Influence of Linguistic Challenges on Attitude towards Mathematics Learning among Upper Primary Students of Kerala

Sarabi M K

&

Abdul Gafoor K.

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Abstract

Aspects that influences mathematics learning is widely studied and language factors have been identified as a key backer to difficulties in learning Mathematics. It is evidenced that not only cognitive factors but also affective factors have vital role in learning mathematics. Such affective beliefs sources from various aspects of mathematics teaching learning process. This study explored influence of linguistic challenges that students encounter while learning mathematics on their attitude towards mathematics learning. A descriptive survey in a sample of 200 students in 7^{th} standard in Kozhikode and Malappuram districts of Kerala with a mathematical language test provided categories of language related difficulties in mathematics learning among Malayalam medium students. The test contained items on 21 areas of difficulties. Students rated their like towards Mathematics learning on a 3 point scale, which is later dichotomised for chi-square analyses. Analysis of association between Difficulties in components of mathematics language and Attitude towards mathematics learning revealed that difficulty in terms- Discipline specific terms, common terms, common terms with specific meaning and Morphology of mathematics terms influences students' attitude towards Mathematics learning. Difficulties related to Mathematical symbols also influences student's attitude towards mathematics whereas mathematical statements are influencing the same to a lesser extent. Giving attention to terminology, symbols and syntactic structures in mathematical statements whether in common or mathematical language should be part of mathematics teaching-learning. This will help to develop positive attitude towards mathematics learning among younger learners which is an important goal of mathematics instruction.

***Keywords*:** Language of mathematics, Linguistic challenges, Mathematics vocabulary, Attitude towards Mathematics.

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Introduction

Language is an instrument of inclusion and exclusion, including in maths teaching. As with learning any other discipline, learning mathematics also is unlocked or constrained by access to the specific language through which it is communicated (Craig & Morgan, 2015). Hence, there is growing recognition that language of mathematics as an important component of instruction (Thompson & Rubenstein, 2000) at school level as well. Subsequently, national focus group on teaching of mathematics (NCERT, 2006) has highlighted the problems created by the language used in textbooks, especially at the elementary level. It was observed that for vast majority of Indian children, the language of mathematics learnt in school is far removed from their everyday language, and hence forbidding. This is a foremost force of alienation of mathematics for learners in schools itself. This problem is intensified in multilingual cultures like India and creates characteristic difficulties particular to every language, since elsewhere it is identified that there are big differences between mathematical discourses in different languages (Barton, 2007). But researches into language aspect of teaching and learning mathematics at school and classroom level, beyond the curriculum and textbook development, is still in a neglected state in various linguistic regions of Indian polity. Mathematics is taught without explicitly introducing its own language and the learner is left to discover the language unassisted (Baber, 2001).

Recent recognition of importance of language of mathematics in classroom practice, if any, is often limited to specialised vocabulary of mathematics. However, mathematical communication is more than vocabulary. For instance, students have to learn to describe patterns, make generalizations, and use representations to support their claims (Moschkovich, 2012). It was in this context, a previous study by the present authors explored and categorised aspects of language of elementary school mathematics when taught through Malayalam (Gafoor & Sarabi, 2015) in Kerala, India. Also, reflecting the increasing recognition that children's mathematical worlds are complex places containing both cognitive and affective elements, subsequent studies has observed that aspects of language of mathematics impacts student perception of difficulty and utility of mathematics. Difficulties in all the components of Mathematical vocabulary, Morphology and pragmatics are contributed to perception of Mathematics as a difficult subject. Out of five components in syntax three are causative factors of perceiving maths as difficult subject. In semantics, Difficulties in 'word meaning in specific context' is the only component contributing to perceived difficulty in Mathematics. (Sarabi & Gafoor, 2017). Utility values, both for present and future, is associated with achievement of terms, pragmatics and symbols more than achievement of syntax, morphology and semantics (Gafoor & Sarabi, 2017). It is clear that, in children's mathematical learning, affective domain is as much important as cognitive aspects including various aspects of its language (Walls, 2001 as cited in Sparrow & Chris Hurst, 2010). Hence this study builds on the previously cited studies by examining which elements of language of mathematics taught through Malayalam impact student likes and dislike towards mathematics among elementary school students in Kerala.

Research Questions

Do levels of difficulty in language of mathematics significantly associate to students' attitude towards mathematics learning? If so, which elements of Mathematics language do influence attitude towards mathematics learning of upper primary students in Kerala more?

Methodology

Descriptive survey including testing, percentage analysis, Chi-square test of independence and calculation of risk ratio were employed. Participants were 200 (with 90 boys and 110 girls), 7th standard students randomly selected from upper primary schools of Kozhikode and Malappuram districts of Kerala. Test of Difficulties in Language of Mathematics diagnose difficulty arising from language related aspects of mathematics learning at elementary level in Malayalam medium schools. The test contained items related to verbal and symbolic expressions, structural and functional aspects of mathematical language identified after the analysis of contents of mathematics textbooks from Standard I-VII. All the 72 items were scored 1 each. Based on their linguistic feature, items were grouped into 21 categories under Terms (6), Symbols (3), Morphology (1), Syntax (5), Semantics (3) and Pragmatics (3) of Mathematics language. On each linguistic category, students who scored less than median (upto to first quartile score depending on the range of distribution) were identified as facing challenge on that element of language of mathematics. Students also reported their like towards mathematics learning as agreement or disagreement to the statement, "I like to learn mathematics".

Results and Discussion

Influence of 6 components of mathematics language on attitude towards mathematics learning is discussed separately. Out of 21 identified language elements in elementary school mathematics, difficulty with 7 elements did not influence students' Attitude towards Mathematics.

Attitude towards Mathematics by Difficulties in Mathematics Terms

Table 1 summarises results of Chi-square Tests showing significant association of Attitude towards Mathematics learning with Difficulty in Mathematics Terms.

Table 1

Chi-square Tests on Attitude towards Mathematics by Difficulties in Mathematics Terms

Language of Mathematics		Attitude towards Mathematics			
Math Terminology	Difficulty status	Like (N_1=131)	Dislike (N_2=69)	Total (N)	Chi-Square
General Terms	Difficulty	57(56.4%)	44(43.6%)	101(50.5%)	7.42 p<.01
	No Difficulty	74(74.7%)	25(25.3%)	99(49.5%)	
Mathematics Terms	Difficulty	47(50%)	47(50%)	94(47%)	18.86 p<.01
	No Difficulty	84(79.2%)	22(20.8%)	106(53%)	
Specialized use of General Terms	Difficulty	54(57.4%)	40(42.6%)	94(47%)	5.09 p<.05
	No Difficulty	77(72.6%)	29(27.4%)	106(53%)	
Geometric Terms	Difficulty	53(57%)	40(43%)	93(46.5%)	5.57 p<.05
	No Difficulty	78(72.9%)	29(27.1%)	107(53.5%)	
Writing numbers in word names & words to numerals	Difficulty	37(50%)	37(50%)	74(37%)	12.49 p<.01
	No Difficulty	94(74.6%)	32(25.4%)	126(63%)	

Student attitude to mathematics learning is significantly associated to their difficulty with terminology in mathematics like 'general terms in mathematics', Mathematics terms', 'Specialized use of General Terms', 'Geometric Terms', and 'Writing numbers in word names & words to numerals'. However, having difficulty in attaining 'terms on Types of Numbers' does not influence attitude towards mathematics [$\chi 2$ (1, N=200) =2.29, p >.05].

Students who dislike mathematics is significantly more among those with difficulty in 'General Terms' (43.56%) than among those without the difficulty (25.25%) [$\chi 2$ (1, N=200) =7.42, p<.01]. Significantly more students with difficulty in 'Mathematics Terms' dislike mathematics (50%) than those without such difficulty (20.8%) [$\chi 2$ (1, N=200) =18.86, p<.01]. Significantly more students with difficulty in 'Specialized use of General Terms' dislike mathematics (42.6%) than those without such difficulty (27.4%) [$\chi 2$ (1, N=200) =5.09, p<.01]. Students who dislike mathematics is significantly more among those with difficulty in 'Geometric Terms' (43%) than among those without such difficulty (27.1%) [$\chi 2$ (1, N=200) =5.57, p<.01]. Significantly more students with difficulty in 'Writing numbers in word names & words to numerals' dislike mathematics (50%) than those without such difficulty (25.4%) [$\chi 2$ (1, N=200)=12.49,p<.01].

The risk of dislike to mathematics learning occur in 56% to 141% more students among those with difficulty in various types of terminology in mathematics, than in students without such difficulty. Specifically, the risk of dislike to mathematics learning is observed to increase, 2.41 times (RR=2.41, 95% CI [1.58, 3.68]) with difficulty in 'Mathematics terms', 1.97 times (RR=1.97, 95% CI [1.35, 2.87]) with difficulty in 'Writing numbers in word names & words to numerals', 1.73 times (RR=1.73, 95% CI [1.15, 2.59]) with difficulty in 'general terms', 1.59 times (RR=1.59, 95% CI [1.08, 2.34]) with difficulty in 'Geometric Terms', and 1.56 times (RR=1.56, 95% CI [1.01, 2.29]) with difficulty in 'Specialized use of General Terms'.

Students dislike mathematics if they fail to achieve mathematics terminology. Criticality of mathematics terminology in contributing to dislike to mathematics are in the order mathematics terms (like Numerator, Denominator and Second order), number names, geometric terms, general terms (like Peculiarities, and Simplify) and Specialized use of General Terms (like Similarity, Difference, Sign, and Volume).

Attitude towards Mathematics by Difficulties in Mathematics symbols

Table 2 summarises results of Chi-square Tests showing significant association of Attitude towards Mathematics learning with Difficulty in Mathematics Symbols.

Table 2

Chi-square Tests on Attitude towards Mathematics by Difficulties in Mathematics Symbols

Language of Mathematics		Attitude towards Mathematics			
Symbol	Difficulty status	Like (N_1=131)	Dislike (N_2=69)	Total (N)	Chi-Square
Fraction form (of common terms)	Difficulty	76(58.5%)	54(41.5%)	130(65%)	8.143 p<.01
	No Difficulty	55(78.6%)	15(21.4%)	70(35%)	
Arithmetic Symbols	Difficulty	43(50.6%)	42(49.5%)	85(42.5%)	14.55 p<.01
	No Difficulty	88(76.5%)	27(23.5%)	115(57.5%)	

Student attitude to mathematics learning is significantly associated to their difficulty with symbols like 'Fraction form (of common terms) and arithmetic symbols. However, attitude towards mathematics is not associated with difficulty in 'Geometrical Symbols' [χ^2 (1, N=200) =0.29, p >.05].

Students who dislike mathematics is significantly more among those with difficulty in 'Fraction form of common terms' (41.5%) than among those without such difficulty (21.4%) [χ^2 (1, N=200) =8.14, p<.01]; the risk of dislike with difficulty being 1.94 times that without difficulty (RR=1.94, 95% CI [1.18, 3.17]). Students who dislike mathematics is significantly more among those with difficulty in 'Arithmetic Symbols' (49.5%) than among those without such difficulty (23.5%) [χ^2 (1, N=200) =14.55, p<.01]; the risk of dislike with difficulty being 2.11 times that without difficulty (RR=2.11, 95% CI [1.42, 3.12]).

Students dislike mathematics if they fail to achieve mathematics symbols. Compared to students without such difficulty, the risk of dislike to mathematics learning increase 94% and 111% with difficulty in Fraction form and Arithmetic Symbols respectively.

Attitude towards Mathematics by Difficulties in Morphology of Mathematics Language

Table 3 summarises results of Chi-square Tests showing significant association of Attitude towards Mathematics learning with Difficulty in Morphology of Mathematics Language.

Table 3

Chi-square Tests on Attitude towards Mathematics by Difficulties Morphology of Mathematics Language

Language of Mathematics		Attitude towards Mathematics			
Morphology Element	Difficulty status	Like (N_1=131)	Dislike (N_2=69)	Total (N)	Chi-Square
Parts of words	Difficulty	69(66.6%)	53(43.4%)	122(61%)	11.07 p<.01
	No Difficulty	62(79.5%)	16(20.5%)	78(39%)	

Student attitude to mathematics learning is significantly associated to their difficulty with 'Parts of words' in mathematics. Students who dislike mathematics is significantly more among those with difficulty (43.4%) than among those without difficulty (20.5%) [χ^2 (1, N=200) =11.07, p<.01]; the risk of dislike for students with difficulty being 2.12 times that without difficulty (RR=2.12, 95% CI [1.31, 3.43]).

Attitude towards Mathematics by Difficulties in Syntax of Mathematics Language

Table 4 summarises results of Chi-square Tests showing significant association of Attitude towards Mathematics learning with Difficulty in Syntax of Mathematics Language.

Table 4

Chi-square Tests on Attitude towards Mathematics by *Difficulties in Syntax of Mathematics Language*

Language of Mathematics		Attitude towards Mathematics			
Syntax element	Difficulty status	Like (N_1=131)	Dislike (N_2=69)	Total (N)	Chi-Square
Arithmetic Principles in Numerals	Difficulty	64(54.7%)	53(45.3%)	117(58.5%)	14.55 p<.01
	No Difficulty	67(80.7%)	16(19.3%)	83(41.5%)	
Translating Algebraic Expressions to Phrases	Difficulty	63(48.1%)	46(42.2%)	109(54.5%)	6.29 p<.05
	No Difficulty	68(74.7%)	23(25.3%)	91(45.5%)	

Student attitude to mathematics learning is significantly associated to their difficulty with Syntactic principles in Mathematics Language, like *'Arithmetic* Principles in Numerals' [as in (150 – 50) – 40 = 150 + (50 + 40)], and in Translating Algebraic Expressions to Phrases (for example, "add a number with its double" = x+2x). But, students' attitude towards mathematics is not influenced by difficulty in 'Translating Phrases into Algebraic Expressions' [χ^2 (1, N=200) =1.25, p >.05], or 'Arithmetic Principles with variables' [as in (X – Y) – Z = X – (Y + Z)] [χ^2 (1, N=200) =1.97, p >.05] and 'Conventions' [χ^2 (1, N=200) =0.37, p >.05].

Students who dislike mathematics is significantly more among those with difficulty in 'Arithmetic Principles in Numerals' (45.3%) than among those without such difficulty (19.3%) [χ^2 (1, N=200) =14.55, p<.01]; the risk of dislike to mathematics for students with difficulty being 2.35 times that without difficulty (RR=2.35, 95% CI [1.45, 3.81]).

Students who dislike mathematics is significantly more with difficulty in 'Translating Algebraic Expressions to Phrases' (42.2%) than that without such difficulty (25.3%) [χ^2 (1, N=200) =6.29, p<.05]; the risk of dislike for students with difficulty being 1.67 times that without difficulty (RR=1.67, 95% CI [1.10, 2.53]).

Attitude towards Mathematics by Difficulties in Semantics of Mathematics Language

Table 5 summarises results of Chi-square Tests showing significant association of Attitude towards Mathematics learning with Difficulty in Semantics of Mathematics Language.

Table 5

Chi-square Test on Attitude towards Mathematics by Difficulties in Semantics of Mathematics Language

Language of Mathematics		Attitude towards Mathematics			
Semantic Element	Difficulty status	Like (N_1=131)	Dislike (N_2=69)	Total (N)	Chi-Square
Word meaning in specific context	Difficulty	57(57.6%)	42(42.4%)	99(49.5%)	14.55 p<.01
	No Difficulty	74(73.3%)	27(26.7%)	101(50.5%)	

Student attitude to mathematics learning is significantly associated to their difficulty with 'Word meaning in specific context' in mathematics; though it is not influenced by difficulty with Semantics of Mathematics Language in attaining 'Statements of Geometric Principles' [χ^2 (1, N=200) =0.00, p >.05] and 'Arithmetic Principles in Common Language' [χ^2 (1, N=200) =0.58, p >.05].

Students who dislike mathematics is significantly more with difficulty in grasping 'Word meaning in specific context' (42.4%) than without such difficulty (26.7%) [χ^2 (1, N=200) =14.55, p<.01]; the risk of dislike for students with difficulty being 1.59 times that of those without difficulty (RR=1.59, 95% CI [1.07, 2.36]).

Attitude towards Mathematics by Difficulties in Pragmatics of Mathematics Language

Table 6 summarises results of Chi-square Tests showing significant association of Attitude towards Mathematics learning with Difficulty in Pragmatics of Mathematics Language.

Table 6

Chi-square Tests on Attitude towards Mathematics by Difficulties in Pragmatics of Mathematics Language

Language of Mathematics		Attitude towards Mathematics			
Pragmatic Element	Difficulty status	Like (N_1=131)	Dislike (N_2=69)	Total (N)	Chi-Square
Word Problems	Difficulty	66(55.5%)	53(44.5%)	119(59.5%)	13.10 p<.01
	No Difficulty	65(80.2%)	16(19.8%)	81(40.5%)	
Reading Geometric Diagrams	Difficulty	43(47.8%)	47(52.2%)	90(45%)	22.74 p<.01
	No Difficulty	88(80%)	22(20%)	110(55%)	
Identifying Operations	Difficulty	47(53.4%)	41(46.6%)	88(44%)	10.17 p<.01
	No Difficulty	84(64.1%)	28(25%)	112(56%)	

Student attitude to mathematics is significantly associated to their difficulty with Pragmatics of Mathematics Language used in 'Word Problems', Reading Geometric Diagrams and Identifying Operations to solve a problem.

Those who dislike mathematics is significantly more: among students with difficulty in 'Word Problems' (44.5%) than among students without such difficulty (19.8%) [χ^2 (1, N=200) =13.10, p<.01]; among students with difficulty in 'Reading Geometric Diagrams' (52.2%) than among students without such difficulty (20%) [χ^2 (1, N=200) =22.74, p<.01]; among students with difficulty in 'Identifying Operations' (46.6%) than among students without such difficulty (25%) [χ^2 (1, N=200) =10.17, p<.01];

Specifically, the risk of dislike to mathematics learning is observed to increase, 2.61 times (RR=2.61, 95% CI [1.71, 3.99]) with difficulty in Reading Geometric Diagrams', 2.26 times (RR=2.26, 95% CI [1.39, 3.65]) with difficulty in 'Word Problems' and , 1.86 times (RR=1.86, 95% CI [1.26, 2.76]) with difficulty in 'Identifying Operations', compared to students without these specific difficulties in pragmatics of language of mathematics.

Conclusions and Implications

In primary school, student attitude to mathematics learning is influenced strongly by difficulty with terminology, symbols, syntactic principle and pragmatics and to a lesser but significant extent by morphology of mathematics vocabulary in Malayalam. Risk of dislike towards elementary school mathematics is doubled if students have difficulty with Mathematics terms, Arithmetic Symbols, Morphology of mathematics terms, Arithmetic Principles (in Numeral form), Reading Geometric Diagrams, Word Problems than if they have no such difficulty. Though to a lesser extent, difficulties with general terms in mathematics, Specialized use of General Terms, Geometric Terms, and Writing numbers in word names & words to numerals, Fraction form, Translating Algebraic Expressions, grasping Word meaning in specific context, and Identifying Operations to solve word problems also put students at risk of disliking mathematics in primary school. Irrespective of their like or dislike towards mathematics, other elements of maths language viz., Translating Phrases into Algebraic Expression, understanding Arithmetic Principles (in variables), Geometric Principles and Conventions are difficult for all students (Sarabi & Gafoor, 2017). Though these are not found to associate with student dislike towards primary school mathematics, these also needs attention. Enculturating students to the vocabulary, phrasing, and meanings of mathematical language is a dimension of instruction that needs specific care (Thompson & Rubenstein, 2000**).** Focus on the various aspects of language of mathematics, including terminology, symbols, syntactic principles and pragmatics, especially on those found to strongly influence the student attitude towards elementary mathematics along with other language factors equally difficult for all categories of students is recommended.

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