathematics amidst COVID-19 pandemic. The results of this study may help improve the comprehension of the challenges in learning mathematics at a distance. Additionally, the study may add important insights to mathematics educators and students. Furthermore, findings may help some practitioners in mathematics education research and may contribute significant information to literature.

2.0. Framework of the Study

During the COVID-19 pandemic, learning mathematics on an online platform faces several obstacles in presenting the lessons (Carius, 2020; Irfan et al., 2020; Lopena et al., 2021). In the study of Amelia et al. (2020), it is stated that students during distance education have experienced difficulties in comprehending their learning modules and assessment activities. In that case, students need attention and proper guidance from their mathematics teacher, which is challenging to happen in the online environment. Hence, this paper theorized that some causal determinants govern the level of challenge in learning mathematics amidst the COVID-19 pandemic. It is worth noting that socio-demographic profiles are affected during the pandemic, adversely influencing educators (Alea et al., 2020; Francom et al., 2021) and learners (Irfan et al., 2020; Cassibba et al., 2021) in the middle of the online learning.

According to Elzainy et al. (2020) and Radha et al. (2020), students are experiencing several difficulties in the e-learning environment, such as internet problems, misuse of technology, struggling to understand the online materials, and lack of interaction, among other problems. It is worthy to note that remote learning in mathematics is an unbending or less interaction between teachers and learners. Balkist and Agustiani (2020) stated that the accuracy of content-based learning in mathematics has diminished through time because it misses direct interaction and creativity in online learning.

In addition, the level of mathematics anxiety is high during the pandemic, which highly affects the learning process of students (Manapa, 2021). However, in the study of Casinillo et al. (2020), a positive learning experience in mathematics, such as enjoyable and creative, can cope with stress and anxiety. This means that the level of challenge is correlated to how enjoyable and creative is the learning environment. Moreover, it is found that different social relationships (Gardee, 2019; Thurston et al. 2020) and learning environment (Spitzer & Musslick, 2021) does have implications in shaping the learners' cognitive process in learning mathematics. Furthermore, health-related aspects of students are a great factor in the learning procedure during the pandemic (Ziols & Kirchgasler, 2021).

3.0. Methodology

Research Design. A quantitative research design was utilized in this study to evaluate students' opinions and how they feel or respond in a peculiar situation. The design considered a large sample size and focused on the quantitative response among students. Moreover, this study involves descriptive methods and inferential modeling to analyze the data gathered.

Participants, Sampling Procedure, and Ethical Considerations. The desired participants were bonafide students of Visayas State University (VSU) Main Campus who were currently enrolled in Mathematics in the Modern World (MMW) during their second semester (A.Y. 2020-2021). In determining the sample size used in this study, a non-probabilistic approach was employed. This infers that the study only considered students who responded to the Google form survey. The online survey was posted in the Facebook group and virtual classroom and opened for about one month.

Hence, a total of 135 MMW students responded to the survey. As for the ethical procedure, a letter to conduct the study was sent to the department head of mathematics. After the approval, the list of MMW students was asked of the teachers handling MMW subjects. After which, students were informed of the purpose of the study and advised that participation is voluntary but highly appreciated. Moreover, MMW students were educated that the data gathered from them contains no sensitive information and will be used solely for research purposes only.

Research Instrument and Data Collection. The survey questionnaire consists of some socio-demographic profiles of students, some characteristics in learning at a distance, some learning experiences in mathematics, and the level of challenge in learning mathematics (dependent variable). For the socio-demographic profile of MMW students, they were asked for the following: sex (0=female, 1=male), age (in years), hometown (0=Rural, 1=Urban), availability of laptop(s) (0=No, 1=Yes), hours studying mathematics topics (per week), money spent on the internet (peso per week), the income of the family (peso per month), social relationship (Scale of 1 to 10), and health (Scale of 1 to 10). For the learning characteristics at a distance, MMW students were asked with the following: on-time submission of outputs (0=No, 1=Yes), internet signal strength (Scale of 1 to 10) and coping with math anxieties (Scale of 1 to 10), and learning environment (Scale of 1 to 10). In addition, students were asked about their learning experiences, such as creative (Scale of 1 to 10) and enjoyable (Scale of 1 to 10). Table 1 shows the mean interval perception score for the independent variables with scale rating and corresponding meaning.

Table 1. Mean interval perception score and its meaning

Mean Perception Score	Meaning
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

Furthermore, as to the dependent variable of this study, MMW students were asked about the level of the following: logical (Scale of 1 to 10), rewarding (Scale of 1 to 10), and difficulty (Scale of 1 to 10). In the case of the dependent variable, it resulted in an average inter-item covariance of 4.78 and a scale reliability coefficient of 0.91. This means that the three-item questionnaire for the dependent variable is reliable. Table 2 shows the challenge perception score and its description.

Table 2. Mean interval challenge perception score and its description

Mean Perception Score	Response	Description
1.00 - 2.80	Strongly Disagree	Not Challenging
2.81 - 4.60	Disagree	Slightly Challenging
4.61 - 6.40	Neutral	Moderately Challenging
6.41 - 8.20	Agree	Challenging
8.21 - 10.00	Strongly Agree	Very Challenging

Data Analysis. After the survey, the information from students was extracted from google form survey to obtain the encoded data on excel and formatted for the software STATA v.14. In summarizing the data, descriptive measures such as mean average and standard deviation were obtained. In addition, percentages and horizontal bar graphs were computed and constructed, respectively, to describe the different levels of challenges in learning mathematics. Moreover, multiple regression analysis or the ordinary least square (OLS) regression model was employed to determine the different factors that significantly affect the level of challenge in learning mathematics at a distance. Hence, the regression equation takes the following form:

$$y_i = \partial_0 + \partial_1 x_{i1} + \cdots + \partial_k x_{ik} + u_i$$

where y_i refers to the level of challenge in learning mathematics, $i = 1, \ldots, n$ and n is the number of MMW students, ∂_t ($\forall t \in \{0, 1, \ldots, k\}$) are the parameters to be approximated, x_{it} ($\forall t \in \{1, \ldots, k\}$) are the different predictor variables, and u_i is the random error in the model. For the interpretation, ∂_t ($\forall t \in \{1, \ldots, k\}$) refers to the approximate increment in the level of challenge in every 1-unit increment in the predictor variable x_{it} ($\forall t \in \{1, \ldots, p\}$), ceteris paribus. Furthermore, the model has undergone some diagnostic tests for validity and tested at a 5% level of significance.

4.0. Results and Discussion

Socio-Demographic Profile

Table 3 shows that the age of MMW students is closed to 20 ($M = 19.88, SD = 1.75$) years old. Dominantly, about 71% are female students and a small fraction of male students (29%). Most of them live in rural areas (73%), and about 27% live in urban areas. On average, 57% of these students use laptops in their online learning, and others use mobile phones. Weekly, their approximate number of hours studying their lessons in mathematics is closed to 5.72 hours ($M = 5.72, SD = 7.18$) and spending PhP 187.10 ($M = 187.10, SD = 176.61$) for internet connection. On average, the monthly family income of these students is closed to PhP 18360.22 ($M = 18360.22, SD = 26522.22$). In regard to learning modality during distance learning, about 53% of the students preferred to have an asynchronous online class, and 47% of them preferred synchronous learning. On average, only 26% of the students say that they have submitted their outputs in mathematics on time. This is due to the internet connection problem, which is only rated as 5.01 (fair) (Table 1), which comes between good and poor. In addition, MMW students fairly ($M = 5.19, SD = 1.86$) cope with math anxiety and experience a poor learning environment ($M = 4.27, SD = 1.69$) during the pandemic. However, social relationships are rated as satisfactory($M = 6.73, SD = 2.11$), perhaps, due to the online connections of friends and classmates. On average, the health aspect of MMW students is rated as fair ($M = 5.20, SD = 2.18$) during the pandemic. Furthermore, students' learning experiences in mathematics during the pandemic are fairly creative ($M = 5.32, SD = 2.23$), and enjoyable ($M = 5.27, SD = 2.26$).

Table 3. Socio-Demographic Variables of Students

Socio-demographic variables	Mean	SD
Age *(in years)*	19.88	1.7452
Male *(dummy)*	0.29	0.4583
Urban *(dummy)*	0.27	0.4477
Availability of laptop(s) *(dummy)*	0.57	0.4969
Number of hours studying math lesson *(per week)*	5.72	7.1827
Amount of money spent on internet connection *(per week)*	187.10	176.6100
Monthly Income of Family[a]	18360.22	26522.2200
Asynchronous *(dummy)*	0.53	0.5007
Submission of Outputs *(dummy)*	0.26	0.4399
Signal Strength[b]	5.01	1.7233
Coping with Math Anxiety[b]	5.19	1.8616
Learning Environment[b]	4.27	1.6875
Social Relationships[b]	6.73	2.1054
Health Aspects[b]	5.20	2.1800
Learning Experience: Creative[b]	5.32	2.2349
Learning Experience: Enjoyable[b]	5.27	2.2567

Note: a-Philippine Peso (Php); b-Scale 1 to 10

Level of Challenge in learning Mathematics at a distance

On average, learning mathematics at a distance is quite logical , and it is considered challenging based on Tables 2 and 4. This means that students' logical reasoning is being used often in the learning process. However, the learning process is challenging to students due to some limitations in the online class and less interaction between teachers and learners (Irfan et al., 2020). This means that the students' ability to reason logically cannot be monitored and developed well by their teachers. In the study of Irawan et al. (2020), it is revealed that students are experiencing adverse psychological impacts during online learning, such as boredom, anxiousness, and mood changes.

In addition, Table 4 reveals that students are neutral to how much rewarding is their experience in learning mathematics at a distance. It is worth noting that courses like mathematics are challenging yet rewarding (Adcock, 2017). However, during the pandemic, technology may deliver the content topics in mathematics but not in an interactive manner. Hence, this might cause mathematics anxiety and stress resulting in class avoidance and laziness in doing assessments and learning activities (Mahmood & Khatoon, 2011; Casinillo et al., 2020). Moreover, students agreed that studying mathematics at a distance is quite difficult (Table 4). According to the findings of Almanthari et al. (2020) and Irfan et al. (2020), there are barriers at the student level that makes the learning process challenging at a distance which includes lack of skill in using technology, internet problem, boredom, and laziness, and lack of time management, among other problems.

Table 4. Level of Challenge in Learning Mathematics Online

Challenge Classification	Mean	SD
Logical	6.64	2.5440
Rewarding	6.13	2.4942
Difficulty	6.58	2.2945
Grand Mean Level of Challenge and SD	6.45	2.4442

Figure 1 shows that 31.11% of the students are experiencing a "Very challenging" learning process at a distance. While about 29.63% of them say that learning at a distance is "Challenging." On average, students learning experience amidst the pandemic is considered "Challenging" based on Tables 2 and 4. This indicates that students during the pandemic face some huge challenges that might lead to a failure in learning (Almanthari et al., 2020).

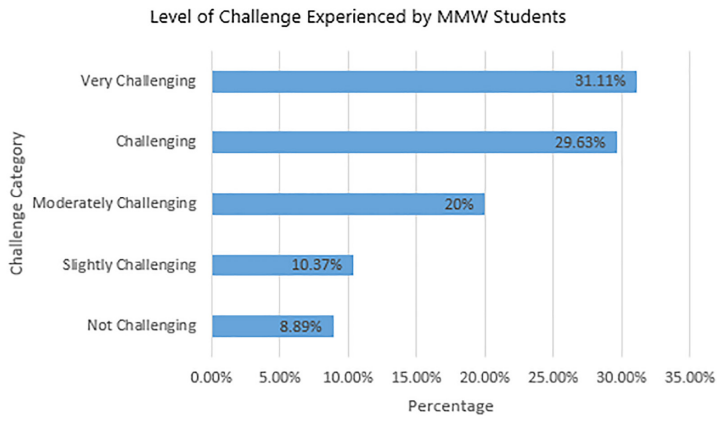

Figure 1. Level of challenge experienced by MMW students

Regression Models

Table 5 represents the three important diagnostic tests for the validity of the multiple regression models. First, the three regression models were checked for homogeneity of the variance of residuals. Hence, by the Breusch-Pagan test, it is found that the three models are homoscedastic. In that case, it is said that the error term in the three regression models is the same across the values of predictors (Mátyás & Sevestre, 2013). According to Allison (2012), if the variance inflation factor (VIF) is lesser than 10, then the multiple regression model is free from multicollinearity of predictors, which can cause misleading results in interpreting the independent variables as a predictor to the dependent variable.

Table 5. Diagnostic Test for Multiple Regression Models

Model	Assumptions	Test Statistic		p-value	Decision
I	Homoscedasticity	Breusch-Pagan	χ^2=4.78	0.0289	Yes
	Multicollinearity	Variance inflation factor (VIF)	Mean VIF=1.39	-	None
	Normality of Residuals	Shapiro-Wilk test	Z =2.37	0.0088	No
II	Homoscedasticity	Breusch-Pagan	χ^2=10.73	0.0011	Yes
	Multicollinearity	Variance inflation factor (VIF)	Mean VIF=1.20	-	None
	Normality of Residuals	Shapiro-Wilk test	Z=1.395	0.0814	No
III	Homoscedasticity	Breusch-Pagan	χ^2=7.27	0.0070	Yes
	Multicollinearity	Variance inflation factor (VIF)	Mean VIF=1.41	-	None
	Normality of Residuals	Shapiro-Wilk test	Z=0.949	0.1712	Yes

Henceforth, Table 5 shows that the three regression models have no problem in regard to multicollinearity between pairs of independent variables, i.e., VIF<10 as the second diagnostic test. This implies no high occurrence of intercorrelations among independent variables in the said three models. Thirdly, the Shapiro-Wilk test and Kernel density estimate was employed to determine the normality of residuals of the three models (Mátyás & Sevestre, 2013). Result reveals that Model I and Model II possesses non-normal residuals. However, Kernel density estimate graphs show that it is almost normal. Moreover, the residuals of Model III are normally distributed . Hence, the three models are valid for extracting inference.

In the three regression models, socio-demographic profiles such as age, hometown, gender, and monthly family income are not significant predictors of the level of challenge in learning mathematics at a distance at a 5% level (Table 6). This indicates that these variables do not influence how they struggle in the learning process. In addition, independent variables related to distance learning such as availability of laptops, number of hours in studying, submission of outputs on time, and learning environment are not also causing some effect to the students' level of challenge at a 5% level of significance (Table 6). Likewise, the health aspect is not a significant factor in the level of challenge in learning mathematics at a 5% level. This result is not parallel to the findings of Zhai and Du (2020) that college students are being challenged due to diagnosable mental health disorders. Moreover, in the study of Alonzi et al. (2020), it is stated that physical health is declining due to inactivity, anxiety, and depression during the pandemic.

Table 6 shows that amount of money spent on the internet (weekly) is a significant predictor for the level of challenge in learning mathematics at a distance in the three models. It is highly significant at a 1% level in Model I. This implies that during the pandemic, students are anxious about money for their internet connectivity and school fees. Apparently, most family income is decreasing, and many parents are losing jobs due to health restrictions (Adhe et al., 2020). It is a challenge for every student to attend online classes and different school activities without money to buy internet load. Hence, the majority of the students prefer the asynchronous type of learning due to the financial aspect. Another reason is that, perhaps, students in the second semester are already exposed to synchronous learning in which they found no difference from the latter.

The model I shows that as the rating of signal internet strength increases, the level of challenge in learning mathematics also increases (Table 6). This result indicates that as students attend classes with good internet connectivity, they have dug into their teachers' learning activities and assessments. In that case, students can experience the logical nature of the subject and be challenged by some limitations in remote learning (Alea et al., 2020; Irfan et al., 2020).

Model II shows that coping with math anxiety influences their level of challenge in learning mathematics (Table 6). It is worthy to note that anxiety is defined as extensive tension or fear. It is found out in the study of Simorangkir et al. (2021) that students are experiencing high anxiety and depression during the COVID-19 pandemic, which is a hindrance to the effective learning process. Evidently, Mendoza et al. (2021) stated that mathematics anxiety is a disturbing factor affecting most college students' academic performance during the pandemic. Model III also reveals that a good rating for social relationships contributes to the challenge in learning (Table 6). During the lockdown, students stay at home and communicate with their friends through social media. However, the effect of social media on academic performance is adverse since it distracts the focus and concentration of students (Dontre, 2021). This implies that students are experiencing a challenge in learning if they are drawn to misuse the technology platform. Additionally, the three regression models reveal that a creative learning experience has contributed to the level of challenge in learning mathematics (Table 6). In creative mathematics learning, students construct knowledge relating to mathematical solutions and processing skills that develop their creative way of thinking (Tan et al., 2020; Batidor & Casinillo, 2021). Furthermore, Model I shows that learning mathematics is enjoyable yet challenging (Table 6). In the study of Risdiyanti and Prahmana (2020), it is stated that interesting teaching strategies and learning activities in mathematics will increase higher-order mathematical abilities, which results in an enjoyable acquisition experience.

Table 6. Regression analysis for the level of challenge and its predictors

Predictors	Multiple Regression Models					
	Model I		Model II		Model III	
	Coefficient[c]	*Std Error*[d]	*Coefficient*[c]	*Std Error*[d]	*Coefficient*[c]	*Std Error*[d]
Age of student *(in years)*	-0.2915[ns]	0.2132				
	(0.1740)	(-1.3700)				
Urban *(dummy variable)*					-0.3744[ns]	0.7581
					(0.6220)	(-0.4900)
Male *(dummy variable)*			0.0825[ns]	0.8534		
			(0.9230)	(0.1000)		
Availability of laptop(s) *(dummy variable)*	0.3991[ns]	0.7975	1.0143[ns]	0.8518	0.6468[ns]	0.8497
	(0.6180)	(0.5000)	(0.2360)	(1.1900)	(0.4480)	(0.7600)
Number of hours studying math lesson *(per week)*	0.0534[ns]	0.0509	0.0415[ns]	0.3845	0.0404[ns]	0.0368
	(0.2970)	(1.0500)	(0.2830)	(1.0800)	(0.2740)	(1.1000)
Amount of money spent for internet *(per week)*	0.0069***	0.0022	0.0054*	0.0031	0.0064**	0.0032
	(0.0020)	(3.1300)	(0.0820)	(1.7600)	(0.0440)	(2.0400)
Monthly Income of Family[a]			0.1305[ns]	0.3568		
			(0.7150)	(0.3700)		
Submission of Outputs *(dummy variable)*	-1.0061[ns]	0.8926				
	(0.2620)	(-1.1300)				
Internet Signal Strength[b]	0.3867*	0.2236			0.1758[ns]	0.2237
	(0.0860)	(1.7300)			(0.4330)	(0.7900)
Coping with Math Anxiety[b]			0.3772**	0.1871	0.3276[ns]	0.2050
			(0.0460)	(2.0200)	(0.1130)	(1.6000)
Learning Environment[b]			0.2771[ns]	0.2786		
			(0.3220)	(0.9900)		
Social Relationships[b]					0.6131**	0.2685
					(0.0240)	(2.8000)
Health Aspects[b]					-0.1068	0.2446
					(0.6630)	(-0.4400)
Learning Experience: Creative	1.5718***	0.2307	2.1828***	0.2533	2.0178***	0.2846
	(<0.0010)	(6.8100)	(<0.0010)	(8.6200)	(<0.0010)	(7.0900)
Learning Experience: Enjoyable	1.0907***	0.2358				
	(<0.0010)	(4.63)				
F-computed	30.3500		24.8400		32.9300	
p-value	<0.0010		<0.0010		<0.0010	
R-squared	0.6583		0.6057		0.6275	

Note: a - Philippine Peso (Php); b - Scale 1 to 10; c - p-value is enclosed with parenthesis; d - t-statistic is enclosed with parenthesis; *p<0.10; **p<0.05; ***p<0.01, ns-not significant

5.0. Conclusion

Results revealed that learning mathematics at a distance is a challenging experience for MMW students. This is due to the new learning environment brought by the pandemic. The new learning platform has many limitations and barriers that students make difficult to cope with. It is concluded in the regression models that some students are having difficulty in acquiring the latest technology and internet loads. This resulted in absences during class sessions and incomplete substance of the content knowledge of mathematics class. It is revealed that a good internet signal contributes to the level of challenge in learning mathematics. In other words, good access to online learning makes them active and penetrating to the class activities. However, students are experiencing difficulty understanding the lessons due to less interaction and proper guidance from instructors/professors. Additionally, students are facing some challenges since they are driven by anxiety and stress brought by the pandemic.

Moreover, learning at home and distraction from social friends are barriers that make learning mathematics difficult at a distance. In conclusion, teachers must show a positive and encouraging attitude towards their students. Additionally, teachers must also cultivate students' interest in learning mathematics by showing some real-life examples and activities. Furthermore, teachers must also consider the deadline of outputs and examinations. For future studies, one may consider students' self-efficacy and subjective well-being in learning mathematics at a distance to strengthen the information of the current study.

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