Secondary School Students' Beliefs concerning Mathematics and its Learning

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Abstract: *Mathematics education usually concentrates on achievement in cognitive domain. As the subject triggers many negative emotions among students, research in mathematics education needs attention on affective outcomes. Learning goals, perseverance, learning strategy and decision regarding future learning may influence students' affect. Students hold many false beliefs regarding the nature of mathematics and learning of it. This study analyzes select affective beliefs held by high school students regarding mathematics and its learning. A survey was conducted on a random sample (n=500) of high school students to obtain their beliefs on learning mathematics. Despite recognizing importance of the subject, most of the students perceive mathematics as difficult and boring, possess beliefs like mathematics is not in their reach, only people with high intelligence can learn mathematics, and also ability to learn the same is an inborn ability. Based on the student beliefs, the study counsels educators for managing the affective issues in mathematics teaching- learning process, with focus on motivational beliefs, interest and anxiety.*

Keywords: *Mathematics teaching, learning, beliefs, difficulties in learning mathematics.*

Mathematical literacy is vital to all individuals for a better living. Hence, mathematics plays an important role in the school curriculum. For reasons including knowledge of mathematics being important for the learning of all other subjects like sciences, and its practical value, cognitive domain achievement in mathematics receives prominent attention in school curricula and practice. Usually schools, teachers and parents pay attention to cognitive aspect of learning mathematics. Many students feel learning of mathematics as difficult. Mathematics learning is known for demanding relatively more cognitive abilities and associated instructional and learning efforts.

Learning outcomes whether cognitive or affective, including of maths, results from the experiences. Hence all learning experiences, within and without classrooms and in and out of schools, needs to be cared for when seeking answers to problems which persists even after concerted efforts, as the

case is with maths learning in schools. Learning experiences, intellectual and emotional, should be managed in ways that improve learning and its horizontal and vertical transfer.This paper reports findings from an exploration of children's affective responses towards mathematics and the implications thereof to management of children's in and out of classroom affective experiences related to maths in secondary schools of Kerala.

Significance of affective Beliefs in Maths Learning

"Children's feeling about mathematics, aspects of the classroom such as teacher-student relationships, or their perception of themselves as learners of mathematics" (Reyes, 1984) constitutes affective factors in maths learning. To be good in learning mathematics, effort is needed from the part of students to master the contents in each standard. Effort of students is determined by their affect. Only when they have sufficient interest and motivation students will take effort. Children's feelings about mathematics include their attitudes, subjective beliefs like expectancy value, task value, self-efficacy and epistemological beliefs. Previous research has shown that students' beliefs might affect their effort, persistence, motivation, and goal(Schunk & DiBenedetto, 2014;Usher & Pajares 2008). Development of positive attitude towards maths study is valuable as it furthers the future effort, learning and development in that area.Attitude towards mathematics is a complex of negative or positive emotions that associate with mathematics, individual beliefs towards mathematics and their behaviour associate with mathematics (Hart, 1989). Individual beliefs are subjective conceptions of students, may be implicit or explicit, and thought to be true, that influence their learning (Op'tEynde, De Corte & Verschaffel, 2002).

Self-efficacy is a person's perception about his ability to reach the goal (Bandura, 1977). Self-efficacy does not represent one's ability, but his beliefs; it affects achievement through the selection of task and effort. Task value beliefs are "beliefs about the importance of, interest in, and value of the task" (Pintrich, 1999). Epistemological beliefs are beliefs hold by students about the nature of knowledge and its acquisition. Epistemic beliefs of students are known to influence the types of achievement goals, learning strategies and achievement of them (Muis, 2008; Muis& Franco, 2009; Trautwein & Ludtke, 2007).It is the teachers' duty to develop positive beliefs in students. This study is an exploration of select affective beliefs, namely interest, value, nature of mathematics, perceived efficacy, effort and ability among high school students of Kerala.

Need for the study

Other than numeracy, mathematics education aims at developing students' inner resources, logical thinking, ability and right attitude for problem solving. While considering the status of mathematics learning, national achievement survey (2014) says, beyond all exertion of educators, researchers and government, deficiencies in school mathematics learning are pervasive throughout the country. Instructional design, focusing cognitive outcome, alone cannot promisethe higher aims of mathematics learning. Teacher must know student beliefs that affect their attitude, learning and thought processing. This will enable teachers to help their learners to set goals and reach utmost performance. By diagnosing students' beliefs and perceptions teacher can correct such beliefs and perceptions and plan the instruction more efficiently.This study looks at the students' beliefs regarding interest in mathematics, value and nature of mathematics learning, perceived efficacy, effort and ability to learn it.

Objectives

This study aims to diagnose high school students' self defeating beliefs regarding interest, value, nature of mathematics, perceived efficacy, effort and ability. Also it analyses the gender differences in holding the beliefs and the relativeratio by gender.

Methodology

Participants

The subjects for the study include five hundred secondary school students of government and aided schools located in Kozhikode and Malappuram districts of Kerala. Sample is comprised of equal number of boys and girls, from twelve randomly selected intact classrooms from as many schools.

Instrument

Data used for the study is derived from apart of questionnaire on students' perception on difficulties in learning mathematics. The survey comprised of eighteen yes or no type items regarding interest, value, and perceived efficacy, nature of mathematics, effort and ability.

Table 1

Eighteen items

Interest	
1	Is mathematic learning interesting?
2	Is mathematics boring?
Value	
3	Is it necessary to learn mathematics?
4	Do you feel mathematics as a necessary subject?
5	Do you think that mathematics learning will be useful for you?
6	Do you feel that it is better to learn other subjects is better than Mathematics
Self-efficacy	
7	Do you think that mathematics can't be learned by you?
8	Do you think that you can succeed in mathematics?
9	Do you have the belief "I never understand mathematics"?
Nature of mathematics	
10	Do you feel mathematics as a difficult subject?
11	Are the topics in mathematics interrelated?
12	Is there more than one way to solve problems in mathematics?
13	Do you think that mathematics has to be learned by heart?
Effort and ability	
14	Do you believe mathematics can be learned by all?
15	Do you think that ability to easily understand mathematics is an inborn?
16	Do you think that you can learn mathematics if you try well?
17	Is it right that in Mathematics learning "Nothing succeeds like success and failure begets failure"?
18	Is it right that "Only people with high intelligence can learn mathematics"?

Procedure

Printed survey instrument is distributed to the studentsafter creating rapport with students, and giving reassurance on anonymity and ensuring their willingness to provide the data. Sufficient time is allowed for completing the questionnaire with factual clarification from the administrator wherever required.

Percentage analysis and χ^2test of independence were used to draw findings.

Results

Students hold varied beliefs regarding the interest, value, perceived efficacy, nature of mathematics, role of effort and ability in learning mathematics, which can affect their learning favorably or adversely. Students' beliefs in each of these areas are discussed under appropriate subheadings.

Students' Interest and value in learning mathematics

Students'value andinterestin learning mathematics and its relation with gender have given in the Table2.

Table 2

Percentage of occurrence of Students' interest and beliefs on learning mathematics by gender

Students' beliefs	% of students		% of students by gender		χ^2	Risk ratio
			Yes	No		
Mathematics is not interesting	34.4	Boys	108(43.2%)	142(56.8%)	17.16**	1.69
		Girls	64 (25.6%)	186 (74.4%)		
Mathematics is boring	30	Boys	95(38%)	155 (62%)	15.24**	1.73 3
		Girls	55(22%)	195 (78%)		
It is better to learn other subjects than Mathematics	70.6	Boys	190 (76%)	60 (24%)	7.2*	1.16
		Girls	163 (65.2%)	87 (34.8%)		
Mathematics is not essential for me	14.4	Boys	47 (18.8%)	203 (81.2%)	7.85**	1.88
		Girls	25 (10%)	225 (90)%		
Mathematics learning will not be useful	5	Boys	17 (6.8%)	233 (93.2%)	3.41	-
		Girls	8 (3.2%)	242(96.8%)		
Mathematics learning is not necessary	2.2	Boys	7(2.8%)	243(97.2%)	0.84	-
		Girls	4(1.6%)	246(98.4%)		

Note: ** indicate significant at .05 level and ** indicate significant at .01 level*

Roughly1/3 of students feels mathematics both as a not interesting and boring subject. These beliefs are held significantly more by boys than girls. Feeling of lack of interest among boys is 1.69 times that of girls, and feeling of boredom among boys is 1.73 times that of girls.

A notable portion of students (14.4%) has a view that mathematics is not essential for them because of reasons like difficulty in understanding and memorizing mathematics and the thoughts like mathematics is not essential in life, owing to it makingany improvement in life and lack of interest in it. Also

they advocate that only very little of what they are learning is needed for them, all other are worst. However, almost all students agree that mathematics learning will be useful in daily life and they perceive the importance of mathematics learning (97.8%).

Almost all students agree with the utility value of mathematics.But most of them (70.6%) value learning of other subjects over mathematics (cost value) and a remarkable percentage of students (14.4%) lack the personal value too. Thesetwo beliefs are significantly more among boys than girls. In case of the personal importance given to mathematics learning, boys who do not possess personal importanceare 1.88 times that of girls.

Students' efficacy beliefs in learning of mathematics

Students' beliefs regarding their efficacy to learn or succeed in mathematics by gender

Table 3

Percentage of occurrence of Students' self-efficacy beliefs regarding mathematics by gender

Students' beliefs	% of students		% of students by gender		$\chi^{2\#}$
			Yes	No	
I never understand mathematics	48.4	Boys	123(49.2%)	127(50.8%)	0.13
		Girls	119(47.6%)	131(52.4%)	
Mathematics can't be learned by myself	23.4	Boys	65(26%)	185(74%)	1.89
		Girls	52(20.8%)	198(79.2%)	
I can't succeed in Mathematics	19.2	Boys	49(19.6%)	201(80.4%)	0.52
		Girls	47(18.8%)	203(81.2%)	

none of the values are significant

Students hold the beliefs, they can't succeed in mathematics because of difficulties they are facing in understanding, learning and remembering mathematical concepts, fear, lack clear picture, lack of members to help, lack of basics, as they don't like mathematics, as they fail most of the times and as it needs high attention. There is no significant difference among boys and girls in case of their self-efficacy beliefs.

Nature of mathematics

Students' beliefs regarding the nature of mathematics and its learning, andits relation with gender have given in the Table 4.

Table 4

Percentage of occurrence of Students' beliefs regarding the nature of mathematics by gender

Students' beliefs	% of students		% of students by gender		χ^2	Risk ratio
			Yes	No		
Mathematics is a difficult subject	51.8	Boys	144 (57.6%)	106(42.4%)	6.74*	1.25
		Girls	115(46%)	135(54%)		
Mathematics should be learned by heart	51.6	Boys	142(56.8%)	108(43.2%)	5.41*	1.22
		Girls	116(46.4%)	134(53.6%)		
There is only one way to solve a problem in mathematics	19	Boys	41(16.4%)	209(83.6%)	2.19	-
		Girls	54(21.6%)	196(78.4%)		
Contents in mathematics are not interrelated	18.2	Boys	52(20.8%)	198(79.2%)	2.27	-
		Girls	39(15.6%)	211(84.4%)		

Note: * *indicate significant at .05 level*

More than half of students feel mathematics as difficult and also that mathematics should be learned by heart, but these two beliefs are not interrelated. Both these beliefs are significantly more among boys (57.6% and 56.8%) than girls (46% and 46.4%). Remarkable portions of students couldn't see any interrelation among the topics of mathematics (18.2%), and believe that there is only one way to solve a problem in mathematics (19%); but these two beliefs are not interrelated.

Beliefs regarding the role of effort and ability in learning mathematics

Students' beliefs regarding the role of effort and ability in learning mathematics, and its relation with gender have given in the Table 5.

Table 5

Percentage of occurrence of Students' beliefs regarding the role of effort and ability in learning mathematics by gender

Students' beliefs	% of students		% of students by gender		χ^2	Risk ratio
			Yes	No		
Only people with high intelligence can learn mathematics	56	Boys	147 (58.8%)	103 (41.2%)	1.59	-
		Girls	133(53.2%)	117(46.8%)		
Ability to understand mathematics easily is more or less an inborn ability	51.6	Boys	122(48.8%)	128(51.2%)	1.57	-
		Girls	136(54.4%)	114(45.6%)		
Mathematics can't be learned by all	49.8	Boys	112(44.8%)	138(55.2%)	5*	0.82
		Girls	137(54.8%)	113(45.2%)		
Effort will not produce better learning	28.8	Boys	85(34%)	165(66%)	6.59*	1.44
		Girls	59(23.6%)	191(76.4%)		
A person's chance for failing or succeeding in mathematics is fixed	23.8	Boys	63(25.2%)	54(21.6%)	.9	-
		Girls	187(74.8%)	196(78.4%)		

Note: ** indicate significant at .05 level*

More than half the secondary school students view mathematics as a subject that can't be learned by all, it is for people with high intelligence or people with inborn ability in mathematics. One quarter of them believe there effort is not that much important in what they achieve in Maths. Student beliefs regarding the role of effort and ability in learning mathematics associated.Those who believe that high intelligence has prominent role in learning mathematics also believe that,mathematics can't be learned by all, ability to understand mathematics easily is inborn, effort will not produce better learning and a person's chance for failing or succeeding in mathematics is fixed. And those who believe one's chance for failing or succeeding in mathematics is fixed also believe ability to understand mathematics easily is inborn and effort will not produce better learning. Significantly more girls than boys believe that mathematics can't be learned

by all, and significantly more boys than girls believe effort will not produce better learning.

Discussions

Most Students'beliefs on nature of mathematics and its learning mostly are of detrimental nature. It may corrode their learning. These beliefs are also found interrelated, that makes it more vulnerable Students' beliefs regarding interest, value, nature of mathematics, perceived efficacy, effort and ability were discussed under separate headings.

Students' Interest and value inlearning mathematics

One by third of students found mathematics learning not-interesting and almost same number of students found it as a boring subject. In case of interest and boredom, role of gender has found significant; in both cases more boys approached undesirable selection. Almost all students accepts the utility value of mathematics, but at the same time majority of them see it as a subject with low cost value. This means there is a greater possibility of choosing other subjects over mathematics.While almost all are accepting that mathematics learning is necessary, a valued portion among them believe that it is not essential for them. Students believe that only basic arithmetic will be useful in their life and all other thing they are learning are not-useful; they don't know the purpose of most of the topic they are learning.

Students' self-efficacy for learning mathematics

A relevant portion of the students do not possess self-efficacy for learning mathematics in desired level. Self-efficacy is very relevant in achievement situations, low self-efficacy affect learning by reducing effort andperseverance, affecting motivation and goal, and high self-efficacy affects learning vice-versa (Bandura, 1977; Pintrich, 1999). These beliefs are also related to feeling that mathematics is a difficult subject in such a way that more number of students who has low self-efficacy in mathematics (n=117) tends to feel mathematics as a difficult subject (72.6%). Collective occurrence of these two beliefs will affect students learning by seizing their readiness to go through the situation; and there might be higher tendency to run away the situation.

Nature of mathematics

Mathematics contents are interrelated well, there may be more than one way to solve mathematics and it is not supposed to learn by heart. Learning of mathematics means meaningful understanding of both content and its nature. Students' beliefs indicate that more than half of students thought that mathematics is difficult and it is to be by hearted; though the number is comparatively less, a notable percentage of students couldn't perceive any interrelation in topics of mathematics. Students' feeling of

difficulty causes negative task value, low self-efficacy, and dislike towards mathematics (Gafoor & Abidha, 2015).

Effort and ability related beliefs

Around half of the students believe that mathematics can't be learned by all, it is meant for highly intelligent and people with inborn abilities. And a good portion of students reject the value of effort. The reality is that there are no researches to prove mathematics learning is depended on inborn ability or high intelligence, but so many to prove effort is influential (Boaler, 2013; Dweck, 2006; Xie, Huang, Hua, Wang, Tang, Craig, Graesser, Lin & Hu, 2013). These beliefs will negatively affect their learning by reducing their effort.

Gender and belief

In all cases of beliefs, where the gender differences are found significant, boys have shown the higher tendency toward undesirable end of the beliefs than girls, except for the belief 'mathematics can't be learned by all'.

Conclusions

Instead of the higher goal suggested by the NCF (2006), students pursue many negative beliefs regarding the mathematics learning. This will adversely affect their learningfor sure. These beliefs might not be developed within short period; these may be the result of their previous experiences with teachers, parents and society. It is important for teachers to attend to these beliefs.

Mathematics is the most misunderstood subject. It may be difficult due to its abstract nature, but surely it can be succeeded by taking systematic effort. The studies reveal ability, intelligence and achievement can be improved through effort (Boaler, 2013; Dweck,2006; Xie,Huang, Hua,Wang, Tang,Craig, Graesser, Lin &Hu, 2013). It is teachers' duty to convince students that no one excels without effort, and that struggle is part of all kind of achievement, and effort should surpass the difficulty. Teachers need measures to arrest these kinds of beliefs. Diemer, Marchand, McKellar, and Malanchuk (2016), says that teachers' differential treatment can corrode students' beliefs. Students learn more effectively if they understand how they learn and how to manage their own learning (Darling-Hammond, Barron, Pearson, et. al, 2015). It is task of teachers to make the students aware of the value of task in mathematics its nature and learning of it, it is

suggested that greater emphasis should be given to students' beliefsregarding mathematics and its learning opposed to content.

Reference

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioural change. *Psychological Review*, *84*, 191-215.

Boaler, J. (2013, March). Ability and mathematics: the mindset revolution that is reshaping education. In *Forum* (Vol. 55, No. 1, pp. 143-152). Symposium Journals.

Darling-Hammond, L., Barron, B., Pearson, P. D., Schoenfeld, A. H., Stage, E. K., Zimmerman, T. D., Cervetti, G. N., & Tilson, J. L. (2015). *Powerful learning: What we know about teaching for understanding*. John Wiley & Sons.

Diemer, M. A., Marchand, A. D., McKellar, S. E., &Malanchuk, O. (2016). Promotive and Corrosive Factors in African American Students' Math Beliefs and Achievement. *Journal of youth and adolescence*, *45*(6), 1208-1225.

Dweck, C.S. (2006) Mindset: the new psychology of success. New York: Ballantine Books.

Gafoor, K. A., &Kurukkan, A. (2015). Why High School Students Feel Mathematics Difficult? An Exploration of Affective Beliefs. ED560266

Hart, L. (1989). Describing the Affective Domain: Saying What We Mean.In Mc Leod& Adams (Eds.) Affect and Mathematical Problem Solving (pp.37-45). New York: Springer Verlag.

Muis, K. R. (2008). Epistemic profiles and self-regulated learning: Examining relations in the context of mathematics problem solving. *Contemporary Educational Psychology*, *33*(2), 177-208.

Muis, K. R., & Franco, G. M. (2009).Epistemic beliefs: Setting the standards for self-regulated learning. *Contemporary Educational Psychology*, *34*(4), 306-318.

National Research Council (U. (1991). *Moving Beyond Myths: Revitalizing Undergraduate Mathematics*. National Academy Press.

Op'tEynde, P., De Corte, E., &Verschaffel, L. (2002).Framing students' mathematics-related beliefs.In *Beliefs: A hidden variable in mathematics education?* (pp. 13-37). Springer Netherlands.

Pintrich, P. R. (1999). The role of motivation in promoting and sustaining self-regulated learning. *International journal of educational research*, *31*(6), 459-470.

Position Paper National Focus Group on Teaching of Mathematics (2006). Offices of the publication department:NCERT.

Reyes, L. H. (1984). Affective variables and mathematics education. *The elementary school journal*, 558-581.

Schunk, D. H., &DiBenedetto, M. K. (2014). Academic self-efficacy. In M.J. Furlong, R. Gilman, & Huebner (Eds.), *Handbook of positive psychology in the schools*, 115-130.NY: Routledge.

Takeuchi, M. A., Towers, J., & Martin, L. (2016). What contributes to positive feelings towards mathematics? Examining mathematics autobiographies. In Wood, M. B., Turner, E. E., Civil, M., & Eli, J. A. (Eds.). *Proceedings of the 38th annual meeting of the North American Chapter of the International Group for the Pyschology of Mathematics Education*. Tucson, AZ: The University of Arizona.

Trautwein, U., &Ludtke, O. (2007).Epistemological beliefs, school achievement, and college major: A large-scale longitudinal study on the impact of certainty beliefs. *Contemporary Educational Psychology*, *32*(3), 348-366.

Usher, E. L., &Pajares, F. (2008). Sources of self-efficacy in school: Critical review of the literature and future directions. *Review of educational research*, *78*(4), 751-796.

Xie, J., Huang, X., Hua, H., Wang, J., Tang, Q., Craig, S., Craig, S.D., Graesser, A. C., Lin, K.I., & Hu, X. (2013). Discovering the Relationship between Student Effort and Ability for Predicting the Performance of Technology-Assisted Learning in a Mathematics After-School Program.