

Exploring the Influence of Gender and Problem-Solving Skills on Mathematical Achievement of Secondary School Students

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Abstract: Problem solving ability plays a central role in determining learner's success in mathematics by promoting conceptual understanding. The present study explores the influence gender and problem-solving ability on mathematical achievement of secondary school students. To achieve the objectives of the present study, a survey technique under descriptive method of research was adopted. Total sample of 1518 grade 9th school students were selected from different districts of Himachal Pradesh by employing a random sampling technique from different schools affiliated with Himachal Pradesh Board of School Education, Dharamshala. For measuring the student's problem-solving skills and Mathematics Achievement, Problem-solving ability Test and Mathematics Achievement Test were used. Statistically data was analysed by employing Analysis of variance (Two Way) for 2x3 factorial design of the study i.e. two types of gender and three level of problem solving ability (i.e. high, moderate and low). Major findings of the study revealed that gender has a significant main effect on mathematical achievement of secondary school students. Further findings identified that problem solving ability has significantly influenced the mathematical achievement of students at secondary stage. In addition to this, results also indicated that gender and problem solving ability (in combination with each other) did not significantly affect the maths achievement of secondary school students.

Keywords: Gender, Mathematical Achievement, and Problem-Solving Skills and Secondary Level.

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I. INTRODUCTION

➤ *Concept of Mathematical Achievement*

Mathematics is universally recognized as a foundational discipline that nurtures logical reasoning, analytical thinking, and quantitative competence. At the secondary school level, mathematical achievement represents a critical indicator of students' academic development and preparedness for higher education and competitive careers. Mathematical achievement refers to the degree to which students attain proficiency in mathematical knowledge, skills, concepts, and applications, as measured through standardized examinations, classroom assessments, and performance tasks. It encompasses computational accuracy, conceptual

understanding, procedural fluency, and the ability to apply mathematical concepts and principles to real-life situation or problems.

Educational theorists have long emphasized the hierarchical nature of learning outcomes. Benjamin Bloom (1956) proposed taxonomy of educational objectives highlighting the progression from knowledge and comprehension to application, analysis, synthesis, and evaluation. In mathematics education, achievement is not confined to memorizing formulas or procedures; rather, it involves higher-order thinking processes that enable students to analyze patterns, interpret data, and solve complex problems. Despite the structured curriculum and standardized

evaluation systems, disparities in mathematical achievement remain evident among secondary school students. These variations can be attributed to multiple factors, including cognitive abilities, instructional practices, motivation, self-efficacy, and particularly, students' problem-solving abilities. Among these determinants, problem-solving ability holds a central position because mathematics itself is fundamentally a problem-oriented discipline.

➤ *Problem-Solving Ability: Meaning and Theoretical Perspectives*

The capacity of an individual's to understand, assess, and address new or complex situations by applying logical reasoning and appropriate strategies as well as techniques is known as problem solving ability or aptitude. In mathematics, it involves identifying relevant information, selecting suitable methods, executing procedures accurately, and verifying solutions. Problem-solving is not merely a mechanical application of formulas but a dynamic cognitive process requiring insight, reasoning, and strategic planning.

From a cognitive perspective, problem-solving ability is closely linked with higher-order thinking skills. Jean Piaget (1970) suggested that during adolescence, individuals enter the formal operational stage characterized by abstract reasoning and hypothetical-deductive thinking. Secondary school students, therefore, are intellectually capable of engaging in complex mathematical problem-solving tasks. However, the extent to which they effectively utilize these cognitive capacities varies from person to person. Furthermore, Lev Vygotsky (1978) emphasized the social and instructional dimensions of cognitive development through the concept of the Zone of Proximal Development (ZPD). According to Vygotsky, appropriate guidance and scaffolding from teachers and peers can enhance students' problem-solving skills. According to this theoretical viewpoint, teaching strategies are vital in determining students' mathematical proficiency.

➤ *Relationship Between Problem-Solving Ability and Mathematical Achievement*

Since mathematics is fundamentally a problem-solving discipline, student's success mostly relies on their capacity to solve problems accurately and efficiently. Problem-solving ability facilitates deeper understanding of mathematical concepts, promotes retention, and enables transfer of learning to new situations. Students with strong problem-solving skills are more likely to tackle mathematical assignments/homework with confidence and persistence, which helps them to enhance their academic performance.

Empirical studies consistently indicated a significant and positive correlation between problem-solving ability and mathematical achievement. Schoenfeld (1985) emphasized that successful mathematical performance depends not only on knowledge of content but also on strategic competence and metacognitive awareness during problem-solving. Students who monitor their thinking, evaluate their strategies, and adjust their approaches tend to perform better in mathematics examinations.

Moreover, problem-solving ability enhances students' conceptual clarity. When learners actively engage in

analyzing and resolving problems, they construct meaningful connections among mathematical ideas. This aligned with constructivist perspectives, which argue that knowledge is actively constructed rather than passively received. Consequently, students who frequently practice problem-solving develop stronger analytical skills and achieve higher scores in mathematics. On the other side, limited problem-solving ability often leads to surface learning, reliance on rote memorization, and difficulty in handling non-routine questions. Secondary school examinations increasingly emphasize application-based and higher-order questions. Students lacking problem-solving competence may struggle to interpret complex word problems, leading to lower achievement levels.

➤ *Importance of Problem-solving Ability at Secondary Stage*

The secondary stage of education is a crucial transitional period during which students encounter advanced mathematical concepts such as algebra, geometry, trigonometry, and statistics. These areas demand abstract reasoning and systematic problem-solving skills. Success at this stage, significantly influences students' academic trajectories, particularly for those aspiring to pursue in STEM i.e. science, technology, engineering, and mathematics fields. Developing problem-solving ability at the secondary level not only enhances mathematical achievement but also fosters life skills such as critical thinking, decision-making, and logical reasoning. Modern educational frameworks emphasize competency-based learning, where problem-solving is regarded as a core twenty-first-century skill. Therefore, strengthening students' problem-solving capacities is essential for improving overall academic standards.

➤ *Need and Significance of the Study*

National Curriculum Framework (2005) stated that "Mathematics is a compulsory subject at secondary stage. Access to quality mathematics education is the right of every child. Mathematics encompasses problem-solving, word problems, pattern creation, figure interpretation, geometric construction, theorem proof, and so forth. It encourages children to use abstraction to establish precise relationships, to see structures and to reason out things to find the truth or falsity of statements. The main objective of secondary mathematics education is to help students acquire critical thinking, problem-solving, and fundamental skills so they may overcome obstacles and issues in their everyday lives.

Although numerous studies have reported the importance of problem-solving skills and ability in mathematics education, but variations in students' achievement level still persist. In many classrooms, emphasis remains on procedural practice rather than analytical reasoning. Consequently, pupils may perform well on daily exercises but struggle with unfamiliar or higher-order problems.

In the context of secondary school education, where board examinations and competitive assessments determine future opportunities, understanding the influence of problem-solving ability on maths' achievement becomes particularly

significant. Identifying the extent to which problem-solving ability predicts academic performance can guide teachers in designing targeted instructional strategies and interventions.

The present investigation seeks to examine the impact of problem-solving ability on mathematical achievement among secondary school students. By exploring this relationship, the findings contributed to the theoretical understanding of cognitive determinants of mathematics achievement and provide practical implications for mathematics educators. Enhancing problem-solving competence may serve as a key strategy for improving overall mathematical performance and fostering long-term academic success. The findings of the study may also contribute to policy makers, curriculum planners by highlighting the significance of problem solving-ability in deep understanding about mathematics concepts. By improving students problem- solving skills and abilities not only improved mathematics performance but also prepared the students for different competitive examinations, STEM careers , life skills as well as life-long learning that make them to self-reliant in future life.

II. REVIEW OF RELATED LITERATURE

Ahmed et al. (2021) see the relationship between problem-solving ability and mathematical achievement and found that strong a significant and positive relationship between problem-solving ability and mathematical achievement furthermore, reported that students who demonstrated higher competence in mathematical reasoning and problem-solving strategies achieved significantly better academic performance in mathematics. Study conducted by Suparman, Juandi, & Herman (2021) entitled to see the influence of students' emotional states and maths problem-solving ability on mathematical achievement among junior secondary school students. Their findings indicated that students who demonstrated stronger problem-solving abilities achieved higher levels of mathematical achievement. Putri and Miatur (2023) examined the effect of problem-solving ability on mathematical achievement of high school students. The results revealed that problem-solving ability significantly predicted the mathematical achievement and inferred that students who having strong analytical thinking and systematic problem-solving strategies achieved significantly higher scores in mathematics examinations. Abdullah & Hamoud (2025) examined the effect of mathematical puzzle-based learning on problem-solving ability and mathematical achievement of primary level students and found that students who were taught mathematics by using puzzle-based activities showed significant improvement in problem-solving skills and mathematical achievement compared with students taught using traditional instructional methods. Gomez-Talal et al. (2025) analyzed international PISA datasets to understand factors influencing mathematics achievement across countries and highlighted that students' problem-solving skills and engagement in learning activities strongly contributed to better mathematics performance. Opesemowo et al. (2025) investigated the effectiveness of after-school academic intervention program on students' mathematical achievement. They reported that regular

academic guidance, problem-solving practice, and teacher's support can effectively improve students' mathematics performance.

From the above cited past researches indicated that problem solving ability play a significant role in enhancing student's mathematical achievement.

➤ Objectives of the Study

The following objectives have been formulated for the current inquiry in light of the problem statement:

- To investigate mathematical achievement of secondary school students with regards to their gender i.e. male and female.
- To study mathematical achievement of secondary school students in relation to their level of problem solving ability i.e. high, moderate and low.
- To study joint effect of gender and problem-solving ability on mathematical achievement of secondary school students.

➤ Hypotheses of the Research

The researcher has been formulated following hypotheses for the present study given as under:

- Male and female secondary school students will not differ significantly with respect to their mathematical achievement.
- There will be no significant differences in the mathematical achievement of secondary school students with respect to different levels of problem solving ability.
- There will be no significant interactional effect of Gender and problem solving ability on mathematical achievement of secondary school students.

III. RESEARCH METHOD AND PROCEDURE

The research methods used in this study is covered in this section. It comprises the study design, research participants, sampling strategy and methodology, research tools, validity and reliability of tools, data collection process, and statistical method.

➤ Research Study Design Employed

In the present study, the investigator follows the quantitative research design. A quantitative approach seeks correlation, relationships, and causality and focuses on gathering numerical data, generalising it across groups of people, or explaining a particular phenomenon. The descriptive survey method was adopted. In descriptive research, the researcher has been studying the phenomenon of interest as it exists naturally; there is no chance to manipulate the individuals, conditions, or events.

➤ Population and Sample

The population for the present investigation included all the secondary school students studying in the IXth grade of different schools affiliated with the Himachal Pradesh Board of School Education, Dharamshala. The sample consisted of 1518 students of both genders (777 male and 741 female) and was taken from the different districts of Himachal Pradesh,

India viz; Hamirpur, Mandi, Kullu and Bilaspur. The respondent’s age group ranged from 13+ to 15 years.

➤ *Sampling Techniques*

In the present study, a multi-stage random sampling technique was employed by the researcher. In the first stage, districts have been selected by stratified random technique, i.e., two high literacy rate and two low literacy rate districts. Further, in the second stage, secondary schools have been taken purposively from the sampled districts. In the final stage, male and female secondary school students were selected from each sampled school by making use of a simple random sampling technique, i.e., the odd-even method.

➤ *Research Tools Used*

In this study the investigator used two standardised tools, viz., Mathematics Achievement Test for IXth Grade Students by Imam and Khatoon (2012) and Problem-solving Ability Test by Dubey and Mathur (2023) is used for data collection. in the present Study: The mathematics achievement test comprises 60 multiple-choice objective type items. The split-half reliability of the tool was 0.89, and test-retest reliability was 0.94. The possible minimum and maximum scores on the test are 00 and 60, respectively. The Problem-solving ability test comprises 20 multiple-choice items. Each test item has four alternative answers out of which only one is correct. The minimum and maximum possible scores ranged from 00 to 20, respectively, in this test. The reliability of the test was calculated by split-half method, and the coefficient of reliability is 0.78.

➤ *Data Gethering Procedure*

The data was collected in the months of May to December 2025. After taking the necessary permission from the Principal/Head Teacher of each sampled schools, the investigator interacted with the respondents of the study. The purpose of the study was made clear to them, and they were

assured that the information provided by them would be used for research purposes only. After this, the booklets of the mathematics achievement test and problem-solving ability test were distributed to students one by one, and all the necessary instructions were read out to them. Then students were asked to start responding to the each item of the given tests. Sufficient time was given to participants to answer all the items of the test. The complete filled-up booklets were collected, and the respondents were thanked for their cooperation.

➤ *Statistical Technique Used*

The data thus collected were analyzed with the help of (SPSS) Statistical Package for the Social Sciences Version-21. Mean (μ) and Standard Deviation (σ) were calculated to assess the levels of mathematics achievement and problem-solving ability of students. In order to find out the main and joint effect of gender and problem-solving ability on mathematical achievement of secondary school students, Two-way ANOVA (analysis of variance) having two type of gender i.e. male and female and three level of problem-solving ability i.e. high, moderate and low was employed.

IV. FINDINGS OF THE STUDY AND DISCUSSIONS

This section comprises the analysis, interpretation of the data, and discussion of the results. In order to study the independent effects of gender and problem-solving ability on mathematical achievement of secondary school students along with their interactional effects, analysis of variance i.e. ANOVA was applied on means of mathematical achievement scores.

The means of mathematical achievement of students with respect to gender and problem -solving ability are given in Table-1 and Figure-1 as under:

Table-1 Showing Weighted Means Mathematical Achievement Scores of Secondary School Students with Regards to their Gender and Problem-Solving Ability

Sr. No.	Gender		Levels of Problem-solving Ability			
			High	Moderate	Low	Total
1.	Male	Mean	35.94	27.08	19.81	27.29
		S.D.	9.88	9.73	5.85	10.51
		N	170	433	174	777
2.	Female	Mean	38.85	27.72	21.86	29.07
		S.D.	8.62	8.92	5.61	10.20
		N	186	372	183	741
3.	Total	Mean	37.46	27.37	20.86	28.21
		S.D.	9.34	9.36	5.82	10.39
		N	356	805	357	1518

Table-1 indicates the mean scores of male (27.29) and female (29.07) secondary school students on mathematical achievement. Further Table depicts that the mean scores of high problem-solving ability (37.46), moderate (i.e. 27.37) and low problem-solving ability (28.99) students with regards to their mathematical achievement.

The pictorial representation of means mathematical achievement scores of male and female students at different levels of problem-solving ability is given below in Figure-1 as under:

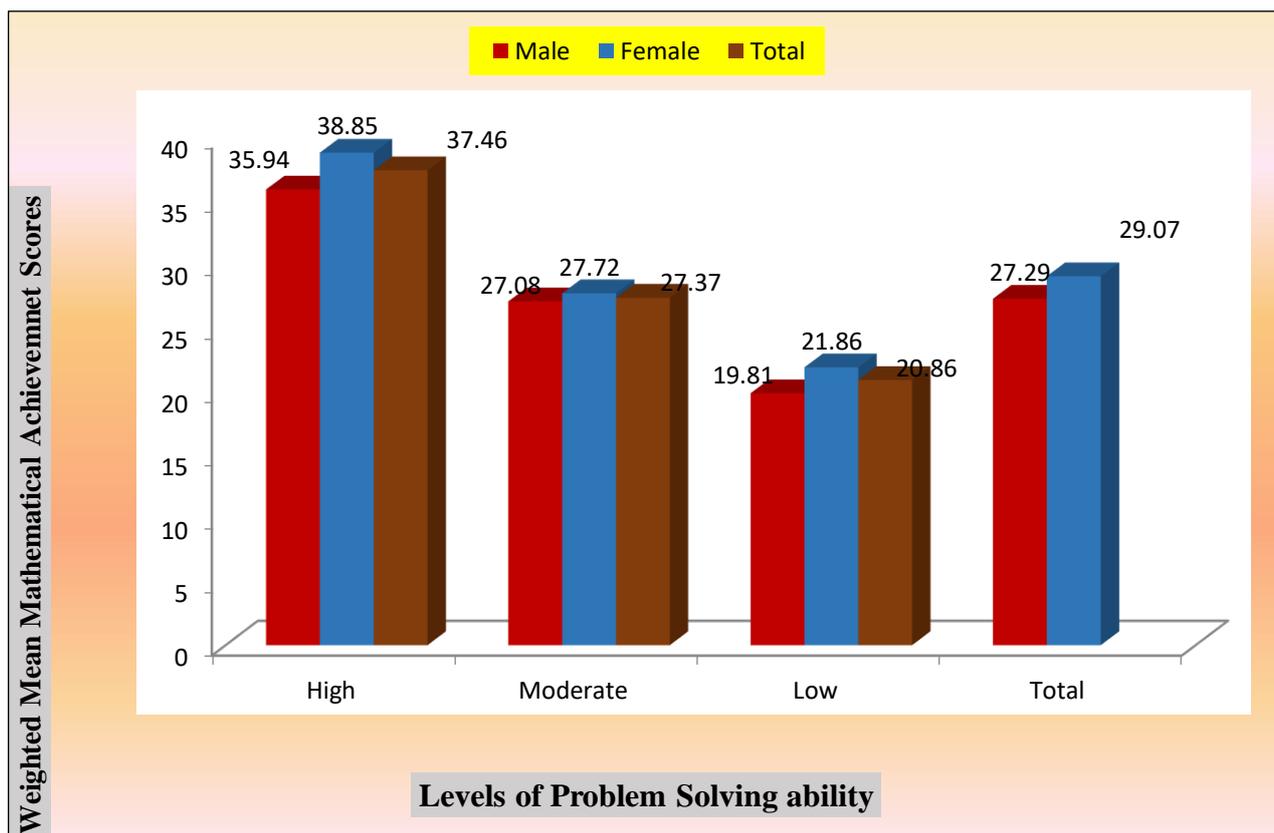


Fig.-1: Bar Diagram Indicating the Mean Scores of Male and Female Secondary School Students at Different Levels of Problem-Solving Ability with Regard to their Mathematical Achievement

From the means of mathematics achievement of students ‘F’ values were calculated. The complete summary of the results is given in Table-2 as below:

Table- 2. Results of (Two Way ANOVA) Analysis of Variance for Mathematical Achievement with Respect to Gender and Level of Problem -Solving Ability

Sr.No.	Source of Variations	Sum of Squares	df	Mean Squares of Variance	‘F’ Values
1	Gender (A)	1144.266	1	1144.266	15.397**
2	Problem solving ability(B)	49912.102	2	24956.051	335.804**
3	Interaction (AXB)	352.891	2	176.445	2.374NS
4	Error Variance	112367	1512	74.317	
5	Total	163893.964	1517		

Note: ** significant at 0.01 level of significance

NS- Not significant

Critical Table value of ‘F’ for df 1/1512=3.84 and 2/1512= 2.99 at 0.05 level of significance

Critical Table value of ‘F’ for df 1/1512=6.64 and 2/1512= 4.60 at 0.01 level of significance

➤ *Independent Effect of Gender on Mathematical Achievement of Secondary School Students*

It is evident from the Table -2 that the obtained F-value for the main effect of gender on mathematical achievement of secondary school students, irrespective of their problem-solving ability, for df 1 and 1512, came out to be 15.397, which is much higher than the table value of (6.44) at the 0.01 level of significance. Hence, the Hypothesis no. 1 that, “Male and female secondary school students will not differ significantly with respect to their mathematical achievement.” was not retained. It can be concluded that gender has a significant effect on mathematical achievement of secondary school students. It is evident from the mean

Table-1 that the total weighted mean scores for female secondary school students (29.07) are significantly higher than the male (27.39) counterparts. It may be concluded that female students significantly exhibited higher level of mathematical achievement as compare to male counterparts. This finding is substantiated by the result of Gomez-Talal et al. (2025) who also found that gender was the significant predictor of mathematical achievement.

On the other hand present finding was contradicted with the findings of Milovanović (2020), and Szczygiel (2020) who reported that there was no significant differences existed

between boy and girl students in terms of their mathematics achievement.

➤ *Main Effect of Problem-Solving Ability on Mathematical Achievement of Secondary School Students*

Further, Table-2 also indicates that the computed ‘F’ value for the main effect of problem-solving ability on mathematical achievement of students, irrespective of their gender, for *df* 2 and 1512, came out to be 335.804, which is much higher than table value (4.60) at 0.01 level of significance. Hence, the Hypothesis no. 2 that, “**There will be no significant differences in the mathematical achievement of secondary school students with respect to different levels of problem solving ability.**” was not retained. It can be inferred that problem solving ability has a significant effect on mathematical achievement of secondary school students. It is evident from the mean Table-1 that the total weighted mean scores for high, moderate and low problem solving ability secondary school students came out to be (37.46), (27.37) and (20.86) respectively. From the above analysis, it may be concluded that students having higher level of problem-solving ability possessed significantly high mathematical achievement as compared to students having moderate and low counterparts.

The present finding is substantiated by the result of Ahmed et al. (2021), Suparman, Juandi, and Herman (2021),

Putri and Miatun (2023) who also reported that problem solving ability had significantly affect the students mathematical performance. Further their studies indicated that students who demonstrated strong analytical thinking and systematic problem-solving strategies achieved higher scores in mathematics examinations.

➤ *Joint Effect of Gender and Problem-Solving Ability on Mathematical Achievement*

It can be seen from the Table-2 that the calculated value of ‘F’ for the interactional effect of gender and problem solving ability on mathematical achievement of secondary school students, for *df* 2 and 1512 came out to be 2.374 which is slightly less than table value (2.99) even at 0.05 level of significance. Hence, Hypothesis no. 8 that “**There will be no significant interactional effect of Gender and problem solving ability on mathematical achievement of secondary school students.**” was not accepted. This shows that gender and problem solving ability (in combination with each other) did not influence the mathematical achievement of secondary school students in significant manner.

Interactional effect of gender and problem-solving ability on mathematical achievement of students is represented below in Figure -2.

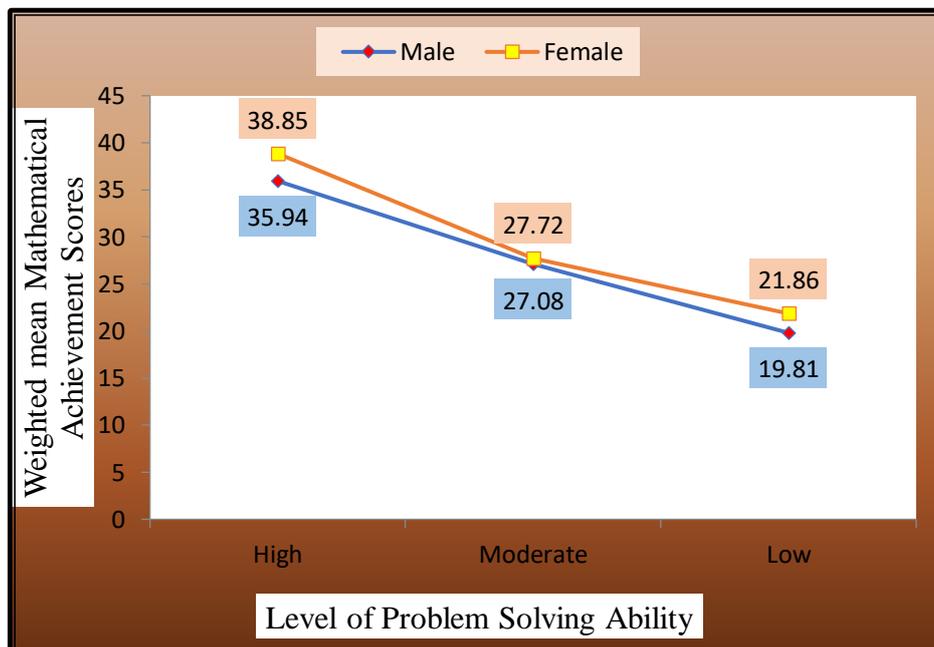


Fig 2 Joint Effect of (Gender and Problem Solving Ability) on Mathematical Achievement of Secondary School Students

The figure-2 representing that the mean scores of female and male secondary school students with high problem-solving ability level i.e. 38.85 and 35.94, followed by moderate (27.08 and 27.08 and low problem-solving ability i.e. 21.86 and 19.81 respectively. These differences are same within the limits of random variations in problem-solving ability i.e. high, moderate and low. From the above analysis it may be said that gender and problem solving ability (in combination with each other) did not affect the mathematical achievement of students in significant manner.

The present finding is supported by Hooda & Madhuri (2018), who also found no significant combined effect of gender and problem-solving ability on mathematical achievement of students at secondary level.

V. EDUCATIONAL IMPLICATIONS OF THE STUDY

The findings revealed that problem solving ability has significantly affected the mathematical achievement of secondary school students. On the basis of the findings of the present study, following educational implications are proposed by the researcher so that it may help teachers policymakers, parents as well as researchers:

- Mathematics teachers should be used appropriate teaching strategies and methods viz; inquiry-based learning, flipped classroom and puzzles based activities, collaborative learning to enhance problem-solving abilities and skills among students during their classroom practices.
- Continuous mathematics pedagogical training programme, refresher courses, symposium discussion, experts talks should be given to mathematics teachers that assist them to implement such strategies that enhance logical thinking, problem solving ability among students.
- Curriculum designers should incorporate real world related problems and project-based learning activities into the mathematics curriculum.
- Schools should be provided multiple learning resources like access to tools and technology, libraries where learner can perceive diverse perspectives and approaches of understanding mathematics concepts and solving the problems.

VI. CONCLUSIONS

Based on results and discussion, it can be concluded that problem solving-ability and gender play a significant independent as well as joint effects on mathematics achievement of students. The secondary level students need to realize their mathematics learning ability. For this, teaching approaches such as inquiry-based learning, collaborative teaching and learning, problem-solving strategies, and activity-oriented teaching have been found effective in enhancing problem-solving skills. Teachers who encourage students to explore multiple solution strategies and reflect on their reasoning contribute to improved achievement outcomes. Thus, the inclusive educational environment created by teachers inside the classroom plays a very significant role in mediating the relationship between problem-solving ability and academic success in both the.

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