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International Journal of Education, Technology and Science
2(4) (2022) 429–454

IJETS
International Journal of Education Technology and Science

THE EFFECT OF MASTERY AND PERFORMANCE RELATED MATHEMATICS LEARNING MOTIVATION ON MATHEMATICS ACHIEVEMENT: THE CASE OF FIRST YEAR UNDERGRADUATE UNIVERSITY STUDENTS IN BONGA UNIVERSITY, ETHIOPIA

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Received: 01.07.2022 *Revised version received: 30.10.2022* *Accepted: 03.11.2022*

Abstract

The main objective of this study was to explore the effect of performance and mastery related mathematics learning motivation on mathematics achievement. A sample of 150 students (86 males and 64 females) was randomly selected from Bonga University. MLM scale containing 11-items was adapted from different literatures. The performance and mastery related motivation Scale was adapted from Butler (2016). The mathematics achievement was measured by 30- items of a self-developed achievement test of Mathematics. Only 25 mathematics achievement test items which obeyed all the psychometric properties of item analysis were retained as a scale for the test administration. The Cronbach alpha reliability of Mathematics achievement test was .84, which is above the acceptable threshold. Confirmatory factor analysis with the help of Structural equation modeling by using STATA15 software was applied to analyze the data. Results revealed that Performance related mathematics learning motivation has significant effect on mathematics achievement, whereas mastery related mathematics learning motivation has no significant effect on mathematics achievement. Further study should be conducted on the unexplained factors of MLM.

Keywords: Mastery; Performance; Achievement; Mathematics Learning Motivation

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1. Introduction

1.1. statement problem

Many studies were conducted concerning the Achievement goal theory which includes mastery goal and achievement goal theory of motivation. For eg. , Gutman (2006) provides an argument on how student and parent goal orientations and classroom goal structures influence the math achievement of African Americans during the high school transition; Lavasani, Malahmadi & Amani (2010) conducted a study on the role of self-efficacy, task value, and achievement goals in predicting learning approaches and mathematics achievement; Mägi, Lerkkanen, Poikkeus, Rasku-Puttonen, & Kikas, (2010) find results and eveidence on the relations between achievement goal orientations and math achievement in primary grades; Luo, Paris, Hogan, & Luo, (2011) conducted an investigation hw do performance goals promote learning by using a pattern analysis of Singapore students' achievement goals; Furner, & Gonzalez-DeHass.(2011) provide evidence. students' mastery and performance goals relate to math anxiety; Keys, Conley, Duncan, & Domina, (2012) conducted a study on the role of goal orientations for adolescent mathematics achievement. Gherasim, Butnaru, & Mairean, (2013) experimented on the Classroom environment, achievement goals and mathematics performance; Park, Gunderson, Tsukayama, Levine, & Beilock,(2016) conduct an inquiry on young children's motivational frameworks and math achievement: Relation to teacher-reported instructional practices, but not teacher theory of intelligence; Scherrer, Preckel, Schmidt, & Elliot, (2020) conducted longitudinal studies on development of achievement goals and their relation to academic interest and achievement in adolescence; Sides, & Cuevas, (2020) argues on the effect of goal setting for motivation, self-Efficacy, and performance in Elementary mathematics; Guo, & Leung, (2021) conducted comparison studies between Chinese Miao and Han students on the achievement goal orientations, learning strategies, and mathematics achievement, Guo, & Hu (2022) conducted a study on the relationship of classroom goal structures to Chinese Miao and Han students' goal orientations and mathematics achievement. But still there is a literature gap that no or little studies were conducted based on mastery goal and Performance goal achievement-goal theory in relation to

Mathematics Leaning Motivation (MLM) and Mathematics achievement in the case of university students in Ethiopia.

1.2. Review of related literature

Achievement goal theory (Ames 1992; Dweck and Leggett 1988; Elliott and Dweck 1988; Pintrich 2000) assumes that students have different reasons for engaging or not engaging in learning and school work. These reasons affect what, how, and why students learn (Patrick et al. 2011) and how they subsequently perform. Typically, two different sets of achievement goals are identified: (1) task and ego goals (Nicholls 1984) or (2) mastery and performance goals **(**Dweck and Leggett 1988). The primary goal of a mastery-oriented person is the learning and mastery of the task for its own sake (similar to intrinsic motivation in Self Determination Theory(SDT) and intrinsic value in Expectancy Value Theory(EVT).

Mastery goals concerned with a desire to achieve competence in terms of set criteria or task mastery. They rely on comparisons with the explicit requirements of the task and/or internal comparisons with an individual’s past or potential attainment. Performance goals, in contrast, reflect a desire to achieve competence to a degree that is relative to the performance of others. The goal here is to do well and gain the rewards associated with high performance. The desire to attain high performance sometimes leads to strategic behaviors that can involve making learning more difficult for competitors (Murdock et al. 2016). These two goal orientations are associated with different consequences in achievement context, with mastery being associated with higher performance than performance orientation.

A mastery goal (also referred to as a learning goal, task goal, or intrinsic goal) is one in which the student’s aim is to gain knowledge or skills. A performance goal (also referred to as an ego goal, ability focused goal, or extrinsic goal) is a competitive goal in which the aim is to look good compared to others (Pintrich, 2000, 2003; Ross, 2008). The choice between mastery goals and performance goals rests on a number of factors, including feelings of self worth, theories of personal intelligence, fear of failure, and fear of looking “bad” in front of others (Ross, 2008).

Performance goals can be further subdivided into performance-approach and performance-avoidance goals, based on students' beliefs that they will do well, or conversely, on a fear of failure (Berger, 2009; Van Yperen, Blaga, & Postmes, 2014). Elliot, Murayama, and Pekrun (2013) propose further subdivisions of goals based on three potential orientations: taskbased, related to the demands of the task; self-based, with an internal metric of the value of the activity; and other-based, with an external interpersonal metric. Each of these orientations is then assigned a valence of approach or avoidance.

Performance-approach goals are positively correlated to self-efficacy, task value, and use of cognitive and self-regulatory strategies (Shunk & Pajares, 2005). Performance-avoidance goals have not been found to be predictive of positive achievement (Elliott & McGregor, 2001; Elliott & Thrash, 2001). Mastery goals are positively correlated with self-efficacy, task value, cognitive strategy use, and self-regulated learning (Ross, 2008). Ryan and Deci (2000a, 2000b) found that mastery goals are correlated with intrinsic motivation, whereas both performance approach and avoidance goals are correlated with extrinsic motivation. Thus, students with a high degree of intrinsic motivation tend to demonstrate mastery goals, and students with high levels of extrinsic motivation demonstrate performance goals. The converse is also true; students with a mastery goal orientation tended to have greater levels of intrinsic motivation, while students with a performance goal orientation tended to have lower levels of intrinsic motivation, and higher levels of extrinsic motivation (Spinath & Steinmayr, 2012). These findings are not surprising, given the direct relationship between having an internal metric (mastery goals, intrinsic motivation) or an external metric (performance goals, extrinsic motivation). Goal orientation was found to be correlated with selfefficacy beliefs, task enjoyment, and interest (Spinath & Steinmayr, 2012).

Goal orientation is a strong predictor of achievement. Students with a mastery goal orientation outperform students with a performance goal orientation (Middleton & Spanias, 1999). Middleton and Spanias (1999) found that students tend to adopt their teachers' goal orientations; therefore, if teachers demonstrate that they value mastery goals, this should impact students' goal orientations and thus increase students' intrinsic motivation. One way to accomplish this is to emphasize criterion- rather than norm-referenced assessments (Wolters & Daugherty, 2007).

The four-goal model, also referred to as the 2×2 model of achievement goals (Elliot & McGregor, 2001; Pintrich, 2000b). Crossed with the mastery-performance dimension, this results in four achievement goals: (a) Mastery-approach goals, which represent a focus on learning and understanding the course material; (b) mastery-avoidance goals, which represent a focus on not losing one's skills or competence; (c) performance-approach goals, generally defined as goals oriented toward outperforming others; and (d) performance-avoidance goals, where students are focused on not looking incompetent to others (Elliot & McGregor, 2001; Pintrich, 2000b).

Performance approach includes: Extrinsic goal value / Normative standards, Will I look smart?, Focus on outcome, Errors indicative of failure, Uncertainty is threatening, Seek flattering information, Emphasizes present ability.

Performance Avoidance includes: Extrinsic goal value / Normative standards, Will I look dumb? , Focus on outcome, Errors indicative of failure, Uncertainty is threatening, Avoid unflattering judgments, Emphasizes present ability

Mastery approach includes: Intrinsic goal value / Personal standards , How can I do it?, Focus on process, Learn from errors, Uncertainty is challenging, Seek accurate information about ability ; Emphasizes effort.

Mastery Avoidance includes: Intrinsic goal value / Personal standards, Can I do it now? Shift from process to outcome, Errors indicative of failure, Uncertainty is threatening, Avoid unflattering judgments, Emphasizes past ability.

1.3. Hypothesis

The study was aimed to test the following research hypothesis:

H01: Mastery related mathematics learning motivation (MLM) has no significant effect on mathematics achievement in the case undergraduate students in Bonga University, Ethiopia.

H02: Performance related mathematics learning motivation (MLM) has no significant effect on mathematics achievement in the case undergraduate students in Bonga University, Ethiopia.

In this regard, the following hypothesized mode was used.

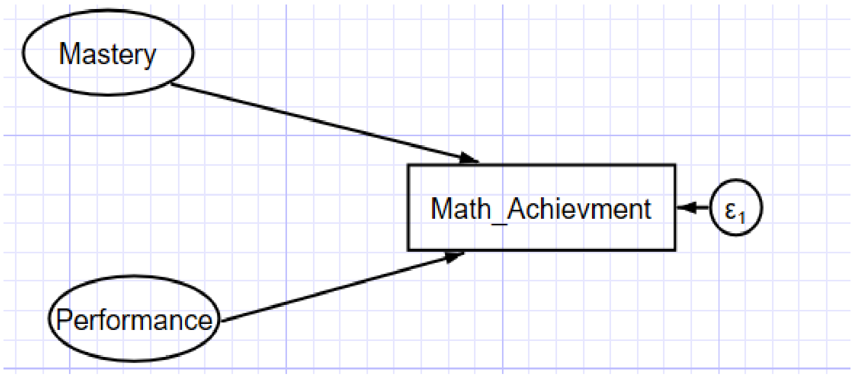

Fig 1: hypothesized model - Conceptual frame work diagram

2. Method

This section includes the sampling and sampling procedures, the sample size, research instrument and data collection procedures, the type of data used, and the method of data analysis.

2.1. Sampling procedures

The probabilistic sampling procedure was employed. Students were randomly selected from science and mathematics classes. Their departments were considered as cluster and thus cluster sampling technique was employed. Once the cluster is identified students were randomly selected from each department by lottery method.

2.2 *Sample size*

The total population of first year undergraduate students in Bong University was 240. Of these, 150 first year undergraduate University students (male =86 Female 64) in Bonga University, were participants of this study by using the Yamane, 1967 formula. 150 students were selected randomly from first year science and mathematics (Mathematics, Physics, Chemistry, and Biology) students.

The demographic characteristics of sample respondents were given in the table 1 below.

Table 1 the demographic characteristics of respondents

		Sex		Total
		Female	Male	
Age	18-25 years	64	86	150
	Total	64	86	150
Department	Physics	5	26	31
	Chemistry	16	20	36
	Biology	19	23	42
	Math	24	17	41
	Total	64	86	150
Mother's Education	Primary Education and below	28	18	46
	Secondary Education	12	19	31
	College diploma	15	20	35
	Higher Education	9	29	38
	Total	64	86	150
Father's Education	Primary Education and below	19	11	30
	Secondary Education	10	27	37
	College diploma	24	25	49
	Higher Education	11	23	34
	Total	64	86	150
Father's Employment	Government Employee	6	2	8
	Self Employed	17	23	40
	Farmer	21	23	44
	Other	20	38	58
	Total	64	86	150
Mother's Profession in Science	No	35	51	86
	Yes	29	35	64
	Total	64	86	150
Father's Profession in Science	No	44	50	94
	Yes	20	36	56
	Total	64	86	150

2.3 Data type

Primary data was collected from all of the respondents. Mathematics learning motivation was measured in terms of scales of mastery and performance related items based on achievement goal theory of motivation. These scales were developed by using in different literatures. All the 150 students were participated to fill the MLM- questions are developed based on the achievement goal theory and the items was adapted from Butler (2016).

2.4 Research Instruments and Data Collection procedures

Intrinsic motivation and extrinsic motivation are independent variables to MLM. Total of 11 items for MLM scale, measured in terms mastery goal related mathematics learning motivation and performance related goal mathematics learning motivation, were adapted from Butler (2016). Of these items, 7 items were for mastery goal mathematics learning motivation and 4 items were for performance goal mathematics learning motivation. In this regard, Self-report questionnaire titled, "Mathematical Learning Motivation (MLM)" in which all 150 respondent students were asked to rate how they think, feel, act, value and evaluate themselves in MLM on a five-point scale, namely: Strongly Agree=5, Agree=4, Neutral=3 Disagree=2,and Strongly Disagree=1 were developed.

30- Items mathematics achievement test was developed. Of these items, only 25-items which pass the psychometric properties of item analysis were applied in test-administration.

2.5 Methods of Data Analysis

The quantitative survey method has employed been employed. Confirmatory factor analysis with the help of structural equation modeling was employed. STATA15 software was used for data analysis.

3. Results

3.1 Measurement model

Confirmatory Factor Analysis using STATA15 was used to determine the psychometric properties Mathematics Learning Motivation(MLM) measured in terms of mastery goal and performance goal, and the mathematics achievement among first year undergraduate university students. The process used the maximum likelihood estimation of confirmatory factor analysis and tested the validity of the model which indicated that the hypothesized model fitted the data. Initially, some items in the data had poor loading on their respective constructs. The items with poor loadings were removed from the model list. Finally only 5 items, 5 items for mastry goal MLM and 4 items for performance goal MLM were retained. (see figure 2).

In the subsequent run and after certain modification indices, the overall fit of the measurement model was adequate with Relative Chi- Square = 51.923 , CFI = .938, RMSEA = .089, SRMR = .053, and p = .000 (see figure 2). All measures were within nearly acceptable values indicating good model fit. Thus from the measurement model the factor loading were substantial and statistically significant at p = .000, and the model was free from offending estimates.

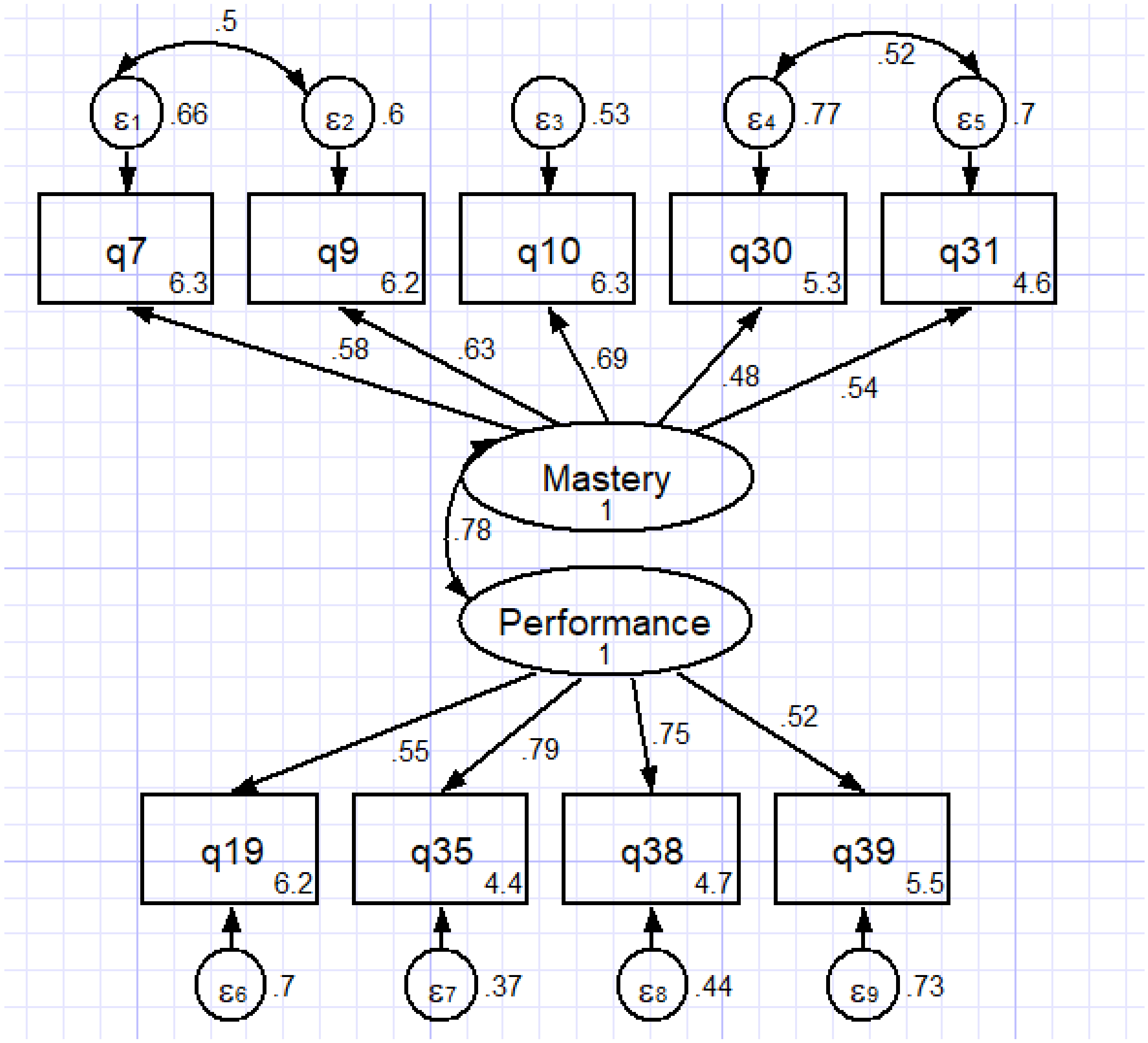

Fig 2: Measurement model

From the measurement model in figure 2, two items, q25 and 26,   wer removed from mastery goal mathematics learning motivation because of their poor loadings.

3.2 Reliability analysis

The overall reliability of mathematics achievement test items measured by Cronbach's alpha was .84 which is above the acceptable threshold level, and the items analysis by using IRT revealed that the items have acceptable level of item discrimination and difficulty indices. Furthermore, from the test characteristic curve (TCC) we observe that individuals with any type of trait level can answer the questions correctly. Furthermore a test information function curve was helped in illustrating the degree to which a test provides different quality of information at different trait levels. Since the curve was bell shaped, as depicted in appendix 4c, indicate that the test was differentiating well among pupils with different trait level. (See appendix-4a, 4b, an 4c).

As per Roldán & Sánchez-Franco(2012), a measure of internal consistency reliability, the composite reliability developed by Werts, Linn, and Jöreskog (1974) fulfills the same task as Cronbach's alpha. The composite reliability of the first order factors was .73 for mastery goal, and .75 for performance goal mathematics learning motivation each of which is acceptable as per Hair et al.(1998) stating that a composite reliability above .70 for a model is adequate . (See appendix-1).

3.3 Construct Validity

Also, both convergent and discriminant validity were examined. The convergent validity which is the extent to which indicators of a specific construct converge or share proportion of variance in common was examined using composite reliability and Average Variance Extracted (AVE). According to Bagozzi & Lee (2002) and Shen et al. (2009), discriminant validity which is the extent to which a construct is truly distinct from other constructs. The AVE was examined as well and the data supported the measurement adequacy with the Average Variance Extracted (AVE) of .4 for mastery goal, and .44 for performance goal mathematics learning motivation which were near to the threshold (.50) and an evidence of convergent validity (Fornell & larker, 1981; Shittu et al., 2011). (see appendix1)

Also the AVE for the Massey goal mathematics leaning motivation, and the Performance goal mathematics leaning motivation were greater than .29, which is the squared correlation between one construct and the other construct which was an evidence for discriminant validity. (See appendix-2). This indicated that the measured variables were more in common with the construct they were associated with than they did with the other constructs (Byrne, 2010).

Thus, as convergent validity and the discriminant validity evidence were supported, we conclude that the model obeys the rule construct validity.

3.4 Full- fledged model

Figure 3 indicate the full fledged model and from this model we get the goodness-of-fit statistics, confirmatory modeling yielded consistence in the causal relationship with the data, with relative Chi-Square = 65.268 ; CFI = .928, RMSEA = .086, SRMR = .057, and p = .000. All the results got indicated that the indices satisfied their critical cut off scores; that is, the model fitted the data. (see appendix 3b).

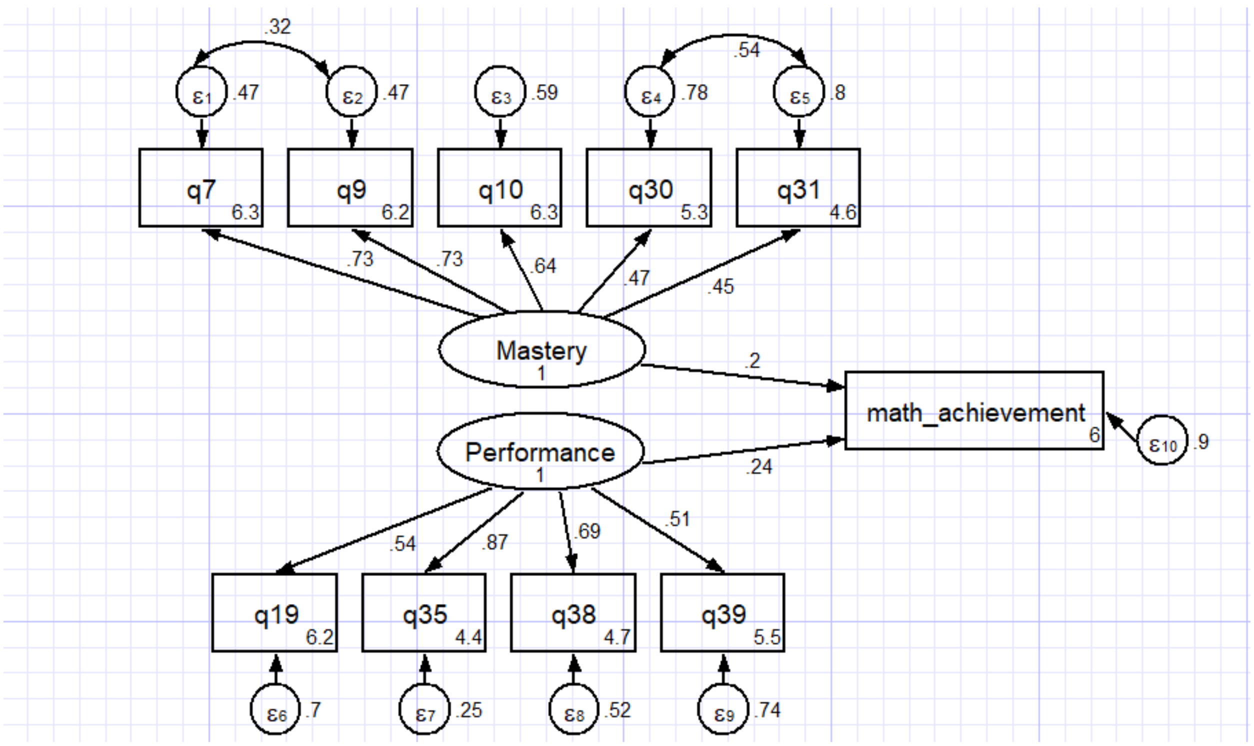

Fig3: full fledge model estimation

According to the coefficients of the causal structure, all path coefficients were statistically significant at .005 levels, showing the practical importance of the model. (see apendix-3 a and b). From the model in figure 3 it can be highlighted that students' Mastery goal based mathematics leaning motivation ($\beta = .2$, $p > .05$) was not contrbuted to students' mathetmatics achievement whereas students' Performancegoal based mathematics leaning motivation ($\beta = .24$, $p < .05$) contrbuted to students' mathetmatics achievement. (see applenix-3).From the findings, the two hypotheses were supported by the results got in the study.

4. Discussion

We observe from the results that Mastery related mathematics learning motivation (MLM) has no significant effect on mathematics achievement in the case undergraduate students in Bonga University, Ethiopia, whereas the Performance related mathematics learning motivation (MLM) has significant effect on mathematics achievement in the case undergraduate students in Bonga University, Ethiopia.

The results was supported by the very defintion of the master goal and performance goal given by (Pintrich, 2000, 2003; Ross, 2008) that a mastery goal (also referred to as a learning goal, task goal, or intrinsic goal) is one in which the student's aim is to gain knowledge or skills; and a performance goal (also referred to as an ego goal, ability focused goal, or extrinsic goal) is a competitive goal in which the aim is to look good achievement as compared to others.

The implication was that as performance goal related mathematics leaning motivation has significant effect on students' mathematics achievement than the mastery goal related mathematics learning motivation, the result will give a big assignment to:

- Teachers to use the performance motivational drivers when teaching mathematics in the class.
- The curriculum designers to include performance goal related tasks, activities, exercises and teaching strategies when designing and developing mathematics curriculum.
- Other stakeholders including the students themselves, parents, educational leaders and the government, and others to focus on such achievement motivation drivers that are related to performance goal of mathematics learning motivation.

5. Conclusion

This study aimed at investigating the contribution of Mastery goal and performance goal mathematics learning motivation on mathematics achievement. Confirmatory factor analysis (CFA) with the help of Structural equation by using STAT15 software was employed to analyses the data. From the results and findings we conclude that :

- Mastery goal oriented mathematics learning motivation does not have significant contribution on mathematics achievement,
- Performance goal oriented mathematics learning motivation has significant contribution on mathematics achievement,

Thus as performance related mathematics motivation is more related to achievement motivation than the mastery goal related mathematics learning motivation, every stakeholder such as teachers, students, parents, educational leaders, policy and curriculum designers, and the government should pay attention on these motivational drivers so as to make students to get good achievement in mathematics. Moreover, this study was based on the achievement goal theory which includes the Mastery and Performance motivation. Though there are many theories of motivation such as self efficacy, self determination, self concept, and others, this study was delimited only on the achievement goal theory to investigate its effect on mathematics achievement. Thus we suggest that further studies should be undertaken by combining other theories of motivation in the context of leaning mathematics.

Acknowledgements

I would like to thank my supervisor Professor Dr. Tesfaye Semela to who gave me a authentic support and follow-ups during this study. I’d also like to express my gratitude to my co-advisor Dr. Abrham Tulu for his follow-ups and support during the research work. I must also thank first year undergraduate students Bonga University students to give the reliable and fresh data. I would also like to thank people who gave support during the research writing and publication processes.

Declaration of Conflicting Interests and Ethics

The authors declare no conflict of interest in this study.

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APPENDICES

Appendix-1: Average variance Extracted (AVE) and Composite Reliability (CR)

Consruct	Item no.	Item	λ	λ^2	1- λ^2	CR	AVE
Mastery Goal Motivation	q7	My goal is to fully understand the mathematics contents taught in class	0.58	0.3364	0.6636		
	q9	My goal is to learn mathematics as much as I can	0.63	0.3969	0.6031		
	q10	I try very hard to understand as deep as possible in mathematics subject matter	0.69	0.4761	0.5239		
	q30	I try to avoid partially understanding of the subject in mathematics	0.48	0.2304	0.7696		
	q31	To avoid failure, it's important to me that I thoroughly understand mathematics	0.58	0.3364	0.6636		
		sum	**2.96**	**1.7762**	**3.2238**	**0.73**	**0.4**
Performance Goal Motivation	q19	My goal is to avoid getting negative feedback concerning mathematics	0.55	0.3025	0.6975		
	q35	My goal is to avoid being less effective in mathematics than other students	0.79	0.6241	0.3759		
	q38	I try hard to avoid producing worse work than others concerning mathematics.	0.75	0.5625	0.4375		
	q39	I am determined to do mathematics well when compared to other	0.52	0.2704	0.7296		
		Sum	**2.61**	**1.7595**	**2.2405**	**0.75**	**0.44**

Appendix- 2: Correlation between constructs

Correlations

		Mastery	Performance
Mastery	Pearson Correlation	1	.540**
	Sig. (2-tailed)		.000
	N	150	150
Performance	Pearson Correlation	.540**	1
	Sig. (2-tailed)	.000	
	N	150	150

**. Correlation is significant at the 0.01 level (2-tailed).

Appendix-3 : Goodness of fit estimates

3a) Measurement model fit and estimates

Fit statistic	Value	Description
Likelihood ratio		
chi2_ms(24)	51.923	model vs. saturated
p > chi2	0.001	
chi2_bs(36)	486.927	baseline vs. saturated
p > chi2	0.000	
Population error		
RMSEA	0.089	Root mean squared error of approximation
90% CI, lower bound	0.055	
upper bound	0.122	
pclose	0.030	Probability RMSEA <= 0.05
Information criteria		
AIC	2703.670	Akaike's information criterion
BIC	2793.587	Bayesian information criterion
Baseline comparison		
CFI	0.938	Comparative fit index
TLI	0.907	Tucker-Lewis index
Size of residuals		
SRMR	0.053	Standardized root mean squared residual
CD	0.902	Coefficient of determination

Standardized	Coef.	OIM Std. Err.	z	P>|z|	[95% Conf.	Interval]
Measurement						
q7 <-						
Mastery	.5811726	.0785601	7.40	0.000	.4271976	.7351475
_cons	6.289078	.3746718	16.79	0.000	5.554735	7.023421
q9 <-						
Mastery	.6303115	.0709289	8.89	0.000	.4912934	.7693295
_cons	6.157146	.3671949	16.77	0.000	5.437457	6.876835
q10 <-						
Mastery	.6869913	.0669529	10.26	0.000	.5557661	.8182166
_cons	6.279497	.3741294	16.78	0.000	5.546217	7.012777
q30 <-						
Mastery	.4785527	.0801032	5.97	0.000	.3215532	.6355521
_cons	5.255439	.3163324	16.61	0.000	4.635439	5.875439
q31 <-						
Mastery	.5441709	.0782949	6.95	0.000	.3907158	.697626
_cons	4.620209	.2808426	16.45	0.000	4.069768	5.170651
q19 <-						
Performa~e	.549642	.0676191	8.13	0.000	.4171111	.682173
_cons	6.171266	.3679947	16.77	0.000	5.45001	6.892523
q35 <-						
Performa~e	.7936203	.0491935	16.13	0.000	.6972028	.8900379
_cons	4.401435	.2687093	16.38	0.000	3.874774	4.928095
q38 <-						
Performa~e	.7498019	.0512474	14.63	0.000	.6493588	.850245
_cons	4.726189	.2867385	16.48	0.000	4.164191	5.288186
q39 <-						
Performa~e	.5238798	.0699766	7.49	0.000	.3867281	.6610314
_cons	5.505951	.3304147	16.66	0.000	4.85835	6.153551

var(e.q7)	.6622384	.091314			.5054113	.8677285
var(e.q9)	.6027075	.0894146			.4506369	.8060954
var(e.q10)	.5280429	.0919921			.3753	.7429505
var(e.q30)	.7709874	.0766672			.6344589	.9368952
var(e.q31)	.703878	.0852116			.5552017	.892368
var(e.q19)	.6978936	.0743326			.566406	.8599053
var(e.q35)	.3701668	.078082			.2448202	.5596901
var(e.q38)	.4377971	.0768508			.310351	.6175792
var(e.q39)	.72555	.0733187			.595184	.8844706
var(Mastery)	1	.			.	.
var(Perfor~e)	1	.			.	.
cov(e.q7, e.q9)	.4980806	.0779954	6.39	0.000	.3452125	.6509487
cov(e.q30, e.q31)	.5169532	.0673022	7.68	0.000	.3850434	.648863
cov(Mastery, Performance)	.775336	.0790811	9.80	0.000	.62034	.9303321

LR test of model vs. saturated: chi2(24) = 51.92, Prob > chi2 = 0.0008

3b) Fully fledged model level fit and estimates

Fit statistic	Value	Description
Likelihood ratio		
chi2_ms(31)	65.268	model vs. saturated
p > chi2	0.000	
chi2_bs(45)	520.183	baseline vs. saturated
p > chi2	0.000	
Population error		
RMSEA	0.086	Root mean squared error of approximation
90% CI, lower bound	0.057	
upper bound	0.116	
pclose	0.024	Probability RMSEA <= 0.05
Information criteria		
AIC	3459.967	Akaike's information criterion
BIC	3561.872	Bayesian information criterion
Baseline comparison		
CFI	0.928	Comparative fit index
TLI	0.895	Tucker-Lewis index
Size of residuals		
SRMR	0.057	Standardized root mean squared residual
CD	0.900	Coefficient of determination

Standardized	Coef.	OIM Std. Err.	z	P>|z|	[95% Conf.	Interval]
Measurement						
q7 <-						
Mastery	.7298258	.0876986	8.32	0.000	.5579396	.901712
_cons	6.289077	.3746732	16.79	0.000	5.554731	7.023423
q9 <-						
Mastery	.725912	.0870242	8.34	0.000	.5553477	.8964762
_cons	6.157142	.3671954	16.77	0.000	5.437453	6.876832
q10 <-						
Mastery	.6367871	.0751594	8.47	0.000	.4894775	.7840968
_cons	6.279489	.3741295	16.78	0.000	5.546209	7.012769
q30 <-						
Mastery	.4728944	.0860004	5.50	0.000	.3043368	.641452
_cons	5.255436	.3163325	16.61	0.000	4.635436	5.875437
q31 <-						
Mastery	.4509087	.0871524	5.17	0.000	.2800931	.6217244
_cons	4.620206	.2808427	16.45	0.000	4.069764	5.170647
math_achievement <-						
Mastery	.2039394	.1155009	1.77	0.077	-.0224381	.4303169
Performance	.244177	.1033965	2.36	0.018	.0415237	.4468304
_cons	6.02678	.3519057	17.13	0.000	5.337058	6.716503
q19 <-						
Performance	.5438669	.0685185	7.94	0.000	.409573	.6781607
_cons	6.171275	.3679949	16.77	0.000	5.450018	6.892532
q35 <-						
Performance	.8677228	.0542112	16.01	0.000	.7614708	.9739748
_cons	4.401451	.2687088	16.38	0.000	3.874791	4.92811
q38 <-						
Performance	.6916949	.0607576	11.38	0.000	.5726122	.8107775
_cons	4.726198	.2867381	16.48	0.000	4.164202	5.288195
q39 <-						
Performance	.5075955	.0704953	7.20	0.000	.3694271	.6457638
_cons	5.505957	.3304143	16.66	0.000	4.858357	6.153557
var(e.q7)	.4673543	.1280095			.2732122	.799452
var(e.q9)	.4730518	.1263438			.2802643	.7984534
var(e.q10)	.5945021	.095721			.4336118	.8150903
var(e.q30)	.7763709	.0813382			.6322536	.9533387
var(e.q31)	.7966813	.0785956			.6566144	.9666268
var(e.math_achievement)	.8987863	.0453831			.8140969	.9922858
var(e.q19)	.7042088	.0745299			.572288	.8665395
var(e.q35)	.2470572	.0940806			.1171267	.5211217
var(e.q38)	.5215582	.0840514			.3803014	.7152826
var(e.q39)	.7423468	.0715662			.6145347	.8967415
var(Mastery)	1	.			.	.
var(Performance)	1	.			.	.
cov(e.q7,e.q9)	.3215777	.1675421	1.92	0.055	-.0067988	.6499542
cov(e.q30,e.q31)	.544218	.064434	8.45	0.000	.4179297	.6705062

LR test of model vs. saturated: chi2(32) = 117.21, Prob > chi2 = 0.0000

Appendix-4: Item discrimination and difficulty indices, Test characteristic curve, and Test information function curve

4a) Item discrimination and difficulty indices

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Discrim	1.949053	.1323764	14.72	0.000	1.6896	2.208506
Item1						
Diff	.0823546	.1402456	0.59	0.557	-.1925217	.3572309
Item2						
Diff	.3865283	.1422731	2.72	0.007	.1076781	.6653785
Item3						
Diff	-.0937328	.1401771	-0.67	0.504	-.3684747	.1810092
Item4						
Diff	.7217876	.1478387	4.88	0.000	.432029	1.011546
Item5						
Diff	.2086929	.1407931	1.48	0.138	-.0672565	.4846422
Item6						
Diff	.3610449	.142007	2.54	0.011	.0827163	.6393735
Item7						
Diff	.0823546	.1402456	0.59	0.557	-.1925217	.3572309
Item8						
Diff	.4631682	.1431925	3.23	0.001	.182516	.7438204
Item9						
Diff	.4375876	.1428652	3.06	0.002	.157577	.7175981
Item10						
Diff	.6435164	.1461523	4.40	0.000	.3570632	.9299696
Item11						
Diff	1.780374	.207493	8.58	0.000	1.373695	2.187053
Item12						
Diff	1.526691	.1854815	8.23	0.000	1.163154	1.890228
Item13						
Diff	.3610449	.142007	2.54	0.011	.0827163	.6393735
Item14						
Diff	.4887866	.1435418	3.41	0.001	.2074498	.7701235
Item15						
Diff	.3610449	.142007	2.54	0.011	.0827163	.6393735
Item16						
Diff	1.688631	.1988317	8.49	0.000	1.298928	2.078334
Item17						
Diff	.4887866	.1435418	3.41	0.001	.2074498	.7701235
Item18						
Diff	1.384214	.1755824	7.88	0.000	1.040079	1.728349

Item19						
Diff	.107581	.1403224	0.77	0.443	-.1674459	.3826078
Item20						
Diff	.5917135	.1451772	4.08	0.000	.3071715	.8762556
Item21						
Diff	1.254532	.1679282	7.47	0.000	.925399	1.583665
Item22						
Diff	-2.990779	.425614	-7.03	0.000	-3.824967	-2.156591
Item23						
Diff	-.1439209	.1403168	-1.03	0.305	-.4189368	.1310949
Item24						
Diff	2.913206	.4211094	6.92	0.000	2.087847	3.738566
Item25						
Diff	1.318068	.1715242	7.68	0.000	.9818867	1.654249
Item26						
Diff	-.4202239	.1425772	-2.95	0.003	-.6996701	-.1407778
Item27						
Diff	-1.417411	.1799719	-7.88	0.000	-1.77015	-1.064673
Item28						
Diff	1.075587	.1592891	6.75	0.000	.7633864	1.387788
Item29						
Diff	1.318068	.1715242	7.68	0.000	.9818867	1.654249
Item30						
Diff	.5401509	.1443099	3.74	0.000	.2573086	.8229932
Item31						
Diff	1.938413	.224512	8.63	0.000	1.498378	2.378448

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4b) Test characteristic curve

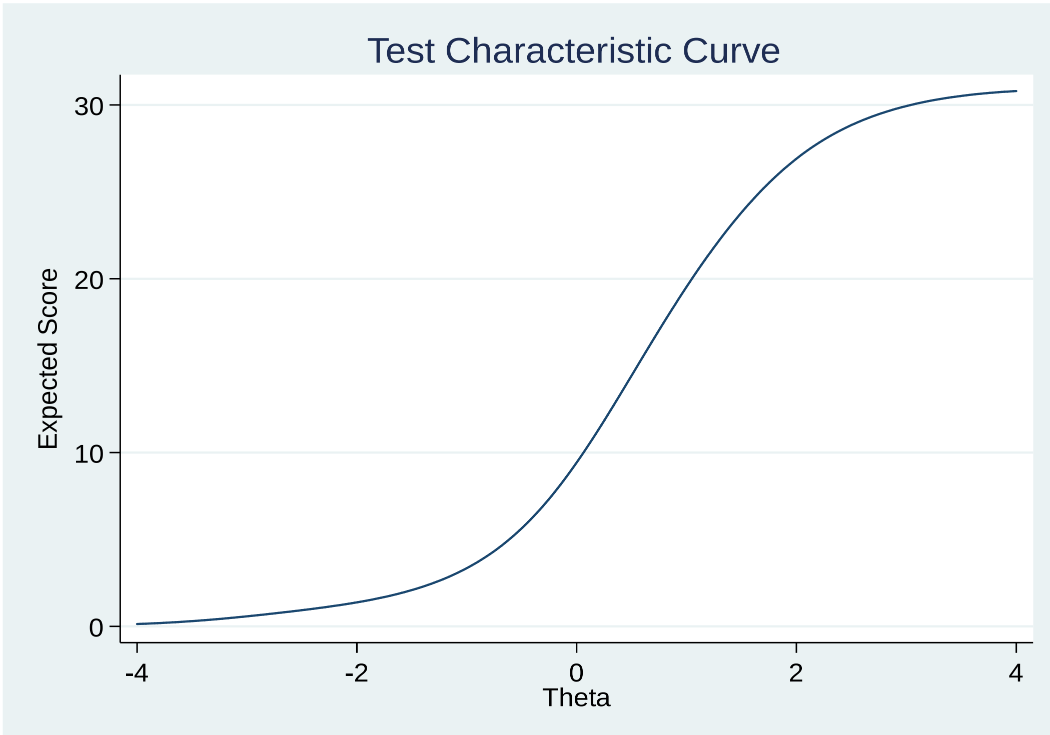

Fig 4: test characteristic curve

4c) Test information function curve

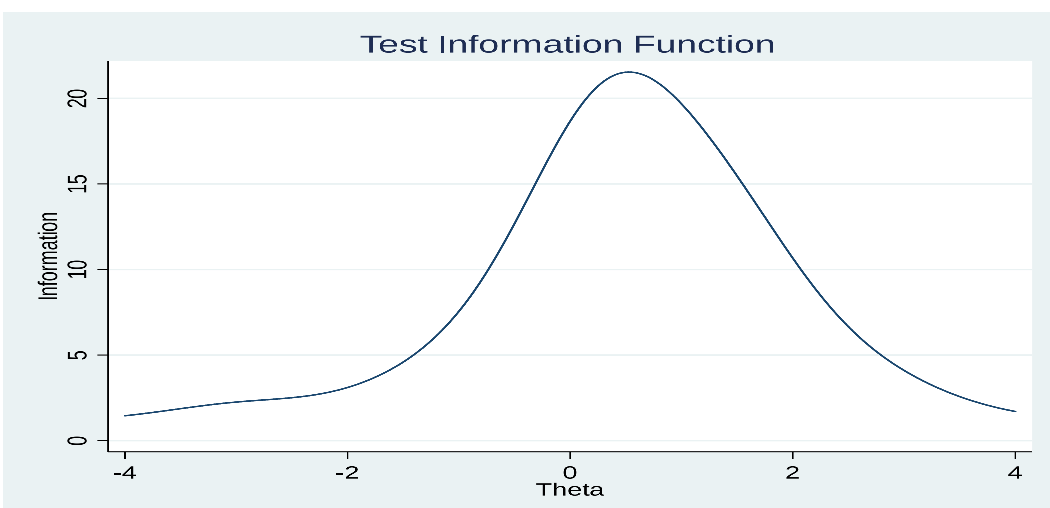

Fig. 5: Test information function curve