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ACADEMIC ACHIEVEMENT OF COLLEGE STUDENTS IN MATHEMATICS IN THE MODERN WORLD IN THE CHANGING NORMAL

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ABSTRACT

This descriptive and correlational study identified the academic achievement level in Mathematics in the Modern World of the first-year college students at the selected Catholic university in Negros Occidental during the changing normal. Respondents were grouped according to the college they are affiliated with and the strand they took during their senior high school. The researchers also compared the performance assessment of the students in the three sub-topics of the subject. Further, they determined the difference in the academic achievement level when respondents were taken according to their demographics. Findings suggested that the level of academic achievement in the course as a whole is only average, with the highest achievement in the most concrete subtopic, which is Patterns in our Word. Moreover, a significant difference in academic achievement was found according to the demographics and subtopics. Results served as the baseline data in the modification of instructional materials and in designing a training/seminar for the teachers of the subject to better address the learning gaps.

Keywords: Academic Achievement, Mathematics in the Modern World, Catholic University, College Students, Changing Normal, Demographics

1. INTRODUCTION

Mathematics is vital in societal development since it is the scientific and technological knowledge foundation [2]; however, poor mathematical achievement has always been a great issue across different countries [8]. Countries in sub–Saharan Africa and in the South Pacific can affirm the decline in students' learning competencies in mathematics despite the government and institutions' efforts to teach the course [8].

In addition, only some students have a propensity for mathematics academically compared to other subjects despite its usefulness [32]. No wonder it was noted that the Philippines landed 5th to the last out of 81 participating nations in the 2022 Program for International Student Assessment or PISA [21].

Students dislike mathematics because of its abstractness, meaning they need to appreciate the relevance of the subject matter in reality [45]. For instance, in a study, it was reported that 82% of the respondents did not like mathematics, and 75% believed that math is not an easy course due to equations and computations, which they can barely relate to practicalities [17].

Hence, Mathematics in the Modern World (MMW), as a General Education Course (GEC) with 3 units, was introduced as a by-product of the curricular reforms that were implemented concerning the Philippine Basic Education [34], which allow students to understand and value the applicability

of math [46]. It was integrated by the Commission on Higher Education into the tertiary curriculum core courses for the students to appreciate mathematics and to see its applicability in the real world [46].

Its features involve the new teaching contents (not the traditional mathematical bunch of formulae and solving), materials, and practices to amend the so-called poor state of teaching mathematics, which includes discussions on mathematics' nature, appreciation of its logical, relevant, and artistic dimensions, and applicability of mathematical skills in everyday life [46]. It was introduced as a prior general course for tertiary students in the Philippines in alignment with the K-12 implementation. Topics in this course include Mathematics and Patterns in our World, Language and Symbols of Math, Mathematical Logic, Mathematical Systems, Apportionment and Voting, and Mathematics of Graphs [9].

However, it was revealed that students' academic performance in MMW at Bukidnon State University, Philippines, is only fairly satisfactory, and they could have scored better and been better in the subject [34].

Furthermore, it was added that the learners' performance in MMW at the other selected state universities in the Philippines is also satisfactory [37], with the students experiencing some difficulties in the different topics, which can be anchored consequently to the students' low retention level in the said subject [2].

Likewise, it was noted that the increase in learning difficulty in mathematics was worsened by several years spent in online learning and any other modalities of distance learning, resulting in the students' poor mathematical foundation [43]. The amount of learning loss that learners continually suffer from brought about by the pandemic's disruption to the global education system is greatly emphasized [42]. Hence, it is anticipated that learners will continue to struggle in Mathematics as teachers and students, by the time of the peak of the pandemic, no longer share the same physical space when learning, causing the latter a poor mathematical foundation [7].

Nonetheless, little to no studies have yet exposed students' competency in the subject during the COVID-19 pandemic [19, 34]; hence, this study aimed to fill in a research gap by investigating the academic achievement of the college students in MMW at the selected Catholic university in Bacolod city, Philippines, in this new normal educational setup. Moreover, the difference in the academic achievement level when respondents are grouped according to their demographics namely the student's college department and senior high school strand was also investigated, as well as the difference in the academic achievement among the 3 chosen subtopics. Findings of this study served as the baseline data for developing an intervention plan in the form of a seminar workshop that included the communication of the significant findings of this study, innovation of instructional materials, and the collaborative making of MMW worksheets that take into consideration the learning diversity of the learners.

1.1 Statement of The Problem

The researchers sought to identify the academic achievement level among the freshmen tertiary students in Mathematics in the Modern World (MMW) during the changing normal at the selected Catholic university in Negros Occidental throughout the first semester of the academic year 2022-2023 in the areas of:

a. Mathematics and Patterns in our Natural World;
b. Mathematical Language and Symbols; and
c. Modular Arithmetic and its Applications

When respondents are treated as a whole and when categorized according to college and their senior high school strands.

Notably, the researchers sought to resolve the following questions:

1. Is the difference in the academic achievement level in MMW courses in the changing normal significant when respondents are categorized according to their demographics?
2. Is the difference in the academic achievement level in MMW course significant in the changing normal when categorized according to the above subtopics?

2. FRAMEWORK OF THE STUDY

The researchers assume that the student's academic achievement level in Mathematics in the Modern World significantly relates to their demographics, strand and college. The assumption is anchored on Carol Dweck's Incremental theory [10], asserting that a person's intelligence is malleable and changeable because it is fluid. Therefore, students' intelligence can increase through diligence, and failure to acquire knowledge is often attributed to their lack of effort [31].

Students who exert more effort on learning Mathematics by choosing a course of study related to it are more likely perform well due to their positive behavior towards Mathematics. Simply put, a person's intelligence is greatly affected by his effort to learn, his determination and resilience, and how much challenge he pursues in the future [20].

2.1 Level of Academic Achievement in Mathematics in the Modern World

Transitioning from high school to college is challenging for students, especially academically. Thus, low retention levels among college learners could be patterned despite the government's effort to boost students' performance, as evident in the K-12 curriculum. As predicted based on students' Grade Point Average (GPA), students will only tend to perform fairly in Mathematics in the Modern World, with their grade only more or less 83% [34].

Meanwhile, it was established through a research instrument that the respondents had slight difficulty on the different topics in the subject with an average performance [37]. With the changing normal due to the pandemic, there is a loss of mathematics learning among students as students spend less time studying the subject [39]. No wonder researchers projected the depreciation of overall mathematics achievement levels brought about by the struggles in distance education caused by the pandemic [36].

Further, although millions of students have already gone back to school in this changing normal as people cope with the pandemic [47], it is still undeniably a fact that learners' math learning today is still influenced by their prior knowledge in the subject, which they have barely acquired during the distant learning modality [11]. Likewise, there is a high percentage of learners who found learning from home ineffective, thus making the amount of learning gain questionable to the teachers [44]. This may cause a further decline in learning tertiary mathematics as it was emphasized that underachievement in mathematics is greatly linked to insufficient mathematical background from secondary education 14].

2.2 Demographics and Academic Achievement Level in Mathematics in the Modern World

The selection of students' course preferences is impacted by their basic and advanced mathematical abilities [25]. Students with higher or advanced mathematical skills are most likely to choose math-related programs, unlike those behind in math gain, who are most likely to pursue programs dealing less with mathematics [50].

Likewise, among the varied factors that affect mathematics achievement of the university students, self-engagement highly impacts learners' mathematical ability [5]. As further stated by the latter, students who obtained excellent academic achievement in mathematics during their high school endeavors normally land in scientific and technological itineraries like computer and engineering courses, while the obverse would tend to enroll in humanistic and social programs. Indeed, learners who are more confident in math take math-related courses and perform better in the subject [15].

The findings above also support the idea that students who are good at mathematics pursue STEM or Science, Technology, Engineering, and Mathematics strand and are well-equipped with their mathematical abilities. Researchers indicated that senior high school students enrolled in STEM due to their interest in fields related to science and mathematics; hence, they tend to perform mathematically better in college since they are intrinsically motivated and are extensively exposed to intensive math courses such as pre-calculus, trigonometry, and calculus before their higher education [33].

Likewise, in the comparison between STEM and non-STEM students' mathematical and reasoning abilities, it is worth noting that there is a significant difference in the Quantitative Literacy and Reasoning Assessment (QLRA) score in favor of the STEM students [12]. In addition, students from non-STEM strands who took supplementary math courses obtained a better score than those who have amateur abilities in mathematics.

Meanwhile, the performance of STEM and non-STEM graduates in tertiary education yielded no significant difference in mathematics, especially in problem-solving [41]. It was found that only a few of their respondents chose STEM because they were good in mathematics and science or wanted to explore more STEM-related fields later on [13]. Also, STEM may be problematic, especially if the learners cannot establish a connection between the relevance of topics and their intended career; hence, good competence in mathematics may only be true for some students of the said strand [29].

2.3 Level of Academic Achievement in Specific Areas in Mathematics in the Modern World

Philippine Commission on Higher Education or CHED proposed a syllabus for MMW, which consisted of 2 sections: mandatory and non-mandatory subjects [34]. Among the mandatory topics are Data Management, Mathematical Language and Symbols, Problem Solving, and Mathematics in our World. In contrast, the non-mandatory subtopics are Apportionment and Voting, Mathematics of Graphs, and Modular Arithmetic [9].

For first-year college students, MMW is a difficult subject, which is evident in their low mean scores, especially in the discussion on Mathematics in our World and Language and Symbols in Math [34]. This is because the learners start to dislike mathematics as it gets more abstract and involves more algebraic thinking [48].

In research findings, first-year students experienced slight difficulties on several subtopics in MMW. The top five topics that obtained the highest difficulty mean scores are the Fibonacci Sequence, Elementary Logic, Organization of Regularities and Patterns in the World, Characteristics of the Language of Mathematics, and Applications of Math in the real world [37].

3. METHODOLOGY

Descriptive-comparative research design was utilized in this study. Specifically, the design is being used to describe the distribution of one or more variables, disregarding any causal hypothesis [1], and then compare groups utilizing finding similarities and differences in an attempt to conclude

about them [35]. In terms of this study, the descriptive design determined students' academic achievement in MMW in the changing normal as a whole and grouped according to their demographics. On the other hand, the comparative design identified, analyzed and explained similarities and differences in the extent of academic achievement in MMW across the different groups and its sub-topics, which enabled the researchers to formulate conclusions about the population based on empirical evidence.

The participants were freshmen college students who took MMW course throughout the first semester academic year 2022-2023. Although there were six colleges in the selected Catholic university, the respondents of this research endeavor were chosen from only five colleges (Arts and Sciences; Accountancy, Business Administration, and Computer Studies; Engineering; Allied Health Medical Sciences; and Education) since students enrolled in the College of Criminal Justice Education were to take MMW in the next semester of the same school year. Non-freshmen students who took the course in the same semester were excluded from the population. The table below presents the distribution of the participants when they are categorized according to their demographics.

Table 1. Distribution of the Participants

Colleges	**Population**	**Sample**
Arts and Sciences (CAS)	215	61
Education (COEd)	163	45
Engineering (COE)	114	32
Allied Health Medical Sciences (CAHMS)	283	80
Accountancy, Business Administration, and Computer Science (CABACS)	207	59
Total	***982***	***277***

The researchers administered a self-made 2-part questionnaire to determine the phenomenon under study.

The preliminary part of the questionnaire aimed to gather the demographic profile of the samples, whereas the second part was comprised of 30 questions covering the identified 3 lessons tackled in MMW. The total number of items was divided into three selected topics in the syllabus: Mathematics and Patterns in the Natural World, Language and Symbols of Math, and Modular Arithmetic and its Applications. Before administering the research questionnaire, the researchers initially prepared a 45-item test, that underwent validity testing done by 5 experts in the field through content validity. The instrument yielded an "essential" rate for all test items. Item analysis and Kuder-Richardson (KR20) for reliability test then followed, establishing a reliability index of 0.737, indicating that the questionnaire is reliable.

Mean and Standard Deviation tests were utilized to find an answer to the general objectives. Since the data gathered was normally distributed upon the run of Anderson-Darling normality test with a p-value of 0.144, Analysis of Variance or ANOVA was utilized for the inferential problems.

4. RESULTS AND DISCUSSION

Academic Achievement in Mathematics in the Modern World in the Changing Normal

Table 2 below, presents the academic achievement level in MMW and its subtopics when respondents are treated as a whole and grouped according to their demographics. In Mathematics and Patterns in our World area, respondents from CAS obtained an "average" academic achievement level (M=6.97, SD=1.79). In contrast, students from the rest of the colleges obtained a "high" achievement level. When grouped according to strand, respondents obtained a "high" academic achievement level in the same subtopic. Meanwhile, in Mathematical Language and Symbols, respondents from all colleges got an "average" achievement level when grouped according to college.

According to strand, students from TVL obtained a "low" achievement level (M=4.63, SD=1.94), while the rest of the strands have an "average" achievement level. On the other hand, in the subtopic Modular Arithmetic and its Applications, respondents from CAS (M=4.97, SD=2.51) and CABACS (M=4.64, SD=2.81) obtained a "low" achievement level, while the rest of the colleges obtained an "average" level when grouped according to college. When grouped according to strand, students from GA (M=4.80, SD=1.93) and TVL (M=4.07, SD=2.39) obtained a "low" achievement level, while the rest of the strands have an "average" level.

Finally, when grouped according to college, the level of academic achievement in MMW of respondents from CoEd (M=19.29, SD=5.04) and CAMHS (M=20.45, SD=6.32) is "high" while the rest of the colleges have an "average" level. When grouped according to strand, the achievement level of students from STEM (M=21.24, SD=5.69) and ABM (M=20.35, SD=5.79) is "high" while the rest of the strands have an "average" level.

As a whole, the academic achievement level in Mathematics and Patterns in our World is "high" (M=7.61, SD=1.82) while "average" for both Mathematical Language and Symbols (M=5.83, SD=2.89) and Modular Arithmetic and its Applications (M=5.46, SD=2.69). In general, the academic achievement in MMW is average (M=18.90, SD=5.75).

Results show that when respondents are grouped according to college, students from the College of Arts and Sciences consistently obtained the lowest mean score in all areas and in Mathematics in the Modern World itself.

More mathematically advanced learners would also choose to pursue math-related programs in college due to their found significance and relevance of the subject [25], while those who do not perform mathematics well at the secondary level will choose not to study mathematics at all in college; hence, they would select courses with lesser mathematics [23].

On the other hand, when grouped according to strand, it can be noted that students who are STEM and ABM graduates are the top achievers in MMW and its subtopics. Indeed, ABM and STEM students are anticipated to perform better in mathematics than the rest of the other strands. Furthermore, STEM and ABM students in mathematics does not significantly vary [30], which is why students from both strands obtained close scores in the assessment.

Meanwhile, it is worth noting that the subtopic with the highest mean score is Mathematics and Patterns in our World, while the subtopic with the lowest mean score is Modular Arithmetic and its Applications. Of all the outlined discussions in the syllabus of MMW, the most liked subject matter of the students is Mathematics and Patterns in our World because the latter is found to be the most concrete topic which makes students appreciate that mathematics indeed is not about numbers and abstract concepts but could be instead about connecting them to the real world, especially with nature [4].

Also, among the topics in MMW, the most concrete is Mathematics and Patterns in our Natural World [34]. Hence, it can be said that Mathematical Language and Symbols and Modular Arithmetic are way more abstract than the former; ergo, students learn and appreciate more effectively what is less abstract to them [28].

Table 2. Academic Achievement in MMW as a Whole and according to Demographics

Variables	Mathematics and Patterns in Our Natural World			Language of Math			Modular Arithmetic			Academic Achievement in MMW		
	M	SD	Int.	M	SD	Int.	M	SD	Int.	M	SD	Int.
College												
CAS	6.97	1.79	A	5.18	2.19	A	4.67	2.51	L	17.11	5.22	A
CABACS	7.78	1.67	H	5.88	2.41	A	4.94	2.81	L	18.31	5.93	A
CAHMS	7.81	2.04	H	6.45	2.70	A	6.19	2.88	A	20.45	6.32	H
CoEd	8.09	1.68	H	5.76	2.43	A	5.44	2.01	A	19.29	5.04	H
CoEng	7.31	1.47	H	5.53	2.46	A	6.13	2.67	A	18.97	5.00	A
Strand												
GA	7.80	1.62	H	5.00	1.49	A	4.80	1.93	L	17.60	2.17	A
HUMSS	7.42	1.90	H	5.29	2.36	A	5.07	2.50	A	17.78	5.48	A
STEM	7.88	1.92	H	6.75	2.63	A	6.61	2.56	A	21.24	5.69	H
ABM	8.05	1.43	H	6.65	2.30	A	5.65	2.97	A	20.35	5.79	H
TVL	7.00	1.69	H	4.63	1.94	L	4.07	2.39	L	15.70	4.85	A
As a whole	***7.61***	***1.82***	***H***	***5.83***	***2.49***	***A***	***5.46***	***2.69***	***A***	***18.90***	***5.75***	***A***

Note: H=High, A=Average, L=Low

Difference in MMW Academic Achievement According to College and Strand

Analysis of variance was used in Table 3 to identify whether the academic achievement level in MMW course significantly varies when participants are categorized according to their college department. Findings reveal that the academic achievement level in MMW differs significantly when the participants are treated according to college [$F(4, 272)=3.232$, $p=0.013$]. Through Post hoc test, it was emphasized that the achievement level of students from CAHMS is significantly higher than that of students from CAS and CABACS.

It was indicated that students' program significantly affects their' mathematical proficiency level since when students choose their courses in college, they always tend to consider their mathematical and scientific abilities [18]. Hence, there is an already developed stereotype asserting that students who have proficient achievement in Math and Science would also land on math-related and medical [26], which explains why the academic achievement of CAMHS students is significantly higher than that of CAS and CABACS since respondents from CABACS were also mostly non-accounting students.

Table 3. Difference in Academic Achievement in Mathematics in the Modern World according to college

College	M	F	df	p
Arts and Sciences	17.11_a (5.22)	3.232*	4 272	0.013
Accountancy, Business Administration, and Computer Studies	18.31_a (5.93)			
Allied Medical Health Sciences	20.45_b (6.32)			
Education	19.29 (5.04)			
Engineering	18.97 (5.00)			

Note: the difference in the means is significant when $p \leq 0.05$
means that share a letter are not significantly different

Analysis of variance was used in Table 4 to calculate whether the academic achievement level in MMW significantly differs when students are grouped according to strand. Results show that the academic achievement level in MMW significantly varies when students are categorized according to their strand [F(4, 272)=9.582, p=0.000]. It was revealed through post hoc test that the achievement level of students from TecVoc is significantly lower than that of students who took HUMSS, STEM, and ABM.

It is supported by a researcher asserting that the senior high school strand is significantly associated with student performance in tertiary mathematics [40]. The latter added that strands that expose more students to mathematics (like STEM and ABM) are more likely to produce mathematically inclined students in the future. Furthermore, the mathematical competency of students from the TVL strand is also significantly lower than the other strands since the curriculum of the former focuses more on skills that are relevant to livelihood and technical projects of the students; therefore, mathematical theories are far offered [30].

Table 4. Difference in Academic Achievement in Mathematics in the Modern World according to Strand

Strand	M	F	df	p
General Academics	17.60 (2.17)	9.582*	4 272	0.000
Humanities and Social Sciences	17.78_a (5.48)			
Science, Technology, Engineering, and Mathematics	21.24_a (5.69)			
Accountancy, Business, and Management	20.35_a (5.79)			
Technological-Vocational and Livelihood	15.70_b (4.85)			

Note: the difference in the means is significant when $p \leq 0.05$
Means that share a letter are not significantly different

Difference in the Academic Achievement in MMW according to its Subtopics

Analysis of variance was used in Table 5 to test whether the academic achievement level in MMW significantly varies according to its subtopics. The difference in the academic achievement according to the different topics is significant [F(2, 274)=127.488, p=0.000]. Post hoc test

established that the achievement level in the three subtopics is significantly different from one another.

the most liked subtopic of the students in MMW is Mathematics and Patterns in our Natural World, while one of the most disliked is Mathematical Language and Symbols [4].The researchers added that students appreciate the former more because it is the most relevant to the real world. In contrast, the latter is found to be more on the bulk of symbols and expressions, which is difficult for the students to learn and eventually appreciate. Thus, this explains the significant gap in the students' achievement scores in the aforementioned topics, as students, especially the low-achieving ones, tend to lose interest in abstract concepts [49].

On the contrary, students scored significantly the lowest in Modular Arithmetic and its Applications because it is the only subtopic that the handlers of Mathematics in the Modern World taught online due to time restraints. This may due to the fact that some students need access to a desirable online learning setup in an online environment, and the learning process could be easily disrupted by noise and technical difficulties [6].

As further added by the latter, it is natural for the students to not effectively learn mathematics online because some students, especially the non-achievers, cannot learn asynchronous course materials on their own, without or with minimal aid from the teacher.

Table 5. Difference in the Academic Achievement in MMW according to its Subtopics

Topics	M	F	df	p
Mathematics and Patterns in Our World	7.61_a	127.488*	2	0.000
	(1.82)		274	
Mathematical Language and Symbols	5.83_b			
	(2.49)			
Modular Arithmetic and its Applications	5.46_c			
	(2.69)			

Note: Difference is significant at $p \leq 0.05$
Means that don't share a letter are significantly different

5. IMPLICATIONS

Results show that the academic achievement in MMW is only average. Therefore, it implies that the students need to explore the applications of the said subject further. Furthermore, the researchers suggest a discernable difference in the academic achievement level according to college and strand in favor of CAMHS and STEM, respectively. Ergo, students' performance in tertiary mathematics is affected by their secondary education math standing since it is also suggested that students exposed more to Math perform better in the subject and tend to proceed to math and science-related subjects in college.

This also implies that Math teachers, especially at the lower levels, play a vital role in the students' competency as they must ensure that mathematical foundations are well-taught to the learners so that they are well-equipped to learn the subject further. Finally, the above findings established the significance of the mean differences among the three subtopics in favor of Mathematics and Patterns in Our World.

This result implies that students learn concrete topics better than abstract ones (Language of Mathematics and Modular Arithmetic). Likewise, Modular Arithmetic scored significantly the lowest since the lesson was mainly delivered online with limited discussion. Hence, learning online is less effective as students cannot clarify their questions and address their learning difficulties asynchronously.

Finally, the overall academic achievement level of the tertiary students in MMW, which is only average, continually challenges the educational institutions of different levels to strive more on improving the teaching quality offered to the learners. With the increased learning loss of the students especially in the advent of the pandemic, schools must work hand in hand with the rest of the stakeholders for the students to be more competent in learning what is necessary.

Mathematics is one of the most essential subjects which every student must be well-equipped with. With the increasing challenges in delivering an efficient teaching instruction for an effective learning experience, schools as well as the government must be innovative enough to cater learning diversity and to hurdle academic adversities.

6. CONCLUSION

From the above findings, the academic achievement level of the freshmen tertiary learners in MMW is only average, and students obtained the highest mean score on the topic Mathematics and Patterns in our Natural World.

The topics in the subject have to be more effectively taught by further improving the course materials, using effective teaching-learning strategies, and making the discussions more relatable to the real world to foster student appreciation.

Moreover, further results affirm that academic achievement in MMW varies significantly when participants are grouped according to their college department and senior high school strand. Thus, students' mathematics standing during their secondary education years significantly impacts their learning in tertiary mathematics because one of the factors students consider in choosing their program in college is their mathematical and scientific competencies.

Hence, students from a certain program would either perform fairly or proficiently in mathematics because they chose the program to avoid math or to enhance and eventually apply their mathematical and scientific literacy, respectively.

Finally, the above results suggested a significant difference in academic achievement according to the three subtopics in Math in the Modern World in favor of Mathematics and Patterns in our World. Therefore, students learn more effectively what they find is more relevant and applicable to their lives.

RECOMMENDATIONS

With the above findings, the researchers recommend that students widen their appreciation of what Mathematics in the Modern World could offer them. Furthermore, the students must be vocal in posing questions and providing feedback to the teachers so that the latter would know how to improve their teaching strategies in addressing learner differences.

It is also recommended that math teachers provide lesson examples that are related and relevant to the student's respective programs so that they can relate to and appreciate the subject content. They are also encouraged to present adequate instructional materials that further focus on the subtopics in Mathematics in the Modern World, which the learners perceive as difficult. Meanwhile, book

authors should consider significant findings in studies on MMW in designing a more comprehensive and enhanced textbook that better addresses the learning gaps identified by the researchers.

Finally, other researchers are encouraged to conduct similar studies in Mathematics in the Modern World in a larger scope. The latter may also explore students' attitudes and learning styles toward learning MMW, or may examine the effectiveness of a specific teaching interventions on academic outcomes.

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