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Predictive Relationship between Achievement Goals, Perceived Teacher Support, Academic Disidentification and Mathematics Achievement

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ABSTRACT

In the present fast-paced world, where technology is evolving at an unprecedented rate, the importance of Science, Technology, Engineering and Mathematics (STEM) disciplines cannot be overstated. Mathematics, one of the prominent components of STEM subjects, forms the bedrock of innovation and problem-solving skills primary in solving real world challenges. Despite the importance, the overall pass rate for many students is below par. The trend remains worrisome in the Kenyan schools and particularly Kisii County; Kenya. It is on this premise that this study explored the predictive relationship between achievement goals, students' perceived teacher support, academic disidentification and mathematics achievement. The study embraced the revised achievement goal (3x2), self-determination, and expectancy value theories. A correlational design was adopted. The target population comprised of all the form three students in Kisii County in 2023. Stratified sampling was used to select the 37 schools that took part in this study. Alongside, simple random sampling was used to obtain the 418 participants. The study's hypothesis was tested using multiple linear regression analysis. The study established that approach valence subscales of achievement goals and autonomy and competence subscales of perceived teacher support have a predictive (positive) value on mathematics achievement whilst avoidance valence, devaluing and discounting negatively predicts mathematics achievement. Across the three school categories, co-educational schools were associated with avoidance motivation. The differences were statistically significant ($F(12, 822) = 4.977$, $p < .0005$; Pillai's $V = .135$; partial $\eta^2 = .068$). This study advocates for mathematics teachers to inculcate approach motivation whilst teaching and learning mathematics particularly targeting co-educational schools since they comprise majority of the students across the Kisii County, Kenya as remedy to the worrisome trend of poor mathematics achievement.

INTRODUCTION

Background to the Study

In today's rapidly evolving world STEM play a crucial role in shaping our society's future. STEM education provides students with the necessary skills and knowledge to thrive in a world driven by technology and innovation. Mathematics is the science of reasoning and computations. It is a fundamental part of STEM (science, technology, engineering, and mathematics) fields, as it is a tool used to describe and analyze the world around us. Mathematics provides leaners with a plethora of skills that include representation, interpretation, reasoning, problem solving, and analytical skills which can be broadly applied across various sectors of the economy including engineering, business and finance (Niswah & Qohar, 2020). It is used to create models and solve problems, and it is essential for understanding and making progress in many areas of science and technology.

Developing analytical skills and logical thinking is vital for success in STEM fields. Mathematics provides the foundation for understanding patterns, relationships, and abstract concepts. Proficiency in mathematics is essential for grasping other STEM disciplines, as it is the language through which scientific and technical concepts are communicated. Despite the critical significance, the poor learner achievement in mathematics is perennial and has been a global concern (Mabena et al., 2021). With reference to the significance of mathematics, learners who obtain poor pass rates in mathematics are more likely to miss out in subsequent training levels especially in STEM subjects, employment, and contribution in the development of the mainstream economy.

In attempts to give insight to the perennial poor pass rate in mathematics, prior studies have majorly leaned towards investigating learner motivation, anxiety, beliefs, and attitude towards mathematics (Namkung et al., 2019; Ozkal, 2019; Davadas & Lay, 2020; Tuncer & Yilmaz, 2020). The findings of these studies have correlated the poor motivation, learner anxiety, and negative beliefs and attitudes towards the subject with poor mathematics performance. These studies have recommended stakeholders to work towards boosting learner motivation and attitude towards mathematics whilst reducing anxiety and negative beliefs about the subject. Despite these recommendations, the problem is still persistent. Consequently, there is a need to explore other perspectives that may help explain the persistent poor pass rates in mathematics. The necessity of examining the predictive relationship between achievement goals, perceived teacher support, academic disidentification and mathematics achievement is, therefore, anchored on this background.

Setting achievement goals (AGs) is a critical component in the academic domain of a learner. Through goal-setting, learners are able to focus, use time and resources more efficiently (Woods, 2020; Beckman et al., 2021). In addition, by referring to the goals, learners gain motivation. Achievement goal orientation (AGT) theory of motivation provides a perceptual understanding of the learner's goals, patterns of behaviors to achieve types of goals and associated outcomes in a learning environment. Therefore, in achievement setting, goals have the capacity to influence or motivate students' academic behaviors. To gain insight into AGs, 3x2 model that is duo valence was embraced. The model points out that in goal pursuit, valence is categorized into either into working towards approach success or avoidance. Approach valence is defined as behavior that is directed towards a desirable outcome whilst avoidance valence is defined as behavior that is directed away from the desirable outcome (Elliot et al., 2011). In this regard, one either approaches the task with the view of achieving its set objectives, or avoiding it.

Importantly, how students perceive their mathematics teachers is a critical determinant on whether students will pass the subject or not. According to Ma et al. (2021), perceived teacher support is extent to which students believe they can rely on their mathematics teachers for help. The proponents of the self-determination theory (SDT) (Ryan & Deci, 2000) hypothesize that individuals have an inner source of motivation that enables them to engage in activities when their needs are met. In learning context, the need for achieving high pass rates is greatly influenced by the student’s individual motivation (i.e., intrinsic or extrinsic). Intrinsic goals utilize one’s inner resources of motivation while extrinsic goals are dependent on external sources of motivation. In a school setup, teachers are external sources of student motivation. Anchored on the tenets of this theory, mathematics teachers can have an impact on student’s motivated behavior to pass mathematics by either meeting or ignoring their basic learning needs. Research within SDT has identified three critical needs (Ryan & Deci, 2017): autonomy, competence as well as relatedness that are instrumental in motivation.

Additionally, ego withdrawal from a domain, academic disidentification, influences outcomes in learning mathematics domain. As such, domain disidentification epitomizes a more permanent separation of the self and the domain in question (Kim & Meister, 2023). Major and Schmader (1998) contends that disidentification is an increase in psychological distance between self and a valued domain that is exemplified through devaluing and/or discounting. They regard devaluing is a reduction in the worth of a domain whilst discounting is disregarding the validity of achievement feedback. Premised on the expectancy value theory (EVT), Wigfield and Eccles (2000) explain that one’s choice to engage in a task and the level of persistence is dependent on the subjective value one attaches to the task. It is against this backdrop that this study sought to establish a predictive model of mathematics achievement from achievement goals, perceived teacher support and academic disidentification.

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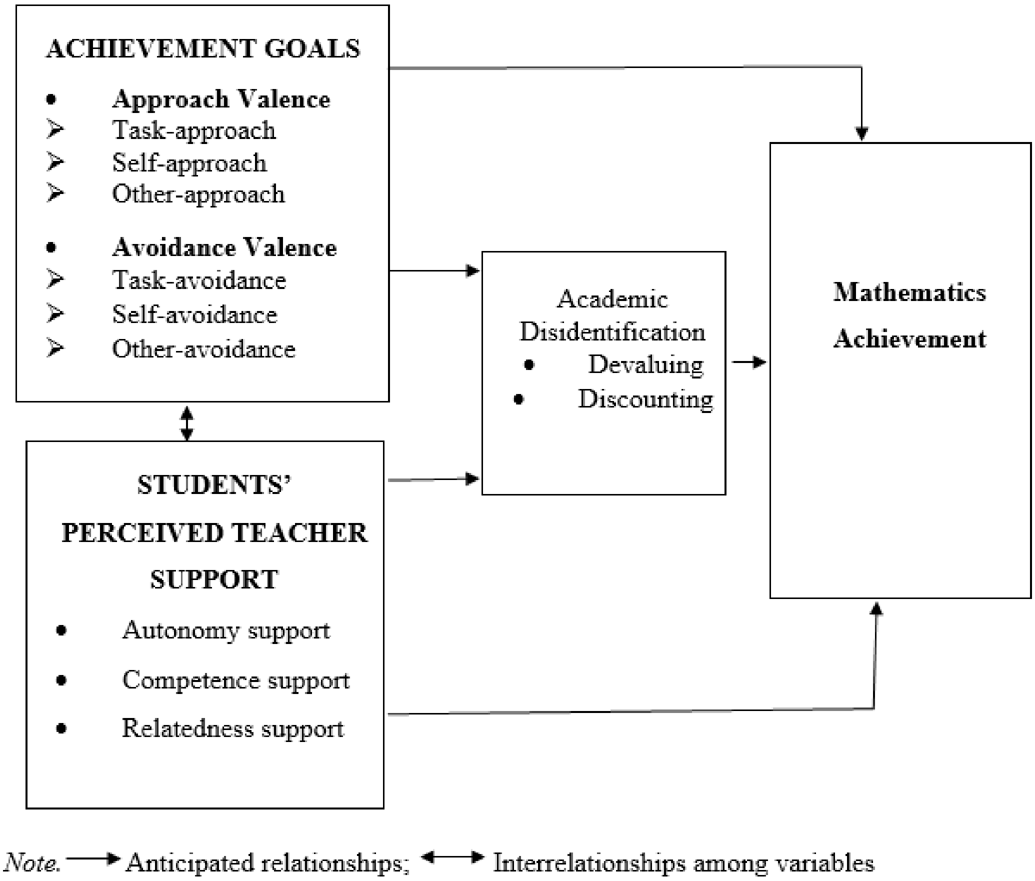
Conceptual Framework



In the study, predictor variables consisted of achievement goals and students' perceived teacher support while the outcome variable was mathematics achievement. The achievement goals and students' perceived teacher support were hypothesized to correlate with mathematics achievement. Achievement goals was duo-valenced. Approach valence had three goals – task approach (Tap), self-approach (Sap), and other approach (Oap); and avoidance valence with three goals as well – task avoidance (Tav), self-avoidance (Sav), and other avoidance (Oav). Students' perceived teacher support, on the other hand, had three sub-dimensions, notably, autonomy support, competence support, and relatedness and hypothesized to relate with mathematics achievement. Academic disidentification had two subscales; devaluing and discounting was the mediating variable.

Research Hypothesis

H_a: Mathematics achievement is significantly predicted by achievement goals, perceived teacher support and academic disidentification

The study hypothesized that there is a positive and significant relationship between achievement goals, perceived teacher support and academic disidentification.

METHODOLOGY

Research Design

The study embraced a correlational design in determining the predictive relationships among the variables. In line with Creswell (2018), the design allows the researcher to make predictions that emanates from those relationships. To collect data, a quantitative approach was adopted. A quantitative approach is characterized by the use of questionnaires as means of collecting data. Bloomfield and Fisher (2019) affirm that a quantitative approach is suitable in triggering respondent's perceptions regarding a variable that is being studied.

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Sampling

The study used stratified sampling to identify the 37 schools that participated in the study since schools in the county are of different categories (National, extra county, county, as well as the sub-county levels). Then, simple random sampling was adopted and guided the study pick participants from each school category. This choice was done in line with Fowler and Lapp (2019) who assert that simple random sampling ensures that all participants are given an equal probabilistic chance of taking part in the study. Further, Gill et al. (2010) who provide a guideline for sample size determination was embraced. Gill and the co-authors point out that in a population of up to 2000, the sample size should be 322. In compensating for non-response, attrition, and incomplete questionnaires, Israel (2020) recommends that the sample size be increased by 30 percent. Based on this procedure, the sample size of the current study consisted of 418 participants.

Research Instruments

Part I of the research instruments consisted of the participant's demographic data that included age, gender and school category. Part II had the sets of questionnaires - Achievement Goal Questionnaire (AGQ) that measured AGs, modified Teacher as Social Context Questionnaire (TASC – Student Version) that measured perceived teacher support, and Modified Intellectual Engagement Inventory (MIEI) that measured academic disidentification. All the items in the research instruments consisted of closed-ended statements.

Pilot study

Determining the feasibility of this study was a fundamental step in ensuring a successful study. Wiesenfarth and Calderazzo (2020) assert that in piloting, adopting at least 10 percent of the sample size meets the suitability criteria for piloting. Based on this guidance, two sub-county schools, one county school, one extra county school, and one national school were picked for piloting. Since there were only two national schools in the county and all participated in the final study, students who took part in the pilot study were exempted from the final study.

Validity and Reliability of the Research Instruments

The construct validity was established through assessment and liaising with supervisors to ensure that the items measure the intended construct domains of the current study. The findings were key in validating the research tools. Determining Cronbach's alpha was helpful in assessing the internal consistency of the items. As pointed out by Taber (2018), alpha value at least 0.7 is a good measure item reliability. Then, the internal consistency of the dimensions between the original authors' and the current study were compared. The findings were presented in Table 3.2.

Table 2.1 Internal Consistency Coefficients for the Adapted Instruments

SN	Scales / Subscales	No. of Items	Alpha Coefficients by Original Authors	Alpha Coefficients from in the current study
1.	Tap	16	0.84	0.76
2.	Sap	10	0.77	0.73
3.	Oap	18	0.93	0.70
4.	Tav	24	0.80	0.77
5.	Sav	8	0.83	0.75
6.	Oav	8	0.91	0.71
7.	AS		0.79	0.70
8.	CS		0.76	0.72
9.	RLD		0.80	0.73
10.	DV		0.66	0.65
11.	DS		0.81	0.74

Note. Tap: Task approach; Sap: Self-approach; Oap: Other approach; Tav: Task avoidance; Sav: Self-avoidance; Oav: Other avoidance; AS: Autonomy support; CS: Competence support; RLD: Relatedness; DV: Devaluing; DS: Discounting

Data Analysis

In regard to data analysis, the hypothesis was tested using multiple linear regression analysis.

RESULTS

Demographic

A cross tabulation was performed to compare the respondents' demographic data based on gender, age, and the students' school categories. The results of the cross tabulation were presented in Table 3.1.

Table 3.1 Students' Demographic Information

Student Demographics	Frequency	Percent
Gender		
Male	205	49
Female	213	51
Total	418	100
Age (Years)		
16-18	404	97.7
Over 18	16	3.3
Total	418	100
School Category		
Girls' School	88	21.1
Boys' School	75	17.9
Co-educational	255	61
Total	418	100

Results in Table 3.1 indicate that slightly more than half (51%) of the respondents were female compared to 49% males. In the age category, most of the respondents (96.7%) were aged between 16 to 18 years while those aged overs 18 years were 3.3%. In regard to school category, the schools were grouped into three groups; girls' schools, boys' schools, and co-educational schools. Most of the participants were from co-educational schools (61%). Participants from girls' schools were 21.1% while those from boys' schools were 17.9%.

Table 3.2 Differences in Mathematics Achievement based on School Category Subscales

		Value	F	Hypothesis	Error df	Sig.
SC	Pillai's Trace	.135	4.977	12.00	822.00	.000
	Wilks' Lambda	.867	5.051	12.00	820.00	.000
	Hotelling's Trace	.150	5.125	12.00	818.00	.000
	Roy's Largest Root	.127	8.718	6.00	411.00	.000

Note. df= degrees of freedom; SC = School Category

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Multivariate analysis was used to assess the differences in mathematics achievement across the school category subscales. Results in Table 3.2 shows that the differences in mathematics achievement were statistically significant between the subscales of the school categories ($F(12, 822) = 4.977$, $p < .0005$; Pillai's $V = .135$; partial $\eta 2 = .068$).

Hypothesis Testing

The hypothesis was tested using multiple linear regression analysis and results presented in the subsequent tables.

Table 3.3 Model Summary for the Prediction of Mathematics Achievement

R	R Square	Adjusted R Square	Std. Error of Estimate
.32	.36	.35	2.17

a. Predictors: (Constant), Academic Disidentification, Achievement Goals, Perceived Teacher Support

Table 3.3 shows that the multiple regression coefficient was 0.32 which implies that achievement goals, perceived teacher support, and academic disidentification positively predict mathematics achievement. The R square value was .36 indicating that 36% in mathematics achievement is explained by achievement goals, perceived teacher support, and academic disidentification. To examine the significance of the prediction model, ANOVA was done (Table 3.4).

Table 3.4 ANOVA Summary for the Prediction of Mathematics Achievement

	Sum of squares	df	Mean squares	F	Sig.
Between groups	217.69	3	72.564	15.41	.00
Within groups	1949.31	414	4.708		
Total	2167.01	417			

a. Dependent Variable: Mathematics Achievement

b. Predictors: (Constant), Academic Disidentification, Achievement Goals, Perceived Teacher Support

Results presented in Table 3.4 indicate that achievement goals, perceived teacher support, and academic disidentification significantly predict mathematics achievement, $F(3, 414) = 15.41$, $P < .00$. To investigate the relationship between the change in the predictor variable for the unit change in the outcome variable for the prediction model, regression coefficients were determined and presented in Table 3.5.

Table 3.5 Regression Coefficients for the Prediction of Mathematics Achievement

Model	Unstandardized coefficients		Standardized coefficients		
	ß	Std. Error	ß	t	Sig.
Constant	2.10	.45	.38	4.64	.00
Achievement goals	.33	.03	.32	.26	.00
Perceived Teacher Support	.31	.03	.38	3.19	.00
Academic Disidentification	-.37	.01	-.39	.3.93	.00

a. Dependent Variable: Mathematics Achievement

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Results in Table 3.5 demonstrate that perceived teacher support had the highest predictive value (ß = .38, $p < .05$). Achievement goals had a predictive value of .32, $p < .05$ while academic disidentification had a predictive value of -.39, $p < .05$. A positive regression coefficient points out that increase in the value of the predictor variable translates to a subsequent increase of the outcome variable. On the other hand, a negative regression coefficient points out that increase in the predictor variable is associated with a decrease in the outcome variable.

Based on the results presented in Table 3.5, the predictive values of the independent variables were statistically significant in predicting of mathematics achievement. A unit change in perceived teacher support resulted in .38 change in mathematics achievement, a unit change in achievement goals results to .32 change in mathematics achievement whilst a unit change in academic disidentification results to -.39 change in mathematics achievement.

The results revealed that achievement goals, perceived teacher support, and academic disidentification significantly predict mathematics achievement. As a result, it was paramount to assess how each of the subscales of the independent variables predicted mathematics achievement. This step was critical giving an inclusive prediction model (Table 3.6).

Table 3.6 Regression Coefficients of the Sub-Dimensions of the Predictor variable

	Unstandardized Coefficients		*Standardized Coefficients*		
	ß	*Std. Error*	ß	*t*	*Sig*
Constant	36.42			13.48	.00
Tap	.62	.23	.72	1.78	.00
Sap	.58	.27	.61	.16	.00
Oap	.61	.18	.48	1.03	.01
Tav	-.48	.14	-.55	.88	.00
Sav	-.55	.21	-.57	1.17	.00
Oav	-.47	.29	-.43	4.19	.00
Autonomy support	.63	.12	.71	. 07	.00
Competence support	.68	.48	.65	.78	.00
Relatedness	.36	.10	.33	1.74	.08
Devaluing	-.53	.29	-.58	4.30	.00
Discounting	-.60	.28	-.75	1.50	.00

a. Dependent Variable: Mathematics Achievement

Table 3.6 shows that predictive values for achievement goal subscales; Tav, Sap, Oap, Tav, Sav, and Oav (ß = .62; ß = 58; ß = .61; ß = -.48; ß = -.55; ß = -.47; $p< .05$ respectively) are all statistically significant. While perceived teacher support subscales; autonomy and competence support (ß = .63; ß = .68; $p< .05$ respectively) were found to be statistically significant, relatedness (ß = .36; $P > .05$) was found to be statistically insignificant. Academic disidentification subscales; devaluing and discounting (ß = -.53; ß = -.60; $p< .05$ respectively) were all found to statistically significant.

Premised on the obtained regression coefficients of the sub-dimensions of the predictor variables, a prediction equation for mathematics performance was developed:

$$\tilde{Y} = 36.42 + .62X1 + .58X2 + .61X3 -.48X4 -.55X5 -.47X6 + .63X7 + .68X8 -.53X9 -.60X10$$

where $\tilde{Y}$ is the predicted mathematics achievement, X1 = Tap goals, X2 = Sap goals, X3 = Oap goals, X4 = Tav goals, X5 = Sav goals, X6 = Oav goals, X7 = autonomy support, X8 = competence support, X9 = devaluing; X10 = discounting.

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The results reveal that a unit change in task approach goals leads to a .72 change in mathematics achievement. A unit change in self-approach goals, other-approach based goals leads to .61, and .48 respective change in mathematics achievement. In regard to avoidance valence, a unit change in Tav, Sav, and Oav leads to -.55, -.57, and -.43 change in mathematics achievement respectively.

In the subscales of perceived teacher support, a unit change in autonomy support leads to .71 change in mathematics achievement whilst a unit change in competence support leads to .65 change in mathematics achievement. Lastly, in the academic disidentification subscales, a unit change in devaluing resulted in -.58 change while discounting leads to -.75 change in mathematics achievement.

DISCUSSION

Both approach and avoidance valences of AGs were found critical in the overall achievement of mathematics. Students embracing approach valence (Tap, Sap and Oap goals) were reported to have approach motivation. This study found approach motivation a fundamental impetus to propelling students to embrace learning mathematics. Approach motivation is associated with the pursuit of goals and opportunities, and is further characterized by feelings of enthusiasm and anticipation driven by drive to attain desirable results. It plays an instrumental role in shaping learning behavior. It proffers goal-directed behavior; consequently, a predictor of mathematics achievement.

Avoidance valence, on the contrary, was characterized as an inclination to evasion from a perceived negative stimulus. Students therefore who embrace Tav, Sav, and Oav based goals tend to avoid mathematics learning activities to evade being gauged against the demands of mathematics task, self – progress, or how one compares in relation to the achievement of others. A student either embraces approach or avoidance valance. This study found approach and avoidance goals significant in predicting mathematics achievement. These findings are in tandem with Papaioannou and Krommidas's (2021) study findings which established that achievement goals significantly predict end-year mathematics grades.

The scaffolding role mathematics teachers' play was also found instrumental in predicting mathematics achievement. When students feel that their teachers value, care for, and support them, they are more likely to develop approach motivation towards solving mathematics problems. In line with the tenets of SDT, teacher's support for autonomy in the classroom positively predicts mathematics achievement. In developing autonomy, students who are given space to shape their own learning path whilst being guided by the mathematics teacher(s) to reflect on their goals and progress are more likely to report high pass rates in mathematics. Importantly, in classrooms, students who embrace avoidance motivation are less likely to develop competence and autonomy therefore less likely to obtain high pass rates in mathematics. These findings are further in agreement with the expectancy-value tenets (Wigfield & Eccles, 2000) which underpins the role of value of teachers' support in fostering enjoyment in student learning and subsequent mathematics achievement.

Different from the majority of the reviewed studies that only used a simple linear relationship to establish predictive model of students' achievement (Mouratidis et al., 2018; Visser and Arends, 2019), the current study developed its predictive model from a psychological perspective that involved ego withdrawal from pursuit of mathematics, academic disidentification. In particular, this study found devaluing and discounting as psychological factors that influence students' mathematics achievements emotionally through ego withdrawal. The current study findings are further in agreement with Eccles and Wigfield (2020) who points out that the value of task in achievement predicts the choice of activity and decisions made to either approach or avoid solving mathematics activities in the future.

CONCLUSION

In conclusion, the current study established that approach valence subscales of achievement goals and autonomy and competence subscales of perceived teacher support have a predictive (positive) value on mathematics achievement whilst avoidance valence, devaluing and discounting negatively predicts mathematics achievement.

RECOMMENDATIONS FOR FUTURE RESEARCH

For future research, a longitudinal study that follows participants for several years to determine the patterns of goal motivation valences and mathematics achievement will be impactful in comparing the findings.

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