*Bulletin of Education and Research*
*June 2015, Vol. 37, No. 1 pp. 55-77*

# The Perceptions of High School Mathematics Problem Solving Teaching Methods in Mathematics Education

Nasrin Akhter*, Mumtaz Akhtar** and Muhammad Abaidullah***

## Abstract

It is generally said in Pakistani classrooms that students face problems in recalling facts in mathematics and it brings hardship for students to understand mathematics meaningfully. Thus, most of the concepts and procedures of mathematics are difficult to understand for many students because rules and algorithms dominate. The purpose is to suggest the ways that might help to improve education in mathematics in developing deeper understandings of mathematical ideas, problem-solving being a possible way forward. The study uses a questionnaire to investigate perceptions of teachers (N=100) and also interviews conducted with 10 mathematics teachers. Overall, teachers were very positive, agreeing it was a useful approach and seeing numerous benefits, including making the learners more skilled and confident. However, they recognised practical difficulties both in terms of preparation and implementation. The resource demands are high, especially in rural schools. They were not confident that the approach helped in meeting diverse abilities. Furthermore, they perceived that problem solving method does not properly fit with a curriculum that over-relies on the text book and an assessment system overloaded with formal examinations which reward recall skills. In simple terms, although teachers are enthusiastic, the method will NOT be implemented and, indeed, cannot be implemented until the curriculum, the text-books and, especially, the assessment system reflect the value of this approach. Resource limitations and lack of training opportunities also are hindrances. Teachers have very limited opportunities to influence any of these areas.

***Key words*:** Mathematical Problem Solving, Mathematics Education, Experienced teachers

*Assistant Professor, University of Education, Lahore. Email: nasrin_cs2005@hotmail.com
** Professor of Education, Institute of Education and Research, University of the Punjab, Lahore
***Assistant Professor of Education, Institute of Education and Research, University of the Punjab, Lahore

## Introduction

Currently, most trends in the Pakistani education system concentrate on acquiring mathematical skills and techniques to solve mathematical problems only, ignoring their application in the real world and in other subjects. However, it is quite possible to pass examinations by seeking to master the procedures with little understanding of their meaning. Students often memorize everything without understanding. As Feynman (1985: 212) comments: "…so you see they could pass the examinations, and 'learn' all this stuff, and not know anything at all, except what they had memorised" and that seems a good description of the Pakistani system. Ali (2008:2) also describes textbooks that stress on finding the answer of questions: "In the present methodology, stress is laid on solving exercises rather than giving the students a clear idea of the fundamental concepts. Thus, the present teaching methodology of mathematics leads students to rote learning of the textbooks". Furthermore, Lester (1985) emphasised that teaching from problem-solving perspectives leads to either a personal competence in mathematical problem solving or using various know-how, which enables students to think for themselves. The trends in teaching in the 21st century bring new challenges to the concept of teaching methods compared to the traditional teaching in the classroom (Hezarjaribi et al., 2009). But, simultaneously, traditional teaching is still considered importance and necessary in the general public to raise the students' academic achievement. Similarly, problem-solving teaching methods are devalued by the teachers in the classroom, arguing that educational circumstances in Pakistan are less likely to apply them. One reason is that assessment systems rely on massive examination only and the current curriculum that covers text books only (Ali, 2008).

If problem solving approaches are to be widely adopted in Pakistan in mathematics, then it is important to explore the perceptions of those teaching mathematics. Of course, resources and training are important issues (Memon, 2007). Nonetheless, the fundamental questions relate to how teachers see the approach and whether they consider it can be implemented.

## Review of the Related Literature

Mathematics is one of the core educational settings and problem solving is identified as a key skill (Booker, 1993). An important aspect of mathematics is mathematical problem solving. Polya (1962) defined problem solving as: "mathematical problem solving as finding a way around a difficulty, and a solution to a problem that is unknown". Schoenfeld (1992) has also endorsed novelty as a

requisite component of mathematical problem solving. Problem-solving is defined as: "the ability to identify and solve problems by applying appropriate skills systematically". Chamberlin (2006) defined problem solving more generally as: "a higher-order cognitive process that requires the modulation and control of more routine or fundamental skills. Problem solving occurs when an organism or an artificial intelligence system needs to move from a given state to a desired goal state".

Problem solving methods often contrasted with traditional lecturing or teaching methods that teacher most frequently in classroom. Kim (2005:11) defined traditional teaching approach as "traditional teaching undertakes the following steps: 1) introduction; 2) development; 3) review". Traditional teaching is usually judged better developing memorising and in evaluating student's knowledge content (Vernon, 1995). in problem based learning curriculum change their traditional teaching methods of lectures, discussions, and asking students to memorise materials for tests. The instructor acts more as a facilitator in teaching process and helps in developing learning.

Xiuping (2002) found that conventional teaching style has certainly some disadvantages those could be "accept critically". Similarly, Kim (2005:9) pointed out: "traditionally learning has been thought to be nothing but a repetitive activity" Nonetheless, Xiuping (2002) also argued that problem solving could not be used all the time and in every aspect of the teaching process, because time is limited and the amount of materials the students should learn is very huge.

Moreover, Mathematical problem solving is often linked with novelty (Kohler, 1925) and Polya is also credited problem solving with innovation. Polya (1981) emphasised that: "solving a problem means finding a way out of difficulty, a way around an obstacle, attaining an aim which was not immediately attainable. Solving problems is the specific achievement of intelligence, and intelligence is the specific gift of mankind: problem solving can be regarded as the most characteristically human activity" (p. 9). He sketched four phases in problem solving as: understanding the problem, devising a plan, carrying out the plan and looking back.

Moreover, problem solving is viewed as a teaching method. McCormick (1990) examined "problem solving" that it encourages active learning as well as a method used in such subjects as mathematics or science or an empirical investigation. Further to this, Peng (2002) examined the role of problem solving in real life: "problem centred teaching is based on the belief that students can perceive the world, as do scientists" (p.8). If the students are exposed to a real world circumstance, the

motivation to solve the problem will force them to invent new concepts. He argued that the aim of problem-centred teaching is not to show how to apply the knowledge but to show how to 'invent' knowledge. Schoenfeld (1992) also supported this by describing that problem-solving teaching is characterized to encourage the students to raise their ideas, seek information, analyse and invent their own ideas and strengthen their individual experiences.

Teachers face difficulties in classroom management, planning and questioning when they teach with problem solving method. Samuel (2002) found that these challenges ranged from lack of expertise in joint planning and joint teaching to difficulty in transforming existing curriculum materials to fit the problem solving approach to the teaching of mathematics. The literature also suggests that novice found problem solving more difficult than the experts. De Vries et al. (1992) also identified that the domain specific knowledge, in the form of schemas, is a major factor distinguishing experts from novices in problem-solving skill. This is noted that competent problem solvers could readily categorise algebra word problems with a high degree of inter-subject agreement (Hayes et al., 1977; Chi et al. 1982).

Teaching and assessment with problem solving methods is more time-taking compared to the traditional teaching methods. Although students' ability to solve real-life problems appears to increase compared with traditional instruction, while, Vernon (1995) argued that instructors have not supported the movement toward this type of learning because they require more time to assess student learning. Moreover, teachers face the problems regarding curriculum and assessment system in Pakistan. Zia (2003) discussed the contemporary condition regarding examination and curriculum in Pakistan that the teachers lack either the confidence, the structure and support that a curriculum can provide. In a consequence, the quality of teaching drops. Moreover, Ali (2008:2) suggested that "The traditional tendency is to emphasise the correct conduct of taught procedures in order to gain 'right' answers and, of course, the importance of being able to 'do' mathematics correctly cannot be underestimated. The danger is that conceptual understanding is neglected and this may lead to an inability to apply mathematical skills in novel situations". Thus, it is difficult to teach using problem solving because of the taught procedure usually traditionally followed by teachers.

A limited research is found regarding teachers' perspective on problem solving (Chapman, 1997). Chapman also noted that the general focus is on teachers' instructional effectiveness rather than teachers' problem solving competence. A similar comment was made by Thompson (1985) as: "research related to instruction

in problem solving has centred on the effectiveness of instructional methods designed to develop global thinking and reasoning processes, specific skills, and general, task-specific heuristics" (p. 281). He also argued that researchers have given the excessively small amount of attention to the role of teachers. Moreover, Saleh (2006) highlighted the situation in contemporary developing Asian countries mathematics from a utility viewpoint, these aspects were not given due consideration in their classroom teaching. Their main purpose of teaching mathematics in school is to help students pass their examinations. These thoughts motivate the research question to explore more about problem solving teaching through teachers' perception that how problem solving is different than traditional teaching particularly in Pakistani. This indicates that there is still a debate around the quantity and the quality of mathematics which should be included in any curriculum to guide what is taught to school students. This is found that presentation of many school mathematics topics has not changed for over 100 years despite the numerous attempts to improve mathematics curricula (Hiebert, 1999).

Another factor that may affect student's achievement is the length of teaching experience. Darling-Hammond (2000) examined that school inputs make little difference in students learning, a growing body of research shows that school can make a difference is due to the teachers. Furthermore, Hoyles (1992) refers to this as "beliefs in practice" suggesting that teachers' beliefs and practices are not merely a reflection of individual preferences, but are also determined by the particular school context.

Also, the literature suggests that the teachers' knowledge influences the lack of adoption of problem solving teaching approaches (Hiebert et al., 1999, Fogarty, 1997). Shulman (1986) divided teacher knowledge into subject-matter content knowledge, pedagogical content knowledge, and curriculum knowledge. Teacher knowledge contains two main components: content knowledge and pedagogical content knowledge (e.g. Brophy, 1991; Fennema & Frank, 1992; Shulman, 1986). Shulman (1986) refers to content knowledge as the amount and organization of knowledge in the mind of teachers, that is, knowing how and knowing why. He described that pedagogical knowledge is the way of representing the subject matter to make it comprehensible to students. Darling-Hammond (2000) described that "teachers qualities that have been examined for their relationship to student learning include measure of academic ability , years of education, years of teaching experience, measures of subject matter and teaching knowledge, certification status and teaching behaviour in the classroom" (p.194). Furthermore, the significance of teachers' conceptions of the subject matter for their teaching practice has been widely recognised. The way teachers teach depends strongly on their own personal view of what constitutes mathematics (e.g. Sanders, 1994; Thompson, 1992).

Furthermore, the teachers' understanding of the subject matter plays a significant role in teaching mathematics (Feiman-Nemser & Bachmann, 1986; Ball, 1988). In a case study by Feiman-Nemser et al. (1990), it became apparent that doing mathematics with the mentee is a way of making subject matter a part of the conversation in learning to teach. While, Halai (1998) specified in a Pakistani context: "I felt that by doing the mathematics, teachers would practice their mathematical thinking skills, which was important if they wanted their pupils to think mathematically. The interactive nature of this means of professional development allowed room for both the personal and professional growth of the teachers. They reflect the attitudes, beliefs, and values of Pakistani teachers and the constraints and possibilities that Pakistani teachers face" (p.312). Similarly, Mohammad (2003) also found in the traditional classroom in Pakistan, learning has been thought to be nothing other than a repetitive activity or a process that involves students coping with newly provided information in examination. This is inevitable given the way national examinations are set. Hence, the reviewed literature forms the rationale for the present study. Gaining a more profound understanding of problem solving according to teachers and students perspective, contemporary situation in education in Pakistan, and further issues in problem-solving teaching carries considerable educational significance. The literature identified a number of issues those are faced by Pakistani teachers i.e. Difficulties to implement new and student-centred teaching methods, the lack of training in problem solving teaching method, insufficient resources when they want to teach with problem solving teaching, National Curriculum and assessment system. So, gaps to conduct further research are justified by exploring teachers' perceptions about problem-solving teaching in the Pakistani classroom.

Given the current educational situation in Pakistan, an important question is to explore what teachers think about how they should teach in contemporary Pakistan and how they should teach to meet 21$^{st}$ century challenges. Indeed, teachers in public sector schools have received pre-service and in-service teaching training and this may involve issues relating to how to implement problem solving in the classroom. How do teachers see what has been provided?

Memon (2007) highlighted some of the issues about the situation of education in contemporary Pakistan as: "The Education Sector in Pakistan suffers from insufficient financial input, low levels of efficiency for implementation of programs, and poor quality of management, monitoring, supervision and teaching" (p.48). Pakistan Country Sector Study (1997) also highlighted situation in Pakistan particularly in rural areas schools: "…In the rural areas it may be too optimistic to expect the communities to be organised and motivated to take on the management of primary

schools" (p. 47). But the current situation indicates that the problems are still present for example, Memon (2007) identified: "Literacy is higher in urban areas and in the provinces of Sindh and Punjab, among the higher income group, and in males" (p.48).

In this situation, the key issues being explored are what are the perceptions of teachers of mathematics related to problem-solving approaches and how do that relate to the experiences of classroom teachers?

## Research Methodology

The idea of using a single approach is supported by some researchers while others advocate the usage of a combination of approaches which can offer a balancing strength (Muijs, 2004; Cohen et al., 2007). Yin (1984, p.92) suggested the benefits of combined approaches in research as: "the combining of several approaches helps to overcome the weakness, biases and limitation of using just a single approach". Furthermore, According to Cohen et al. (2007), "the usage of a mixture of research approaches helps in collecting more comprehensive and vigorous data, and helps to make the researcher to be more confident that his findings are valid" (p.233). This study employed a questionnaire and semi-structured interview and the reason for choosing two approaches within this study was the distinctive contribution that each particular approach could offer to the investigation of the research questions. Understanding and identifying teachers' perceptions involves the interpretation of the perceptions of teachers and these were grouped on two categories. Firstly, experienced and less experienced teachers and secondly, teachers who have math as a major and teachers studied other subjects as a major. Therefore, the interpretive paradigm is considered appropriate to uncover all the aspects of this issue. According to Cohen et al., the understanding of personal actions and opinions in a specific situation is highly focused by the interpretive paradigm (2000). In addition, the interpretive paradigm is appropriate for exploring, describing, discovering, constructing both human and social phenomena (Johnson and Christensen, 2008). Crossley (1996) also supported these ideas, the interpretive paradigm is appropriate to apply to investigations of human behaviour, experiences and activities in a particular situation.

The aim of the questionnaire and interviews was to gain the live experiences of respondents according to their teaching experience and their major area of study. A list of all the aspects of problem-solving methods was drawn up from the literature and the questions were developed to explore the lists of topics about the problem solving method relating to the effects of pre-service and in-service training, classroom practice, advantages and difficulties teachers found in the classroom when

they teach with this method. Moreover, 10 teachers' interviews were conducted using convenience sampling technique and helped in interpreting the opinions of teachers. However, due to time constraints a semi-structured interview was considered better to get responses in depth. To uphold ethics and ensure no bias, the structured questionnaire and interviews were thoroughly planned and carefully worded, with meticulous discussion regarding the interpretation of the questions.

Based on construction of the questionnaire, Reid (2006) stated the reliability in a questionnaire as: if the questionnaire is carefully constructed and is administered under the circumstances where respondents are able to be honest in answering and the sample size is large enough to draw some clear conclusion, then the reliability is likely to be good. In this study, all traits are met to ensure the reliability of the research instruments. Also, validity measures that all the questions designed to measure a particular trait are indeed measuring the same trait in this study (Bennet, 2001; Reid, 2006). The sample was selected by the convenience sampling technique because allocation of the mathematics teachers and time of meeting with them were specified by the principals of the schools. 10 teachers were interviewed.

## Results of the Study

The results are presented in the tables.

**Table 1**

*Teachers, their Background and Training*

| N = 100 | Teacher Characteristics | % |
|---|---|---|
| Experience | Experienced Teachers | 73 |
| | Less Experienced Teachers | 27 |
| Discipline background | Mathematics/physics | 57 |
| | Other subjects | 43 |
| Qualification | Bachelor degree | 64 |
| | Masters degree | 33 |
| | Academic vocational qualification | 3 |
| N = 100 | Training | % |
| Training Attended | Discussed how to teach a particular concept | 47 |
| | Worked on preparing instructional materials together | 40 |
| | In-service training about lesson planning | 60 |
| | In-service training about Assessment techniques for problem solving | 68 |

Their response patterns are now summarised in tables 2 to 5, with all data shown as percentages.

**Table 2**
*Training on using Problem Solving Methods*

| Statements | SA | A | N | D | SD |
|---|---|---|---|---|---|
| You are motivated to plan lesson using the problem solving method in mathematics. | 26 | 58 | 6 | 6 | 0 |
| This training proved helpful to implement pedagogies with the problem solving method in the classroom. | 13 | 76 | 3 | 6 | 0 |
| This training taught you how to integrate information technology with problem solving. | 10 | 76 | 14 | 0 | 0 |
| This training helped you to manage the learners with different abilities in the classroom when teaching using the problem solving method. | 20 | 40 | 0 | 30 | 0 |
| The training gave you an insight into how to lead a mathematical activity and informal discussion | 20 | 71 | 6 | 3 | 0 |

In is clear that the teachers see training in using problem solving as important, with the vast majority agree or strongly agreeing with four of the statements. However, in considering the handling of diverse learner abilities, a large minority did not find the training helpful. Indeed, coping with the wide range of abilities in any classroom is perhaps one of the most difficult tasks for teachers.

**Table 3**
*Difficulties in using problem solving methods*

| Statements | SA | A | N | D | SD |
|---|---|---|---|---|---|
| This method is difficult when students are larger in number in the classroom. | 16 | 71 | 10 | 3 | 0 |
| This method is not suitable when time span is short for teaching. | 6 | 62 | 16 | 16 | 0 |
| You spend more time to prepare a lesson. | 10 | 80 | 7 | 3 | 0 |
| You need enough space, resources and feasible environment in the class. | 20 | 71 | 3 | 3 | 3 |
| It is difficult to satisfy the learners of different abilities. | 3 | 54 | 33 | 10 | 0 |
| It is more difficult to satisfy slow and weak learners through problem solving. | 20 | 57 | 23 | 0 | 0 |
| The problem solving method with IT requires extra training and is expensive. | 40 | 48 | 6 | 6 | 0 |

Generally, the teachers see the difficulties in using this approach, requiring more time in the lesson as well as more demands in preparation. There are resource implications, especially if IT is involved, while meeting the diverse needs of learners of a wide range of abilities is not easy.

**Table 4**
*Advantages of problem solving methods*

| Statements | SA | A | N | D | SD |
|---|---|---|---|---|---|
| Problem solving helps students to use mathematics in their daily life. | 37 | 57 | 6 | 0 | 0 |
| Involvement and attention span of students can be enhanced. | 16 | 78 | 6 | 0 | 0 |
| Understanding of the laws of mathematics helps develop induction and deduction skills. | 16 | 53 | 26 | 3 | 0 |
| Students learn to draw diagram and pictures themselves to solve problems. | 6 | 68 | 20 | 6 | 0 |
| Students are no longer afraid of long problem statements. | 3 | 55 | 16 | 26 | 0 |
| Students find relief from panic near the examination. | 3 | 60 | 10 | 27 | 0 |
| Problem solving reduces the need to revise prior to examinations. | 0 | 77 | 20 | 3 | 0 |

In some areas, the teachers are very positive. Thus, understanding, involvement and application are seen as being helped by this approach. It is interesting that the teachers see problem solving as helping students to use mathematics in their daily life. It is highly unlikely that this is true but evidence is required. In many areas, teachers consider that the approach has no clear advantages or disadvantages.

**Table 5**
*Problem solving methods and students' achievement*

| Statements | SA | A | N | D | SD |
|---|---|---|---|---|---|
| You always get a good response from students | 16 | 43 | 30 | 6 | 0 |
| Students are motivated actively to solve the problems by themselves. | 10 | 70 | 17 | 3 | 0 |
| You find the problem solving method supportive for learners of all abilities in the class. | 0 | 40 | 20 | 40 | 0 |
| When I use this method, student achievement is high. | 0 | 60 | 30 | 10 | 0 |
| Problem solving is helpful to eliminate cramming and last-minute revision. | 13 | 68 | 13 | 6 | 0 |
| Problem solving is helpful to make a learner more skilled and confident. | 10 | 84 | 6 | 0 | 0 |
| The mathematics curriculum is designed to use the problem solving method frequently. | 0 | 26 | 64 | 10 | 0 |
| Text books are structured to support problem solving strategies. | 3 | 60 | 10 | 27 | 0 |
| Problem solving is helpful to improve students' performance in exams. | 3 | 54 | 23 | 20 | 0 |
| Problem solving helps students to mentally represent mathematical problems | 3 | 67 | 30 | 0 | 0 |

Overall, here again, the views of teachers are positive, although, in some items, they see no advantages or disadvantages of the approach. In particular, student reaction and potential benefits are seen as good. Of particular interest is the view that the approach helps to make learners more skilled and confident.

***Opinions of teachers according to their level of experience***

In the first part of grouped analysis, teachers were divided into two groups on the basis of years of experience they had. The aim was to find out the difference between how opinions of ET relate to the opinions of LET. Chi-squares were used to compare the difference between their opinions of ET and LET. It is found that the groups differ significantly on discussions on how to teach and working on preparing instructional material with each other. No significant difference was found between the opinions of ET and LET about visit to other classes and being visited by other teachers informally. It is found that ET and LET differ significantly on planning instructions, using problem solving method in curriculum design and assessment

techniques. But there was no significant difference between ET and LET in receiving pre and in-service trainings about problem solving pedagogy and use of IT in the classroom. ET and LET are significantly different in their opinions to get motivation to plan lessons and implement problem solving method in the classroom by pre-service and in-service training. Nonetheless, there is no significant difference in their opinions in integrating information technology with problem solving method, manage learners with different abilities and leading a mathematical ability how students can apply math into their daily life.

***Opinions of teachers according to their major area of studies***

The aim was to see how MT reflects their opinions about the implementation of the problem solving method within the classroom, compared to NMT. There was no obvious pattern, but worth noting the significance differences were found that NMTs were more positive about problem solving being helpful to eliminate cramming than MT. Also, MTs were more positive that it is difficult to teach with problem solving when the students are larger in number. There were few statically significant comparisons obtained because the samples were too small for the use of chi-square.

***Findings from interview data***

By the analysis of teacher interviews, it was found that problem solving methods are well perceived by the teachers. Almost all teachers believed that problem solving is useful to teach in the classroom regarding learning and students achievements. The majority of teachers considered that the problem solving teaching method is helpful for both teachers and students. For example, one stated that the, "Problem solving method is the most beneficial method for the learning of mathematics".

However, the majority of experienced teachers considered that this method is more applicable to those students who like to learn through problem solving teaching. This is self-evident. Everyone learns best by methods that suit them! For example, one noted that, "I always use the method liked by the students not with everyone". Moreover, the majority of teachers also put emphasis on the needs of the need of teachers training and reforms: "Reforms are required to improve the methods and plan". Teacher training about problem solving teaching was considered useful for the teachers. The teachers of all groups agreed with the view that: "If more training is given by the devoted persons and also attention is given by the policy makers, the problem solving method will be helpful in making teaching-learning method more productive". Hence, teacher training on the innovative and challenging methods are seemed very helpful.

The majority of teachers believed that problem solving teaching is useful to teach in the classroom regarding students' learning and achievements. One teacher expressed her views that, "There are advantages of maths problem solving. Teachers understanding, performance, efficiency, pedagogy and knowledge of the curriculum get improved in using problem solving approaches. And Teachers understand the process of maths problem solving method". Also, the majority of teachers emphasised that mathematics should be taught with problem solving according to the level of students and with proper number of students in class. Another teacher expressed the views that, "Mostly teachers do not use problem solving methods. They avoid it because they do not understand the process of problem solving approaches. Also, they cannot seem to manage the classroom with large number of students. These could only be used with the shining and bright students. Overall, teachers are realistic is seeing genuine problems that need to be addressed if they are to follow this approach.

The curriculum is highly pressurised and overloaded and teachers from all groups perceived difficulties regarding class size under the current time pressures, especially in the schools of rural areas. For example, one said, "To teach the student according to their level is too difficult." They also showed their opinions about physical environment in the classroom. For example, one stated that, "The environment of the class should be according to their subject matter". The less experienced teachers noted the limitations of problem solving teaching regarding resources. For example, one less experienced teacher expressed, "Sources are insufficient to meet this method of teaching". The problem with class size was also mentioned by the majority. For example: "Teach the student according to their level, Size of students should be adequate and proper time should be given to the lesson". Similarly, one teacher (not maths/physics) observed that, "If class size is big this method is difficult to have fruitful results". The majority also argued that problem solving teaching is more time-consuming when preparing lesson. For example, one pointed out "More time required for lesson planning."

Nonetheless, the teachers were aware of the problems in using problem solving teaching particularly in contemporary Pakistani classroom. The majority of experienced teachers observed that most students and teachers are not interested in implementing this method because the curriculum and assessments system does not emphasise problem solving teaching. Furthermore, there are difficulties for those students that study in the rural areas schools: "Poor students particularly of rural areas feel many difficulties to avail this method of teaching" while another noted that, "This method is difficult when learners belong to far off areas from the institution". Moreover one

expressed in this way that "Pakistani rural school use this method of teaching rarely as there are difficulties in working this method." The participants' expressions indicate that the teachers working in the rural areas schools are deprived of the modern facilities and resources in the classroom. They are also not trained enough to take an innovative, students centred and challenging teach method in the classroom. Thus, problem solving methods cannot be seen in working in the rural area schools and because rural area schools have greater problem than the urban are schools.

They highlighted the issue that teacher with maths-major can work better than the non-math majors. For, example, one teacher expressed the view that, "the choice of methodology also depends on teacher qualification. Science major cannot teach effectively but math major can show a better performance because they are more trained. In the public sector, recently, the trends to use problem solving are increasing. In females, I noticed that there is a lack of confidence but they still attempt to perform best". Moreover, a lack of interest and willingness because of several constraints was noted by another teacher: "Teachers' likeliness to this method is very little. And the teachers' willingness is not there". Overall, while they felt that problem solving methods are good for students' learning, the approach will not be used because of the many constraints

## Discussion

The study reported a high level of satisfaction towards the problem solving method in the classroom. This is consistent with the findings in most of the items in each question. Teachers like to teach with problem solving teaching to enhance the learning and interest of students in the classroom (Lester, 1980). The majority of teachers received pre-service and in-service trainings related to planning instruction, the curriculum design and use of information technology and assessment technique using problem solving pedagogy. However, Marcus et al., (2009) and Wright (1990) noted the importance of possessing the appropriate pedagogical skills. While Pakistani teachers have pre-service training, there is little in-service training.

Keast (2003) and Zohar et al. (2001) expressed the view that teacher's reflection and involvement in professional development opportunities seemed to provide a means for the change. Here, the participants reported that changes in ways of preparing teachers will result in changes to the outcome in classroom performance. The literature also reported other factors that problem solving could impact on learning and develop higher order thinking skills among learners. A vast majority of teachers were agreed that problem-solving teaching is useful to improve all classroom

practice through training with the result reported in (Hutchinson, 1989; Fernandez et al. 2003; Amanda et al, 2009). Although training for problem solving teaching methods are appreciated by teachers and encourage collaborations in the classroom, it was not without problems. For instance, participants felt that training had not helped in handing diverse abilities.

While the focus on memorisation and rote learning can be causes of fear in students (Ali, 2008), there is uncertainty that a problem-solving approach will make much difference here (Xin Ma, 1997; McGowan, 1961; Aiken, 1970; Wood, 1988; Rensick et al, 1982). Indeed, the stifling effect of the examination system may be more important, a situation where the assessment system in Pakistan at elementary level over-relies on exam and no part of exam goes to in-session activities (Ali, 2008) and teachers do not find opportunity to evaluate students with problem solving because the purpose of assessment is to pass exams only (Saleh, 2006).

While the respondents wish for successful implementation, the problems of lack of expertise in joint planning and joint teaching to difficulty in transforming existing curriculum materials that over rely on text books only (Ali, 2008; Memon, 2007) are very real. Textbooks cannot be changed unless the assessment system is changed (Ali, 2008). Teachers felt that the approach would assist learning and student achievement consistent with the views of Anderson et al., (2004) and Stacey (2003). Indeed, the teachers thought that the problem solving method is the most useful method to teach mathematics. However, there are increased time demands, problems of class sizes and lack of sufficient resources, consistent with the views of Samuel (2002), Lesh and Zawojewski (2007) and Hiebert et al. (1997)

Overall, the majority of the teachers indicated that they were not interested in implementing this method because curriculum and assessment systems do not emphasise problem solving teaching. In simple terms, there are no rewards for the learners. The lack of development programmes and resources also pose problems, leading to further anxiety (Ma, 1997; Memon, 2007; Halai, 1998). In addition, respondents pointed out that problem solving is difficult to implement when teaching in rural area schools because of untrained staff and insufficient resources. Training problems were especially acute for the less experienced teachers and financial restraints had reduced opportunities (Memon, 2007; Halai, 1998). Nonetheless, the teachers claimed that they had received more in-service training about the use of IT integrated with problem solving teaching in the classroom through in-service trainings, than in initial training. Problem solving teaching requires enough space resources and feasible environment in the classroom (e.g. Memon, 2008, Halai, 1998; Anderson et al., 2005).

This section discusses the similarities and difference between the teachers divided into groups on their major area of study: MT and NMT. Consistent with Marcus et al. (2009), the teachers collaborate to each other regarding their social setting. It has also been shown how the respective context determines the interpretation of mathematical knowledge. Consistent with Jaworski (1994), the majority of MT and NMT discuss about teaching, prepare instructional materials, visit another teachers' classroom and get observed informally by other teachers weekly and monthly. The extended discussions with the teachers are useful because this enhanced reflection and supported their development. Consistent with Zia (2003), mathematics teachers should develop an understanding of discussion-based teaching in a lower secondary mathematics class. Moreover, the majority of MT and NMT received pre-service and in-service training on planning lesson, using pedagogy, using computers in the classroom and assessment techniques. Also, MT and NMT have similar views that problem-solving teaching can help students in their daily life and interesting to them. This is consistent with Peng (2002), though problem centred teaching, students can perceive the world, as scientists do. Thus, the students are exposed to a real world circumstance using problem solving methods; they are motivated to solve the problem. This way they are forced to invent new concepts.

## Conclusions

In looking at the views of teachers in relation to using problem-solving as a method of teaching, the following benefits were indicated:

> Teachers agreed it was a useful approach and the majority of teachers agreed that problem solving helps students to use mathematics in their daily life, enhances their attention span, reduces the need to revise prior to examinations, reduces cramming, makes the learner more skilled and confident, improves students' performance in exams and is useful to integrate with IT (but this requires extra training and is expensive).

Tue following problems were also identified:

> It is difficult with large classes and is time demanding both in terms of preparation and implementation. The resource demands are high, especially in rural schools. They were not confident that the approach helped in meeting diverse abilities. Furthermore, they perceived that problem solving method does not properly fit with a curriculum that over-relies on the text book and an assessment system overloaded with formal examinations which reward recall skills.

In simple terms, although teachers are enthusiastic, the method will NOT be implemented and, indeed, cannot be implemented until the curriculum, the text-books and, especially, the assessment system reflect the value of this approach. Resource limitations and lack of training opportunities also are hindrances. Teachers have very limited opportunities to influence any of these areas.

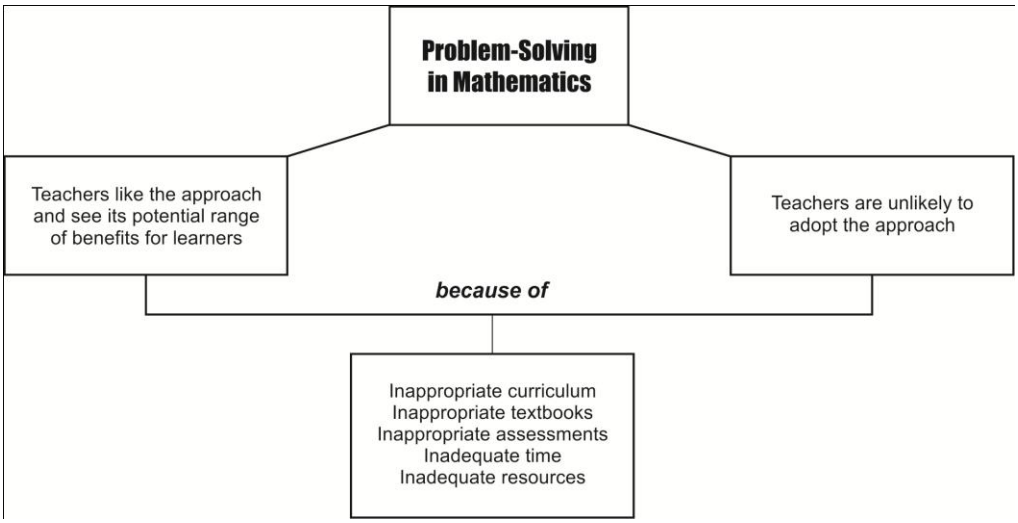


***Figure1*:** Conclusions

## References

Al-Enezi, D. Farahan (2008). A Study of Learning Mathematics Related to some Cognitive Factors and to Attitudes, University of Glasgow, UK.

Ali, A. A. (2008). Perceptions, Difficulties and Working Memory Capacity Related to Mathematics Performance, University of Glasgow, UK.

Anderson, J., White, P., and Sullivan, P. (2005). Using a schematic model to represent influences on, and relationships between, teacher's beliefs and practices. Mathematics Education Research Journal, 17(2), 9-39.

Askew, M; Brown, M; Rhodes, V; Johnson, D and William, D. (1997), Effective Teachers of Numeracy, London, King's College.

Boone, Harry N. (1990). Effects of approach to teaching on student achievement, retention and attitude, Journal of Agricultural Education

Brophy, J. E. (1991). Teachers Knowledge of Subject Matter as it Relates to their Teaching Practice, Advances in Research on Teaching, Vol. 2 Greenwich CT, JAI Press.

Boser, Richard A. (1993), the Development of Problem Solving Capabilities in Pre-service Technology Teacher Education, Journal of Technology Education (4)2.

Bigge, M.L. & Shermis, S.S. (1992). Learning Theories for Teachers. (5th ed.). New York: Harper Collins Publishers.

Brace, Nicola, Kemp, Richard & Snelgar, Rosemary (2000), SPSS for sychologists, London, Macmillan press ltd,

Brooks, Jacqueline G. & Martin G. Brooks (1993). In Search of Understanding: The Case for Constructivist Classrooms. Alexandria VA: American Society for Curriculum Development.

Cooney, T. J. (1988). The issue of reform. Mathematics Teacher, 80, 352–363

Darling-Hammond, Linda. (2002, September 6). Research and rhetoric on teacher certification: A response to "Teacher Certification Reconsidered," Education Policy Analysis Archives, 10(36).

Dienes, Z. P. (1960). Building up Mathematics. London, Hutchinson.

Dogru and Kalender (2007), Applying the Subject "Cell" Through Constructivist Approach during Science Lessons and the Teacher's View, Journal of Environmental & Science Education, 2 (1), 3-13

Ernest, Paul (1989). 'Philosophy, mathematics and education'. International Journal of Mathematical Education in Science and Technology 20, pp.4,555 — 559

Finucane, M. L., Alhakami, A., Slovic, P., Johnson, S. M. (2000). The affect heuristic in judgments of risks and benefits. Journal of Behavioral Decision Making, 13(1), 1-17.

Feiman-Nemser, S., & Paine, L. (1992). The learning from mentors study: Year 3 continuing proposal. East Lansing, MI: National Center for Research on Teacher Learning.

Felder, R.M. and Brent, R. (2003). "Learning by Doing": the philosophy and strategies of active learning, pp. 282-283.

Feynman, R. P. (1985). "Surly you're joking, Mr. Feynman" Adventures of a curious haracter. New York: W. W. Norton.

Frank, M. L. (1988). Problem solving and mathematical beliefs. Arithmetic Teacher, 35(5), pp. 32-34.

Funkhouser, C., & Dennis, J. (1992). The effects of problem-solving software on problem-solving ability. Journal of Research on Computing in Education, 24 (3), pp. 338-347.

Flanders, M. A. (1970), Analyzing Teacher Behavior, Reading, Mass: Addison-Wesley.

Halai, Anjum (1998), Mentor, Mentee and Mathematics: A Story of Professional Development, Mathematics Education Review (1).

Halai, Anjum (2001), 'on becoming a 'Professional Development Teacher': A Case from Pakistan. Mathematics Education Review 14.

Hiebert, James et al. (1997), Making Mathematics Problematic: A Rejoinder to Prawat and Smith, Educational Researcher, pp. 26, 24

Hezarjaribi, Habib A. & Mollaye, Saif A. (2009), A Comparative Study between Using Problem-Solving And Traditional Teaching Principles On Education. EABR & TLC Conference Proceedings Prague, Czech Republic.

Good, T. L. & Brophy, J. E. (1990). Educational psychology: A realistic approach. (4th Ed.).White Plains, NY: Longman.

Jansen, Amanda &. Spitzer, Sandy M. (2009), Prospective middle school mathematics teachers' Reflective thinking skills: descriptions of their students' thinking and interpretations of their teaching, Journal of Mathematics Teacher Education

Jonassen and David Hengag (2002). Supporting problem solving in online learning. Quarterly Review of Distance Education (3)1, p.1-13.

Glasersfeld, E. von (1995) Radical constructivism: A way of knowing and learning. Falmer Press: London.

Jaworski, B. (1994). Investigating mathematics teaching: A constructivist inquiry. London: The Falmer Press.

Patton, M. (2001). Qualitative Research & Evaluation Methods. Thousand Oaks, CA: Sage.

Peng, Guohua (2002), Two Student-centred Teaching Methods in Mathematics, The China Papers

Kim, Jong S. (2005). The Effects of a Constructivist Teaching Approach on Student Academic Achievement, Self-Concept, and Learning Strategies. Asia Pacific Education Review, 6(1) .pp. 7-19

Larkin, Jill H. and Reif, F. (1979). 'Understanding and Teaching Problem-Solving in Physics'. International Journal of Science Education, (1)2, pp. 191 — 203.

Lin, Fou-Lai (2000), Making sense of mathematics teacher education, Journal of Mathematics Teacher Education 3: pp. 183–190.

Lee, Kwangho (2006), Teacher's knowledge of middle school students' mathematical thinking in algebra word problem solving

Ma, Xin (1999). Meta-Analysis of the relationship between anxiety towards mathematics and achievement in mathematics. Journal for Research in Mathematics, 30(5). 221-229

Matthews, M.R. (2000), 'Constructivism in Science and Mathematics Education'. In D.C. Phillips (ed.), National Society for the Study of Education, 99th Yearbook, Chicago, University of Chicago Press, pp. 161-192.

Miles, M. (1990). 'Special Education in Pakistan', International Journal of Disability, Development and Education 37, pp. 2,159 — 168

Mohammed, R. F. (2004). Practical Constraints upon Teacher Development in Pakistani Schools. Journal of In-service Education, (30)1, pp.101-114

Meece, J. L. (1981). Individual differences in the affective reactions of middle and high school students to mathematics: A social cognitive perspective (Doctoral dissertation, University of Michigan, 1981). Dissertation Abstracts International, 42, 2035A.

Muijs, D. Harris et al. (2004). Improving Schools in Socio-Economically Disadvantaged Areas: An Overview of Research. School Effectiveness and School Improvement 2004, 15(2), 149-176.

Murphy, Danald Harad. (1988).Modifying the traditional classroom model to facilitate the development of creative skills. Masachoset.

Nespor, Jan (1987). 'The role of beliefs in the practice of teaching'. Journal of Curriculum Studies. (19)4, pp. 317 — 328.

National Council of Teachers of Mathematics (2000). Principles and Standards for School Mathematics. Reston, VA: NCTM.

Oppenheim, A. N. (1992). Questionnaire design, interview and attitude measurement. London & New York: Continuum.

Osgood, C. E., Suci, G. J., & Tannembaum, P.H. (1957). The measurement of meaning. Urbana, University of Illinois Press.

Orton, A. (2004). Learning Mathematics: Issues, Theory, and Classroom Practice. London: Continuum.

Polya, G. (1985). How to solve it (2nd ed.). Princeton, NJ: Princeton University Press.

Peng, Guohua (2002), Two Student-centred Teaching Methods in Mathematics: The China Papers,

Roberts, A. Wayne (1995). Faces of Mathematics, Third Edition. New York: HaperCollins College Publishers. p.479.

Schoenfeld, Alan H.; D. Grouws (Ed.) (1992). "Learning to think mathematically: Problem solving, metacognition, and sense-making in mathematics". New York: Academic Press.

Richardson, F. C., Suinn, R. M. (1972). The Mathematics Anxiety Rating Scale: Psychometric data. Journal of Counselling Psychology, 19, 551-554.

Schoenfeld, A. H. (1985). Mathematical problem solving. New York: Academic Press.

Sellwood, P. (1989). the role of problem solving in developing thinking skills. The Technology Teacher, 49(3), 3-10.

Simmons, Malcolm (Ed.) (2001). The Effective teaching of mathematics, London: Longman.

Saleh, Fatimah (2006). The University of Malaya. School of Educational Studies. University Sains Malaysia

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. Educational Researcher, 15(2), 4-14.

Spangler, D. A. (1992). Assessing students' beliefs about mathematics. Arithmetic Teacher, 40(2), pp. 48-152.

Savage, E., & Sterry, L. (Eds.) (1991). A conceptual framework for technology education. Reston, VA: International Technology Education Association.

Stonslessy, Shisley (1996). Students achievement and attitudes in traditional and non-traditional teaching . Geometrid.

Thompson, A. G. (1988). learning to teach mathematical problem solving: Changes in teachers' conceptions and beliefs. In R. I. Charles & E. A. Silver (Eds.), The teaching and assessing of mathematical problem solving, Vol. 3. Reston, VA: NCTM. pp. 232-243

Thompson, A. (1992). Teacher's beliefs and conceptions: A synthesis of research. In D. A. Grouws (Ed.), Handbook of research on mathematics teaching and learning. National Council of Teachers of Mathematics. New York: Macmillan. pp. 127–146.

Thomas J (1985), a beginning teacher's view of problem solving, Journal for Research in Mathematics Education, 5(16), pp. 324-336.

Vernon, D. T. (1995). Attitudes and opinions of faculty tutors about problem-based learning. Academic Medicine, 70(3) 216-223.

Weber, K. (2005). Problem-solving, proving, and learning: The relationship between problem-solving processes and learning opportunities in the activity of proof construction. Journal of Mathematical Behavior, 24, pp. 351-360.

Wood, E. F. (1988). Math anxiety and elementary teachers: What does research tell us? For the Learning of Mathematics, 8(1), 8-13.

Xiuping, Zhang (2002), the Combination of Traditional Teaching Method and Problem Based Learning, the China Papers, Vol. 1, pp.30-36

Yang, M-Y. (2000). Problems Solving in Chemistry at Secondary School Science, PhD Thesis, Glasgow, University of Glasgow, UK.

Zohar et al. (2001). Teachers' beliefs about low- achieving students and higher order thinking. Teaching and Teacher Education 17, 469-485