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Assessment Of Mathematical Problem-Solving Skills Of Class VIII Students

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Abstract

The present study was intended to assess the Mathematical problem-solving skills of class VIII students. The survey method was used to collect data from a sample of 300 male and female students of class VIII from both public and private schools in Lahore. A Mathematical Problem Solving (MPS) test of 10 questions was designed and administered to measure the level of problem-solving skills in class VIII students. Students' scores of MPS were analyzed through descriptive statistics to decide about the Mathematical proficiency level of the students and to compare the problem-solving skills of male and female students of both public and private schools. Findings illustratethatthe Mathematical problem-solving skills of the majority of the students in public schoolsare at a low level of proficiency than private school students.In public schools, the Mathematical problem-solving skills (MPS) of female students were found comparatively better than their male counterparts but in private schools, male students excelled. Mathematics teachers' training sessions at the elementary level are strongly recommended to improve the level of Mathematical problem-solving skills of the students.

Keywords: Mathematics, problem-solving skills, assessment, elementary level

INTRODUCTION

There is a globalmission to boostmathematical problem solving among students. Problem-solving and reasoning skills have grown increasingly important.According to Ernest (1988 as cited in McIntosh, 2000), rather than learning facts, rules, and processes, the problem-solving approach allows students to expand their Math skills to build creativity and exploration skills.According to the National Council of Teachers of Mathematics (NCTM,2000), "Problem-solving is central to inquiry and application which should be interwoven throughout the Mathematics curriculum to provide a context for learning and applying Mathematical ideas" (p.256).

Problem-solving in Mathematics is a process of presenting such a novel problem for which no directand obvious solution available for a student. Even no algorithm could help to solve the problem (Schonfeld, 1992).The purpose of problem-solving learning is to increase high-level cognitive abilities in general. Higher-order thinking skills have the following characteristics: they are not algorithmic, they are more complex, they produce a diversity of answers, they involve a variety of criteria and cognitive processes, and they

require a significant amount of mental work (Alimuddin, Ruslan,& Nasrullah, 2018).Because of the various benefits that a skilled problem solver would have in everyday life and at work, problem-solving is also considered one of the most significant talents that a learner would have in the twenty-first century. So, problem-solving should be viewed as an integrated element of mathematics education, rather than as exercises that students do at the end of each unit in their school textbooks (Khalid et al., 2020). Problem-solving is a skill, uses cognition processes to solve a real-life problem and involves the manipulation of experience and knowledge with the current situation (Mushtaq, 2011). Indeed, teaching Mathematics through a problem-solving approach makes sense of theoretical knowledge. Mathematical problem solving is not just about cramming formulas and calculate answers rather using decision-making abilities to explore the right path and means to solve the problem (Habib& Rana, 2020).

Assessment of Mathematical problem-solving skillshas been a challenging task ever. Students' problem-solving skills may be judged through presenting unfamiliar tasks for which there are no readily available procedures. The nature of the tasks must be challenging but within the ability of the students (McIntosh, 2000).Diversity of tools can be found in the literature but the problem-solving test is most common to assess the Mathematical problem-solving skills of the students.According to DES (2017), mathematical proficiency has five components; "conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition" (p. 5).

In Pakistan, according to Punjab Examination Commission (PEC) 2018, Mathematics achievement scores of class VIII were at a poor level of proficiency. Moreover, analysis of content-wise ability measures shows that class VIII students' problem solving and conceptual understanding skills were below the procedural knowledge. Keeping in view, this is the requirement of the time to take serious steps to introduce to bring reforms in Mathematics teaching to improve students' Mathematical abilities in general and problem-solving skills specifically at the middle level.

Problem-solving Rubric

A long history of problem-solving assessment is deep-rooted in Polya's (1957) framework of Mathematical problem-solving skills. NCTM suggested diverse ways to assess students' multifaceted mathematical thinking using problem-solving tasks through Polya's four steps of problem-solving assessment (NCTM 2000, 2010).

Although different rubrics were developed to assess mathematical problem solving but Polya's framework is considered as the foundation of all those models or frameworks. According to Schoenfeld (2007), Polya's framework is still alive in existing theoretical works regarding mathematical problem-solving.Understanding the problem, devising a strategy, carrying out the plan, and examining the result are the four steps in Polya's framework for mathematical problem-solving.Students must engage in real-world problem solving of unknown situations, as depicted by this model, by estimating, discovering, and making meaning of mathematics (Faulkner et al., 2021).Detail of the four steps of Polya’s framework is described afterward in the data analysis section.

Objectives of the study

The present study is intended to:

1) assess the level of Mathematical problem-solving skills of class VIII students.
2) compare the Mathematical problem-solving skills of class VIII students in public and private schools of Lahore.
3) compare the Mathematical problem-solving skills of class VIII male and female students.

Research Questions

1) What is the level of problem-solving skills among class VIII students in the subject of Mathematics?
2) Is there any significant difference in the mean scores of Mathematical problem-solving skills of public and private students of class VIII?
3) Is there any significant gender difference in the Mathematical problem-solving skills of class VIII students?

Significance of the study

The present study is significant to get awareness about the Mathematical problem-solving skills of class VIII students. It may assist curriculum developers and educationists to bring reforms in the Mathematics curriculum at the elementary level to enhance student's abilities to apply their theoretical knowledge for solving everyday life problems. Results of the current study may help out to plan Mathematics teachers' training sessions in the right direction and also toreview the assessment system of Mathematics at the elementary level.

Designof the study

The study is descriptive in nature and data was collected throughthe survey method.Collected information was used to study the levels of Mathematical problem-solving skills among students of class VIII. All the students of class VIII in public and private schools situated inLahore city were the target population of the study. The random sampling method was used to select two public schools (one girls'& other boys')and one private school with co-education to study the Mathematical problem-solving skills of the students. The sampling detail is shown below:

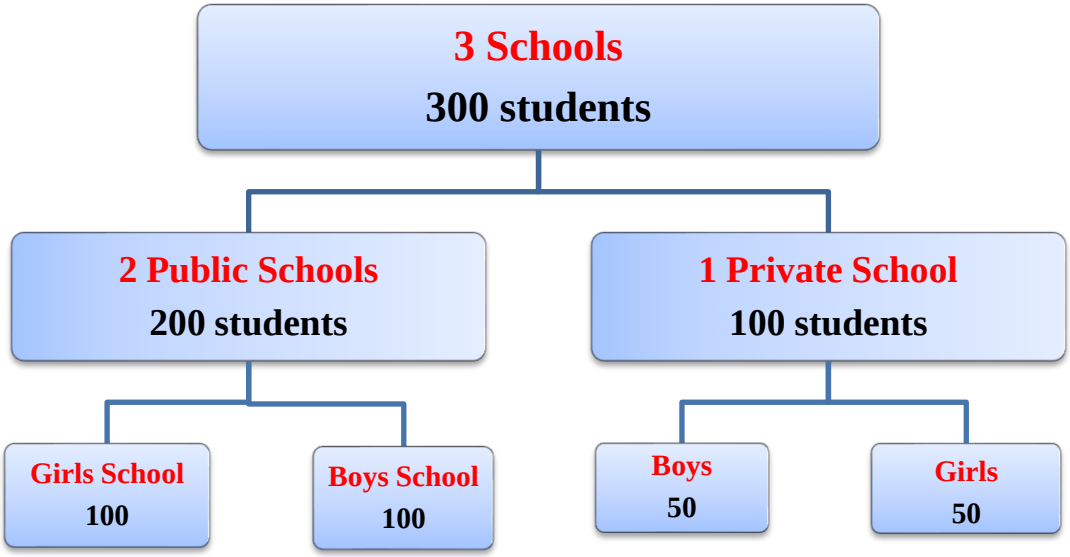


Figure 1 Sampling Diagram

Instrument

A Mathematics Problem Solving (MPS) test consists of 10 questions was designed to measure the ability of the students to comprehend the meanings of Mathematical problems, decision about the use of an appropriate method for a solution, and way to implement a method and then to check after calculating the answer.Although different textbooks are being taught in the public and private schools those considered for the study are in progress. However, there are many common topics included in the syllabus of those schools.Test items were developed from those selected common topics including Ratio, Percentage, Rate, Algebraic equations, area, and perimeter of simple closed shapes. It was made sure that all the students who participated in the study have gone through the above-stated topics in their respective classes before the administration of the test.

Content validity of the test (MPS) was ensured through peer review and expert judgment of Mathematics subject specialists. A pilot study of (MPS) test on 50 students helped to improve the validity of the instrument. Necessary amendments were made in the instrument in the light of peers' reviews and experts' opinions. The reliability of the final instrument used was calculated as 0.957.

Data collection

Instrument (MPS) was personally administered by the researcher in all the schools included in the sample. Students were asked to do all the required work on the answer sheets along with the solution. Clear instructions were written on the question paper, even

then it was explained verbally also that students must read and understand the questions before deciding about the selection of the method to use for finding the solution. It was emphasized that to keep in mind to check the work again to avoid calculation mistakes.The researcher herself invigilated during tests to ensure the authenticity of the students 'responses.

Data analysis

283 tests were found to be completed and appropriate for analysisfrom the selected sample of 300 students of class VIII. Each question of the test was marked according to the given rubric based on Polya's framework (1957).

Steps	Description	Marks allocated
Understand the problem	Complete understanding of the problem .e.g. what the question is about? Which values are provided? What is asked to find? etc	2
Devise a plan	Selection of the method used to find the solution	1
Carry out the plan	The way to implement the selected method.	1
Examine the solution	To check the calculation	1

Figure 2 Test Rubric

All 10 questions were marked according tothe allocated marks for each step in the rubric. Individual and total scores of four stepsof the rubric i.e. understand the problem, devise a plan, carry out the plan and examine the solution, for all questions were tabulated. Descriptive statistics (Mean and standard deviation) of the above-mentioned scores were calculated to decide the Mathematics proficiency level of the students.

6 Levels of Proficiency (PISA 2018 Mathematics)

To find the level of proficiency of Mathematics problem-solving skills among class VIII students, PISA 2018 criteria for Mathematics proficiency levels was used.

In PISA 2018 "students'mathematical literacy was expressed on a six-level scale, where lowest level "1" and highest level "6" corresponds to specific scores given below:

Mathematics Proficiency levels

Level 6668 and above

Level 5 607 – 667 High achievement level of mathematical proficiency

Level 4545 – 606

Level 3 483 – 544

Level 2	421 – 482	Baseline level of mathematical proficiency
Level 1	359 – 420	Low achievement level of mathematical proficiency

To decide the mathematical proficiency level of an individual student the test scores were converted into z scores. These scores were compared with PISA (2018) criteria to assign a specific level of proficiency.

Results

Table 1 Assessment of proficiency level of Mathematical problem solving

	Public. Schools			Private schools	
Proficiency Level	Male (%)	Female (%)		Male (%)	Female (%)
Level 1	42	10		3	8
Level 2	45	41		8	16
Level 3	11	40		24	16
Level 4	2	9		18	16
Level 5	0	0		11	8
Level 6	0	0		36	36
	100	100		100	100

Table 1 shows that 42% male and 10% female students in the public sector are at a low achievement level of mathematical proficiency. While the percentage of students with a high achievement level of mathematical proficiency is zeroin the public sector. On the other hand in the private sector 47% male and 44%, female students were assigned a high achievement level of mathematical proficiency, and only 3% male and 8% female students in the private sector are at low achievement level of mathematical proficiency.

The achievement level of Mathematical proficiency is significantly low in the public sector than the Achievement level of mathematical proficiency in the private sector.

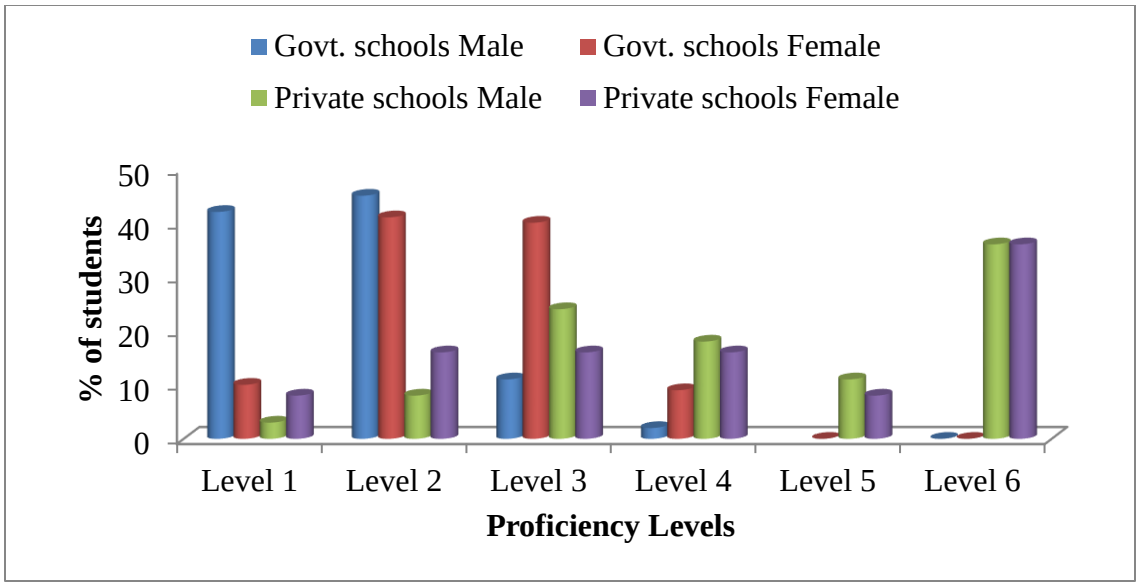


Figure 3 Achievement level of Mathematical proficiency

Multiple bar graphs give a picture of comparative analysis of proficiency levels of class VIII students' gender-wise as well as sector-wise.It shows the trend of Mathematical problem-solving skills of male and female students of the public sector towards low achievement level of mathematical proficiency. While the Mathematical problem-solving skills of male and female students of the private sector are more likely towards a highachievement level of mathematical proficiency.

Furthermore, the above graph shows that the proficiency level of Mathematical problem-solving skills of female students of public schools is slightly better than their male counterparts.

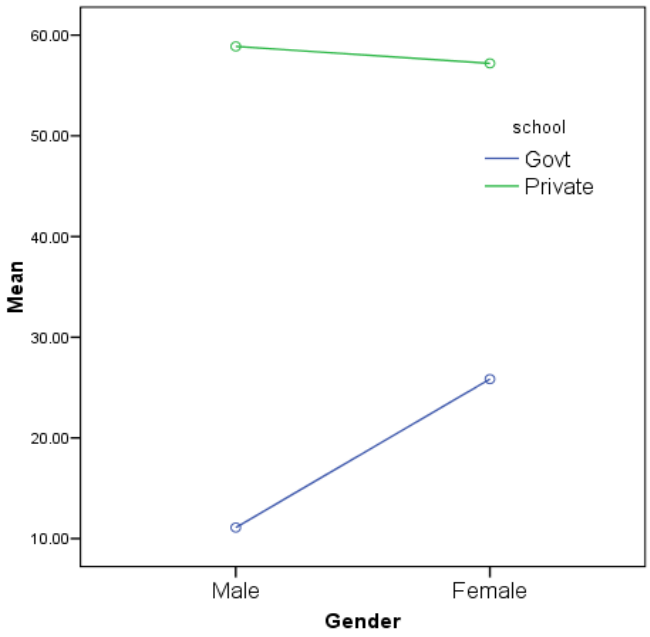
Tests were marked according to the above-mentioned rubric standard and data collected was tabulated in individual and total scores of all four steps.

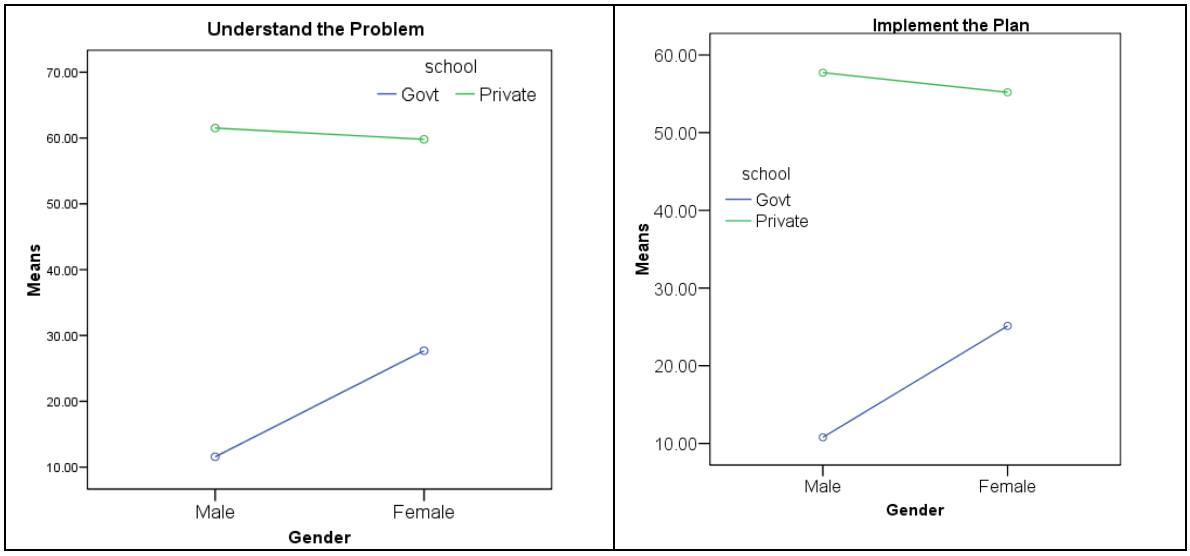
Table 2 Comparison of Govt. schools and Private schools with gender regarding problem-solving skills

	Govt. Schools			Private Schools		
	Male M(SD)	Female M(SD)	Total M(SD)	Male M(SD)	Female M(SD)	Total M(SD)
Understand the Prob.	11.6(14.0)	27.7(14.3)	19.1(16.2)	61.5(24.2)	59.8(31.8)	61.0(26.3)
Devise a plan	10.9(12.8)	27.7(14.3)	17.88(15.6)	58.9(25.5)	57.2(33.8)	58.5(27.86)
Implement the plan	10.8(12.6)	25.6(14.9)	17.5(15.5)	57.7(26.0)	55.0(35.5)	57.0(28.7)
Check the	10.7(12.3)	25.1(15.0)	16.5(15.1)	54.7(26.6	54.0(35.1	54.5(28.9)

solution			)	)
Total	11.1(13.06)	25.85(14.54)	58.8(25.0)	57.2(33.5)

Table 2 illustrates lower mean Mathematical scores of public school students in all steps of problem-solving. On the other hand, mean Mathematical scores of private school students in all steps of problem-solving were found good.





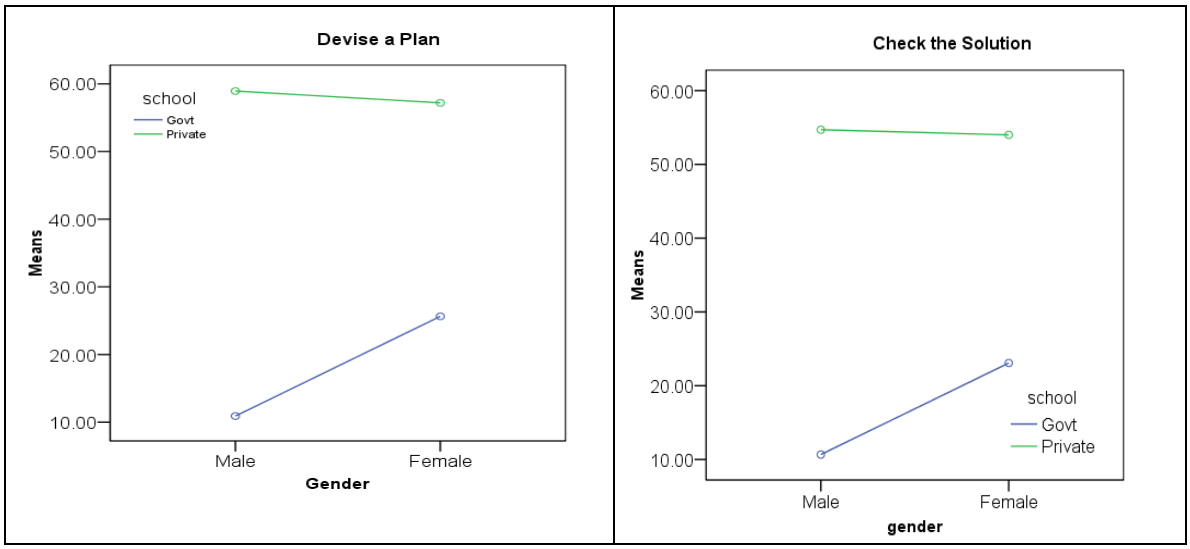


Figure 4 Interaction between gender and sector

Discussions

Results of the present study revealthe level of Mathematical problem-solving skills of class VIII students of both public and private schools.In public school, the majority of the students were found at the low level of Mathematical problem-solving skills while unfortunately, there was no student on the high achievement level of mathematical proficiency. These findings are aligned with similar findings of former studies and reports (Tayyaba, 2010; PEC, 2018).In the latest Exam analysis report of Punjab Examination Commission (2018), Mathematics result was not only low among all other subjects but also below average.Likewise, the greatest "weak students' learning outcomes" were also identified in Mathematics and a bigger part of those was from the application domain of cognitive level in public schools.

A significant difference is observed in the levels of the students of public and private schools. There were few in a private school at the low level of Mathematical problem-solving skills whereas the majority of the students of public school were found there.

Furthermore, at a high level of proficiency almost half of the private school students were found but no student of public school was there.This is a great difference between the levels of Mathematical problem-solving skills of public and private schools. These findings also support the results of a previous comparative study of public and private schools (Awan & Zia, 2015).
Findings of that study concluded that despite the free education with textbooks in public schools; parents don't prefer to send their children to public schools. The quality of education is low as compared to the private schools in Pakistan.In general, Pakistani public school teachers use traditional methods during Mathematics teaching which encourage memorization and cramming rather than conceptual learning. (National Curriculum for

Mathematics,2006; Amirali & Halai, 2010; Mohammad, 2002). Whereas,Mathematical Problem solving needs strong conceptual knowledge with other skills.
The findings of the present study also expose thesignificant gender difference in the Mathematical problem-solving skills of class VIII students in the public sector. The mathematical problem-solving skills of female students were significantly better than their male counterpartsin public school.These findings are not aligned with the findings of earlier research (Halai, 2010).In a situational analysis report, Halai (2010) reported gender differences in Mathematics education in Pakistan because of the incompetency of female Mathematics teachers.However, in private school, no significant gender difference in Mathematical problem-solving skills at all proficiency levels was found.

The findings of the present study will help to spread awareness about the present level of Mathematical problem-solving skills of class VIII students. To enhance the Mathematical problem-solving skills of class VIII students in public schools, teachers are required to concentrate on new techniques and strategies in classroom teaching. Mathematics teachers' training sessions under specific guidelines and consistent follow-up of those steps are strongly recommended for Mathematics teachers at the elementary level.The curriculum and assessment system must bring reforms in the Mathematics curriculum at the elementary level to enhance student's abilities to apply their theoretical knowledge for solving everyday life problems.

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