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Multivariate Analysis on The Effect of Grade Level and Sex on The Learning Motivation in Mathematics Among Junior High School Learners

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ABSTRACT: This paper examined the effect of the learner's grade level and sex on their learning motivation in mathematics. The study adapted the Mathematics Motivation Questionnaire (MMQ) and was administered to 159 junior high school students in Siquijor State College. The data were analysed using the Statistical Package for Social Sciences (SPSS) version 21. Multivariate Analysis of Variance (MANOVA) was used to determine whether multiple levels of independent variables on their own or in combination with one another influence the dependent variables. Results of the study revealed significant effect of grade level and sex on the student's learning motivation in mathematics. Likewise, the study elaborated that the combined effect of grade level and sex is statistically significant. The study recommends for the development of interventions and educational policies that foster a positive learning experience and encourage a lifelong appreciation of mathematics, regardless of grade level and sex.

KEYWORDS: learning motivation, age, grade level, intrinsic value, test anxiety

INTRODUCTION

In today's technologically advanced society, Mathematics is considered the backbone of modern science making it a remarkably efficient source of new concepts and tools to understand the complexities of the modern societies. However, despite its significance and relevance, mathematics remained the killer subject that many students in the secondary level hated, struggled and even avoided. As possessing mathematical skills is essential, the need to design instruction to make students motivated in learning mathematics and foster positive learning experience is deemed necessary, but remained fundamental challenge among educators in science, technology, engineering, and mathematics (STEM) disciplines (Wigfeld, Tonks, & Klauda, 2016).

Overwhelming evidences from previous research studies highlighted the crucial role of motivation in learning mathematics. Renninger & Hidi (2019) revealed that motivated students are more likely to invest effort toward mastering the material, employ effective self-regulation strategies, persist in the face of challenges, and demonstrate higher levels of achievement. Prior research indicated that motivation, as a resource, provided the energy which fueled the learners to persevere and complete activities (Ryan and Deci, 2017) and sparked students' interests in a variety of academic areas (Smith et al.,2012). In addition, learners that are motivated are more likely to complete a task or activity to the end and succeed in it, regardless of how difficult or challenging it may be (Gopalan et al., 2017).

The level of motivation to learn and excel in mathematics varies among individuals as influenced by myriad of factors, including grade level and sex. Learner's grade level, being a significant factor can have a profound impact on learning motivation in mathematics. As the students continue to progress through different stages of their academic journey, their cognitive abilities, emotional development, personal interests, likewise, evolved. Learners in lower grade levels exhibit a natural curiosity and eagerness to learn mathematics while learners from higher grade levels faced increased academic pressures and shifting priorities that can affect their motivation levels to learn mathematics. Furthermore, sex difference in learning motivation in mathematics is equally crucial. Previous researches provide evidence to show biases associated with mathematical ability based on sex. These biases impact students' self-perception and beliefs about their capabilities in mathematics, subsequently influencing their motivation to engage in the subject. Hence, exploring whether there are inherent differences in the learning motivation between male and female students can help debunk these biases and promote equal opportunities for all learners in mathematics education.

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This research was aimed to examine the effect of grade level and sex on the learning motivation in mathematics among junior high school learners. Ultimately, understanding how grade level and sex influences with learning motivation in mathematics can guide educators in designing motivational strategies that tap into student's unique characteristics and learning preferences, and encourage a lifelong appreciation of mathematics.

LITERATURE REVIEW

Learning Motivations in Mathematics

Motivation can be described as the process by which goal-directed behaviour is initiated and maintained (Cook and Artino, 2016). Motivation to learn can be fostered from the internal or external or both. Evidence from past studies revealed many factors that can motivate learners to engage in mathematics such as utility value (Vaara et al.,2021), intrinsic value (Yunos et al., 2021), self-efficacy (Heffernan et al., 2020), and self-regulation (Alzahrani, 2022). On significant study conducted by Vaara et al (2021) showed that students had a special interest in learning Mathematics. The study indicated that the students desire to learn mathematics is personally driven especially when they believe that Mathematics is important to their future academic endeavors. As a result, it becomes the push factor to always work hard to achieve excellent results in Mathematics. Meanwhile, Yunos et al (2021) found out that intrinsic value as driver in learning mathematics. The finding of the study elaborated that learners' desire to learn Mathematics was influenced by how much importance they gave to the learning process.

Moreover, on a different but more relevant context, educators also play a big role to influence students' motivation in learning mathematics. A study highlighted that students are interested to study mathematics if the educators actively facilitate them since mathematics requires problem-solving skills (Heffernan et al., 2020) and supplemented by the innovative strategies used by the educators while teaching Mathematics (Alzahrani, 2022). The support that educators should provide is necessary because when educators are playing their role, students tend to feel excited to solve the question until they are finally confident that they can figure out the question on their own. Similarly, the metacognitive strategies used help to boost learners' confidence in their skills and eventually make them feel they can successfully manage their learning. As a result, these skills help students perform better in mathematics class.

Grade Level and Sex Difference in the Learning Motivations in Mathematics

Research has confirmed gender differences in mathematics self-concept, self-efficacy, and interest, suggesting that boys generally have better motivational profiles in mathematics than have girls (Costes et al., 2008). Another study found out that girls were significantly more likely than boys to fall into the utility profile or low-motivation profile (Lazaridez, 2014). According to previous research (Guo et al., 2015; Ganley and Lubienski, 2016), girls report lower levels of individual interest and perceived mathematics competence. The most significant differences are in secondary school and university students rather than students in lower educational levels. Overall, students' motivations was found to be high and majority of the respondents were in the high level for effort but were only moderate for self- efficacy. Significant difference was established in overall motivation scores between the female and male respondents, but not for the subscales effort, self-efficacy and worry

On the contrary, the recent study of Ulfah, Akmalia, & Jusra, (2023) indicated that students' learning motivation in mathematics was in the high category. However, there was no significant difference in the motivation of learning mathematics students. It was also established that students' age had a significant effect on the student's academic performance and students' age had no significant effect on the academic motivation (Rodríguez, Regueiro , Piñeiro, Estévez, and Valle, 2020).

Taking into account difference in motivation of students in different grade levels, research has shown that as children progress in grade level, their interests in learning, particularly mathematics, fade away (Otoo et al., 2018). Another study indicated that statistically significant differences in 8th grade and 9th grade as to learning motivation in terms of self-efficacy, but there are no differences in either value or cost. Futhermore, motivational differences are not given in any scale in 9th grade (Gasco, Gone, Villaroel, 2013).

MATERIALS AND METHODS

Research Design

The study was a quantitative research which employs descriptive causal-comparative research design. Hussain (2019) elaborated that the causal-comparative research design is the best approach to be used for comparing two or more groups to find the differences or determine whether the independent variable influences dependent variable. In this study, the researcher determined how the grade level and sex affect the student's learning motivation in mathematics in terms of intrinsic value, self-regulation, self-efficacy, utility value, and test anxiety.

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Research Locale & Respondents

The study was conducted in Siquijor State College specifically in the Junior High School Department. The respondents of the study include the junior high school learners enrolled during the academic year 2022-2023. These learners are from varying grade level from grade 7 to grade 10. The respondents of the study were selected based on proportionate random sampling and only those students with complete grades from 1st quarter to 3rd quarters were qualified to participate in the study. The study focused on secondary students because decreases in mathematics motivation at this age are more pronounced compared to other academic domains (Wigfeld et al., 2016).

Sampling Design

In selecting the respondents of the study, the respondents employed stratified random sampling. A total of sample of 159 students participated in the study comprising of 49 Grade 7, 39 Grade 8, 31 Grade 9, and 40 Grade 10 learners. These students are enrolled during the academic year 2022 -2023. Exclusions from the study are those students having incomplete grades in the first three quarters.

Instrumentation

The respondents of the study were asked to answer the adapted questionnaire from the study of Fiorella et. al (2021) in order to assess the learning motivation among junior high school learners. The Mathematics Motivation Questionnaire (MMQ) contains five (5) latent factors and a total of 19 items indicators. The five factors of the instrument include intrinsic value (3 items), self-regulation (4 items), self-efficacy (4 items), utility value (4 items) and test anxiety (4 items). The MMQ provided a reliable, valid, and measure of the specific factors underlying mathematics motivation among secondary students.

Data Analysis

Data were analysed using the SPSS version 21. Descriptive statistics, test of assumption, and MANOVA were utilized to facilitate the analysis of data. In this study, mean and standard deviation were used to determine the student's level of learning motivation in mathematics. Meanwhile, Box's M, Kolmogorov-Smirnov, and Levene's test were used to determine homogeneity, normality, and equality of variance, respectively. Finally, Multivariate Analysis of Variance (MANOVA) was used to determine whether multiple levels of independent variables on their own or in combination with one another influence the dependent variables.

RESULTS AND DISCUSSION

Table 1. Descriptive Statistics of the Dependent Variables of the Study

Dependent Variables	Mean	Std. dev.	Qualitative Description
Intrinsic Value	4.14	1.64	High
Self-regulation	3.86	0.59	High
Self-efficacy	3.58	0.86	High
Utility Value	4.14	0.62	High
Test Anxiety	3.85	0.70	High

As shown in the table, student's learning motivation in mathematics on the five (5) factors obtained a mean score between 3.58 to 4.14 which can be classified as high in terms of it qualitative description. This finding implies that students are highly motivated to learn mathematics because it is personally valuable to them (intrinsic value), and found it personally relevant to their lives and future careers (utility value). Moreover, students possess necessary competence to learn mathematics (self-efficacy) and show willingness to engage in learning strategies to learn mathematics. Despite all these, student's feeling of anxiety toward being assessed in math or compared with others remained high.

The findings of this study corroborates to the findings of previous studies. The recent study of Ulfah, Akmalia, & Jusra, (2023) indicated that students' learning motivation in mathematics was in the high category. Vaara et al (2021) showed that students had a special interest in learning Mathematics. The study indicated that the students desire to learn mathematics is personally driven especially when they believe that Mathematics is important to their future academic endeavors.

Table 2. Tests of Homogeneity of Covariance

Box's Test for Equality of Variance	
Box's M	334.275
F	2.787
df1	105
df2	16048.556
Sig.	.000

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One of the assumptions of multivariate analysis of variance (MANOVA) is the equality of covariance. To test this assumption, the study used the Box's M test. Box's M is a parametric test used to compare variation in multivariate samples. More specifically, it checks to find out whether two or more covariance matrices are homogeneous.
As reflected in the table, the sig. value of .000 is lesser than .05 suggesting that the assumption of homogeneity of covariance was not satisfied across the sex and grade level.

Table 3. Test for Normality of Residuals of the Dependent Variables

Variables	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
Intrinsic Value	.288	159	.000	.498	159	.000
Self-regulation	.133	159	.000	.955	159	.000
Self-efficacy	.084	159	.008	.972	159	.003
Utility Value	.119	159	.000	.946	159	.000
Test Anxiety	.126	159	.000	.960	159	.000

As shown in the table, both the Kolmogorov-Smirnov and Shapiro-Wilk statistic reported significance value (.000) lesser than .05 in the five (5) constructs of learning motivation in mathematics. Hence, the data collected on the dependent variables are not normally distributed. This non-normality condition is due to skewness in the responses of the students towards their learning motivation in mathematics.

Table 4. Test of Multicollinearity Statistics

Dependent Variables	Collinearity Statistics	
	Tolerance	VIF
Intrinsic Value	.935	1.070
Self-regulation	.655	1.526
Self-efficacy	.711	1.407
Utility Value	.762	1.312
Test Anxiety	.926	1.080

The assumption of multicollinearity was also tested using variance inflation factor and tolerance. Multicollinearity is the undesirable situation where one independent variable is a linear function of other independent variables (Ibrahim et al., 2018). Thompson, Kim, Aloe, & Becker (2017) suggests that a tolerance value greater than .01 and VIF of less than 5 indicates that there is no evidence of multicollinearity.

As revealed in the table, the variance inflation factor (VIF) of the dependent variables ranges from 1.070 to 1.526 which are all less than 5. On the other hand, tolerance readings yielded reasonable values ranging from .655 to .935. These figures are indicative that there is no multicollinearity issues in the study.

Table 5. Test of equality of variance in the Learning Motivations in Mathematics

Learning Motivations	**F**	**df1**	**df2**	**Sig.**
Intrinsic Value	1.123	7	151	.352
Self-regulation	.825	7	151	.568
Self-efficacy	2.275	7	151	.031
Utility Value	1.610	7	151	.136
Test Anxiety	1.127	7	151	.349

Test for equality of variance was checked using the Levene's test. As gleaned from the table, self-efficacy has a significance value less than .05. This means that the Levene's test for equality of variance is significant indicating that variances are not equal.
However, the Levene's test showed insignificant results in other constructs of learning motivation in mathematics such as intrinsic value, self-regulation, utility value, and test anxiety. Therefore, the assumption of equal variances across groups holds true.

Table 6. Multivariate Test for Year Level and Sex

	Effect	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Obs. Power
Intercept	Wilks' Lambda	.988	2354.14	5	147	.000	.988	1.000
	Hotelling's Trace	.012	2354.14	5	147	.000	.988	1.000
	Roy's Largest Root	80.07	2354.14	5	147	.000	.988	1.000
	Pillai's Trace	80.07	2354.14	5	147	.000	.988	1.000
Grade Level	Wilks' Lambda	.247	2.68	15	447	.001	.082	.994
	Hotelling's Trace	.769	2.70	15	406	.001	.084	.989
	Roy's Largest Root	.279	2.71	15	437	.001	.085	.994
	Pillai's Trace	.146	4.36	5	149	.001	.128	.962
Sex	Wilks' Lambda	.083	2.67	5	147	.024	.083	.802
	Hotelling's Trace	.917	2.67	5	147	.024	.083	.802
	Roy's Largest Root	.091	2.67	5	147	.024	.083	.802
	Pillai's Trace	.091	2.67	5	147	.024	.083	.802
Grade level * Sex	Wilks' Lambda	.129	1.34	15	447	.176	.043	.818
	Hotelling's Trace	.874	1.36	15	406	.166	.044	.781
	Roy's Largest Root	.141	1.37	15	437	.156	.045	.831
	Pillai's Trace	.117	3.48	5	149	.005	.105	.906

The multivariate test showed a significant effect for the grade level as it reported Wilk's lambda of 0.247, F=2.68, p-value = .001<.05, partial eta squared = .082, and the power to detect effect is 0.992. Likewise, the test also provide evidence to show significant effect of sex as evidenced by Wilk's lambda of 0.083, F=2.67, p-value = .024<.05, partial eta squared = .083, and the power to detect effect is 0.802. In addition, the combined effect of grade level and sex is significant using Pillai's trace value of .117, F = 3.48, p-value =.005<.05, partial eta squared = .105, and the power to detect effect is .906.

According to previous research (Costes et al., 2008; Guo et al., 2015; Ganley and Lubienski, 2016), girls report lower levels of individual interest and perceived mathematics competence.

Table 7. Univariate Table for the Significant Effect of the Grade Level and Sex on Learning Motivations in Mathematics

	Dependent Variable	Df		F	Sig.	Partial Eta Squared	Observe power
Grade level	Intrinsic Value	Contrast	3	3.73	.013	.069	.800
		Error	151				
	Self-regulation	Contrast	3	.969	.409	.019	.261
		Error	3				
	Self-efficacy	Contrast	3	.199	.897	.004	.086
		Error	151				
	Utility Value	Contrast	3	.606	.612	.012	.174
		Error	151				
	Test Anxiety	Contrast	3	5.80	.001	.103	.947
		Error	151				
Sex	Intrinsic Value	Contrast	1	2.53	.114	.017	.353
		Error	151				
	Self-regulation	Contrast	1	.463	.497	.003	.104
		Error	151				
	Self-efficacy	Contrast	1	.951	.331	.006	.163
		Error	151				
	Utility Value	Contrast	1	.569	.452	.004	.116
		Error	151				
	Test Anxiety	Contrast	1	8.58	.004	.054	.829
		Error	151				
Grade Level * Sex	Intrinsic Value	Contrast	3	.015	.998	.000	.053
		Error	151				
	Self-regulation	Contrast	3	1.246	.295	.024	.329
		Error	151				
	Self-efficacy	Contrast	3	.553	.647	.011	.162
		Error	151				

	Utility Value	Contrast	3	.191	.902	.004	.085
		Error	151				
	Test Anxiety	Contrast	3	4.075	.008	.075	.837
			151				

The univariate table revealed that some constructs obtained p-values less than 0.05 indicating that sex and grade level are significant factors affecting learning motivation in mathematics. Specifically, the effect of grade level is significant to intrinsic value (F=3.73, p =.013 <.05) and test anxiety (F=5.80, p =.001 <.05) while the effect of sex is significant only to test anxiety (F=8.58, p =.004 <.05). Taking into account the combined effect of both independent variables, it can be observed from the table that a significant effect was evident in text anxiety(F=4.075, p =.008 <.05).

As discussed in literature, students with higher levels of mathematics anxiety or test anxiety generally have negative views of mathematics, show a tendency to avoid mathematics, and exhibit lower mathematics achievement (Dowker et al., 2016)

Table 8. Comparison of Bootstraps and Empirical Results

	Mean			Standard Error			Confidence Interval			
Dependent Variable	Empirical	Bootstrap	Bias	Empirical	Bootstrap	Bias	Emp. Upper	Emp. lower	B. Upper	B. Lower
Intrinsic Value	4.14	4.14	.00	1.298	.131	-0.10	3.89	4.40	3.956	4.361
Self-regulation	3.86	3.86	.00	.0467	.046	-0.00	3.77	3.96	3.779	3.945
Self-efficacy	3.58	3.58	.00	.0679	.068	-0.00	3.44	3.71	3.436	3.741
Utility Value	4.14	4.14	.00	.049	.046	-0.00	4.04	4.24	4.049	4.239
Test Anxiety	3.85	3.85	.00	.056	.063	-0.00	3.74	3.96	3.716	3.974

The study employed boot strapping analysis to determine whether the violations of some of the assumptions were sensitive enough so as to negatively affect the findings of the study. The idea behind bootstrapping is that inference about a population from sample data can be modeled by resampling the sampled data and performing inference about a sample from the resampled data.

As reflected from the table, results showed no evidence on the presence of biasness in the data because there were no differences in the results obtained from the empirical and bootstrapped results. This finding implies that those assumptions that were not satisfied were not sensitive and therefore, did not significantly affect the findings.

CONCLUSION

This study sought to examine the effect of grade level and sex on the learning motivation in mathematics of the students. The results of this study highlighted that student's learning motivation in mathematics varies with grade level and sex. This finding implies that there are significant differences between students' learning motivation in mathematics and that the model used for the study was generally sensitive and hence fit for the study. Specifically, the effect of grade level is significant with intrinsic value and test anxiety. Likewise, the effect of sex is significant with test anxiety. Moreover, the combined effect of grade level and sex is statistically significant with learning motivations in the aspect of test anxiety. In light of the findings of this study, it is recommended to develop interventions and educational policies that foster a positive learning experience and encourage a lifelong appreciation of mathematics, regardless of grade level and sex. Lastly, future studies may take into consideration to include other DepEd school in the province in the sampling to provide and establish strong statistical analysis and solid evidence. Further research should be done in order to confirm or refute the findings of this study.

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DECLARATIONS

Ethical Approval. This is not applicable. However, the researcher sought approval from the College President of Siquijor State College for the conduct of the said research undertaking.

Informed Consent. All the respondents voluntarily give their consent to participate in the study by affixing their signature in the consent form.

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