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Learning Style and Performance in Mathematics of Senior High School Students Using Online Blended Learning Modality

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Abstract. Teaching and learning mathematics are a significant concern in any educational system and became more challenging during the pandemic when an online, blended learning modality is being implemented. Hence, this descriptive-comparative-correlative research study sought to determine the dominant learning style and level of performance in general mathematics of the 222 senior high school students using online, blended modality during the school year 2021-2022 when they are grouped according to sex and tracks. The researcher made use of a standardized Learning Style inventory and a researcher-made test questionnaire which has a content-validity index of 1.00 indicating a high validity and a Cronbach's alpha of 0.901 which indicates a very high reliability. Results showed that the dominant learning style of the Grade 11 students is auditory, while their performance level in General Mathematics is average; there is a significant difference in their performance in General Mathematics when students are grouped according to tracks; and there is no significant difference between the learning style and level of performance in General Mathematics of the senior high school students [X^2 (220)=0.335,p=0.656]. Thus, students' learning styles is not a sole factor on how well they perform in general Mathematics. There might be other aspects such as study habits, math anxiety, grit, and the like which can be further investigated by future researchers.

Keywords. Education, learning styles, general mathematics, descriptive-comparative-correlational design, Philippines

1. Introduction

While it is undoubtedly one of the most dreaded subjects, mathematics remains a significant focus from elementary to higher education and unquestionably remains an integral component of one's daily life. Over the years, many researchers conducted scientific and educational studies to identify potential explanations for students' mathematical success. One of these causes is their preferred learning style.

According to the learning styles principle, each learner has a preferred method for ingesting and comprehending new information [1]. In education, these preferences are divided into four groups: visual, auditory, tactile, and kinesthetic. According to this notion, students will learn more effectively if taught in a way that suits their preferences.

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Moreover, due to the coronavirus 2019 (COVID-19) illness, the Department of Education adjusted how instruction was delivered to continue offering education to all students despite the pandemic. Thus, it challenged the learners to comprehend the most dreaded subject in various forms of delivery of instruction, such as blended and distance learning modes via printed or digital modules, online learning resources, and radio and TV-based instructions [2].

Awareness of the learners' learning style and their level of performance in General Mathematics would benefit both the learners and the teachers to improve the teaching and learning experience. This study sought to identify the learners' learning style and performance in General Mathematics in the new normal.

2. Statement of the Problem

The study determined the dominant learning style and level of performance in general mathematics of senior high school students using an online, blended modality during the school year 2021-2022 when they are grouped according to sex and tracks.

Specifically, it sought to answer the following questions:

a. Is there a significant difference in the learning style of senior high school students when they are grouped according to sex and track?
b. Is there a significant difference in the level of performance in general mathematics of senior high school students when they are grouped according to sex and tracks?
c. Is there a significant relationship between learning styles and performance in general mathematics?

3. Hypotheses

a. There is no significant difference in the learning style of senior high school students when they are grouped according to sex and track.
b. There is no significant difference in the performance in general mathematics of senior high school students when they are grouped according to sex and tracks.
c. There is no significant relationship between learning styles and performance in general mathematics.

4. Review of Related Literature

4.1. Learning styles. The term learning styles refers to the understanding that every student learns differently. According to Fleming (2011), learning styles are the preferred ways that individuals in society or pupils like to receive and impart information. Additionally, Brown [3] describes learning styles as how people process information in a learning environment. Moreover, learning style preference refers to the decision to favor one condition over another. Learning styles are the general methods students employ to study a new language or any other subject, such as global or analytic, auditory or visual [4]. Some definitions of learning style include the distinctive cognitive, affective, social, and physiological responses that are generally consistent indications of how learners perceive, interact, and respond to the learning environment [5].

4.2. Performance in General Mathematics. Performance, specifically academic performance, is measurable at any time [6]. Performance is a person's observable or measurable behavior in a particular situation [6]. Performance measures the aspect of behavior that is observable at a specific event and is measured by a performance test. For instance, a student's performance in General Mathematics entails behavior that may be observed and measured in the subject. It consists of results from the teacher's tests or exams obtained at any given moment.

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Students' grades on quizzes, regular exams, performance tasks, and other assessments make up their overall performance [6]. The general hypothesis is that individuals will learn more effectively if they receive instruction in their chosen modality (visual, aural, or kinesthetic) [7]. Therefore, "verbalizers" or verbal learners will perform better academically if they are given verbal instructions, while "visualizers" or visual learners will perform better if the knowledge is provided visually [8]. Gjolami and Bgheri [9] discovered an excellent correlation between 102 students' problem-solving and VAK learning preferences. Teachers in the United Kingdom agreed that pupils learn better when they receive information in their preferred learning style, according to a Dekker study conducted in 2012 [21].

4.3. Learning Style and Performance in General Mathematics. In a study on learning styles and academic achievement among secondary students by [6] at the University of Nairobi, it was discovered that multiple-style learners—those with bimodal and trimodal learning preferences—were more prevalent than those who chose a single learning style (visual, auditory, and kinesthetic). This study also discovered a link between secondary school student's academic achievement and their preferred learning techniques. – include all cited sources in the references. These claims are supported by the current study, which highlights the benefits of adopting various teaching styles and techniques in the classroom. This study found that when lessons are presented in a way that is appropriate for each student's learning style, both low achievers and average students perform better on standardized achievement tests. According to the study, low achievers' poor memory is caused by weak auditory memory. Low student accomplishment results from students' inability to retain information from lectures, conversations, or reading, particularly in a typical classroom where professors predominate, and students primarily listen to or read. Teachers who use novel teaching techniques need to know this knowledge to succeed [6].

5. Theoretical Framework

This study theorizes that learning influences academic performance, focusing on the learner, not the teacher.

This study is anchored on Neil D. Fleming's VARK or VAK model of learning style theory, one of the most popular and commonly applied theories in learning styles [1]. According to Fleming, students can enhance their learning by concentrating on the mode that benefits them the most by using the VAK model to find their favorite learning style [6]. In other words, the learning styles hypothesis holds that learning is increased when learning styles and instructional models are matched. For the VAK/VARK models, this would include tailoring training to students' sensory functions; for example, a visual learner would receive visually focused instruction, an auditory learner would receive verbal instruction, and so on. [10].

According to Wickramsinghe and Hettiarachchi [11], the VAK theory is now a favorite of the accelerated learning community because its principles and benefits extend to all types of learning and development, far beyond its early applications.

The three primary sensory receptors—vision for visual learning, hearing for auditory learning, and touch for kinesthetic learning—are the foundation for the visual, auditory, and kinesthetic learning styles. Others have enhanced the VAK model by adding "reading," now known as VARK, and "tactile," making it VAKT. Still, others have combined the terms, creating VARKT [1].

Learners receive and learn new knowledge and experiences through all three modalities. However, according to the VAK theory, typically, one receiving technique predominates. This

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dominant style identified the most effective way for a person to learn new knowledge, although it may only apply to some or even most tasks. Depending on the learning activity, the learner may select a single learning style or a combination of styles [1]. Individuals can determine the learning most effective when they know their chosen learning style(s). Knowing one's learning style enables him or her to select the most effective learning methods [12].

6. Conceptual Framework

Figure 1 describes the study's conceptual framework inspired by the Fleming VAK model but includes a tactile learning style; hence, the VAKT model.

The model shows that the independent variables, which are the senior high school students' sex and track, were identified to determine their level of mathematics performance in General Mathematics and their preferred learning style, namely visual, auditory, kinesthetic, or tactile, when taken as a whole and grouped according to the variables mentioned earlier.

The student's preferred learning styles, visual, auditory, kinesthetic, or tactile, were determined using a standardized Learning Style inventory. The performance in general mathematics was analyzed using their quiz results on the General Mathematics assessment tool, which underwent validity and reliability testing.

As presented in the diagram, the researcher used the results of both the learning style and the level of performance in general mathematics to formulate instructional materials appropriate to the learners' learning styles to aid teachers in improving their teaching strategies and methods to understand General Mathematics better.

Moreover, the diagram shows a connection between the instructional materials and the respondents, for these will greatly benefit not only the teachers but also the students.

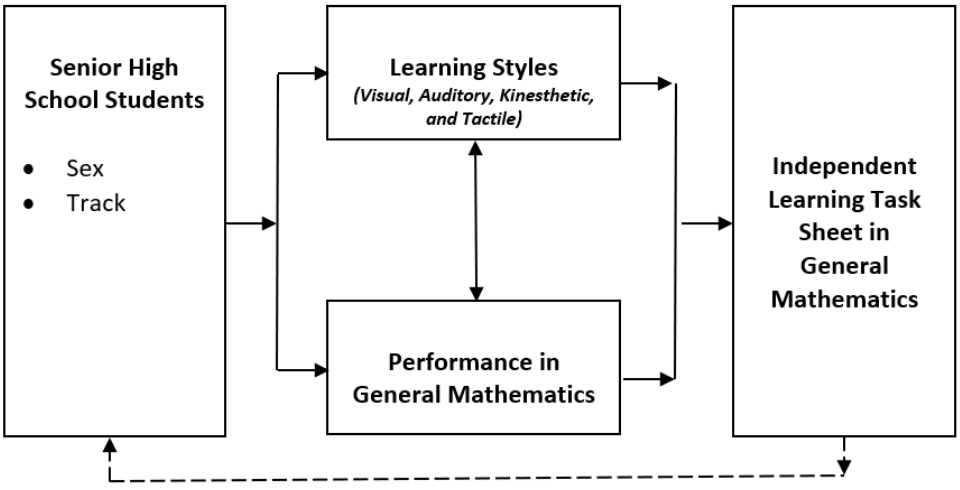

Figure 1. Conceptual Model

7. Methodology

This study utilized descriptive and comparative research design in determining the dominant learning style and the level of performance in General Mathematics of the senior high school students in the new normal.

It also used correlational research design to identify if there is a significant relationship between the student's learning style and level of performance in General Mathematics.

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Two hundred and twenty-two (222) respondents participated in this study. These respondents answered two research instruments: a standardized learning style instrument and a researcher-made questionnaire which underwent validity having a 1.00 Content Validity Ratio indicating very high reliability and reliability testing having 0.901 Cronbach's Alpha which means it has very high reliability.

Descriptive analysis was employed utilizing appropriate statistical tools. The Chi-square test for independence was employed to determine the significant difference in the learning styles of senior high school students when grouped according to sex and track. The Mann-Whitney and Kruskal-Wallis were used to determine the significant difference in the performance in General Mathematics of senior high school students when grouped according to sex and track. The Chi-square test for Association was used to determine the significant relationship between the learning styles and performance in General Mathematics.

8. Result

8.1 Profile of the Respondents. Table 1 presents the demographic profile of the respondents, identified using stratified random sampling. The respondents were grade 11 students enrolled in a Catholic university during the school year 2021-2022.

Out of 514 grade 11 students, 222 participated in this study. Forty-four and six-tenths percent (n=99) were males, and 55.4% (n=123) were females.

When students' chosen track is considered, most of the students were from the STEM track, which is 74.8% (n=166) of the respondents. Those who took ABM are 14.0% (n=31) of the respondents; HUMSS is 6.8% (n=15); and TVL is 4.5% (n=10).

Table 1. Demographic Profile of the Respondents

Variables	f	%
Sex		
Male	99	44.6
Female	123	55.4
Track		
ABM	31	14.0
HUMSS	15	6.8
STEM	166	74.8
TVL	10	4.5
Total	***222***	***100.0***

8.2 Dominant Learning Styles of Senior High School Students. able 2 shows the dominant learning styles of senior high school students. Results show four (4) categories of learning styles of senior high school students: unimodal, bimodal, trimodal, and multimodal.

For the unimodal category, more senior high school students use auditory learning styles (f = 77) in learning mathematics, followed by students using visual learning styles (f = 43). As for the bimodal category, most students use visual-auditory learning styles (f = 12), while for the trimodal category, students use visual-auditory-tactile (f = 15) learning styles. Lastly, twelve (12) students use all learning styles in the multimodal category.

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Table 2. Dominant Learning Styles of Senior High School Students

Learning Style	f	%
Unimodal		
Visual	43	19.4
Auditory	77	34.7
Tactile	17	7.7
Kinesthetic	17	7.7
Bimodal		
Visual - Auditory	12	5.4
Visual - Tactile	5	2.3
Visual - Kinesthetic	5	2.3
Auditory - Tactile	8	3.6
Auditory - Kinesthetic	2	0.9
Tactile - Kinesthetic	4	1.8
Trimodal		
Visual - Auditory - Kinesthetic	4	1.8
Visual - Auditory - Tactile	15	6.8
Auditory - Tactile - Kinesthetic	1	0.5
Multimodal		
Visual - Auditory -Tactile - Kinesthetic	12	5.4
Whole	***222***	***100***

8.3 Performance in General Mathematics of Senior High School Students. Table 3 shows that students have an "average" level of performance in general mathematics when taken as a whole (M = 9.83, SD = 4.98).

Both male (M = 9.18, SD = 4.90) and female (M = 10.36, SD = 5.00) students have an "average" level of performance in general mathematics.

Meanwhile, when the students were grouped according to tracks, students under the tracks of ABM (M = 10.06, SD = 5.00) and STEM (M = 10.34, SD = 5.02) showed an "average" level of performance in general mathematics. However, students under the tracks of HUMSS (M = 7.07, SD = 3.22) and TVL (M = 4.90, SD = 1.66) showed a "low" level of performance in general mathematics.

The result of this study agrees with the findings of Syamsuri et al. [13] that the grade 11 students' mathematics achievement is generally in the medium (or average) category.

Table 3. Level of Performance in General Mathematics of Senior High School Students

Variables	N	M	SD	Interpretation
Sex				
Male	99	9.18	4.90	Average
Female	123	10.36	5.00	Average
Tracks				
ABM	31	10.06	5.00	Average
HUMSS	15	7.07	3.22	Low
STEM	166	10.34	5.02	Average
TVL	10	4.90	1.66	Low
Whole	***222***	***9.83***	***4.98***	***Average***

Note: Mean Scale; 0.00 – 4.00 Very low, 4.01 – 8.00 Low, 8.01 – 12.00 Average, 12.01 – 16.00 High and, 16.01 – 20.00 Very high

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8.4 Difference in the Learning Styles of Senior High School Students when they are Grouped according to Sex and Tracks. Table 4 used Chi-square to analyze the difference between students' dominant learning styles when grouped according to sex and tracks. The findings of this study revealed that when grouped according to sex, the student's dominant learning style does not show a significant difference. The study of Cabual corroborates this finding [14] that the students' sex does not have a substantial difference with their learning styles. When determined, the learning styles of males and females yielded no significant difference.
However, in the study of Dobson [15], the learning style most preferred by the respondents showed a significant difference they were grouped according to sex.
The same results were obtained when learners' learning styles were categorized by the chosen tracks. This finding implies that the learners' preferred tracks do not impact their learning preferences. The findings of this study are corroborated by the study by Cabual [14], which found no significant differences in the student learning styles when they were classified according to the various tracks or fields of expertise.

Table 4. Difference in the Learning Styles of Senior High School Students when they are Grouped according to Sex and Tracks

Variables	X^2	*df*	*p*
Sex	49.267	39	0.126
Tracks	11.672	13	0.555

8.5 Difference in the Level of Performance in General Mathematics of Senior High School Students when they are Grouped according to Sex and Tracks. Table 5 shows no significant difference in the level of performance in General Mathematics of senior high school students when grouped according to sex. Meanwhile, there is a significant difference in the level of performance in General Mathematics of senior high school students when grouped according to tracks.

According to some studies, boys typically perform better on arithmetic examinations than girls, especially when the latter requires higher-level cognitive activities [16]. Also, according to Alova and Alova [17], female students performed much better academically than male students in general mathematics.

Contrary to popular belief and their findings, there is no significant difference in the math performance of male and female pupils in this study. The outcome suggests that pupils of both sexes are equally skilled in mathematics and do not suggest that one does better. Therefore, sex cannot predict how well a student will succeed in mathematics. This finding is corroborated by Capinding [18], who found no association between high school students' arithmetic achievement and their sexual orientation.

Regarding the tracks, Alova and Alova [17] supports the finding of this study. It also concurs with Tamayo's study [19], which suggested that graduates from the academic track performed better in mathematics than graduates from the TVL program. The result of this study is consistent also with Mamolo's research [20], which showed a significant difference in the students' general mathematics proficiency of those in the TVL and academic tracks.

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Table 5. Difference in the Level of Performance in General Mathematics of Senior High School Students when they are Grouped according to Sex and Tracks

Variables	M	U / X^2	df	p
Sex				
Male	9.18	5267.5		0.083
Female	10.36			
Tracks				
ABM	10.06			
HUMSS	7.07	6.054*	2	0.048
STEM	10.34			
TVL	4.90			

*Note: *p < 0.05*

8.6 Post hoc Analysis on the Difference in the Level of Performance in General Mathematics of Senior High School Students when they are Grouped according to Tracks. In Table 6, Post hoc analysis was utilized. It shows that students in the TVL track differ from students in ABM and STEM tracks, with differences of -5.16 and – 5.44, respectively. In addition, students with the HUMSS track differ from students with the STEM track, with a mean difference of – 3.27.

The findings of this study revealed that between TVL and ABM, ABM students perform better in General Mathematics. Between TVL and STEM, STEM students perform better in General Mathematics. Moreover, between the HUMSS and STEM students, the result of this study shows that STEM students perform finer than the HUMSS.

Table 6. Post hoc Analysis on the Difference in the Level of Performance in General Mathematics of Senior High School Students when they are Grouped according to Tracks

Sample 1-Sample 2	Mean Difference	SE	Std. Test Statistic	Sig.
TVL-HUMSS	- 2.17	26.125	1.004	0.315
TVL-ABM	- 5.16	23.273	2.703	0.007
TVL-STEM	- 5.44	20.837	3.257	0.001
HUMSS-ABM	- 2.99	20.127	1.822	0.069
HUMSS-STEM	- 3.27	17.253	-2.413	0.016
ABM-STEM	- 0.28	12.521	-0.397	0.692

8.7 Relationship between the Learning Styles and Performance in General Mathematics. Table 7 shows no significant relationship between the senior high students' learning styles and their performance in General Mathematics.

A student's learning style does not strongly influence their ability to perform well in mathematics. In other words, regardless of a student's preferred learning style, they have an equal chance of performing well in mathematics.

This result could have important implications for educators. A one-size-fits-all approach to teaching mathematics may be effective for all students, regardless of their learning style preferences. However, it is essential to note that this conclusion is only valid for the specific sample of students and learning styles studied.

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Table 7. Relationship between the Learning Styles and Performance in General Mathematics

Variables	X^2	df	p
Learning Styles Performance	0.335	220	0.656

9. Summary

The dominant learning style of senior high school students is auditory learning, and they have average performance in general mathematics. There is no significant difference in the learning styles when grouped according to sex and tracks. There is no significant difference in the level of performance in general mathematics when grouped according to sex, but when grouped according to tracks, there is a significant difference. There is no significant relationship between learning style and level of performance in general mathematics.

This study theorized that learning styles influence performance in mathematics. However, in this study, the theory presented was rejected since the results showed no significant relationship between the preferred learning style of the learner and their level of performance in general mathematics. Some studies support the findings of these studies as well as those that contradict them. However, knowing the dominant learning style of the learner cannot harm them. They could benefit from it significantly or insignificantly. That is why teachers should still find ways to deliver math lessons so that the learners can better understand, esp. now in the new normal.

10. Conclusion

Based on these results, learning style is not the sole factor in learners' performance in mathematics. There might also be some factors that need to be explored and studied upon, such as self-concept, anxiety, self-efficacy, and study habits.

11. Recommendation

The researchers recommend still letting the teachers continue to enhance and update teaching pedagogies to match the learners' learning styles and create learning activities relevant to the learners' needs, whether face-to-face, online distance learning, modular distance learning, and the like. Moreover, consider factors determining the students' mathematics performance in the new normal (such as math anxiety, math self-efficacy, motivation, and the like). Creating podcasts or recording videos to meet the learners' needs is also recommended.

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