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Research Article

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Classroom-based psychosocial mathematical learner identities and student performance in mathematics among secondary school students in Kilifi County, Kenya

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ABSTRACT

The article shares findings from the study objective to determine the extent to which classroom-based psychosocial mathematical learner identity influences student performance in Mathematics. The sociocultural theory of learning formed the theoretical framework. The study applied a correlational research design on a sample size of 100 students, using a Student Observation Checklist and Student Mathematics Achievement Test to obtain quantitative data. The technique of correlation determined the influence of classroom-based psychosocial mathematical learner identity on student performance in Mathematics. The study indicated that classroom-based psychosocial mathematical learner identity is a determinant for student performance in Mathematics tests. The study recommends the organization of Mathematics classrooms to allow equal participation and metacognitive support.

Keywords: mathematics education, mathematical learner identities, sociocultural theory, performance in mathematics

INTRODUCTION

This article is based on a larger study that sought to investigate the relationship between mathematical learner identities and student performance in mathematics to generate its guiding management prototype. Mathematical learner identity research in mathematics education is a key aspect in the learning and teaching of Mathematics, responsible for student performance in mathematics (Bishop, 2012). The research on mathematical learner identities was a social turn introduced in mathematics education by Lerman (2000), framed on sociocultural theories of learning (Darragh, 2016). The classroom-based psychosocial mathematical learner identity includes teacher support, student engagement, peer influence, affective factors, student cooperation, and equality. The mathematical classroom involves tasks, norms, teacher pedagogy, and curricula that develop psychosocial-related mathematical learner identities which influence student performance in mathematics (Polman, 2006). This study is based on socio-cultural aspects, which focuses on identity development in mathematics being within a community at school or in a social network (Wenger, 1998) to relate classroom-based psychosocial mathematical learner identity and student performance in mathematics.

The current study operationalized identity in Mathematics as enacted and constrained in a particular social context of secondary school learners experiencing local classroom practices (Bishop, 2012; Nasir, 2002). An identity in mathematics is self-view, negotiated socially, and highlighted by historical events, personal narratives, experiences, routines, and participating ways (Bishop, 2012). Therefore, mathematical learner identity is an individual's perception of "who one is mathematically", to an extent of seeing value and developing a commitment to mathematics (Allen & Schnell, 2016). Mathematical learner identities are either positively or negatively grouped per the "narratives" students perceive themselves with mathematics (Allen & Schnell, 2016). The sub-themes and codes for characteristics of positive and negative mathematical identity groups adopted from Doward`s (2017) are presented in **Appendix A**. Whereby, learners of positive mathematical identities view themselves as able to succeed in mathematics either through innate qualities or persistent effort, with a concern for maintaining a successful image. Unlike learners of negative mathematical identities, who are centrally characterized by an oppositional identity. They avoid mathematical involvement as they view themselves as of low ability in mathematics and the uselessness of mathematics to them (Doward, 2017). However, the sources of both the positive and negative classroom-based psychosocial Mathematical learner identities are little known.

Statement of the Problem

The study of mathematical learner identity is a one-dimensional idea of learning mathematics based on the sociocultural theory of learning. Mathematical learner identities are key components of learning mathematics that relate to performance in mathematics. Lack of development of mathematical learner identities results in neither mathematical conceptual understanding nor a holistic lens for learners to examine their mathematical experiences within a social context inside and outside the mathematics classroom. However, little is known about the influence of classroom-based psychosocial mathematical learner identity on student performance in Mathematics to generate its guiding management prototype. It is because of this identified knowledge gap that the study was designed to correlate classroom-based psychosocial mathematical learner identity and student performance in mathematics with an intention to generate its prototype guideline for consideration towards the enhancement of mathematics education in addressing the persistent poor students` performance in mathematics.

Research Question

RQ1 To what extent does classroom-based psychosocial mathematical learner identity influence student performance in mathematics?

Theoretical and Conceptual Frameworks

This study was founded on Vygotsky's (1978) sociocultural theory of learning as a basis for correlational investigation of classroom-based psychosocial mathematical learner identity and student performance in mathematics that generates its management prototype. The sociocultural theory of learning views social relationships as the center of cognitive enhancement and identity construction, which may vary among cultures. Learning is also a social task rather than being only a cognitive affair (Wenger, 1998). Behavior and learning are influenced by personal, social, and circumstantial issues (Vygotsky, 1978). It is perceived that by nature, individuals are societal and responsive; therefore, their ideas and actions are tactful to the complications of their social environment, in particular the instructional context (Wenger, 1998).

Tenets of Vygotsky's (1978) sociocultural theory of learning are of importance in this study. Perceive learning as a social task rather than being only a cognitive affair. This permitted the systematic study of classroom-based psychosocial mathematical learner identities and student performance by connecting to aspects of "social participation" (Wenger, 1998) and "thinking of thinking" (Brown, 1987). Therefore, Vygotskian sociocultural theory of learning informed the study objective, literature review, variables under study, and the intended guiding prototype. That is, the sociocultural theory focuses on the significance of varying social contexts in which the students gain psychosocial assistance in their learning activities, be it school, friends, or the context of social tasks (Williams, 2016). The interactive nature of learning during the dialogic construction of identities and knowledge develops classroom-based psychosocial Mathematical learner identities and improves student performance as negotiated meaning in experience (Vygotsky, 1978).

Therefore, since the sociocultural theory of learning emphasizes social relationships as the center of identity construction under different aspects among customs, then the classroom-based psychosocial mathematical learner identity on student performance is an aspect of learning mathematics too. Also, the student performance can be attributed to the selected source of mathematical learner identities as well as influenced by other learning factors like peer influence, teacher support, parental involvement, cultural stereotypes and myths, or norms in mathematics.

RESEARCH METHODOLOGY

The research methodology entails the materials and methods used for the study. The research was of a correlational study design that employed both quantitative and qualitative research methods. It was conducted in two purposively sampled County secondary Schools in Ganze Sub-County of Kilifi County, Kenya. A sample of twenty-five percent (n = 50) form two (Grade 10) learners, aged 16 to 17 years from different ethnic practices, in each sampled school was chosen, resulting in a twenty-five percent (n = 100) total sample size. The students` sampling process involved a preliminary investigation to identify the positive and negative mathematical learner identity groups guided by Doward's (2017) codes as in **Appendix A**. The study had two positive and negative mathematical identity groups in each of the sampled schools.

During the 16 weeks of learning mathematics, two research assistants were recruited and trained. The two (2) research assistants identified to administer the research tools were trained by the researcher in their respective allocated sampled schools using a summarized study package. The participating research assistants include two graduate students in mathematics education from the University campuses within Kilifi County. One research assistant, as observer, implemented the Student Observation Checklist (SOC) while the other one administered the Student Mathematics Achievement Test (SMAT). Training of these participating research assistants lasted approximately an hour for each pair within their allocated sampled schools in a one-month preliminary investigation period. All research assistants received the same information on the importance of Mathematical learner identities to performance in Mathematics, together with all study materials with their explanations. The materials include SOC and SMAT. An inclusive was a detailed study timetable to ensure all research assistants administered the research instruments on the identified days.

The research assistant in charge of SOC observed the sessions of both positive and negative mathematical identity groups in their different classrooms twice a week, guided by the Student Observation Checklist (SOC). The items of the Student Observation Checklist (SOC) are included in **Appendix B**. Training of the observers includes a discussion of the checklist items about the student's classroom psychosocial aspects (Moats, 2014). The observers paid attention to learner behavior in the classroom during teaching sessions and focused on learners' physical engagement with various learning variables, cognitive and affective behaviors with peers, as well as noting behaviors interfering with the engagement of the student during instruction. At the end of the learning period, the Student Mathematics Achievement Test (SMAT), as attached in **Appendix C**, was administered. It aimed at assessing the solving of mathematical problems using the mathematical concepts learned by the students. A table of specifications was used in writing the items based on the six Bloom taxonomy levels. The questions were scored based on their weight, totaling 30 marks, like the learners` normal Continuous Assessment Test (CAT) using the Guiding Marking Scheme for SMAT in **Appendix D**.

At the piloting stage, both the content and construct validity of the instruments were determined. Content validity was determined by manually computing the content validity ratio (Lawshe, 1975):

$$CVR = \frac{n_e - \left(\frac{N}{2}\right)}{\frac{N}{2}} \tag{1}$$

where, CVR = content validity ratio, n_e= number of correct responses, N = number of total participants.

The content validity of the research instruments clicked CVR = 0.045 at p < 0.05.

Improved items were administered to the same respondents to further validate the research tools. A correlation of the test-retest outcomes was done with the aid of SPSS Version 21.0 software and established the construct validity of the study tools at r(50) = .85, p = .5. This strengthened both construct and content validity. The RIT and SMAT were constructed together with experts from Social Sciences (Methods of Social Research I/II) and Educational Psychology faculty experts together with KCSE Mathematics Examiners of Mathematics Paper One (121/1).

The method of split-half established the reliability of the SOC and SMAT research tools during the piloting stage. Was done by the items coded using even or odd numbering before manual computing by:

$$rxx = [2r½½] / [1 + r½ ½] \tag{2}$$

where, rxx = whole test reliability, r½ ½ = half-test reliability.

The reliability of the research instruments clicked rxx = 0.00095 at p < 0.001 using the split-half computation in the test-retest technique. Thereafter, improved research tools were applied to the sampled participants during the actual research.

The data collection was preceded by a period of preliminary investigation for four (4) weeks at the onset of Term One. General classroom observations and background discussions with all form two students were carried out in their sampled schools. This enabled the researcher to familiarize themselves with the locale for the activity of investigation, as well as identify the mathematical identities of learners to subdivide them into negative and positive mathematical identity groups. Also, during the preliminary investigation period, the researcher consulted the School of Education coordinators in the University campuses within Kilifi County to purposively choose two research assistants using the following specifications: only graduate students in mathematics education, having interpersonal, communication, observational, and time-management skills. The research assistants administered the Student Observation Checklist (SOC) to gather quantitative data on learners` classroom-based psychosocial mathematical identities to determine their influence on student performance in mathematics during analysis. The positive and negative classroom-based psychosocial mathematical learner Identities raw scores are presented in **Appendices E** and **F**. Lastly, students were assessed on the mathematical concepts learned within the 16 weeks using the Student Mathematics Achievement Test (SMAT). The student mathematics achievement test descriptive results are presented in **Appendix G**.

The quantitative data from the Student Observation Checklist (SOC) and Student Mathematics Achievement Test (SMAT) were edited and coded before being analyzed with the aid of SPSS Version 21.0 software. A code sheet synthesizing the data was generated from a computer codebook. Random cross-tabulation was done to remove any erroneously entered data. The coefficient of correlation between the quantitative data obtained using SOC and SMAT was determined with the aid of SPSS Version 21.0 software. The correlation coefficient determined the extent to which classroom-based psychosocial Mathematical learner identity influences student performance in Mathematics. The quantitatively analyzed data were presented in a tabular form and then explained.

PRESENTATION OF FINDINGS AND DISCUSSION

The study ought to determine the extent to which classroom-based psychosocial mathematical learner identity influences student performance in mathematics. The classroom-based psychosocial mathematical learner Identity scores and student mathematics achievement test descriptive results were correlated according to group. The results are presented in **Tables 1** and **2**.

Table 1. Correlation between positive classroom-based psychosocial MLI and SMAT

	Gender	**Student mathematics achievement test**	
Positive classroom-based psychosocial MLI	Boys	Pearson correlation	.877*
		Sig.	.000
		n	25
	Girls	Pearson correlation	.877*
		Sig.	.000
		n	25

*Correlation is significant at the 0.05 level (2-tailed)

Table 2. Correlation between negative classroom-based psychosocial MLI and SMAT

	Gender	Student mathematics achievement test	
Negative classroom-based psychosocial MLI	Boys	Pearson correlation	.5184*
		Sig.	.000
		n	25
	Girls	Pearson correlation	.5184*
		Sig.	.000
		n	25

*Correlation is significant at the 0.05 level (2-tailed)

The study found that there was a strong positive correlation, r(25) = .877, p = .00001, between positive classroom-based psychosocial mathematical learner identity and student performance in mathematics, for both boys and girls. This means that high positive classroom-based psychosocial mathematical learner Identity scores go with high student mathematics achievement test descriptive results. Since r = .877, then the value of r^2, the coefficient of determination, is 0.7698. This implies that 76.98% of the total student performance in Mathematics is accounted for by positive classroom-based psychosocial mathematical learner identity. Therefore, the positive classroom-based psychosocial mathematical learner identity is determinant for one to perform well in mathematics tests. The finding is attributed to Bishop`s (2012) compiled socio-metacognitive determinants, such as task variables, teacher pedagogical knowledge, and curricula underlying positive classroom-based psychosocial mathematical learner identity that influence student performance in mathematics. The study finding has a great contribution to STEM. Positive classroom-based psychosocial mathematical learner identity is a socio-motivational construct known to be a predictor of achievement in mathematics. Students who identify positively with mathematics are more likely to pursue advanced courses and Science, Technology, Engineering, and Mathematics (STEM) related careers.

Also, there was a moderate positive correlation, r(25) = .5184, p = .007936 for boys, and r(25) = .596, p = .001667 for girls, between negative classroom-based psychosocial mathematical learner identity and student performance in mathematics. This means that there is a tendency for negative classroom-based psychosocial mathematical learner identity scores to go with low student mathematics achievement test descriptive results. Since boys' r = .5184, then the value of r^2, the coefficient of determination, is 0.2687. This implies that 26.87% of the total boys' performance in mathematics is affected by the negative classroom-based psychosocial mathematical learner identity. Whereas girls' r = .596, then the value of r^2, the coefficient of determination, is 0.3552. This implies that 35.52% of the total girls' performance in Mathematics is accounted for by negative classroom-based psychosocial mathematical learner identity. Therefore, the negative classroom-based psychosocial mathematical learner identity determine low performance in mathematics tests based on gender. This finding is supported by Boaler's (2000) articulation that some negative socio-metacognitive practices in the classroom, such as interacting learners, lack of meaning, and monotony, develop a negative classroom-based psychosocial mathematical learner identity that influences student performance in mathematics. The study finding also contributes to STEM, when predicting a student's interest in a STEM profession, the classroom-based psychosocial mathematical learner identity acts as a complete mediator of the level of mathematics anxiety. In other words, negative classroom-based psychosocial mathematical learner identity does raise students' anxiety towards mathematics, which in turn leads to low performance against venturing into STEM-related careers (Mweni et al., 2023).

In the view of contributing new knowledge towards improving Mathematics Education, the implication of the study findings generates a prototype guideline for the management of classroom-based psychosocial mathematical learner identity in mathematics classrooms. The guiding management prototype is fused into the critically reviewed studies related to mathematical learner identities, as shown in **Figure 1**. The study of mathematical learner identities was founded on the Vygotsky's (1978) sociocultural theory of learning that stems from Wenger's (1998) sociocultural aspect of identity. Doward (2017) subdivided the mathematical learner identities into innate-ability, persistent-effort, and image-maintenance positive identities, while oppositional identity is negative. Based on the tenet of Vygotsky's (1978) sociocultural theory of learning, the study established that mathematical learner identities is of a classroom-based psychosocial sourced aspect. This aspect underlies the improvement of mathematics education by enabling mathematics teachers to perceive learning mathematics as social rather than being only a cognitive affair.

Therefore, the prototype guideline is a procedural, continuous, and repeated process in the teaching and learning of mathematics. The management of classroom-based psychosocial mathematical learner identity in mathematics classrooms can be well achieved using the following sequenced guidelines:

a) Mathematics teachers to identify classroom–based psychosocial mathematical identity among learners by analysis of data collected using the Student Observation Checklist that focuses on learner behaviors in the mathematics classroom.

b) Mathematics teachers to organize mathematics classrooms that allow equal social participation of learners as they communicate their meanings of mathematical concepts to peers.

c) Mathematics teachers initiate social and metacognitive support that suppresses the negative effects of peer influence among students during mathematics engagement.

d) Mathematics teachers to administer the Student Mathematics Achievement Test and determine the improvement index of performance in Mathematics.

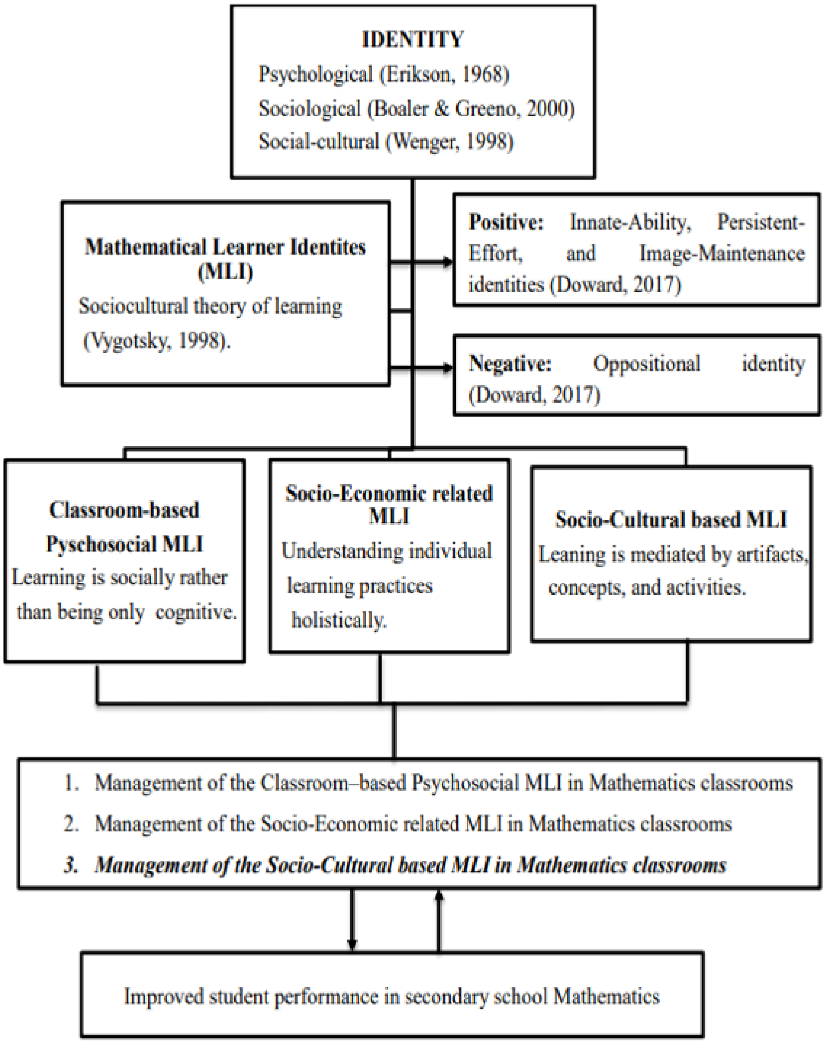

Figure 1. A prototype guideline for the management of mathematical learner identities in mathematics classrooms (Mweni et al., 2023)

CONCLUSION

Therefore, the contribution of the study was that mathematical learner identities are significantly linked to student performance in mathematics. The students' poor performance in mathematics is often a concern despite its critical value in the community and needs to be effectively addressed. The consideration of the prototype guideline for the management of classroom–based psychosocial mathematical learner identity in mathematics classrooms, towards the improvement of mathematics education, was shown by the research to be an effective way of addressing the persistent poor student performance in secondary school Mathematics.

Contribution to the Literature

The study based on the Sociocultural Theory of learning established that mathematical learner identities are of classroom-based psychosocial sourced aspects. The aspects that underlie the improvement of mathematics education include: Mathematics teachers perceiving learning mathematics as social rather than being only a cognitive affair, investigating and understanding individual learning practices more holistically, and understanding that the learning of mathematics is mediated by cultural artifacts, concepts, and activities. In particular, the contribution of the study was that classroom-based psychosocial mathematical learner identity is a determinant for student performance in Mathematics tests. The students' poor performance in mathematics is often a concern despite its critical value in the community and needs to be effectively addressed. Mathematics teachers have to organize mathematics classrooms that allow equal social participation of learners as they communicate their understanding of mathematical concepts to peers. Also, the mathematics teachers need to initiate social and metacognitive support that suppresses the negative effects of peer influence among students during mathematics engagement. Therefore, the consideration of the prototype guideline for classroom-based psychosocial mathematical learner identity in mathematics classrooms, towards the improvement of mathematics education, was shown by the study to be the main effective contribution to the reviewed literature.

Recommendation

Based on the foregoing discussion of the findings and conclusion, the research article recommends that secondary school mathematics teacher educators should be sensitized to the need for mathematics teachers to organize mathematics classrooms that allow equal social participation and provision of metacognitive support among learners. Since there was a positive correlation between classroom-based psychosocial mathematical learner identities and student performance in mathematics, teachers should encourage communication of mathematical meanings free from the negative effects of peer influence among learners.

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AI statement: The authors stated that no AI technologies were used in any part of this study.

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Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

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APPENDIX A

Table A1. Sub-themes and codes for characteristics of positive and negative mathematical identity groups

Groups	Sub-themes	Main codes
Positive mathematical identities	Innate-ability identity	PC1 Influenced by classroom environment favoring Mathematics.
		PC2 Self Positive view on mathematical competence.
		PC3 Competence in Mathematics is perceived as inborn.
		PC4 Mostly individualized task involvement.
		PC5 Strong succeeding ambition.
		PC6 Committed to solving Mathematics problems.
		PC7 Mathematics associates future imaginations.
		PC8 Highest performance in Mathematics.
	Persistent-effort identity	PC9 Influenced by classroom environment favoring Mathematics.
		PC10 Self Positive view on mathematical competence.
		PC11 Competence in Mathematics is perceived as inborn.
		PC12 Mostly individualized task involvement.
		PC13 Strong succeeding ambition.
		PC14 Committed to solving mathematics problems.
		PC15 Mathematics associates future imaginations.
		PC16 Highest performance in Mathematics
	Image-maintenance identity	PC17 Weakly Influenced by classroom environment favoring Mathematics.
		PC18 Self Positive view on mathematical competence.
		PC19 Competence in Mathematics is perceived as effort-based.
		PC20 Weakly involved in interactive tasks.
		PC21 Mostly ambitious in avoiding failure.
		PC22 Faintly Mathematics associates with future imaginations.
		PC23 Weakly Mathematics alignment. PC24 Modest performance.
Negative mathematical identity	Oppositional identity	NC1 Influenced by classroom environment disfavoring Mathematics.
		NC2 Negative perceptions of mathematical competence.
		NC3 Mathematical competence is perceived as essentially inborn.
		NC4 No individualized engagement in mathematical activities.
		NC5 Lack of succeeding ambition in Mathematics.
		NC6 Lack of commitment to solving Mathematics problems.
		NC7 Mathematics does not associate with future imaginations.
		NC8 Lowest performance in Mathematics.

PC = Positive characteristics, NC = Negative characteristics (adapted from Doward's, 2017)

APPENDIX B

Two recruited and trained research assistants implemented the Student Observation Checklist (SOC). They were supposed to apply their interpersonal and communication skills in welcoming the students to the observation sessions and establish rapport with them before adhering to the following instructions.

Instructions

When completing the checklist, they paid attention to the learner behavior in the classroom during teaching instruction, student physical, engagement, cognitive, and affective behaviors with peers, noting behaviors interfering with the engagement of the student during the instruction process. They ticked appropriately for each student twice in a week.

Table B1. Student observation checklist (SOC)

No.	Statements	Never	Little	Sometimes	Mostly	Always
1	Is attentive in class					
2	Does well with peers					
3	Thoroughly tackles own work, and well, instead of just attempting to get by					
4	Acts carelessly without being still					
5	Active group participant					
6	Completes assignments					
7	Requires always to be reminded					
8	Disrupts the work of peers					
9	Persist in challenging problems					
10	Doesn't care about classroom activities					
11	It is passive and isolated					
12	Tackles more assignments with honest effort					
13	Pose questions for detailed information					
14	Speaks a lot with classmates					
15	Doesn't initiate independently; instead is dependent on help from others to keep working					
16	Attempts to complete difficult assignments					
17	Volunteers to respond to a question or provide information					
18	Easily discouraged by an obstacle in schoolwork					

APPENDIX C

Student Mathematics Achievement Test (SMAT)

Two recruited and trained research assistants administered the Student Mathematics Achievement Test (SMAT). They were supposed to apply their interpersonal and communication skills in welcoming the respondents and establishing rapport with them before explaining the following instructions.

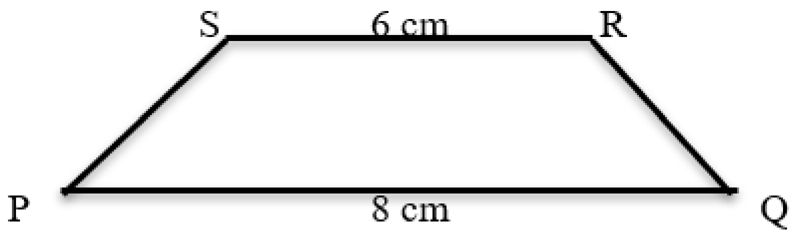
Instructions

Total: 30 marks Time: 1 hour

This is a test on Mathematics assessing the solving of mathematical problems using the mathematical concepts learned in Terms One and Two as per the Form Two (Grade 10) Mathematics syllabus. The test results were used in determining the correlation between classroom-based psychosocial Mathematical learner identities and student performance in Mathematics. Students responded to all task items honestly and accurately. The responses were considered towards the improvement of Mathematics Education in addressing the persistent low students` performance in Mathematics.

Question 1

A. In the trapezium PQRS shown below, PQ = 8cm and SR = 6cm.



If 28 cm^2 is the trapezium's area, calculate the perpendicular distance between PQ and SR. (3 marks)

B. A garden is in the shape of a right-angled triangle. The length of the shortest side is 17m and the area of the garden is 346.8 m^2. Find the distance of the longest side of the garden. (3 marks)

Question 2

A. Given that sin2x = cos(3x-10°), find tan x, correct to 4 significant figures. (3marks)

B. A line L is perpendicular to the line $\frac{2}{3}x + \frac{5}{7}y = 1$. Given that L passes through (4, 11), find the equation of L in the form $y = mx + c$, where m and c are constants. (3 marks)

Question 3

A. Two numbers p and q are such that $p^3 \times q = 189$. Find p and q. (3 marks)

B. Calculate the reciprocal of 0.0247 using mathematical tables and evaluate $\frac{\sqrt[3]{3.025}}{0.0247}$, to 2 decimal places. (3 marks)

Question 4

A. A small cone of height 8 cm is cut off from a bigger cone to leave a frustum of height 16 cm. If the volume of the smaller cone is 160 cm^3, find the volume of the frustum. (3marks)

B. A right pyramid has a rectangular base of length 80 cm and width 60 cm. The slant edges of the pyramid are 130 cm each. Find the volume of the pyramid. (3 marks)

Question 5

A. A triangle T with vertices A (2, 4), B (6, 2) and C (4, 8) is mapped onto triangle T^1 with vertices A^1 (10, 0), B^1 (8, -4) and C^1 (14, -2) by rotation. On a grid provided, determine the center and angle of rotation that maps T and T^1. (3marks)

B. The number is of two-digits such that, the addition of its digits is 13. When the digits are reversed, the initial number is raised by 9. Find the initial number. (3 marks)

APPENDIX D

Table D1. Guiding marking scheme for SMAT

Qn.	Working out	Marking	Assessed learning activities
1A	$\frac{1}{2}(8+6)h = 28$ cm^2 7h = 28 H = 4 cm	M1 M1 A1 03	Application of formulae Solving problem Accuracy with correct units
1B	Area = $\frac{1}{2}$ × b × h Let h be the other shorter side 346.8 = $\frac{1}{2}$ × 17 × h h = 40.8 Longest side = $\sqrt{17^2 + 40.8^2} = \sqrt{1953.64}$ = 44.2 m	B1 M1 A1 03	Application of formulae Pythagoras' theorem Accuracy with correct units
2A	$2x+(3x-10) = 90°$ $5x = 100°$ $x = 20°$ tan 20° = 0.3640	M1 A1 B1 03	Complementary angles Accurate answer with units Reading mathematical tables
2B	$\frac{2x}{3}+\frac{5y}{7} = 1$ $14x+15y = 21$ $y = \frac{-14}{15}x+\frac{21}{15}$ gradient of L = $\frac{15}{14}$ Equation of L $\frac{y-11}{x-4} = \frac{15}{14}$ $y = \frac{15}{14}x+\frac{47}{7}$	B1 M1 A1 03	Straight-line equations Gradient relationship of perpendicular lines Accuracy in the $y = mx + c$ format
3A	189 = 3 × 3 × 3 × 7 = 3^3 × 7 p^3 × q = 3^3 × 7 p = 3, q = 7	B1 B1 B1 03	Factor method Laws of indices Both correct solutions
3B	$\frac{1}{0.0247} = \frac{1}{2-47} \times 10^2 = 0.4049 \times 10^2 = 40.49$ $\frac{\sqrt[3]{3.025}}{0.0247} = \sqrt[3]{3.025} \times 40.49 = 58.56$	B1 M1 A1 03	Reading mathematical tables Computation using reciprocals Accuracy to 2 decimal places
4A	Linear scale factor = $\frac{1}{3}$ Volume scale factor = $\frac{1}{27}$ Let volume of bigger con be V $\frac{160}{V} = \frac{1}{27}$ V = 4320 cm^3 Frustum (4320 – 160) = 4160 cm^3	B1 A1 B1 03	Relationships of scale factors Correct bigger volume Solving accurately
4B	Height h = $\sqrt{130^2 - 50^2}$ = 120 cm Volume = $\frac{1}{3}$ × 80 × 60 × 120 = 192000 cm^3	M1 M1 A1 03	Application of formulae Solving problem Accuracy with correct units
5A	Correct graphing Center of rotation (4, -2) Angle of rotation – 90	B1 B1 B1 03	Rotational symmetry on a grid Determining the centre Measuring the angle
5B	Let the number be xy so $x + y = 13$ $(10y+x) - (10x+y) = 9$ or $-x + y = 1$ $x + y = 13$ $\underline{-x + y = 1}$ $2y = 14$ i.e. $y = 7, x = 6$ Number is 67	M1 M1 B1 03	Formulation of equations Solving problem Correct values and the number

Key: M = Method, B = independently for both method and answer, A = Accuracy

APPENDIX E

Table E1. Positive classroom-based psychosocial mathematical learner identity raw scores

Gender	Classroom-based psychosocial mathematical learner identity scores											
Boys (n = 25)	60	70	75	60	50	50	45	55	50	70	50	65	65
	50	45	50	45	50	45	50	50	55	65	65	50	
Girls (n = 25)	60	55	50	45	50	45	50	45	55	50	70	60	45
	65	75	70	65	55	45	50	60	45	75	45	65	

APPENDIX F

Table F1. Negative classroom-based psychosocial mathematical learner identity raw scores

Gender	Classroom-based psychosocial mathematical learner identity scores												
Boys (n = 25)	25	45	20	40	35	30	45	40	45	40	35	25	40
	30	35	35	40	25	45	30	30	40	45	35	40	
Girls (n = 25)	35	45	35	40	45	40	20	45	25	30	40	45	20
	45	35	25	45	40	30	45	20	45	25	45	30	

APPENDIX G

Table G1. Student mathematics achievement test descriptive results

Group	Gender	Student mathematics achievement test descriptive results												
Positive MLI (n = 50)	Boys (n = 25)	25	24	22	21	20	23	20	21	22	23	24	25	21
		20	22	23	20	21	24	23	22	20	22	21	20	
	Girls (n = 25)	28	28	26	25	23	22	26	22	24	25	27	21	20
		23	23	21	25	26	24	27	23	20	25	24	22	
Negative MLI (n = 50)	Boys (n = 25)	05	11	13	17	16	06	10	07	09	14	15	08	12
		17	16	05	12	13	09	07	06	08	10	11	05	
	Girls (n = 25)	08	12	16	15	16	17	17	16	16	19	16	18	14
		16	18	13	16	09	11	10	19	17	18	15	12	