

The Effectiveness of the Collaborative Teaching Strategies in Improving the Problem-Solving Skills of the Grade 9 Learners in Science in Capalonga District, Division of Camarines Norte

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ABSTRACT

This article examined the effectiveness of collaborative teaching strategies in improving the problem-solving skills of Grade 9 learners in Science in Capalonga District, Division of Camarines Norte, during School Year 2024-2025. The study was situated within the continuing demand for science instruction that develops learner participation, evidence-based reasoning, and collaborative problem-solving. It focused on four instructional strategy domains: inquiry-based learning, technology and digital tools, formative assessment, and differentiated instruction. It also examined four learner outcome domains: solution accuracy, group interaction and participation, critical thinking application, and creative and innovative solution development. The article responds to the need for science classrooms that move beyond content recall and toward active knowledge construction. Contemporary science education expects learners to investigate phenomena, interpret evidence, collaborate with peers, and apply scientific ideas to real-life problems. Collaborative teaching strategies are relevant to these expectations because they allow learners to share ideas, negotiate meanings, and build solutions collectively. In this context, the study provides empirical evidence on how such strategies are utilized and how they relate to the development of problem-solving skills. The study employed a descriptive-evaluative-correlational research design. Purposive sampling was used in selecting Capalonga District as the research locale, while total enumeration was applied to include thirty-one Grade 9 Science teachers as respondents. Data were gathered through a structured questionnaire that measured both the utilization and effectiveness of collaborative teaching strategies. The data were analyzed using weighted mean, rank, Kendall's Coefficient of Concordance W, and chi-square at the 0.05 level of significance. Findings revealed that collaborative teaching strategies were much utilized in Science 9 instruction, with an overall weighted mean of 3.97. Formative assessment obtained the highest mean of 4.18, followed by inquiry-based learning with 4.09 and differentiated instruction with 4.06. The use of technology and digital tools obtained the lowest mean of 3.54, although it was still interpreted as much utilized. This pattern suggests that teachers were more confident in classroom-based assessment and inquiry routines than in more advanced forms of digital integration. The test of agreement on the rank orders of utilization showed no significant agreement across the different school categories. Kendall's W values ranged from 0.32 to 0.40, and the computed chi-square values did not exceed the tabular values at the 0.05 significance level. The null hypothesis was therefore accepted for inquiry-based learning, technology and digital tools, formative assessment, and differentiated instruction. This indicates that school categories did not demonstrate statistically uniform ranking patterns in how collaborative teaching strategies were utilized. The effectiveness of collaborative teaching strategies in improving problem-solving skills was generally rated as much effective. Group interaction and participation obtained the highest weighted mean of 4.22, followed by critical thinking application with 3.76 and improvement in solution accuracy with 3.63. Development of creative and innovative solutions obtained the lowest mean of 2.90 and was interpreted as effective. These results indicate that collaboration more strongly supported social participation and analytical thinking than independent innovation and original scientific production. The test of agreement on the rank orders of effectiveness showed mixed results. No significant agreement was found for improvement in solution accuracy, group interaction and participation, and critical thinking application. However, a significant agreement was found for development of creative and innovative solutions, with Kendall's W of 0.47 and

computed chi-square of 22.56 exceeding the critical value at the 0.05 level. This finding suggests stronger convergence among respondents in recognizing creative and innovative solution development as a differentiated and less developed outcome area. The results highlight the central role of structured collaboration in Science 9 instruction. The strong rating for group interaction suggests that collaborative strategies help learners listen actively, participate in discussions, assume roles, and develop accountability in group tasks. The favorable rating for critical thinking also suggests that collaborative learning can support deeper questioning, evaluation of perspectives, and data-based reasoning. However, the lower rating for creative and innovative solutions indicates that collaboration must be intentionally designed to move beyond discussion and toward invention, experimentation, and original output. The study implies that policy and instructional support should prioritize teacher training, digital access, formative assessment routines, and innovation-oriented science tasks. School heads, science coordinators, and curriculum supervisors may use the findings to strengthen classroom observation tools, peer mentoring, resource banks, demonstration teaching, and science club activities. The results also suggest that technology integration must be purposeful rather than merely supplementary. Digital tools should be used to support experimentation, collaborative documentation, graphing, simulation, and learner-generated scientific products. The article concludes that collaborative teaching strategies are meaningfully embedded in Science 9 instruction and are positively associated with the development of learners' problem-solving skills. The strongest gains were observed in interaction, participation, critical thinking, and solution accuracy. The weakest area was creative and innovative solution development, indicating the need for more project-based, inquiry-rich, and technology-supported learning opportunities.

1. Introduction

Science education has increasingly been shaped by the need to prepare learners for complex, uncertain, and problem-oriented environments. In contemporary societies, scientific literacy is not limited to remembering facts or naming concepts. Learners are expected to investigate situations, interpret evidence, communicate claims, and decide on solutions that are reasonable and responsible. This broader view of science learning makes problem-solving a central outcome of basic education.

International education frameworks have emphasized that students must learn how to solve problems with others. The OECD describes collaborative problem-solving as the capacity to engage effectively with others by sharing understanding, effort, knowledge, skills, and strategies to reach a solution (OECD, 2017). This definition reflects the reality that many scientific and social problems are too complex to be solved by isolated individuals. It also supports the need for classroom practices that combine cognitive work with communication, teamwork, and shared accountability.

The Philippine basic education curriculum similarly recognizes science as a learner-centered and inquiry-based field. The Department of Education science curriculum emphasizes evidence, hands-on activities, scientific attitudes, and active learner participation (Department of Education, 2016). The MATATAG science curriculum further highlights creativity, openness, critical thinking, problem-solving, and reflective thinking as important learning and innovation skills (Department of Education, 2023). These curricular directions make collaborative strategies highly relevant to Science instruction in junior high school.

Collaborative teaching strategies are grounded in the idea that learning improves when students work together toward shared academic goals. Social interdependence theory explains that cooperation becomes productive when learners recognize mutual goals, individual accountability, promotive interaction, interpersonal skills, and group processing (Johnson & Johnson, 2009). In Science classrooms, these elements are especially important because scientific tasks often require observation, hypothesis testing, evidence analysis, and explanation. Collaboration allows learners to compare ideas and refine their reasoning through interaction.

Cooperative and collaborative learning have been widely recognized as pedagogical practices that promote both socialization and academic learning. Gillies (2016) explained that cooperative learning supports thinking and learning when teachers deliberately structure interaction and guide group processes. This means that group work becomes effective not simply because learners sit together, but because the activity requires interdependence, communication, and shared responsibility. Therefore, collaboration must be planned as an instructional strategy rather than treated as an informal classroom arrangement.

Inquiry-based learning is one important expression of collaborative Science teaching. Inquiry begins with questions, problems, or phenomena that require learners to investigate and construct explanations. Meta-analytic evidence indicates that inquiry-based learning becomes more effective when it is guided by appropriate scaffolding (Lazonder & Harmsen, 2016). In Grade 9 Science, guided inquiry can help learners ask scientific questions, design investigations, interpret results, and connect concepts to real-world problems.

Problem-solving in Science is also strengthened when learners are exposed to open-ended and evidence-rich tasks. Open-ended problems encourage students to examine multiple possibilities instead of searching for one memorized answer. These tasks can promote critical thinking because learners must justify procedures, analyze evidence, and defend conclusions. When undertaken collaboratively, open-ended tasks also require learners to negotiate ideas and consider alternative interpretations.

The use of technology and digital tools has become another significant dimension of collaborative Science instruction. Educational technology can support visualization, simulation, experimentation, data representation, and collaborative documentation. Mishra and Koehler's technological pedagogical content knowledge framework stresses that effective technology integration requires the

interaction of content knowledge, pedagogy, and technology knowledge (Mishra & Koehler, 2006). This means that digital tools should not merely decorate lessons but should deepen scientific understanding and learner participation.

Despite the promise of technology, digital integration must remain evidence-based and context-sensitive. UNESCO (2023) cautions that technology in education should be evaluated in terms of relevance, equity, scalability, and sustainability. This caution is important for districts where digital resources, connectivity, and teacher readiness may vary across schools. A collaborative Science lesson using technology is therefore effective only when the tool supports a clear learning process and remains accessible to learners. Formative assessment is another major component of collaborative teaching. It allows teachers and learners to monitor understanding while learning is still taking place. Hattie and Timperley (2007) emphasized that feedback can strongly influence learning when it helps learners understand where they are going, how they are progressing, and what they need to do next. In collaborative Science classrooms, formative assessment can be delivered through quizzes, rubrics, peer assessment, self-assessment, exit tickets, and group reflections.

Feedback becomes especially important in problem-solving tasks because learners need to evaluate both the correctness of their answers and the quality of their reasoning process. Panadero and Lipnevich (2022) argued that feedback should be understood as a complex process involving content, timing, source, and learner uptake. In group activities, feedback may come from teachers, peers, rubrics, and reflective discussions. This makes formative assessment a bridge between collaborative activity and improved scientific performance.

Differentiated instruction complements collaborative learning by recognizing that students differ in readiness, interest, learning preferences, and support needs. Tomlinson (2014) described differentiation as a responsive approach to teaching that adjusts content, process, product, and learning environment according to learner diversity. In Science 9 classes, differentiated instruction may include flexible grouping, tiered tasks, scaffolded questions, hands-on activities, and multiple formats for demonstrating learning. These practices help ensure that collaboration does not benefit only the most confident learners.

The development of problem-solving skills requires both cognitive and social dimensions. The ICAP framework suggests that learning outcomes improve when learners move from passive reception to active, constructive, and interactive engagement (Chi & Wylie, 2014). Collaborative Science tasks can place learners in the interactive mode when they explain, challenge, and build on one another's ideas. This interaction can support deeper learning when it is connected to evidence and teacher-guided reflection.

However, not all forms of collaboration automatically produce higher-order learning. Group activities may become superficial when learners divide tasks mechanically, when stronger learners dominate, or when the activity lacks a meaningful problem. The Education Endowment Foundation notes that collaborative learning is distinct from unstructured group work because it requires tasks that ensure participation and collective responsibility (Education Endowment Foundation, n.d.). This distinction is important in evaluating the quality of collaborative strategies in actual Science classrooms.

In the local context of Capalonga District, Science teachers work within varied school conditions and learner needs. Differences across mega, big, medium, and small schools may influence available resources, class interaction patterns, technology access, and teacher support. These differences make it necessary to examine not only whether collaborative strategies are used, but also how consistently they are perceived across school categories. The use of Kendall's W in the study is therefore useful because it tests agreement in rank orders among respondent groups.

This article was developed to determine the effectiveness of collaborative teaching strategies in improving the problem-solving skills of Grade 9 learners in Science. Specifically, it examined the extent of utilization of inquiry-based learning, technology and digital tools, formative assessment, and differentiated instruction. It also assessed the effectiveness of these strategies in improving solution accuracy, group interaction and participation, critical thinking application, and creative and innovative solution development. The study contributes to Science education by connecting instructional practice, learner problem-solving outcomes, and evidence-based policy recommendations for junior high school instruction.

2. Methodology

The study employed a descriptive-evaluative-correlational research design to determine the utilization and effectiveness of collaborative teaching strategies in Science 9. The descriptive component was used to present the extent to which specific strategies were practiced in classrooms. The evaluative component was used to determine the perceived effectiveness of these strategies in improving problem-solving skills. The correlational and agreement-testing component was used to examine the consistency of rank orders across different groups of respondents.

The research was conducted in Capalonga District, Division of Camarines Norte, during School Year 2024-2025. The locale was selected because it provided a relevant setting for examining collaborative Science teaching across different school categories. The schools were represented in the analysis as mega, big, medium, and small schools. This categorization allowed the study to examine differences and similarities in instructional utilization and effectiveness across varied school contexts.

The respondents were thirty-one Grade 9 Science teachers in the selected district. Total enumeration was used because the population of Grade 9 Science teachers was manageable and directly relevant to the objectives of the study. The inclusion of all qualified respondents strengthened the completeness of the data within the chosen locale. It also reduced sampling exclusion and allowed the study to capture a fuller picture of teacher perceptions in the district.

Purposive sampling was used in selecting Capalonga District as the study site. This sampling approach was appropriate because the study had a specific focus on Science 9 instruction in that district and on teachers who were directly involved in the implementation of collaborative strategies. The respondents were not randomly selected from a wider provincial population. Instead, the study deliberately focused on the group most capable of providing data on the instructional practices under investigation.

Data were gathered using a structured questionnaire. The instrument measured the extent of utilization of collaborative teaching strategies along inquiry-based learning, use of technology and digital tools, formative assessment, and differentiated instruction. It also measured the effectiveness of collaborative teaching strategies in improving problem-solving skills along improvement in

solution accuracy, group interaction and participation, critical thinking application, and development of creative and innovative solutions. The items were organized using a weighted response format that allowed the computation of domain means and ranks. The questionnaire data were encoded, tallied, tabulated, and analyzed using descriptive and non-parametric statistical tools. Weighted mean was used to determine the level of utilization and effectiveness for each indicator and domain. Rank was used to determine the relative position of each indicator and domain based on the computed weighted mean. These tools were appropriate because the study intended to summarize teacher ratings and determine dominant patterns in instructional practice and perceived learner outcomes.

Kendall's Coefficient of Concordance W was used to test the agreement on the rank orders among the different school categories. The corresponding chi-square statistic was computed to determine whether the observed agreement was statistically significant. The level of significance was set at 0.05. The null hypothesis was accepted when the computed chi-square value did not exceed the tabular value, and it was rejected when the computed value exceeded the tabular value.

The interpretation of weighted means followed the scale provided in the study. For utilization, weighted means from 4.50 to 5.00 were interpreted as Very Much Utilized, 3.50 to 4.49 as Much Utilized, 2.50 to 3.49 as Utilized, 1.50 to 2.49 as Fairly Utilized, and 1.00 to 1.49 as Not at All. For effectiveness, weighted means from 4.50 to 5.00 were interpreted as Very Much Effective, 3.50 to 4.49 as Much Effective, 2.50 to 3.49 as Effective, 1.50 to 2.49 as Fairly Effective, and 1.00 to 1.49 as Not at All. These scales were used consistently in interpreting the results.

The analysis was organized around the research questions of the study. First, the extent of utilization of collaborative teaching strategies was presented by domain and school category. Second, the agreement on the rank orders of utilization was tested using Kendall's W and chi-square. Third, the effectiveness of collaborative teaching strategies in improving problem-solving skills was presented by outcome domain. Finally, the agreement on the rank orders of effectiveness was tested, and policy recommendations were formulated from the empirical findings.

3. Results and Discussions

This section presents the findings on the utilization and effectiveness of collaborative teaching strategies in Science 9. The results are organized according to the study objectives and are presented through summary tables, indicator-level evidence, and tests of agreement. Each table is followed by analytical discussion to clarify the meaning of the computed values and their implications for Science instruction. The interpretation focuses on how the findings support instructional improvement, learner problem-solving development, and policy formulation.

Table 1. Summary of the Extent of Utilization of Collaborative Teaching Strategies in Science 9

Strategy Domain	Mega	Big	Medium	Small	Overall WM	Interpretation	Rank
Formative Assessment	5.00	3.54	3.82	4.37	4.18	Much Utilized	1
Inquiry-Based Learning	4.32	3.67	3.95	4.43	4.09	Much Utilized	2
Differentiated Instruction	4.59	3.54	4.16	3.94	4.06	Much Utilized	3
Use of Technology and Digital Tools	3.84	2.73	3.87	3.72	3.54	Much Utilized	4
Overall	4.44	3.37	3.95	4.12	3.97	Much Utilized	-

Table 1 shows that collaborative teaching strategies were generally much utilized in Science 9, with an overall mean of 3.97. This result indicates that Grade 9 Science teachers regularly employed collaborative approaches in classroom instruction. The strongest area was formative assessment, which obtained a weighted mean of 4.18. This suggests that teachers frequently used assessment and feedback practices to monitor learners' progress during collaborative learning.

Inquiry-based learning ranked second with a mean of 4.09, showing that teachers commonly used questioning, guided investigation, scientific exploration, and open-ended problem-solving tasks. This is important because inquiry allows learners to experience Science as a process of investigation rather than only as a body of information. Differentiated instruction followed closely with a mean of 4.06. The proximity of these values indicates that inquiry and differentiation were both embedded in Science 9 teaching practices.

The use of technology and digital tools obtained the lowest mean of 3.54, although it remained within the much utilized range. This means that digital tools were present in instruction but were less consistently utilized than formative assessment, inquiry-based learning, and differentiated instruction. The lower score may reflect resource limitations, varying teacher readiness, or uneven access to advanced digital applications. This result supports the need for targeted professional development and resource support for technology-enhanced Science learning.

The overall findings suggest that collaborative teaching in the district was more strongly rooted in assessment, inquiry, and flexible classroom methods than in technology-intensive practices. This pattern is understandable because quizzes, rubrics, discussions, and hands-on activities are more accessible than virtual labs, augmented reality, or graphing software. However, Science problem-solving increasingly requires learners to handle data, visualize concepts, and communicate findings using digital tools. Therefore, technology integration should be strengthened while maintaining the already strong use of formative assessment and inquiry-based learning.

Table 2. Test of Significant Agreement on Rank Orders of Utilization

Strategy Domain	Indicators	Kendall W	Chi-square	df	Critical Value .05	Decision	Agreement
Inquiry-Based Learning	11	0.32	12.80	10	18.31	Accepted	Not significant

Strategy Domain	Indicators	Kendall W	Chi-square	df	Critical Value .05	Decision	Agreement
Use of Technology and Digital Tools	11	0.40	16.00	10	18.31	Accepted	Not significant
Formative Assessment	10	0.40	14.27	9	16.92	Accepted	Not significant
Differentiated Instruction	11	0.33	13.20	10	18.31	Accepted	Not significant

Table 2 presents the Kendall W and chi-square results for agreement on the rank orders of utilization across school categories. All four instructional domains produced computed chi-square values that were lower than their corresponding tabular values at the 0.05 level. The null hypothesis was therefore accepted for inquiry-based learning, use of technology and digital tools, formative assessment, and differentiated instruction. This means that the rank order agreement among the school categories was not statistically significant.

The absence of significant agreement suggests that school categories did not rank the indicators in a uniform way. Mega, big, medium, and small schools may have different classroom conditions, resources, teacher experiences, or learner characteristics. These contextual differences can affect how specific collaborative strategies are prioritized and implemented. For example, technology-based strategies may depend more strongly on available equipment and connectivity than formative assessment practices.

The Kendall W values ranged from 0.32 to 0.40, which indicates only modest levels of concordance. This finding does not mean that collaborative strategies were absent; rather, it means that the order of emphasis varied among school categories. Such variation is common in field-based educational settings because schools implement strategies according to local realities. It also shows why district-wide interventions should avoid a one-size-fits-all approach.

From an instructional leadership perspective, the result points to the need for harmonized standards and contextualized support. Schools may benefit from shared lesson exemplars, peer demonstration teaching, common rubrics, and collaborative planning sessions. These mechanisms can help create stronger alignment across school categories without removing flexibility. Consistency in purpose, rather than uniformity in method, should guide the improvement of collaborative Science instruction.

Table 3. Salient Utilization Indicators by Strategy Domain

Domain	Highest-Rated Indicators	Lowest-Rated Indicators	Overall WM	Interpretation
Inquiry-Based Learning	Open-ended tasks (4.32); guided inquiry (4.31).	Experiments (3.76); hypothesis testing (3.84).	4.09	Much Utilized
Use of Technology and Digital Tools	Multimedia (4.31); digital platforms (3.95).	Graphing (2.94); flipped class (2.99).	3.54	Much Utilized
Formative Assessment	Quizzes (4.55); rubrics (4.54).	Exit tickets (3.48); group reflections (3.95).	4.18	Much Utilized
Differentiated Instruction	Hands-on tasks (4.40); modified lessons (4.31).	Extension tasks (3.83); differentiated questioning (3.86).	4.06	Much Utilized

Table 3 identifies the most and least utilized indicators within each instructional domain. In inquiry-based learning, open-ended problem-solving tasks and guided inquiry obtained the highest ratings. These findings suggest that teachers gave learners opportunities to think through problems and receive scaffolding while learning. However, hands-on experiments and hypothesis formulation obtained lower relative scores, showing that practical investigation can still be intensified.

In technology and digital tools, multimedia resources and digital platforms were the most utilized practices. This indicates that teachers were more comfortable using technology for content reinforcement and access to online learning materials. However, graphing software, flipped classroom strategies, virtual labs, collaborative online tools, and AR/VR applications were weaker areas. The pattern suggests that digital technology was used more for presentation and support than for data analysis, experimentation, and collaborative production.

In formative assessment, quizzes, knowledge checks, rubrics, diagnostic tests, and feedback were strongly practiced. This result shows that teachers used assessment to clarify expectations and track learning progress. The weaker use of exit tickets and group reflections implies that quick end-of-lesson checks and metacognitive processing may not yet be fully institutionalized. Strengthening these practices can help learners become more reflective and responsible in collaborative tasks.

In differentiated instruction, hands-on activities, modified lessons, and flexible grouping emerged as strong indicators. These practices suggest that teachers attempted to respond to different learning preferences and readiness levels. However, extension tasks for advanced learners and differentiated questioning obtained lower relative scores. This indicates that differentiation should address not only struggling learners but also learners who need enrichment and higher-level challenges.

Table 4. Summary of the Effectiveness of Collaborative Teaching Strategies in Improving Problem-Solving Skills

Problem-Solving Outcome Domain	Weighted Mean	Interpretation	Rank
Group Interaction and Participation	4.22	Much Effective	1
Critical Thinking Application	3.76	Much Effective	2
Improvement in Solution Accuracy	3.63	Much Effective	3
Development of Creative and Innovative Solutions	2.90	Effective	4
Overall	3.63	Much Effective	-

Table 4 shows that collaborative teaching strategies were generally much effective in improving the problem-solving skills of Grade 9 learners. The overall mean was 3.63, which indicates favorable teacher perceptions of learner outcomes. The highest-rated domain was group interaction and participation, with a mean of 4.22. This confirms that collaborative strategies were especially strong in improving learner engagement, teamwork, listening, contribution, and shared accountability.

Critical thinking application ranked second with a mean of 3.76. This suggests that collaborative activities helped learners analyze problems, evaluate perspectives, recognize patterns, and reason through scientific questions. Improvement in solution accuracy followed with a mean of 3.63, showing that learners improved in measurement, scientific method, data interpretation, and logical reasoning. These results indicate that collaboration supported both social and cognitive dimensions of problem-solving.

The development of creative and innovative solutions obtained the lowest mean of 2.90 and was interpreted as effective. This finding suggests that while learners were able to participate and think critically, they were less frequently observed to generate original experiments, prototypes, or novel solutions. Creativity requires more than discussion; it requires time, materials, challenge, experimentation, and permission to explore alternatives. Thus, innovation-oriented learning needs more deliberate instructional design.

The ranking of outcomes shows a developmental pattern in learner problem-solving. Collaboration first strengthens participation and interaction, then supports reasoning and accuracy, and later may contribute to creativity if tasks are designed for innovation. The current results suggest that the district has already built a foundation for teamwork and critical thinking. The next instructional priority should be the transformation of collaborative activity into creative scientific production.

Table 5. Salient Effectiveness Indicators by Problem-Solving Outcome Domain

Outcome Domain	Highest-Rated Indicators	Lowest-Rated Indicators	Overall WM	Interpretation
Improvement in Solution Accuracy	Measurement/data precision (3.85); method accuracy (3.81).	Reducing misconceptions (3.38); correct formula use (3.41).	3.63	Much Effective
Group Interaction and Participation	Teamwork attitude (4.39); active listening (4.37).	Peer teaching (3.76); group confidence (4.07).	4.22	Much Effective
Critical Thinking Application	Deep questions (4.19); perspective evaluation (4.05).	Data patterns/trends (3.54); challenging assumptions (3.60).	3.76	Much Effective
Development of Creative and Innovative Solutions	Creative everyday use (3.17); outside-the-box inquiry (3.10).	Independent experiments (2.52); original solutions (2.67).	2.90	Effective

Table 5 provides more detailed evidence on the strongest and weakest indicators of problem-solving improvement. In solution accuracy, the highest indicators were improved precision in measurement and data collection and the ability to follow scientific methods accurately. These results suggest that collaborative strategies helped learners become more careful and systematic in scientific work. However, the lower scores for reducing misconceptions and applying scientific formulas show that conceptual accuracy still requires further attention.

In group interaction and participation, the strongest indicators were positive attitude toward teamwork, active listening, contribution to group discussions, and improved problem-solving efficiency. These outcomes reflect the social benefits of structured collaboration. They show that learners did not only work side by side but also engaged with one another's ideas. The relatively lower score for peer teaching and mentoring suggests that stronger learners may need guidance on how to support peers productively.

In critical thinking application, classroom questions that encouraged deeper thinking obtained the highest rating. Learners were also perceived to evaluate different perspectives before reaching conclusions. These results show the importance of teacher questioning in shaping the quality of collaborative reasoning. The lower score for recognizing patterns and trends in data indicates a need to strengthen data literacy in Science activities.

In creative and innovative solutions, everyday application of scientific principles and thinking outside the box were relatively stronger than other indicators. However, creating experiments beyond classroom activities and proposing original scientific solutions were weaker. This suggests that learners may be applying concepts creatively in familiar contexts but are less ready to design independent scientific products. More project-based and design-based Science tasks are needed to address this gap.

Table 6. Test of Significant Agreement on Rank Orders of Effectiveness

Outcome Domain	Indicators	Kendall W	Chi-square	df	Critical Value .05	Decision	Agreement
Improvement in Solution Accuracy	11	0.37	14.80	10	18.31	Accepted	Not significant
Group Interaction and Participation	10	0.23	8.28	9	16.92	Accepted	Not significant
Critical Thinking Application	11	0.367	14.80	10	18.31	Accepted	Not significant
Development of Creative and Innovative Solutions	13	0.47	22.56	12	21.03	Rejected	Significant at 0.05

Table 6 shows the test of agreement on the rank orders of effectiveness. The null hypothesis was accepted for solution accuracy, group interaction and participation, and critical thinking application. This means that no significant agreement existed among school

categories in ranking these three outcome areas. The variation suggests that schools may observe different learner gains depending on their instructional practices and classroom conditions.

The development of creative and innovative solutions was the only area where the null hypothesis was rejected. Its Kendall W of 0.47 and chi-square value of 22.56 indicated significant agreement at the 0.05 level. This result means that respondents showed stronger convergence in recognizing this domain as a distinct effectiveness area. Given its lower mean, the agreement may reflect a shared perception that innovation remains a common challenge across schools.

This finding is important because creativity and innovation are often more difficult to develop than participation or routine accuracy. Learners can join discussions and complete guided tasks, but original scientific solution-making requires deeper autonomy, resourcefulness, and experimentation. A significant agreement in this area suggests that the district can treat innovation development as a priority for collective improvement. It also justifies the formulation of targeted policies for project-based Science learning.

The mixed agreement results show that effectiveness is not uniform across all problem-solving dimensions. Some domains may be strongly influenced by teacher style, resource availability, class size, and learner readiness. District leaders can use these findings to identify where schools need shared standards and where they need differentiated support. Innovation-oriented Science learning appears to require both district-level policy direction and school-level instructional creativity.

Table 7. Evidence-Based Policy Directions Derived from the Findings

Area	Evidence from Results	Policy or Instructional Direction
Inquiry-based learning	Much utilized, but hands-on experimentation and hypothesis testing obtained lower relative scores.	Conduct regular training on inquiry-based Science 9 strategies; design real-life scientific investigations that require evidence, collaboration, and analysis.
Technology and digital tools	Lowest utilization domain, with limited use of graphing tools, flipped content, online collaboration platforms, virtual labs, and AR/VR tools.	Provide grants or resource support for science technology tools; train teachers in TPACK-aligned use of educational technology for interactive science learning.
Formative assessment	Highest utilization domain, led by quizzes, rubrics, diagnostic tests, feedback, and instructional adjustment.	Institutionalize weekly formative assessment routines aligned with collaborative problem-solving and use assessment results for remediation and enrichment.
Differentiated instruction	Much utilized across indicators, but extension tasks and differentiated questioning require strengthening.	Promote seminars, demonstration teaching, and coaching on differentiated collaborative learning for diverse readiness levels.
Problem-solving outcomes	Group interaction and critical thinking were stronger than creative and innovative solution generation.	Integrate group tasks that require prototypes, sustainable solutions, science clubs, innovation projects, peer assessment, and recognition of collaborative problem-solving outputs.
Monitoring and sustainability	Kendall W results show consistent but not always statistically aligned rank orders across school categories.	Use classroom observation criteria, resource banks, quarterly instructional-material review, mentoring, and monitoring tools focused on participation, accuracy, critical thinking, and innovation.

Table 7 translates the empirical findings into evidence-based policy directions. The findings support regular training on inquiry-based learning, especially in hands-on experimentation and hypothesis testing. Although inquiry-based learning was much utilized, some practical investigation indicators obtained lower relative scores. This means that training should move beyond theory and focus on designing classroom investigations that learners can actually perform.

The table also highlights the need to strengthen technology and digital tools. Technology was the lowest utilization domain, and advanced digital practices were less evident than basic multimedia use. Policy support should therefore include access to tools, teacher training, and localized resource banks. Digital integration should focus on science-specific tasks such as graphing, simulation, collaborative documentation, and presentation of research findings.

Formative assessment and differentiated instruction should be sustained because both were much utilized. However, their improvement should focus on deeper learner reflection, exit tickets, peer assessment, enrichment tasks, and differentiated questioning. These practices can help teachers respond to learning gaps while also challenging advanced learners. They can also make group work more accountable and more connected to problem-solving outcomes.

Finally, policy recommendations should directly address the weakest problem-solving outcome: creative and innovative solution development. Schools may establish science clubs, project-based innovation tasks, peer-sharing sessions, and recognition mechanisms for collaborative scientific solutions. Monitoring tools should include indicators for participation, accuracy, critical thinking, and creativity. This will help ensure that collaborative teaching produces not only active learners but also learners who can design original and useful solutions.

4. Conclusions and Implications

4.1 Conclusions

The study concludes that collaborative teaching strategies were substantially integrated into Science 9 instruction in Capalonga District. The overall utilization mean of 3.97 indicates that these strategies were much utilized by Grade 9 Science teachers. This means that collaborative approaches were not isolated classroom practices but recurring parts of instruction. Formative assessment,

inquiry-based learning, differentiated instruction, and technology-supported teaching were all present in the instructional environment.

Formative assessment emerged as the most utilized collaborative teaching strategy. This indicates that teachers strongly relied on quizzes, rubrics, diagnostic tests, immediate feedback, and instructional adjustment to support learning. Such practices are important because they make learner progress visible and allow teachers to respond before misconceptions become fixed. In collaborative settings, formative assessment also helps clarify expectations and strengthen accountability.

Inquiry-based learning and differentiated instruction were also much utilized. Their high ratings suggest that Science teachers supported learner questioning, guided inquiry, real-life exploration, hands-on learning, flexible grouping, and scaffolding. These practices are aligned with the goals of Science education because they encourage learners to investigate, reason, and participate. However, lower relative scores in experiments, hypothesis testing, enrichment, and differentiated questioning show that these areas still need improvement.

The use of technology and digital tools was the least utilized among the four instructional domains, although it remained much utilized overall. This suggests that teachers used digital resources, multimedia, and online platforms but had less consistent use of advanced tools such as graphing software, virtual labs, collaborative digital platforms, AR/VR tools, and flipped classroom resources. The conclusion is not that technology was absent, but that its deeper science-specific use was limited. This area requires systematic support.

The rank-order tests for utilization showed no significant agreement across school categories. This means that the way collaborative strategies were prioritized varied among mega, big, medium, and small schools. The absence of significant agreement points to contextual differences in implementation. Therefore, instructional improvement should combine district-wide standards with school-sensitive interventions.

The collaborative teaching strategies were generally much effective in improving Grade 9 learners' problem-solving skills in Science. The strongest area was group interaction and participation, followed by critical thinking application and solution accuracy. These findings show that collaboration was especially effective in strengthening the social and analytical aspects of learning. Learners were perceived to participate more actively, listen to peers, evaluate ideas, and improve scientific procedures.

Creative and innovative solution development was the weakest problem-solving outcome. Although it was interpreted as effective, its mean was lower than the other domains. This indicates that learners were less frequently observed to design original experiments, propose novel scientific solutions, or create innovative outputs beyond regular classroom activities. Therefore, collaborative strategies need to be strengthened through project-based, design-based, and innovation-oriented Science tasks.

The agreement test for effectiveness revealed that the development of creative and innovative solutions was the only area with significant agreement across school categories. This suggests that respondents consistently recognized innovation as a distinct and common concern. The result supports the formulation of policy recommendations focused on inquiry training, digital tools, formative assessment, differentiated instruction, innovation projects, peer assessment, and instructional monitoring. Overall, the study concludes that collaborative teaching is a useful instructional pathway for improving problem-solving skills, but it must be deepened to produce more creative scientific outcomes.

4.2 Implications

The findings imply that school heads should sustain collaborative teaching as a major instructional approach in Science 9. Since the strategies were much utilized and much effective, they should be included in instructional supervision, professional development, and classroom observation priorities. School leaders may use the results to guide coaching conversations with teachers. The emphasis should be on improving the quality of collaboration rather than merely increasing the frequency of group activities.

For Science teachers, the study implies the need to design collaborative tasks that require evidence, reasoning, and shared responsibility. Group work should not be limited to discussion or reporting. It should require learners to investigate, test, interpret, justify, revise, and present solutions. Teachers should provide clear roles, rubrics, feedback, and reflection activities so that collaboration becomes academically productive.

For curriculum supervisors and coordinators, the findings imply the need to align Science learning tasks with collaborative problem-solving competencies. Lesson exemplars should include guided inquiry, formative checks, differentiated tasks, and technology-supported investigation. Curriculum monitoring should look at both instructional processes and learner outputs. This can help ensure that the curriculum develops accuracy, participation, critical thinking, and creativity together.

For technology integration, the findings imply that access and training must be improved. Teachers need support in using graphing tools, simulations, virtual laboratories, online collaborative platforms, and learner-generated digital outputs. Technology should be connected to scientific inquiry and not used only for presentations. This implication is especially important because technology and digital tools obtained the lowest utilization rating.

For assessment practice, the strong use of formative assessment implies a valuable foundation for instructional improvement. However, schools should further institutionalize exit tickets, group reflections, peer assessment, and self-assessment. These tools can help learners examine their own problem-solving processes and improve their group contributions. They also support learner autonomy and accountability in collaborative settings.

For differentiated instruction, the results imply that teachers should balance remediation and enrichment. While scaffolding and modified lessons support struggling learners, advanced learners also need extension tasks, complex questions, and opportunities for independent inquiry. Differentiation should therefore address the full range of learner readiness. This will make collaboration more inclusive and more challenging for all learners.

For policy development, the findings imply that innovation should be treated as a deliberate outcome of Science instruction. The lower rating for creative and innovative solutions suggests that schools should provide structured opportunities for prototypes, eco-friendly solutions, science fairs, classroom investigations, and problem-based projects. Recognition systems may also motivate

teachers and learners to produce original scientific outputs. Policy should make creativity visible in planning, assessment, and monitoring.

For future research, the findings imply the need to examine learner-level evidence of problem-solving performance. Future studies may include direct assessment of student outputs, classroom observation, interviews, and comparative designs across districts or grade levels. Researchers may also explore how technology access, teacher readiness, class size, and school category affect collaborative Science instruction. These directions can deepen understanding of how collaborative teaching produces measurable gains in scientific problem-solving.

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