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BELIEFS ON MATHEMATICAL PROBLEM SOLVING: A CASE STUDY ON INDIAN UNDER GRADUATE MATHEMATICS STUDENTS

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Abstract

This paper will discuss the Beliefs on Mathematical Problem Solving, a case study on subjects of 59 Indian college students who are studying under Gauhati University, the State Assam in India. A questionnaire of 34 items with the items reliability (Cronbach's alpha) 0.88 is first time administered to our students. We want to learn their beliefs about six domains on mathematical problem solving which are identified as important of understanding, predetermined sequence of steps, time consuming math's problems, have several ways of solutions, kind of Mathematics Instruction and usage of technologic equipments. There are 18 positively and 16 negatively stated items which are included to each domain on mathematical problem solving. The study revealed that the beliefs more than half of the students on mathematical problem solving followed in the direction of strong agreements on positive statements and not agree on the negative statements to all other domain besides beliefs about following predetermined sequence of steps. For these statements the belief of the

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students are going agreement on negative statements but the positive statements are not belief.

1. Introduction

As defined by Polya [11, 12] mathematical problem is a problem that presents an objective which does not have an obvious solution or solution process. However, mathematical problems must meet at least three conditions, such as individuals must accept an engagement with the problem, they must encounter a block and see no immediate solution process, and they must actively explore a variety of approaches to the problem. Teachers' ample knowledge about their students is very important in coordinating a real problem solving. Raymond [13] identified that a problem solving means different things to different people, while others have been viewed as a goal; process; basic skill; mode of inquiry; mathematical thinking and teaching approach. Polya [11, 12] further described it as a means of finding a way out of difficulty, a way around an obstacle, attaining an aim which was not immediately attainable and it is on this conception that people focus their work. Students' effective learning depends on teachers beliefs about content, how students learn that leads to better approach of teaching. Currently, the significance of mathematical beliefs has been widely acknowledged. A belief is defined as "mental constructs that represent the codification of people's experiences and understandings" (Schoenfeld [15, p. 19]).

It is believed that college students have already developed a wide range of beliefs about the mathematical content and the nature of mathematics as well as about learning mathematics before undertaking their first education course. Skott [17] further explained that these beliefs are often based on their own experiences as students of mathematics and, for better or for worse, often form the foundation for their own practice as students of mathematics. Lovat and Smith [7] reported that students' belief systems reflect individual philosophies about the nature of knowledge and how to acquire it, which in turn, influence teachers' curriculum decision making and teaching approaches. Mathematics students' beliefs can be thought of as an individual's perspective on how one engages in mathematical tasks and

pedagogical practices. Thompson [19] highlights that a growing body of writing shows that mathematics student's beliefs affect their classroom practices although the nature of the relationship is highly complex and dialectical. There is also an acknowledgement that one of the roles of the teacher education programs is to reshape these beliefs and correct misconceptions that could hinder effectively mathematics teaching. Based on the significance of teachers' beliefs in students learning, the present study aimed to investigate mathematical problem solving beliefs by deeply looking on the process and solution of mathematical problem solving in one of Indian universities.

2. Statement of Problem

Several empirical researches has proved that the term problem solving has been studied in developed countries as can be seen in the work of earlier famous authors such as (Polya [10], Lester [5], Schoenfeld [14]) and all agreed that a problem occurs only when someone is confronted with a difficulty for which an immediate answer is not available. The major task is not about finding the intrinsic characteristic of a problem because authors emphasized that the ability to find an appropriate solution to an existing problem depend on the solver's knowledge and experience. Consequently, a problem might be a genuine problem for one individual but might not be for another. This study generally, look specifically seeks to look into under graduate students' beliefs about mathematical problem solving by focusing on the process and solution of mathematical problem solving in universities in India. Specifically, the study seeks to answer the following questions: What beliefs do student have about mathematical problem solving? Moreover, what relationship do gender and study level have on the beliefs of student about mathematical problem solving? Teachers' beliefs have great influence to the nature of mathematics, the way it should be taught, the classroom practices, as well as student learning outcomes. Although Raymond ([13, p. 552]) thinks teachers' mathematics beliefs, in relation to the nature of mathematics, and recommend that, the teaching and learning of

mathematics is a function of the personal judgments of the problem solver about the subject and problem formulated from experiences in mathematics". He opined that students' beliefs and teachers' beliefs play a significant role in mathematical problem solving. Hence, the study together with its findings will serve as the baseline information to explain and provide empirical evidence which will measure the magnitude of under graduate mathematics students' beliefs on mathematical problem solving and their implication in today's mathematics classrooms in India.

3. Objectives

The broad objective of the study is to investigate under graduate mathematics students' beliefs about mathematical problem solving. The specific objectives are:

i. To explore the level of under graduate students' beliefs on mathematical problem solving.

ii. What beliefs about mathematical problem solving do under graduate mathematics students' have?

4. Research Questions

The following research questions have been used in order to achieve the research objectives:

(a) What beliefs about the importance of understanding why a solution to a mathematics problem works do under graduate maths students' have?

(b) What beliefs about mathematics problems that cannot be solved by following a predetermined sequence of steps do under graduate maths students' have?

(c) What beliefs about time consuming when solving mathematics problems do under graduate maths students' have?

(d) What beliefs about mathematics problems that have multiple ways of solution do under graduate maths students' have?

(e) What beliefs about the kind of mathematics instruction emphasized by the principles of new mathematics curriculum do under graduate maths students' have?

(f) What beliefs about the usage of technologic equipment's do under graduate maths students' have?

5. Literature Review

5.1. Importance of problem solving in mathematics education

Problem solving has occurred since the first human being discovered the importance of shelter and food or to flee from the predators (Brown [1]). The advancement of human environment resulted in unforeseen environmental contingencies, new problems discovered and led to the urgency to formulate alternative and new methods of finding answers to peculiar scenarios. Meanwhile, mathematics emanated as an answer to these requests and the improvement of mathematics presented more avenues to realize difficult tasks. Schroeder and Lester [16] identified that Problems creates "an atmosphere for students to make known on their conceptions about the nature of mathematics and develop a relational perceptive of mathematics" as the most imperative task of problem solving in mathematics. They highlighted that understanding mathematics is fundamentally seeing how things connect together in mathematics, thinks that the taking down of notes and the act of memorizing mathematical problem solving steps by students prevents them from how things are connected or fit together. Essentially, a person's knowledge relating to mathematical ideas increases to a higher selection of contexts, as one relates a given problem to a superior number of the mathematical ideas implicit in it, or as one constructs relationships among the various mathematical ideas embedded in a problem". The direction of mathematics students towards thinking about their current concepts about mathematics creates cognitive conflict, as students work through mathematical problems, "they reevaluate their conceptual knowledge, relearn mathematics content and become more open to alternative ways of learning mathematics (Steele and Widman [18, p. 190])." What this entails is that

mathematics as a dynamic subject helps students view it in such perspectives and realize that opportunity to organize their ideas, take part in mathematical discussions, and defend their conjectures (Manuel [8]). Also, by recalling on their solutions, they adopt different mathematical skills, master a deeper insight into the structure of mathematics, and achieve a disposition toward generalizing which also helps them to get their hands on means of thinking, habits of persistence and curiosity, and confidence in some situations they are not familiar with and these are useful in their daily life (NCTM [9]).

By so doing the best time and resourceful period of student's life can be put to proper use and adequate monitoring of progress can be carried out systematically. Efficient problem solvers can evaluate scenarios cautiously in mathematical term as "their knowledge is well fitted and made of abundant schemata (Lester [6, p. 665])." For a good problem solver to rely entirely on "surface features", they were found to emphasize more on "structural features" of problems to "monitor and regulate their problem solving skills" thereby obtaining savvy solutions" to problems. The resemblance of learning how to play baseball and mathematics solving was compared by Lester [5], and conclude that it takes time to master the act of problem solving and hence become a good problem solver. Willoughby [20] on his part related problem solving to riding a bicycle because the two constant and persistent practice. Despite the suggestion that problem solving be integrated into school mathematics curriculum and that learners be made to practice it as much as possible, current study reveal that many teachers still believe the main aim mathematics as chiefly carrying out computation and, hence, suspend problem solving until learners get acquainted with facts and pass all timed tests.

5.2. Problem solving in India

India is a developing country with vast chunk of human resources. The Indian Government has realized the importance of educational development and therefore, provides required importance in education. A multi-level structured education system prevails in India. There have been many studies related to education issues in India, while discussing the education and caste

in India, Chauhan [4] pointed out that low school enrolment and completion rates, high dropout and failure rates are reported the characteristic amongst the weaker section of the society.

On the study of secondary school education in Assam, Das and Baruah [3] pointed out that academic performance as well as mathematics performances of the government and private schools are better than the schools not getting government aids. Their study also revealed that mathematics performance of schools is positively correlated with (a) the academic performance of school indicated by School Leaving Pass Percentage and also (b) with the performances in the subjects other than mathematics. The study of present scenario of mathematics and science learning in Morigaon (Assam), Bhagowati [2] availed the problems and issues in Secondary Education. She also reported about the poor performance and lack of basic knowledge of mathematics from primary level to secondary level and 10% of students are interested to study science stream in Higher Secondary level.

6. Methodology

The present study adopts the descriptive survey design. It is a survey study, because a survey design mainly provides a quantitative or numeric description of trends, attitudes, or opinions of a population by studying a sample of that population. This study mainly focused on investigating what beliefs do under graduate mathematics students' have about mathematical problem solving based on the proposed mathematical problem solving beliefs.

First time there are 39 items of questionnaire are administered to the 23 (14 male and 9 female) students who are selected randomly from the populations for the purpose test-retest method of reliability in between two months. But out of them 34 items have reliability (Cronbach's Alpha) 0.88 (Appendix-A). The Likert type items were used to evaluate the under graduate maths students' beliefs on several topics related to mathematical problem solving. The study was carried out in even semester of the

University annual calendar. This study includes independent and dependent variables with regards to study questions. The independent variables are beliefs, gender and study year (classes), whereas dependent variables is the mean scores of mathematical problem solving beliefs scale, which is continuous variable with maximum value 5 and minimum value 1. Descriptive statistic used to determine student's beliefs mean scores, where inferential statistics used to test the influence of gender and study year on students mean scores beliefs.

7. Data Analysis

7.1. Participants' background

In this study there 59 (36 male and 23 female students) B.Sc. mathematics students in my college of three different courses are involved. 18 students are from 2nd semester (major in maths) where 6 are female and 12 are male, 20 students of 4th semester (major in maths) where 7 are female and 13 are male. And 21 students of 2nd Semester (maths as general) where 10 are female and 11 are male. All the students have a good performance during their past examinations as in HSLC (CBSC) and HSSLC (CBSC). The students for this study have general pass percent in HSSLC examination in the range from 59% to 91% and their marks in the subject mathematics have in the range from 50% to 88% all of 57 students involve for this study. But two of them have marks in maths are 41 and 46. Among 20 students of the 4th semester (major) 15 students have average grade point for 1st, 2nd and 3rd semester exams in the range from 4.0 to 7.5 and two students failed in 2nd and three students failed in 3rd semester. On the other hand out of 18 students of the 2nd semester (major in maths) 13 students have GP in the range from 3.0 to 9.5 and other 6 students failed in the 1st semester exam. Similarly 17 students of the 2nd semester (maths as general) have GP in the range from 2.0 to 7.0 and other 4 students failed in the 1st semester exam. So all the students have a good experience on mathematical problem solving during their past 12 to 13 years from starting their school time to till now.

7.2. What beliefs about mathematical problem solving do under graduate mathematics students have?

A. Beliefs about the importance of understanding problem solution

The study examined the participants' responses to the importance of understanding why a mathematical problem solution be works. Four positively stated items (5, 16, 21, and 26) and two negatively stated items (1 and 10) were used. The results reveal that approximately 46% of college students (with the mean of 2.63) did not believe (overall responses of strongly disagree and disagree) that it is not important to understand why a mathematical procedure works as long as it gives a correct answer (Item 1). Thirty nine (66.1%) of participants (with the mean of 3.95) belief that a person who does not understand why an answer to a mathematics problem is correct has not really solved the problem (item 5). But 51% of participants (with the mean of 3.23) negatively perceived that it does not really matter if you understand a mathematics problem whether you can get the right answer. (Item 10). Likewise, 54 (91.5%) of the students (with the mean of 4.38) believe that in addition to getting a right answer in mathematics, it is important to understand why the answer is correct (Item 26). Approximately 75% of college students (with the mean of 3.79) supported the idea of spending time in solving to a particular mathematical problem (Item 16). Most of students (53%) valued a demonstration of good reasoning should be regarded even more than students' ability to find correct answers. (Item 21). Thus, as it can be observed in Figure 1, most of students (62%) have positive beliefs about the importance of understanding problem solution. This shows that majority of under graduate students have positive beliefs about the importance of understanding problem solution.

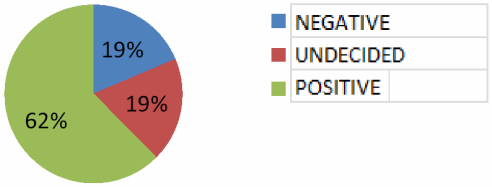

Figure 1. Beliefs about the important of understanding.

B. Beliefs about the use of predetermined sequence of steps

The study investigated the students' responses to questionnaire items related to a thought that there are mathematical problems that can be solved with step-by-step procedures. Three positively stated items (6, 17 and 27) and four negatively stated items (2, 11, 22 and 30) were used. It shows that the highest (91.5%) of college students (with the mean of 4.47, shown in Appendix B) believe that any problem can be solved if you know the right steps to follow (Item 2). Though the item is negatively stated almost all 97 % of students (with the mean of 4.27) believe that to solve most mathematics problems, students should be taught the correct procedure (Item 22). Thirty four (57.6%) of students (with the mean of 3.34) believe that learning to do problems is mostly a matter of memorizing the right steps to follow (Item 11), whereas 44 (74.6%) of students reported that memorizing steps are not that useful for learning to solve problems (Item 27). Forty two (71.1%) of students (with the mean of 3.74) believe that mathematicians seldom have step-by-step procedures to solve mathematical problems (Item 6). 34 (57.6%) of students (with the mean of 2.09) do not have beliefs that problems can be solved without remembering formulas (Item 17). But 66% of students (with the mean of 3.80) have beliefs that without a step-by-step procedure, there is no way to solve a mathematics problem (Item 30). Thus, as shown in Figure 2, only 32% of participants have positive beliefs about the application of predetermined sequence of steps in solving mathematical problems.

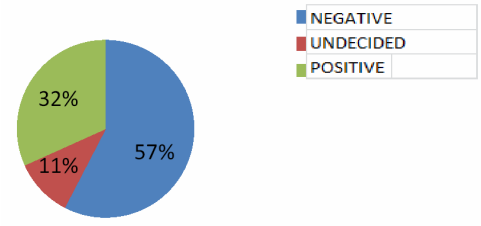

Figure 2. Beliefs about following predetermined sequence of steps.

C. Beliefs about time consuming mathematics problems

Time consuming is the crucial notion in mathematical problem solving. The study investigated the participants' responses to the items related to time

consuming in solving mathematical problems. There were positively (3 and 12) and negatively (7 and 18) stated items related to this category. The result shows that, 67.7% of participants did not believe (with the mean of 2.16) that mathematics problems that take a long time to complete cannot be solved (item 7). However about 53% of the students (with the mean of 3.46) indicated strong belief to the idea that time consuming problems are not bothering (Item 3). Mostly, 77.9% of the students' (with the mean of 3.97) beliefs that Hard mathematics problems can be done if one just hang in there (Item 12). On other hand, though the statement is negatively stated, 64.4% of participants appreciated (with the mean of 3.44) to the idea that to be good in math, one must be able to solve problems quickly (Item 18). Hence, as shown in figure: 3 below, 57% of participants have positive beliefs about the time consuming in solving mathematical problems. This also shows that majority of students have positive beliefs about the available time in solving mathematical problems.

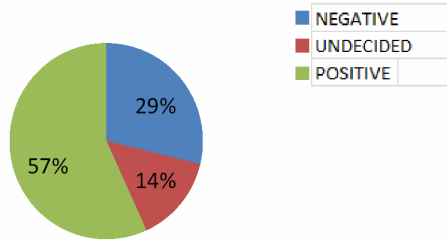

Figure 3. Beliefs about time consuming mathematics problems.

D. Beliefs about problems of multiple ways of solution

Problems of multiple ways of solutions are mostly emphasizing in learning mathematical problem solving. The study examined the participants' responses to the items related to this category. There were four positively stated items (4, 13, 23, and 31) and three negatively stated items (8, 28 and 33). More than 93% of the students (with a mean of 4.39) firmly believe that good mathematics teachers show students lots of ways to look at the same questions (Item 31). Likewise, more than 88% of students (with the mean of 1.60) disagree with the statement that there is only one correct way to solve a mathematics problem (Item 8). About 81% of the students (with the mean of

4.05) believe that if a student is unable to solve a problem one way, there are usually other ways to get the correct answer (Item 23). Furthermore, about 68% of students (with mean of 3.82) believe that it is possible to get the correct answer to a mathematics problem using methods other than the one the teacher or the textbook uses (Item 4). Likewise, 79% of students (with the mean of 3.90) supported the idea that if a student forgets how to solve a mathematics problem the way the teacher did, it is possible to develop different methods that will give the correct answer (Item 13). Incredibly, more than 56% of students (with the mean of 3.50) strongly believe that good mathematics teachers show students the exact way to answer the mathematics questions they will be tested on (Item 28). On the other hand about 49% students have belief and 32% students do not have belief that hearing different ways to solve the same problem can confuse students (Item 33). Therefore, as it can be observed in Figure 4, more than half (67%) of students have positive believe about problems that have multiple ways of solution. This shows that majority of students have positive beliefs about problems that have several ways of solutions.

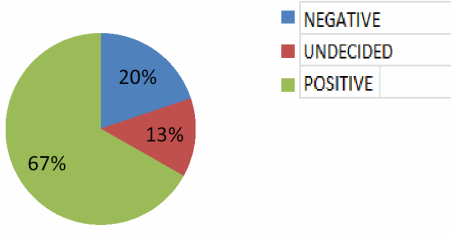

Figure 4. Beliefs about mathematics problems have several ways of solutions.

E. Beliefs about the kind of mathematics instruction

A particular kind of mathematics instruction has been emphasized to align with the whole process of learning mathematical problem solving skills. This study aimed to find out the kind of believe students held to the items related to the new principle of mathematics curriculum emphasized instruction. There were two positively stated items (19 and 29) and two negatively stated items (14 and 24) related to this category. The results show

that about 91.5% of students (with the mean of 4.42) believe to the idea of sharing problem solving thinking and approaches with other students (item 19). Though, the statement was negatively stated, about 68% of the students believe (with the mean of 3.91) that problem solving is primarily the application of computational skills in mathematics. (Item 14). Similarly, 47% of the students reflected positively to the idea that it is better to tell or show students how to solve problems than to let them discover how on their own, whereas 40% of the students reported negatively to this idea (Item 24). But most of the students about 80% (with the mean of 4.03) strongly supported that teachers should encourage students to write their own mathematical problems (Item 29).Thus, as shown in figure: 5 below, more than half 55% of students have positive belief about mathematics instructions. This shows that majority of students have positive beliefs about mathematics instructions.

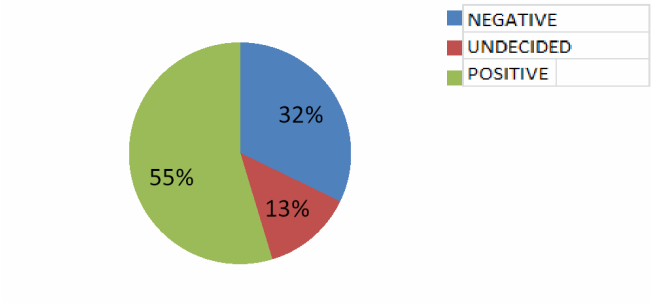

Figure 5. Beliefs about the kind of mathematics instructions.

F. Beliefs about the usage of technologic equipments

The usage of technologic equipment's in solving mathematical problems are mostly emphasizing in learning mathematics. The study examined the students' responses to the items related to this category. There were three positively stated items (15, 20 and 34) and three negatively stated items (9, 25 and 32). Large number, 83% of students (with the mean of 4.15) strongly belief the idea that teachers can create new learning environments for their students with the use of technology (Item 20). Similarly about 76% of the students (with the mean 3.79) belief that students can learn more mathematics more deeply with the appropriate and responsible use of

technology (Item 34). 66% of the students (with the mean of 2.28) not belief that using technology is a waste of time while solving problems (Item 25). On the other hand about half 52% of students (with the mean 3.52) strongly belief and 25% of students are not belief and 20% of students are in indecision that technologic equipment's (Like calculator) harm students' ability to learn mathematics (Item 32). Likewise, eventually same portion of students (with the mean of 3.47) 46% of students belief but 42% of students are in indecision to the idea that Technologic equipment's are useful in solving problems (Item 15). But equal portion of students (with the mean of 3.00) 39% of students belief and 36% of students are not belief that using technologic equipment's (like calculator) in problem solving is cheating (Item 9). While 25% of students are in indecision to that item. Thus form the figure: 6 more than half 56% of students belief positive and same number 22% of students are negative and undecided about the usage of technologic equipment's on problem solving.

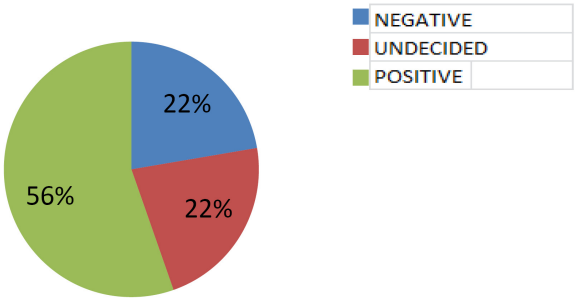

Figure 6. Beliefs about the usage of technologic equipment's.

8. Conclusions

Mainly, the study purposed was to explore Indian mathematics students' beliefs about mathematical problem solving. Through questionnaire items, students' beliefs were examined based on the nature of mathematical problem solving. Mathematical problem solving beliefs held by student teachers were a significant aspect to be studied, for example, 93% of students believe good mathematics teachers show students lots of ways to look at the

same questions and though the item is negatively stated all most all 97% of students believe that to solve most mathematics problems, students should be taught the correct procedure. This study is discovered that about 91% of students believe on three most important mathematical problem solving beliefs that in addition to getting a right answer in mathematics, it is important to understand why the answer is correct and secondly any problem can be solved if you know the right steps to follow and the third, students should share their problem solving thinking and approaches with other students. Besides the study revealed some significance of students' beliefs on mathematical problem solving, for example, 83% of students believed that teachers can create new learning environments for their students with the use of technology and 81% students approaches to several ways of solutions as if a student is unable to solve a problem one way, there are usually other ways to get the correct answer. And 80% of students thought that teachers should encourage students to write their own mathematical problems. This study is stated that one criterion for a true mathematical problem is that, an individual has no readily obtainable procedure for finding solution to a given problem. Thus, for example, as characteristics of the nature of mathematical problems, believe to the idea of sharing problem solving thinking and approaches with other students there are mathematical problems that cannot be solved without, step by step procedures, this study seen it as one of the beliefs to be well investigated. The results of the present study may reinforce the need of mathematical problem solving. More specifically, encouraging mathematics educators to employ problem solving instructional strategies in all courses pursued under mathematics education program.

Appendix A

The belief survey of under graduate mathematics students on mathematical problem solving

This survey is prepared to better understand the beliefs of under graduate mathematics students hold toward problem solving in mathematics. There is no penalty if you decide not to participate or to later withdraw from the study. Please be assured that your response will be kept absolutely confidential. The study will be most useful if you respond to every item in the survey.

Thank you in advance for your assistance in studying this survey.

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PART I: DEMOGRAPHIC INFORMATION SHEET

1. (a) Name:…… (b) Gender: Male Female

(c) Class:……

2. Mathematics is a subject for you as (a) Major (b) General

3. What are your percentages/Grade Points

HSLC	HS		TDC					
	Arts	Sc.	B.A.			B.Sc.		
			Sem-I	Sem-II	Sem-III	Sem-I	Sem-II	Sem-III

4. What is your average percentage/ grade points in mathematics:

HSLC	HS		TDC					
	Arts	Sc.	B.A.			B.Sc.		
			Sem-I	Sem-II	Sem-III	Sem-I	Sem-II	Sem-III

PART-II: THE BELIEF SURVEY OF UNDER GRADUATE MATHEMATICS STUDENTS ON MATHEMATICAL PROBLEM SOLVING

Please, provide your opinion for each item using the following scale by placing a tick on the response that best fits you.

SA = Strongly Agree, A = Agree, N = Neutral, D = Disagree, SD = Strongly Disagree

ITEMS	SA	A	N	D	SD
1. It is not important to understand why a mathematical procedure works as long as it gives a correct answer.	(5)	(4)	(3)	(2)	(1)
2. Any problem can be solved if you know the right steps to follow.	(5)	(4)	(3)	(2)	(1)
3. Mathematics problems that take a long time are not bothering.	(5)	(4)	(3)	(2)	(1)
4. It is possible to get the correct answer to a mathematics problem using methods other than the one the teacher or the textbook uses.	(5)	(4)	(3)	(2)	(1)
5. A person who does not understand why an answer to a mathematics problem is correct has not really solved the problem.	(5)	(4)	(3)	(2)	(1)
6. Mathematicians seldom have step-by-step procedures to solve mathematical problems.	(5)	(4)	(3)	(2)	(1)
7. Mathematics problems that take a long time to complete can not be solved.	(5)	(4)	(3)	(2)	(1)
8. There is only one correct way to solve a mathematics problem.	(5)	(4)	(3)	(2)	(1)

9. Using technologic equipment's (like calculator) in problem solving is cheating.	(5)	(4)	(3)	(2)	(1)
10. It does not really matter if you understand a mathematics problem whether you can get the right answer.	(5)	(4)	(3)	(2)	(1)
11. Learning to do problems is mostly a matter of memorizing the right steps to follow.	(5)	(4)	(3)	(2)	(1)
12. Hard mathematics problems can be done if one just hang in there.	(5)	(4)	(3)	(2)	(1)
13. If a student forgets how to solve a mathematics problem the way the teacher did, it is possible to develop different methods that will give the correct answer	(5)	(4)	(3)	(2)	(1)
14. Problem solving is primarily the application of computational skills in mathematics.	(5)	(4)	(3)	(2)	(1)
15. Technologic equipment's are useful in solving problems.	(5)	(4)	(3)	(2)	(1)
16. To do a solution of a mathematics problem works as time well spent.	(5)	(4)	(3)	(2)	(1)
17. Problems can be solved without remembering formulas.	(5)	(4)	(3)	(2)	(1)
18. To be good in math, one must be able to solve problems quickly.	(5)	(4)	(3)	(2)	(1)
19. Students should share their problem solving thinking and approaches with other students.	(5)	(4)	(3)	(2)	(1)

20. Teachers can create new learning environments for their students with the use of technology.	(5)	(4)	(3)	(2)	(1)
21. A demonstration of good reasoning should be regarded even more than students' ability to find correct answers.	(5)	(4)	(3)	(2)	(1)
22. To solve most mathematics problems, students should be taught the correct procedure.	(5)	(4)	(3)	(2)	(1)
23. If a student is unable to solve a problem one way, there are usually other ways to get the correct answer.	(5)	(4)	(3)	(2)	(1)
24. It is better to tell or show students how to solve problems than to let them discover how on their own.	(5)	(4)	(3)	(2)	(1)
25. Using technology is a waste of time while solving problems.	(5)	(4)	(3)	(2)	(1)
26. In addition to getting a right answer in mathematics, it is important to understand why the answer is correct.	(5)	(4)	(3)	(2)	(1)
27. Memorizing steps are not that useful for learning to solve problems.	(5)	(4)	(3)	(2)	(1)
28. Good mathematics teachers show students the exact way to answer the math question they will be tested on.	(5)	(4)	(3)	(2)	(1)
29. Teachers should encourage students to write their own mathematical problems.	(5)	(4)	(3)	(2)	(1)
30. Without a step-by-step procedure, there is no way to solve a mathematics problem.	(5)	(4)	(3)	(2)	(1)

31. Good mathematics teachers show students lots of ways to look at the same questions.	(5)	(4)	(3)	(2)	(1)
32. Technologic equipment's (Like calculator) harm students' ability to learn mathematics.	(5)	(4)	(3)	(2)	(1)
33. Hearing different ways to solve the same problem can confuse students.	(5)	(4)	(3)	(2)	(1)
34. Students can learn more mathematics more deeply with the appropriate and responsible use of technology.	(5)	(4)	(3)	(2)	(1)

Thank you

Appendix B. Descriptive statistics

Item	Mean	Std. Deviation
1	2.63	1.291
2	4.47	.774
3	3.46	1.144
4	3.82	1.212
5	3.95	.971
6	3.74	1.094
7	2.16	1.152
8	1.60	1.025
9	3.00	1.218
10	3.23	1.069
11	3.34	1.108

12	3.97	.982
13	3.90	.824
14	3.91	.880
15	3.47	.878
16	3.79	1.176
17	2.09	1.232
18	3.44	1.236
19	4.42	.951
20	4.15	.979
21	3.88	.880
22	4.27	.715
23	4.05	.860
24	3.05	1.262
25	2.28	1.308
26	4.38	.855
27	3.95	1.090
28	3.50	1.143
29	4.03	1.008
30	3.80	1.095
31	4.39	.851
32	3.52	1.380
33	3.14	1.152
34	3.79	.767

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