

Problem-Solving Skills of Secondary School Students: A Comparative Study Based on Gender and Locality

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Abstract: Secondary school students' problem-solving skills are vital and help in increasing their critical thinking, decision making, and quality learning. The study is entitled "Problem-Solving Skills of Secondary School Students: A Comparative Study Based on Gender and Locality" study to look for any significant difference in problem-solving capacities according to the gender and place that they are going into. A descriptive survey approach was used by the study. Using stratified random and simple random sampling techniques, from Balasore district, Odisha 120 secondary school students were selected for the sample. It consisted of 60 male and 60 female pupils, 60 rural and 60 urban pupils. Data was collected with the Questionnaire on Problem-Solving Skills (QPSS), an instrument compiled by the researcher that consists of 30 questions over five dimensions: identifying a problem, analyzing the problem's situation, generating alternatives, making decisions and implementing solutions. Reliability of the tool was acceptable (Cronbach's alpha = 0.82). Data analysis was performed using mean, standard deviation, and independent samples t-test. No difference in problem-solving skills was found between male and female ($t = 0.86, p = .392$) or between rural and urban students ($t = 0.42, p = .675$). Interpretation of effect size also indicated that there were negligible differences in these two comparisons. From the result, it can be concluded that gender and locality do not have any significant effect on secondary school students' problem-solving skills. For example, it underlines the need more equitable learning experience and enhancement in learner-centered instructional practices so that better problem-solving abilities can be developed for all students. Its findings provide evidence for educational planning and policy.

Keywords: Problem-Solving Skills, Gender, Locality, Secondary School Students.

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I. INTRODUCTION

➤ Background

Twenty-first century education emphasizes not only the transfer of information for the imparting of knowledge but also ensures the development of core life skills that help students to be equipped with important life skills to help them face the challenges faced by the world. Problem-solving skills, among them, for example, are one such talent regarded as critical to success in both academic achievements and personal development. By identifying problems to identify, reasoning the problems, analysing, generating and evaluating options, generating and evaluating possible solutions, and making decisions for a problem to solve it and develop critical and creative methods to develop decision-making, critical and logical thinking. As the contemporary world gets increasingly complex, more interconnected, and a more technology and economically regulated environment, students must be

competent at adapting to the new circumstances and solving complex problems (Mayer, 1998; Jonassen, 2011). As we progress through secondary education, we begin taking students past just rote memorization and into the application of academic and social skills in more complex contexts. As a result, acquiring problem-solving skills at this level has emerged as one of the primary focuses of educational research today, resulting in improved academic achievement, decision-making skills, self-confidence and a passion for lifelong learners (Heppner & Petersen, 1982).

Academic achievement, creativity, adaptability and resilience among students based on research studies nearly related to problem-solving skills. These competencies can further be strengthened through learner-centered education models; however, variations may exist based on gender and locality. Mayer (1998) focuses on problem solving as an essential cognitive process required for effective learning.

Despite its importance, few empirical studies have focused on the problem-solving skills of secondary school students in Balasore District, Odisha, warranting additional research in this area.

➤ *Rationale*

Secondary school students require good problem-solving skills which promote critical thinking, making sound decisions, and effective handling of academic and real-life challenges. These abilities enable learners to analyze situations, evaluate alternatives, and apply suitable strategies to solve problems. According to (Mayer, 1998) problem-solving skills are considered as fundamental component of competency development and adaptation. They are considerably crucial for students who face complex academic and practical life situations (Jonassen, 2011). Despite the secondary education stage being crucial for improving these competencies, in the Balasore district of Odisha, minimal study has been conducted on the problem-solving skills of secondary school students. This gap in the literature highlights the need for a focused investigation in the local educational context. Therefore, it is relevant to assess their current level and examine differences based on gender and locality. Findings will guide improvements in both instructional approaches and learning outcomes.

II. REVIEW OF RELATED LITERATURE

Problem-solving skills are well known 21st-century skills that help secondary school students analyze situations and find solutions by using logical reasoning skills in academic as well as practical scenarios. Contemporary research treats problem-solving not simply as a distinct skill but as an integrated cognitive task that is inter-linked with critical thinking, creativity, metacognition, and self-regulated learning (Ajani, 2024; Garil & Dio, 2024). Previous studies can be systematically classified into main areas of focus that describe problem-solving skills as they emerge in school-based contexts.

➤ *Instructional Approaches and Problem-Based Learning*

A number of studies have shown how effective student-centered instructional techniques, particularly Problem-Based Learning and promoting students' problem-solving skills. In their systematic review of this research, Garil and Dio (2024) discovered that PBL enhances learners' reasoning and analytical capabilities as learners are exposed to authentic real-world problem situations. Similarly, Hanifah et al. (2024) found PBL to strengthen mathematical problem-solving skills through active participation, collaboration, and inquiry-based learning. Further supporting this hypothesis is the study of Aiyesi et al. (2025), which emphasized that the use of systematic methods for conflict resolution in an instructional setting contributes to better learning outcomes compared to lecture-based pedagogies. Meta-analytic evidence by Amao Llaulli and Vicuña Parra (2026) also finds a strong positive impact of problem-based learning on student functioning, particularly in cases when questions require reasoning beyond memorization.

➤ *Technology Integration and Digital Learning Environments*

According to recent studies, the role of technology cannot be ignored for the development of students' problem-solving skills. Dzulfikar et al. (2024) discovered ICT tools like simulations, visualization software, and interactive platforms help to improve and organize children's understanding of complex challenges. In the same way, Sihotang et al. (2025) found that digital technologies, complemented with problem-solving activities, promote students' ability to handle complex learning tasks and critical thinking.

➤ *Cognitive, Motivational, and Individual Factors*

According to Tasgin and Dilek (2023) self-efficacy is a crucial deciding factor for students' problem-solving skills and critical thinking temperament, which forms a bridge between self-efficacy and problem-solving accomplishment. Additionally, Sihotang et al. (2025) observed that overall problem-solving instructional approaches can promote students' engagement, motivation, critical thinking, and output in problem-solving. Irrespective of these advantages, Phillips et al. (2016) found that most of the secondary school students face problems while executing, planning, monitoring and evaluating in their real-life activities.

➤ *Cooperative Learning and STEM-Based Instruction*

Most of the previous studies showed that cooperative learning and collaborative learning improve problem-solving skills. A study conducted by Nanditya and Dewanti (2025) revealed that peer discussions with collective solutions can be improved by cooperative learning. Akcay Malcok and Ceylan (2020) found that real-world problem-solving and disciplines can be integrated through STEM activities. At the same time, Sari et al. (2025) revealed that inquiry-based STEM learning environments are responsible for establishing 21st-century skills (critical thinking, creativity, and problem solving). From these findings, we can conclude that interdisciplinary and active learning enhances problem-solving activities.

➤ *Traditional Instructional Challenges and Skill Gaps*

Though education gives utmost importance to problem-solving skills, still a large number of secondary school students fall behind in systematic approaches to academic problems. In addition to that, Orihuela De la Cruz (2025) states that there is a gap between curriculum goals and classroom practices, which leads to students being devoid of clear and organized strategies. Variations in different instructional approaches and varied learning environments lead to compromised student engagement, problem-solving ability, and cognitive growth.

➤ *Gender and Problem-Solving Skills*

In India, mixed results can be seen from research on gender and problem-solving skills. Several previous studies highlight that if educational opportunities are equal, then there are no major differences that exist. As we can see, Salde (2025) found no noticeable differences among senior secondary students, although slightly higher scores were reported for females. In addition to that, Kumar and Acharya (2025) concludes the corresponding outcome in Odisha. In

contradiction to that, Singh and Equbal (2023) found that gender may affect problem-solving ability. Likewise, Rather and Kushwah (2025) noticed superior problem-solving skills among males in their study. These conflicting situations highlight the need for more research across gender and problem-solving relationships.

➤ *Locality and Problem-Solving Skills*

In recent studies conducted in India, mixed results were found regarding the relationship between locality and problem-solving skills. Sharma and Bora (2024) observed no statistically noticeable variation between rural and urban secondary school students' problem-solving skills. Similarly, Pradhan (2025) reported no substantial locality differences in problem-solving capabilities related to science among secondary school students in Odisha. Kumar and Acharya (2025) also observed that factors such as school environment and family educational background exerted only a limited influence on students' problem-solving skills. These findings indicate that improved access to educational resources, common curricular frameworks, and expanding learning opportunities may have narrowed traditional gaps between rural and urban learners.

➤ *Research Gap*

Given the nature of the literature and the extensive focus on data on problem-solving skills in secondary education, most of the empirical studies focus on instructional strategies at the secondary level that include PBL, STEM, ICT integration, cooperative learning, rather than on demographic differences. While existing literature emphasizes cognitive and motivational factors that influence problem-solving (Tasgin & Dilek, 2023; Phillips et al., 2016), limited attention has been given to how gender and locality affect these skills at the secondary level. Moreover, most studies are conducted in broader or international contexts, with little region-specific evidence from districts like Balasore, Odisha. Few studies have explored these differences in the particular setting of Balasore District, Odisha. Consequently, a distinct gap in the research is identified regarding demographic differences in students' problem-solving skills, which warrants empirical study within Balasore District.

➤ *Objectives*

- To compare the problem-solving skills of secondary school students on the basis of gender.
- To compare the problem-solving skills of secondary school students on the basis of locality.

➤ *Hypotheses*

- H01: There is no significant difference between male and female secondary school students in their problem-solving skills.
- H02: There is no significant difference between rural and urban secondary school students in their problem-solving skills.

III. METHODOLOGY

The study made use of a descriptive survey method. This method was used to collect the data from a representative sample and helps in describing and analysing existing educational conditions and relationships among learning in their actual context.

➤ *Population of the Study*

The population of the study comprised all secondary school students studying in recognized secondary schools of Balasore District, Odisha.

➤ *Sample and Sampling Technique*

A total of 120 secondary school students from six secondary schools in Balasore District, Odisha, participated in the study. The sample was deemed adequate for examining group differences through the independent-samples *t*-test. Equal representation was maintained across the study variables, comprising 60 male and 60 female students, as well as 60 students each from rural and urban schools. The detailed sample breakup given below:

Table 1 Distribution of Sample by Gender and Locality

Locality	male	female	Total
Rural	30	30	60
Urban	30	30	60
Total	60	60	120

From both rural and urban areas, the schools were selected using the stratified random sampling technique. After that, by using the simple random sampling technique, the participants were selected.

➤ *Tools Used for Data Collection*

A questionnaire on the problem-solving skills scale (QPSS) was developed and validated by the researcher. The QPSS included five dimensions and 30 items in total. The said instrument was made using a five-point Likert Scale having Strongly Agree (SA), Agree (A), Undecided (UD), Disagree (D), and Strongly Disagree (SD), and those options

were assigned numerical values as 5,4,3,2,1 respectively. Higher Scores are interpreted as higher problem-solving skills. The PQSS was designed based on an extensive literature review and expert suggestions with consultation from the field of educational research.

➤ *Validity and Reliability of the Tool*

Five experts from an education and educational psychology background were consulted to establish the content validity of the researcher-made QPSS. Experts were given suggestions to improve item relevance, clarity, and adequacy. Their feedback was incorporated into the

instrument. In addition to that, a pilot study was conducted on 30 samples that were excluded from the main sample. Reliability of the instrument was tested through Cronbach's alpha. Reliability testing obtained a result of Cornbach's alpha of 0.82 with good internal consistency. By combining both content validity and reliability, the QPSS was suitable for the collection of required data. But further study shall do exploratory and confirmatory analysis to establish construct validity.

➤ *Procedure of Data collection*

Data collection took place after getting approval from the respective school authority. Participants were informed about the study's purpose and guidelines for answering the scale. The researcher asked participants to answer the QPSS honestly.

➤ *Statistical Technique is Used*

After collection, the data were systematically encapsulated, and tabulated for analysis. Relevant statistical methods were applied to test the research objectives and test the hypotheses. The following statistical measures were utilized:

- Mean
- Standard Deviation
- Independent Samples t-test
- Before applying t-tests, assumptions of normality and homogeneity of variance was tested.
- Shapiro-Wilk test confirmed that data were normally distributed ($p > .05$ for all groups).
- Levene's Test indicated homogeneity of variance ($p > .05$).
- Since assumptions were satisfied, parametric t-tests were considered appropriate.

Mean and Standard Deviation, were used to summarize the level and variability of problem-solving skills among secondary school students under descriptive statistics. Group differences based on gender and locality were examined using the Independent Samples *t*-test, which was applied under the assumption of normal data distribution.

➤ *Delimitations of the Study*

- Secondary school students studying in selected schools of Balasore District, Odisha.
- A sample of 120 students only.
- The assessment of problem-solving skills as measured by the investigator-developed questionnaire.
- Gender (male and female) and locality (rural and urban) as the demographic variables considered for comparison.

➤ *Ethical Considerations*

Ethical considerations were carefully observed throughout the study. Participation was voluntary and kept anonymous. All information obtained from the participants was treated confidentially and utilized solely for academic and research purposes.

IV. RESULTS AND ANALYSIS

Under following section problem-solving skills of secondary students' is discussed:

➤ *Gender Differences in Problem-Solving Skills*

An independent *t*-test was performed to determine whether male and female secondary school students differed significantly in their problem-solving skills.

Table 2 Gender-wise Comparison of Mean Problem-Solving Skill Scores among Secondary School students

Group	N	M	S.D	df	t-value	p-value	Remark
Male	60	120.83	12.79	118	0.86	.392	Not Significant at 0.05 level
Female	60	122.63	9.94				

To examine gender-based differences in problem-solving skills, an independent-samples *t*-test was performed. The results presented in Table 2 show that female students recorded a marginally higher mean score ($M = 122.63, SD = 9.94$) than male students ($M = 120.83, SD = 12.79$). The larger standard deviation among male students indicates greater variability in their scores. Despite the difference in

mean values, the analysis revealed that the difference was not statistically significant, $t(118) = 0.86, p = .392$. Since the obtained *p*-value exceeded the 0.05 level of significance, the null hypothesis (H_{01}) was failed to be rejected. These findings suggest that male and female secondary school students demonstrated comparable levels of problem-solving skills.

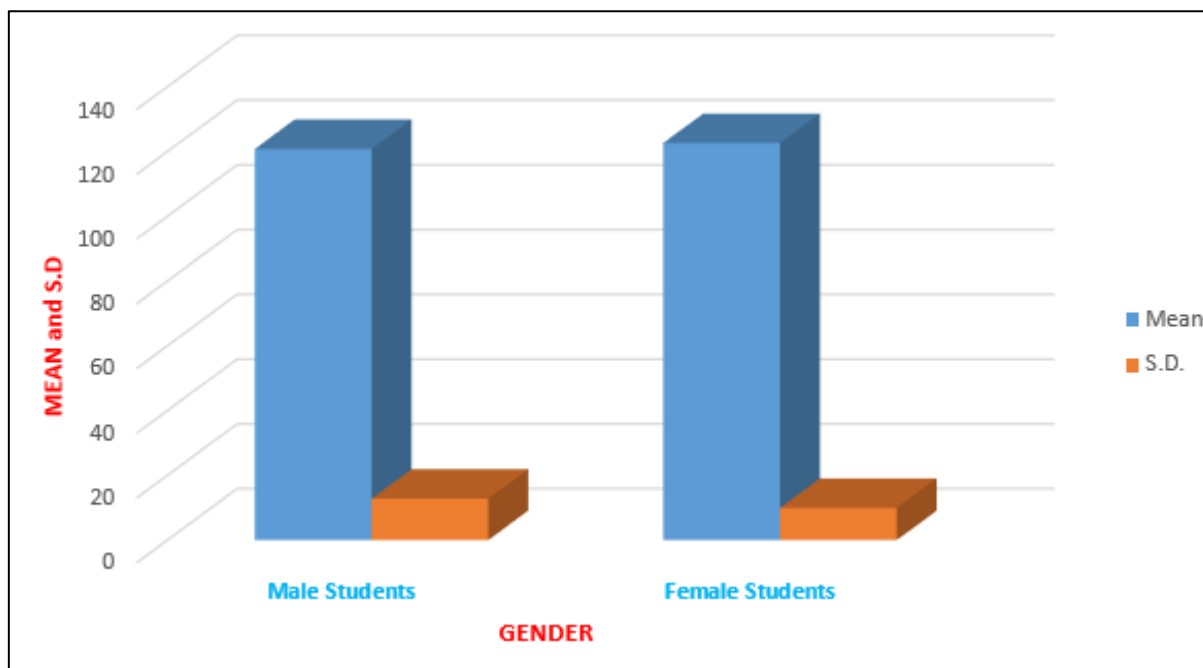


Fig 1 Mean Problem-Solving Scores of Male and Female Students

➤ *Male vs Female – Effect Size & 95% CI*

• *Given:*

- ✓ Male: $M = 120.83$, $SD = 12.79$, $n = 60$
- ✓ Female: $M = 122.63$, $SD = 9.94$, $n = 60$
- ✓ Mean difference = -1.80
- ✓ Pooled $SD \approx 11.51$

• *Cohen's d:*

$$d = \frac{M_1 - M_2}{S_p} = \frac{120.83 - 122.63}{11.51} \approx -0.16$$

• *Interpretation:*

- ✓ $d = -0.16 \rightarrow$ very small effect size
- ✓ Indicates negligible gender difference

95% Confidence Interval (Mean Difference)

Standard Error (SE) ≈ 2.07

$$CI = (M_1 - M_2) \pm t_{0.05} \times SE$$

95% CI $\approx [-5.90, 2.30]$

• *Interpretation:*

- ✓ Interval includes 0 \rightarrow no significant difference confirmed
- ✓ True difference could be slightly in either direction

Table 3 Effect Size – Gender Comparison

Group Comparison	Mean Difference	Cohen's d	95% CI (Difference)	Interpretation
Male vs Female	-1.80	-0.16	[-5.90, 2.30]	Negligible effect

The effect size (Cohen's $d = -0.16$) indicates a very small and practically negligible difference between male and female students. The 95% confidence interval includes zero, confirming that the observed difference is not statistically meaningful.

➤ *Locality Differences in Problem-Solving Skills*

An independent t -test was performed to determine whether urban and rural secondary school students differed significantly in their problem-solving skills.

Table 4 Significance of difference between urban and rural students in their mean problem-solving scores

Group	N	M	S.D	df	t-value	p-value	Remark
Urban	60	121.28	11.10	118	0.42	.675	Not Significant at 0.05 level
Rural	60	122.18	11.85				

To investigate whether locality influenced problem-solving skills, an independent-samples t -test was carried out between rural and urban secondary school students. As shown

in Table 4, rural students achieved a marginally higher mean score ($M = 122.18$, $SD = 11.85$) compared with their urban counterparts ($M = 121.28$, $SD = 11.10$). The standard

deviation values suggest that the distribution of scores was fairly similar across both groups, with slightly greater variation among rural students. However, the statistical analysis revealed that the observed difference was not significant, $t(118) = 0.42, p = .675$. Since the obtained p -value

was greater than the 0.05 level of significance, the null hypothesis (H_0) was failed to be rejected. The findings indicate that rural and urban secondary school students did not differ significantly in their problem-solving skills.

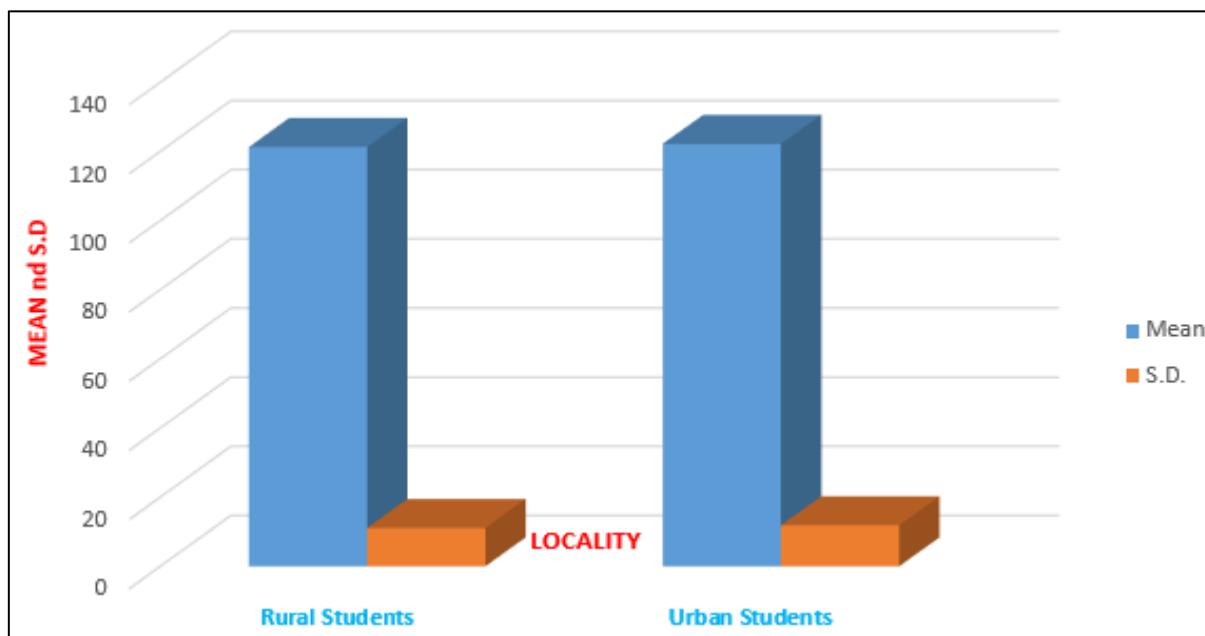


Fig 2 Mean Problem-Solving Scores of Rural and Urban Students

Rural vs Urban – Effect Size & 95% CI

• Given:

- ✓ Rural: $M = 122.18, SD = 11.85, n = 60$
- ✓ Urban: $M = 121.28, SD = 11.10, n = 60$
- ✓ Mean difference = 0.90
- ✓ Pooled SD: ≈ 11.48

• Cohen's d:

$$d = \frac{122.18 - 121.28}{11.48} \approx 0.08$$

• Interpretation:

- ✓ $d = 0.08 \rightarrow$ extremely small effect
- ✓ Practically no rural–urban difference

95% Confidence Interval (Mean Difference)

Standard Error (SE): ≈ 2.09

95% CI $\approx [-3.20, 5.00]$

• Interpretation:

- ✓ Includes zero \rightarrow non-significant
- ✓ Very narrow difference range

Table 5 Effect Size – Locality Comparison

Group Comparison	Mean Difference	Cohen's d	95% CI (Difference)	Interpretation
Rural vs Urban	0.90	0.08	[-3.20, 5.00]	Negligible effect

The effect size ($d = 0.08$) indicates an extremely small and practically negligible difference, suggesting that locality has minimal influence on problem-solving skills in the present sample.

V. DISCUSSION

➤ Interpretation of Gender Findings

The result of the study revealed that there was no statistical difference between male and female secondary school students' problem-solving skills. This suggests that gender was not a determining factor in students' ability to

solve problems within the context of the present study. A possible explanation for this result is that both male and female students are generally exposed to similar educational experiences, teaching practices, learning resources, and classroom activities. As a result, they may have comparable opportunities to develop and apply problem-solving skills. Since problem solving is largely shaped by learning experiences, practice, and the quality of instruction received, differences based solely on gender may be less evident in contemporary educational settings. Consequently, the findings indicate that the development of problem-solving

skills is influenced more by educational factors than by gender.

This finding resonates with recent literature that underscores the role of structured learning environments and learner-centered pedagogies in closing conventional gender gaps in higher-order thinking skills (Ajani, 2024). This finding agrees with the studies of Salde (2025) and Kumar and Acharya (2025) that found no significant gender differences in problem-solving ability among school students. The result contrasts with Rather and Kushwah (2025), who observed relatively higher problem-solving ability among male students. The variation in findings across studies may be explained by differences in participant characteristics, educational environments, and the assessment instruments used by researchers.

➤ *Interpretation of Locality Findings*

The result of the study revealed that there was no statistical difference between rural and urban secondary school students' problem-solving skills. This finding suggests that locality had a limited influence on problem-solving ability. The similarity in scores may be attributed to improved access to education, a common curriculum, and the wider availability of learning resources across both rural and urban settings.

Previous research identified that problem-solving abilities relied more on quality learning and good classroom management rather than on the locality of students (Garil & Dio, 2024; Sari et al., 2025). Similar results were produced by Sharma and Bora (2024) and Pradhan (2025), who identified no noticeable differences in problem-solving skills between students from rural and urban areas.

➤ *Integrated Interpretation*

Across gender and locality, problem-solving skills do not vary significantly, as reported by the findings of the study. From this, it can be concluded that factors such as gender and locality have limited influence on students' problem-solving skills. So the differences in this skill are attributed to other factors such as educational, personal, and environmental factors.

➤ *Effect Size Interpretation*

In the analysis part of this study, the effect size was calculated, and a value for gender ($d = -0.16$) and for locality ($d = 0.08$) was obtained. These values clearly show that there was a negligible effect. Confidence intervals included zero, so the differences calculated were not practically meaningful, which indicates the problem-solving abilities of secondary students were affected little by gender and locality variables.

➤ *Educational Implication of the Study*

From the study, it can be concluded that there are no significant differences in gender and locality in the problem-solving skills of students. So they have similar learning abilities, which emphasizes more equitable opportunities. Schools should integrate project-based learning and collaborative learning in instructional methods to improve

problem-solving skills. Similar strategies should be followed by the teacher training program to nourish the skills among students. Policymakers need to consider these findings and suggested strategies for teacher training to build a more equitable cognitive development and readiness for 21st-century skills.

VI. CONCLUSION

The school must promote critical thinking, reasoning, and decision-making skills within all students, as suggested by the findings of the study. The study was conducted on secondary school students of Balasore district, Odisha, and concluded that gender and locality have no or little effect on students' problem-solving skills. It can be seen from the study that rural and urban students exhibit a similar kind of problem-solving ability. These findings of the study were again supported by effect size analysis, which states that the effect size was negligible and practically not significant on students' problem-solving skills

The study shows that demographic variables have very little influence on students' problem-solving skills. So it can be inferred that other factors such as learning experiences, teaching practices, and active engagement in the classroom have a noticeable effect on students' problem-solving skills. So it can be clearly stated that if students are provided with more equitable opportunities, then they can develop a similar kind of problem-solving skills regardless of gender and locality.

From the study, it is clearly visible that learner-centered and problem-centered instructional approaches have maximal value in the development of students' higher-order thinking skills. Overall, the findings of the study contribute to the understanding of students' problem-solving skills and how to create an equitable learning environment that can support all students, irrespective of their gender and locality.

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