

## EFFECT OF PROBLEM SOLVING ABILITY ON ACADEMIC ACHIEVEMENT OF HIGH SCHOOL STUDENTS: A COMPARATIVE STUDY

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### Abstract

The ability of problem solving has a fundamental role in students' academic performance and their construction of the concepts. Keeping this in view, the present investigation has been planned out to examine the effect of problem solving ability on the academic achievement of high school students. The descriptive method was adopted in the present study. A sample of 250 students (165 male, 85 female) studying in 10th class of high schools affiliated to CBSE of Rohtak district was selected by using random sampling technique. In order to assess the Problem Solving Ability, Problem Solving Ability Test (PSAT) (2006) developed by Dr. L. N. Dubey was used. The marks obtained by the students in 9<sup>th</sup> class (previous class) were considered as the academic achievement of students. ANOVA supplemented by t-test was applied for data analysis. The findings of the study revealed that problem solving ability had a significant effect on academic achievement of high school students. It is further revealed that the female students performed better as compared to male students. However, no interaction effect of problem solving ability and gender was found on academic achievement of high school students.

**Keywords: Problem Solving Ability, Academic Achievement, High School Students.**

### INTRODUCTION

In the highly achieving society of today, success has become an index of attaining position and respect. Greater premium has been laid on the academic achievement of students. A good academic achievement record of students is an index of an effective educational system. It is the tangible result of the quantity and quality of knowledge attained. It is the ripe fruit of slow and steady cultivation of knowledge and skills. Education is frequently concerned with the need to improve students' academic achievement. The large number of researches on

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student's achievement bears testimony to this concern (Bajah, 1979 [4]; Babalola, 1979 [3]; Holliday, 1981 [15]; Oni, 1981 [22]; Okoye, et al.2008 [24]).

One of the major features of contemporary educational thinking is a growing concern about the development of effective personality and efficiency of teaching learning outcomes that can be assessed in terms of students' achievement. Academic development of the pupil is the primary concern and the most important goal of education. Academic achievement can be defined as performance, knowledge or skill acquired after instructions and training in courses or subjects of study, usually determined by test score or by marks assigned by teacher (Dictionary of Education, 2003)[8]. There are many factors which affect academic achievement viz. intelligence, personality, motivation, school environment, heredity, home environment, learning, experiences at high school, interests, aptitudes, family background, socio economic status of the parents and many more other factors influenced the academic achievement. Despite this, one of the major factors of education is the ability of problem solving that affect the academic achievement. Problem solving is the key to success and has been regarded as the most significant aspect of human behaviour. Problem solving ability plays an important role in the academic achievement of students and has been received broad public interest as an important competency in modern societies. In educational large-scale assessments, paper-pencil based analytical problem solving was included first (Programme for International Student Assessment, PISA, 2003(OECD, 2003 [23])). Enhancing students' problem solving capacity is one of educational psychology's greatest challenges and is a major demand placed on any educational institution (Mayer and Wittrock,2006 ) [18]. Bearing this in mind, it is not surprising that educational large-scale assessments (LSAs) around the world have recently identified problem solving as a core domain that complements classical literacy concepts in high school subjects.

Problem solving is the framework or pattern within which creative thinking and reasoning take place. According to Mayer and Wittrock (2006) [18], problem solving is cognitive processing directed at achieving a goal when no solution method is obvious to the problem solver. This definition consists of four parts: first part, problem solving is cognitive i.e. problem solving occurs within the problem solver's cognitive system and can only be inferred from the problem solver's behavior. The second part, problem solving is a process i.e.

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problem solving involves applying cognitive processes to cognitive representations in the problem solver's cognitive system. The third part, problem solving is directed i.e. problem solving is guided by the problem solver's goals and the last part, problem solving is personal i.e. problem solving depends on the knowledge and skill of the problem solver. In sum, problem solving is cognitive processing directed at transforming a problem from the given state to the goal state when the problem solver is not immediately aware of a solution method. Problem solving is related to other terms such as thinking, reasoning, decision making, critical thinking, and creative thinking. Another important area is the study of human problem solving with subject matter areas such as reading, writing, Mathematics and Science that is psychologies of subject matter (Mayer 1987). Instead of studying how people think in general, psychologists of subject matter investigate how people think scientifically or mathematically or how people think within the process of reading or writing a passage. It was also revealed that problem solving is the best predictor of achievement of Mathematics and Physics in high school students when gender was taken as demographic variable (Bhatt, 2014 [5]; Kousar, 2010 [20]). Problem solving ability is necessary skill when students further in their study. Many researches show that different abilities have been used in learning. The results show that sometime problem solving ability is successful with particular task of students but sometime is not. Researchers have come out with varied results sometimes complementary to each other, and sometimes contradicting each other. Thus, in the present study attempt has been made in the direction of exploring the impact of problem solving ability on academic achievement.

### **Theoretical Background / Literature**

Literature points out that among the priorities, problem-solving ability is a requirement for success in mathematics and science course (Dhir, 2014 [9]; Adesoji, 2008 [2]). Moreover, Darchingpui (1989) [7], Gupta (2014) [14] and Kumar et al. (2014) [17] pointed towards the students' Problem solving ability based on the variables types of the high school, academic success, socio-economic and socio-cultural background. The ability of problem solving has a fundamental role in students' academic performance and their construction of the concepts (Gakhar et al., 2004 [13]; Kousar, 2011[20]). Adesoji, 2008 [2] detected that there was no

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difference in the performance of students in the different ability levels after the treatment. The findings showed that students' ability have significant influence on problem-solving task (Adeyemo, 2010 [1]). However the effect of caste and gender was also found on problem solving ability and academic achievement of students (Gupta, 2014 [14]). Improving the ability of problem solving ability is a key factor for content learning. Most of the studies given above carried out to assess the problem solving ability with science and mathematics and different variables. However, no study has been carried out to assess the effectiveness problem solving on academic achievement in relation to male and female. Under the light of aforementioned information, the present study aims has been designed to access the effect of gender and problem-solving ability of school students on academic achievement.

### **OBJECTIVES OF THE STUDY**

The present study asserts to meet the following objectives:

1. To study the effect of problem solving ability on academic achievement of high school students.
2. To study effect of gender on academic achievement of high school students.
3. To study the interaction effect of problem solving ability and gender on academic achievement of high school students.

### **DESIGN OF THE STUDY**

**Method:** Descriptive survey method was used in this study.

**Sample** The sample comprised 250 X class students from high schools affiliated to CBSE was selected through random sampling technique. Further sample was bifurcated based on the basis of gender i.e. male (165), female (85) and problem solving ability i.e. high problem solving ability (75), average problem solving ability (75) and low problem solving ability(100) ).The breakup detail of sample is given in table 1.

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**Table 1: Breakup Details of the Sample Selected for the Study**

Group	Problem Solving Ability		
	High	Average	Low
Male	47 (above15)	54 ( between 12-14)	64 (below 11)
Female	28 (above 14)	21 (between11-13)	36 (below 10)

### Tool Used

Problem Solving Ability Test (PSAT) developed by Dr. L.N. Dubey (2006) [10] was used to determine the level of problem solving ability among high school students. The reliability calculated through split-half reliability coefficient was found to be 0.78 and the reliability also calculated through rational equivalence method was found to be 0.76. The validity of this scale was determined by finding correlation of scores with standardized test.

### Statistical Techniques Employed

Mean and S.D. were worked out on the scores of achievement of high school students under study. Analysis of Variance (ANOVA) with 3×2 factorial design was employed to study the main effects and interactional effect of independent variables (problem solving ability, gender) on dependent variable (academic achievement) supplemented by t-test. To test the assumption of homogeneity of variance for ANOVA, Levene's Test for homogeneity of variances was employed. The data was analyzed by using SPSS.

### DATA ANALYSIS & DISCUSSION

This section explores the effect of problem solving ability and gender on academic achievement of the high school students. In the present study, the value of homogeneity of variance was calculated by Levene's test and it was 1.61 which is not significant at 0.05 level of significance. It means that variance of all the six groups were similar.

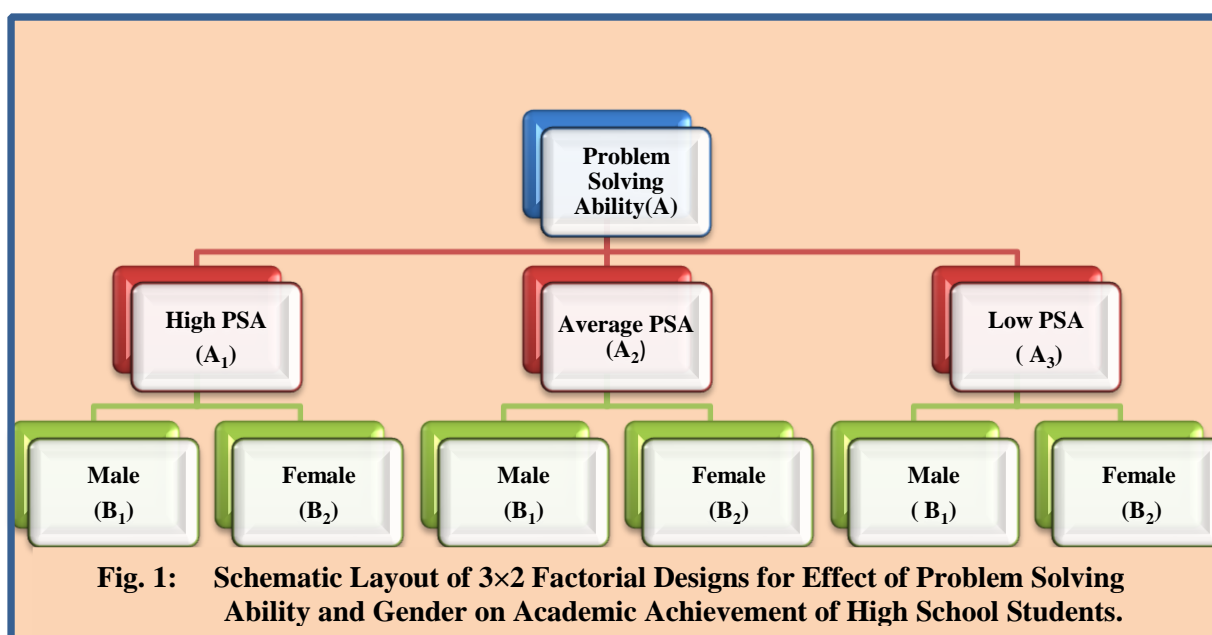
In order to study the main and interaction effects problem solving ability and gender on academic achievement of the high school students, data was subjected to analysis of variance of (3×2) factorial study with a randomized group design. In this section, the first independent

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variable i.e. problem solving ability coded as A was varied into three group high problem solving ability ( $A_1$ ), average problem solving ability ( $A_2$ ) and low problem solving ability ( $A_3$ ). The second independent variable i.e. gender coded as B was varied at two levels male ( $B_1$ ) and female ( $B_2$ ). A layout of the factorial design used in the study for the variables problem solving ability and gender has been presented in Fig.1. The means and S.D.'s of different sub-samples have also been presented in the Table 2. Mean achievement scores of high school students in relation to problem solving ability and gender have been presented graphically in Fig.2



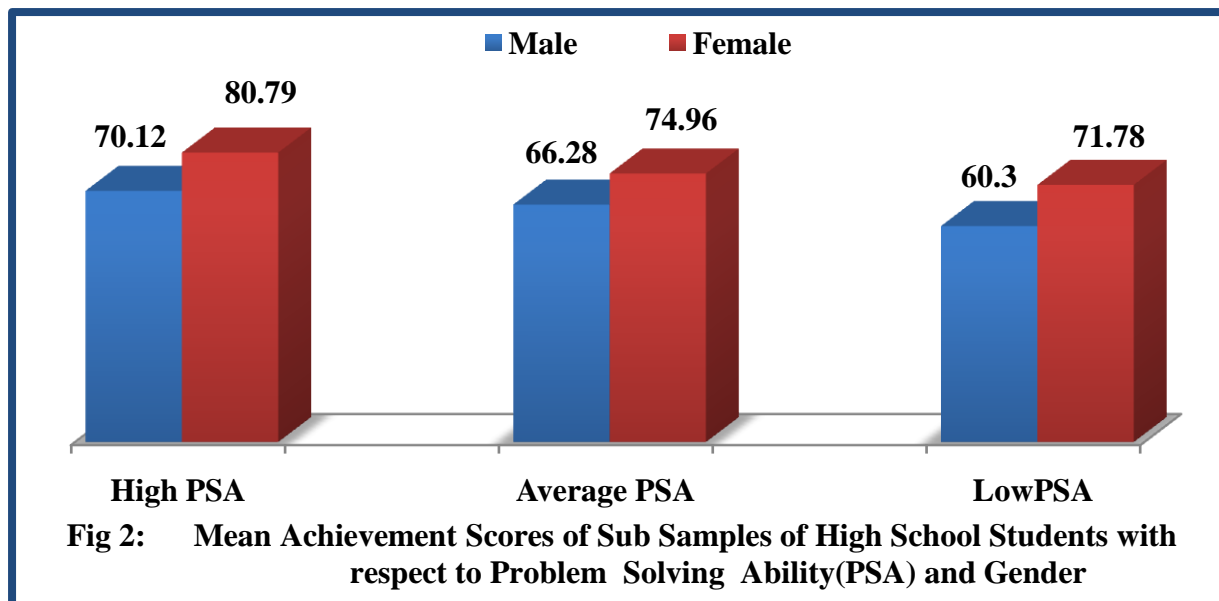
**Table 2: Means and S.D's of Sub Samples for Achievement Scores of High School Student with respect to Problem Solving Ability and Gender**

PSA	Gender	N	Mean	S. D.
<b>High PSA</b> ( $A_1$ )	<b>Male(<math>B_1</math>)</b>	47	70.12	14.20
	<b>Female(<math>B_2</math>)</b>	28	80.79	10.75
<b>Average PSA</b> ( $A_2$ )	<b>Male(<math>B_1</math>)</b>	54	66.28	12.29
	<b>Female(<math>B_2</math>)</b>	21	74.96	10.57
<b>Low PSA</b> ( $A_3$ )	<b>Male (<math>B_1</math>)</b>	64	60.30	9.92
	<b>Female(<math>B_2</math>)</b>	36	71.78	12.27

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**Fig 2: Mean Achievement Scores of Sub Samples of High School Students with respect to Problem Solving Ability(PSA) and Gender**

**Table 3: Summary of Two-Way ANOVA for Mean Achievement Scores of High School Students with respect to Problem Solving Ability and Gender**

Sources of Variation	Df	S S	M S	F-ratio
PSA(A)	2	3544.985	1772.49	12.54**
Gender (B)	1	5710.768	5710.77	40.39**
PSA*Gender	2	72.419	36.21	0.26(NS)
Between cells	5	10185.97	...	
Within subjects	244	34502.96	141.41	
Total	249	44688.933		

\*\*Significant at 0.01 level

NS=Not Significant

**Main Effect (Problem Solving Ability (A) and Gender (B))**

**Problem Solving Ability (A)**

For the main effect of problem solving ability on academic achievement of high school students, it is evident from Table 3 that F-ratio 12.54 with df 2 and 244 which is significant at 0.01 level leading to the inference that problem solving ability has a significant role in determining academic achievement. Therefore, it was found that there is significant effect of problem solving ability on academic achievement. It means that the students having the

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problem-solving approach showed much better academic achievement. The reason behind that problem solving ability helps students to think and find the solutions more systematically and logically. The result is in agreement with the studies of Kousar Parveen (2010) [20] and Chang et al. (2002) [6] who revealed that students showed good performance if they had the problem solving ability. On the contrary, Jeotee (2012) [16] reported that the problem solving ability had negative influence on academic ability. In order to investigate further, to find which group among high PSA, average PSA and low PSA show better performance, one-way ANOVA is being computed and has been presented in Table 4.

**Table 4: Summary of One-Way ANOVA for Mean Achievement Scores of High school Students with respect to Problem Solving Ability**

Sources	Df	SS	MS	F-ratio
<b>Among Groups</b>	5	9131.78	1826.38	12.53**
<b>With in Groups</b>	244	35557.15	145.73	
<b>Total</b>	249	44688.93		

**\*\* Significant at 0.01 level**

The F -ratio vide Table-4 for find the effect of high problem solving ability, low problem solving ability and average problem solving ability on academic performance is 12.53 with df 5 & 244 which is significant at 0.01 level leading to inference that there exists significant difference in academic achievement of high school students of three groups of problem solving ability. It means that high PSA, average PSA, low PSA groups show much difference in their academic achievement The‘t’ test has been further employed to find out the difference in mean scores of academic achievement for different groups and has been presented in Table-4.1

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**Table 4.1: 't'-values for the Mean Achievement Scores of High School Students with respect to Problem Solving Ability**

Groups of PSA	N		Mean		S.D.		t-value
<b>HPSA vs. APSA.</b>	75	75	74.10	68.72	13.9	12.3	2.51*
<b>APSA vs. LPSA</b>	75	100	68.72	64.4	12.3	12.26	2.31*
<b>LPSA vs. HPSA</b>	100	75	64.4	74.10	12.26	13.9	5.14**

**\*\* Significant at 0.01 level**

**\*Significant at 0.05 level**

**HPSA=High Problem Solving Ability; APSA= Average Problem Solving Ability; LPSA=Low Problem Solving Ability.**

It is clear from Table-4.1 that 't'-value 2.51 with df 148 for the mean achievement score between the high PSA and average PSA of high school students is significant at 0.05 level. The 't'-value 2.31 with df 173 for the mean achievement score between the average PSA and low PSA of high school students is significant at 0.05 level. The 't'-value 5.14 with df 173 for the mean achievement score between the high PSA And low PSA of high school students is significant at 0.01 level. In the context of mean scores, it has been found that the mean achievement scores of high school students of high PSA group (74.10) is more than of groups of average PSA (68.72) and low PSA (64.4) students. Therefore, it interpreted that high PSA have high academic achievement. The reason is that high problem solving ability helps in developing critical thinking in students, which helps in concept formation that is pre-condition for the good academic performance. This result is in agreement with the findings of Adesoji (2008) [2] who reported that the students who are high achievers in problem solving showed superior academic achievement. The mean achievement scores for main effect corresponding to problem solving ability on academic achievement have been presented graphically in Fig. 3.

### **Gender (B)**

For the main effect of gender on academic achievement, it can be inferred from the Table 3 that F-ratio is 40.38 with df 1, 244 which is significant at 0.01 level. It indicates that gender has a significant role in determining academic achievement of high school students. Therefore, it was found that there exists significant effect of gender on academic achievement

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of high school students. In order to investigate to support that result further the 't'-value is computed and has been presented in Table-5.

**Table 5:'t'-value for the Mean Achievement Scores of High School Students with respect to Gender**

Group	N	Mean	S.D.	't'- value
Male	165	65.05	12.6	6.68**
Female	85	75.53	12.1	

**\*\*Significant at 0.01 level**

It is evident from the Table 5 that 't'-value is 6.68 with df 248 for the mean scores of academic achievement between the male students and female students is significant at 0.01 level. In the context of mean scores, it has been found that the mean score of academic achievement of female students (75.53) is higher than male students (65.05). The girls are performing better than boys. The reason may be that female students treated equally in their development and education and provided the congenial environment. This result is in agreement with the findings of Nataraj and Manjula (2012) [21] & Farooq et al. (2011) [12] who reported that female students showed higher academic achievement as compared to the male students of high school. This result is in contrast with findings of Kumar et al. (2014) [17] and Kalhotra (2010) [19] who reported that male students showed high achievement than female. The mean scores for the effect of gender on academic achievement have been presented graphically in Fig. 3.

**Interaction Effect of Problem Solving Ability and Gender on Mean Achievement Scores of High School Students (A×B)**

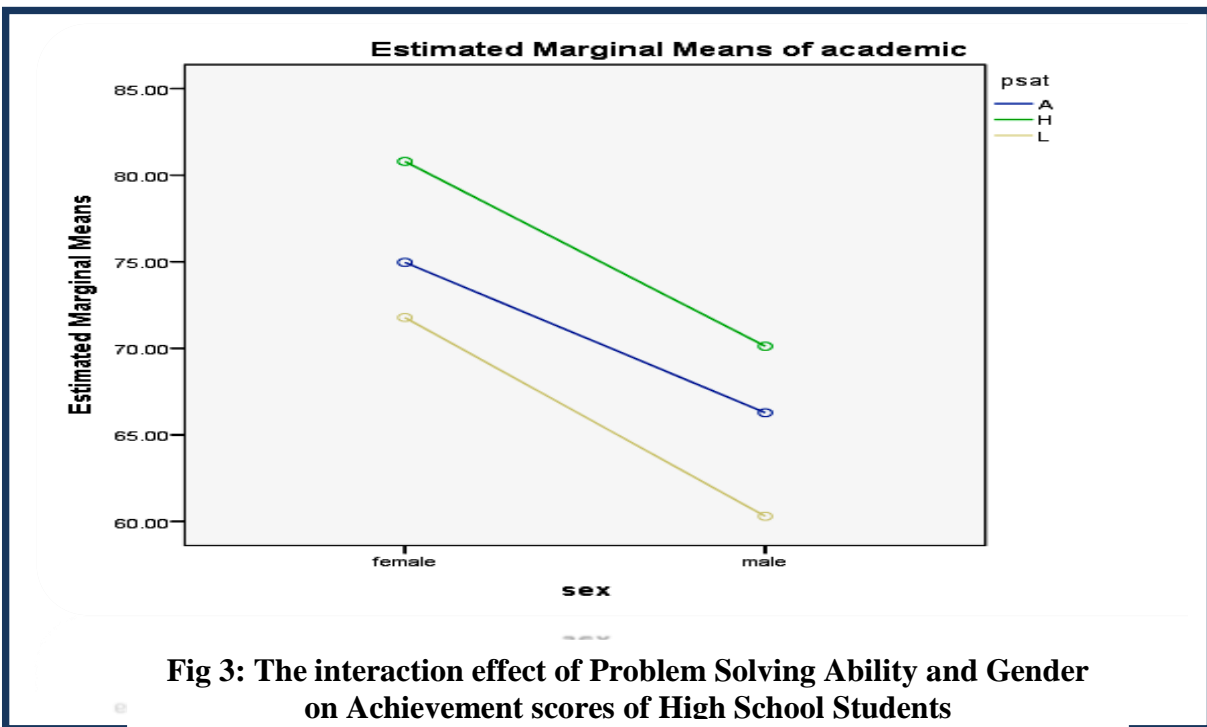
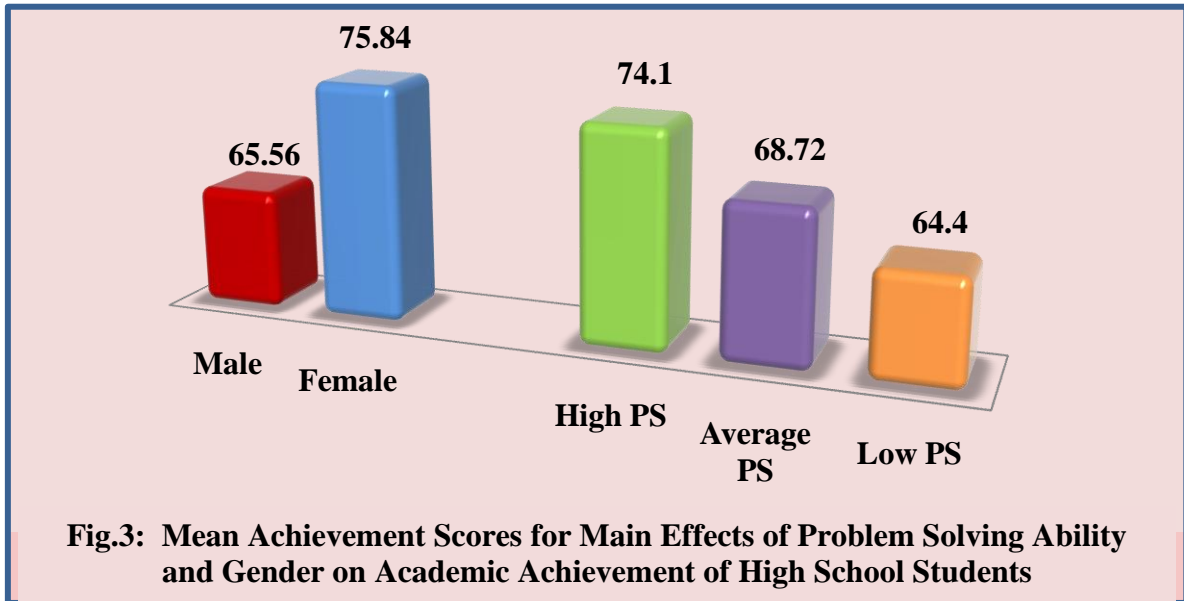
From Table 3, the value of F-ratio for interaction of problem solving ability and gender is 0.26 with df 2, 244. Which is not significant interaction effect between problem solving ability and gender at 0.01 level .It leads to the inference that problem solving ability and gender do not interact with each other. Therefore, it is found that there exists no significant interaction effect of problem solving ability and gender on academic achievement of high school students. This finding is in agreement with findings of Sirohi & Usha (2013)[25] who revealed that male and female of under graduate students do not differ as regards to their problem solving ability. Therefore, it may be said that the problem solving ability of both groups male and female is same with regard to their academic achievement of high school

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students. The reason for this finding is that both groups provided same education so that have approximate same cognitive abilities. This result is in contrast with findings of Nataraj and Manjula (2012)[21]; Kumar et al.(2014)[17] and Kalhotra (2010)[19] who reported problem solving ability of both groups male and female were different with regard to their academic achievement. The Line graph in Fig.4 shows that there is no interaction effect of PSA and gender on academic achievement of high school students.



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## **FINDINGS OF THE STUDY**

- ❖ The study revealed that problem solving ability had a significant effect on mean achievement scores of high school students. A significant difference found in academic achievement among high, average and low problem solving ability high school students. It further revealed that students with high problem solving ability also exhibited high academic achievement than average problem solving ability students and low problem solving ability.
- ❖ Gender was reported to have a significant effect in mean achievement scores of high school students. After comparing the mean achievement scores of boys and girls with the help of t-test, significant difference was found between the achievement scores of boys and girls leading to the conclusion that female students performed higher academic achievement as compare to male students of high schools.
- ❖ No significant interaction effect of problem solving ability and gender on mean achievement scores of high school students was found.

## **EDUCATIONAL IMPLICATIONS**

In the present study, it was found that there is very much influence of problem solving ability on the academic achievement of students. Problem solving is an individualized process, which requires various strategies to tackle. The classroom teacher can develop a scientific approach to solve problems that the students are expected to face in social life. The implication of this study is that all pupils can be provided with an environment, which is suitable according to their behaviour so that their creativity may be flourished. Moreover, home & school can play important roles in developing a positive attitude for the development of creativity among students. Teacher can use pedagogical strategy for foster problem solving ability. The low level of problem solving ability is a pointer towards “learning deficiency syndrome” and needs attention of school authorities. Therefore, school authorities need to take steps to diagnose the crucial difficulty areas in basic education. For this purpose, the high school teachers are required to be trained for use of diagnostic and criterion based evaluation procedures to make teaching-learning process more effective as well as child centered to enhance level of problem solving ability.

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Teaching methodology and technique may need to be revised to increase the problem solving ability. It is the responsibility of the teachers to identify such students who have low problem solving abilities and try to modify their learning and thinking power through various audio-visual aids. Teachers must encourage students to adopt a reasonable risk-taking attitude while solving problems. Risk-taking attitude leads the students to overcome mental fixation while solving problems in skill tests, such as, reasoning skills test, problem solving ability test, personality test, and so on. The findings of the study also exhibited that demographic variable such as gender has significant effect on the academic achievement of high school students. The female students possess significantly higher academic achievement than their male counterparts did. Studies such as this one can assist with the understanding of student's problem solving ability from an empirical point of view. In brief, it has been concluded that problem solving ability of the students help them building strong cognitive ability, which should be in a better position to reap the benefits of high academic achievement, enrolled in reliable future career choice and job availability.

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