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Social Belongingness and Group Dynamics in Fostering Learning Engagement and Scientific Investigative Performance among Grade 10 Students

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ABSTRACT

Science education equips students with the knowledge and skills necessary for life inside and outside the classroom. Research highlights that students' ability to construct ideas and rules based on observations is critical to effective science learning. Elkina and Planinsic (2024) emphasize the importance of allowing students to explore multiple explanations for experiments, using their prior knowledge and reasoning skills freely without waiting for external validation. Soares et al. (2023) also note that the transition from everyday intuitive thinking to structured scientific reasoning remains a challenge for many students.

This study investigated the impact of social belongingness and group dynamics on students' learning engagement and scientific investigative skills in science education. A sequential exploratory mixed-methods design was used, incorporating qualitative and quantitative approaches for a comprehensive analysis. The qualitative phase involved in-depth interviews with three science teachers, while the quantitative phase utilized survey questionnaires administered to 161 Grade 10 students from Plaridel National High School. Purposive sampling was employed (Singh & Masuku, 2014), and data were gathered using performance assessments, rubrics, interviews, and surveys. Statistical analyses, including mean, standard deviation, frequency, percentage, and Pearson's correlation coefficient, were used to determine relationships between variables.

Results revealed that students with a strong sense of belonging and positive group dynamics exhibited higher engagement levels and stronger scientific investigative skills. Teacher assessments reinforced the importance of collaborative learning in improving student performance and motivation. The study emphasizes the importance of creating inclusive and interactive learning environments that promote engagement in science. The findings suggest that educators should implement strategies to promote peer collaboration, teacher support, and structured activities, ensuring that students feel valued and connected in their learning environments. These insights contribute to science education research, providing practical recommendations for enhancing teaching methodologies and ultimately bridging the gap between student engagement and meaningful learning experiences.

Keywords: *Belongingness, Group Dynamics, Peer Collaboration, Scientific Investigative Performance*

Introduction

Science education equips students with the knowledge and skills necessary for life in the classroom. It extended beyond memorizing facts and formulas, encouraging inquiry, critical thinking, and collaborative learning (Abragan et al., 2022). However, ensuring that students remained actively engaged in science learning had been a persistent global challenge.

Research highlighted that students' ability to construct ideas and rules based on observations was critical to effective science learning. Elkina and Planinsic (2024) emphasized the importance of allowing students to explore multiple explanations for experiments, treating all ideas equally until they are tested and verified. This approach encouraged students to use their prior knowledge and reasoning skills freely, without waiting for external validation. Through hypothesizing, testing, and revising their explanations, students engaged in cycles of inquiry and reflection, deepening their understanding of scientific concepts.

A persistent challenge in science education has been the gap between intuitive everyday thinking and structured scientific reasoning. Personal experiences shaped everyday thinking, while scientific reasoning demanded evidence-based approaches (Soares et al., 2023). This shift had been difficult for students to master, hindering their transition into the scientific mindset.

Research suggested that enhancing student engagement requires more than just delivering content effectively. Social factors such as a sense of belonging and positive peer interactions significantly influenced motivation and participation (Perez et al., 2022). A strong sense of belonging encouraged

participation and motivated students to ask questions, engage in discussions, and contribute to group work. Conversely, students who felt isolated were less likely to participate meaningfully, limiting their academic progress.

Positive group dynamics also played a critical role in fostering effective learning. Students who collaborated well, respected each other's ideas, and shared responsibilities developed essential teamwork skills necessary for scientific inquiry. However, poor group interactions discouraged participation and limited opportunities to explore and understand scientific concepts (Gonzales & Reyes, 2021; Forsyth, 2018).

In the Philippines, these challenges were compounded by several systemic issues. Many public schools faced shortages of laboratory facilities and outdated resources, particularly in rural areas, which limited students' access to hands-on scientific experiments (Delos Reyes et al., 2020). Practical learning opportunities have been crucial for developing students' analytical and problem-solving skills. However, due to resource limitations, teachers often relied on outdated textbooks or digital simulations, which could not fully replicate the experience of real-life experimentation (Torres & Domingo, 2022). Addressing these resource gaps has been essential to ensuring equitable learning opportunities and improving science education outcomes (Ramos et al., 2023).

Balla (2024) highlighted additional challenges, including a shortage of qualified science teachers, overcrowded classrooms, and insufficient time allocated for science education. Students also faced personal difficulties such as family problems, poverty, and bullying, all of which affected their motivation and self-confidence in learning science. With the shift towards Education 4.0, digital literacy has become a crucial component of science education; however, many students lack the necessary skills and access to technology. These factors further widened the gap in learning outcomes.

This study investigated the impact of social factors, including belongingness, peer relationships, and group dynamics, on student engagement and learning outcomes in science classrooms. While effective curriculum design was essential, understanding how students interacted socially within their learning environment was equally important for improving engagement.

By examining these dynamics, this research aimed to provide insights that could help educators foster more inclusive and collaborative science classrooms. When students felt supported by their peers and were motivated to participate, their engagement improved, resulting in better academic performance and a deeper interest in science.

Addressing these social factors, alongside improving access to resources, has been critical to bridging the gap between teaching practices and meaningful student engagement. Ultimately, creating positive learning environments where students feel valued and connected could lead to more effective science education outcomes.

Research Method

The researcher employed a quantitative design, specifically a descriptive research design. Descriptive studies are used to describe the characteristics of a population and examine variations in characteristics and practices (Siedlecki, 2019). A structured survey questionnaire was administered to 138 Grade 10 students. The questionnaire assessed various aspects, such as students' sense of belonging, group dynamics, and interactions with science class teachers. The teachers provided in-depth perspectives on classroom dynamics through semi-structured interviews, with a particular focus on student interactions, collaborative work, and teacher-student relationships. Responses were analyzed using both descriptive and inferential statistics, with correlation and regression analyses applied to explore relationships between the variables.

Additionally, teachers used a rubric to assess students' learning engagement and scientific investigative performance, which also contributed to the quantitative analysis of the data. These rubric assessments provided insights into student performance by evaluating criteria such as participation, effort, and interest in science activities. The results from the rubric were combined with the survey data to provide a comprehensive understanding of students' engagement levels.

The combination of survey responses and performance assessments ensured a thorough exploration of how social belongingness and group dynamics contributed to students' interest and success in science learning. The review also guided the adaptation of the Performance Assessment on Scientific Investigative Performance, which was used to evaluate students' engagement, group dynamics, and social belongingness in the science classroom.

Results and Discussion

This chapter presents the analysis and interpretation of the data about the problems addressed in this study.

TABLE 1

Student's Sense of Social Belongingness as Experienced in Science Class as to Acceptance

Indicators		Mean	SD	VI
1.	I have consistently felt that my perspectives are welcomed and respected by peers during science discussions.	3.20	0.72	SE
2.	I feel included with my peers, even when my contributions go against the norm.	2.86	0.74	SE
3.	I feel confident that my classmates acknowledge and value my individuality in science activities.	3.07	0.70	SE
4.	I express my unique ideas when the atmosphere in my science class gives me confidence.	2.87	0.88	SE
5.	I am part to every group discussion, regardless of my viewpoints.	3.14	0.77	SE
6.	I trust that my peers will consider my thoughts and ideas fairly.	3.08	0.67	SE
7.	I receive acceptance from my classmates, which allows me to fully engage in class activities.	3.17	0.72	SE
8.	I feel that my peers accept me regardless of my level of participation.	3.03	0.82	SE
9.	I feel accepted by my peers through the respectful interactions in science class.	3.06	0.78	SE
10.	I am confident that my peers stand by me in any academic or social challenges I face in science class.	2.99	0.83	SE
Overall		**3.05**	**0.53**	**SE**

Legend*:* *3.50 – 4.00; Highly Experienced (HE), 2.50 – 3.49; Substantially Experienced (SE), 1.50 – 2.49; Slightly Experienced (se), 1.0 – 1.49; Not Experienced (NE)*

The table shows that the student's sense of social belonging is substantially experienced in acceptance. The results also shows that most of the students feel accepted when they feel that they are part of every group discussion, regardless of their viewpoints, which allows them to fully engage in science activities, resulting in better learning outcomes and indicates that they have established a substantial level of experienced being accepted in a group. Conversely, the relatively lower scores suggest that some students may have concerns about whether their differing opinions are truly accepted in the group, as some emphasize competition over collaboration, which can intimidate students who prefer teamwork or need extra support.

TABLE 2

Student's Sense of Social Belongingness as Experienced in Science Class as to Belonging

Indicators	Mean	SD	VI
11. I feel a strong sense of belonging because of the collective goals of my science class.	2.93	0.79	SE
12. I feel that my presence in science class is essential to the group's cohesion and success.	2.93	0.72	SE
13. I feel deeply connected to my peers because of the shared experiences in science class.	2.96	0.79	SE
14. I experience a strong sense of unity with my classmates, which enhances my commitment to group tasks.	3.14	0.75	SE
15. I strengthened my sense of belonging in a science class since my peers recognized my efforts.	3.02	0.79	SE
16. I feel like a key member of the group because of the inclusive practices in my science class.	2.92	0.79	SE
17. I feel a stronger sense of belonging because of the encouragement I receive from my peers.	2.92	0.76	SE
18. I feel that my contributions are integral to the sense of belonging we share in science class.	2.90	0.71	SE
19. I experience a strong sense of belonging because mutual respect is fostered in my science class.	2.96	0.70	SE
20. I strengthen the overall sense of community in the class through my involvement in science activities.	3.00	0.77	SE
Overall	**2.97**	**0.51**	**SE**

Legend*: 3.50 – 4.00; Highly Experienced (HE), 2.50 – 3.49; Substantially Experienced (SE), 1.50 – 2.49; Slightly Experienced (se), 1.0 – 1.49; Not Experienced (NE)*

The table shows that the student's sense of social belongingness is substantially experienced. When students are allowed to participate in their science projects and presentations, they experience a significant sense of belonging, indicating that they have gained a solid foundation of knowledge and skills in science. However, relatively lower scores suggest that some students may not fully appreciate the importance of their contributions to the overall science classroom. Some students believe they are "not good at science" due to past struggles or a lack of confidence, which leads them to feel out of place in the classroom.

TABLE 3

Student's Sense of Social Belongingness as Experienced in Science Class as to Integration

Indicators	Mean	SD	VI
21. I integrate my ideas into group projects effortlessly, confident that my classmates value diverse perspectives.	2.93	0.75	SE
22. I feel that my input is effortlessly integrated into group discussions and activities.	2.80	0.69	SE
23. I integrate smoothly into collaborative tasks because of the dynamic in my science class.	2.99	0.73	SE
24. I find it easy to merge my thoughts with those of my peers during group science experiments.	3.06	0.78	SE
25. I feel supported by my science class environment in effortlessly integrating my contributions into group work.	3.05	0.77	SE
26. I feel that my ideas are not only heard but also effectively integrated into the group's approach to science problems.	2.90	0.78	SE
27. I enhanced my ability to integrate into group tasks because of the collaborative spirit in my science class.	3.01	0.75	SE
28. I find that my suggestions naturally complement those of my peers, facilitating smooth group integration.	2.93	0.76	SE
29. I find it easier to participate in group work because of the class's inclusive approach to integrating all contributions.	3.02	0.80	SE
30. I believe that the unity in my science class helps me integrate my strengths with those of my peers.	3.17	0.75	SE
Overall	**2.99**	**0.51**	**SE**

Legend: *3.50 – 4.00; Highly Experienced (HE), 2.50 – 3.49; Substantially Experienced (SE), 1.50 – 2.49; Slightly Experienced (se); 1.0 – 1.49; Not Experienced (NE)*

The table shows that the student's sense of social belongingness in integration is substantially experienced. When students perceive a sense of unity, they are more likely to contribute confidently, knowing that their input will be valued and seamlessly integrated into group efforts.

On the other hand, relatively low scores suggest that some students struggle to incorporate ideas during discussions fully.

TABLE 4

Student's Sense of Social Belongingness as Experienced in Science Class as to Peer Relationship

Indicators	Mean	SD	VI
31. I enhance collaboration on complex science tasks because of the trust I share with my peers.	3.01	0.77	SE
32. I feel that my positive relationships with classmates are crucial for effective group work in science.	3.07	0.79	SE
33. I foster a collaborative and successful learning environment through the support I receive from my peers.	2.99	0.77	SE
34. I improve our group performance through the mutual respect that defines my relationships in science class.	3.09	0.72	SE
35. I am confident that my peers and I can rely on each other for academic support in science.	3.00	0.75	SE
36. I positively impact our ability to work together on science projects through the rapport I have with my classmates.	3.14	0.75	SE
37. I feel that the strong peer relationships in my science class contribute to our academic success.	3.16	0.76	SE
38. I have built a supportive network along with my classmates that enhances our learning in science.	3.17	0.74	SE
39. I believe that the positive dynamics among my peers make group work in science more effective.	3.10	0.76	SE
40. I am motivated to contribute more actively to science class by the relationships I have with my classmates.	3.12	0.76	SE
Overall	**3.08**	**0.54**	**SE**

Legend: *3.50 – 4.00; Highly Experienced (HE), 2.50 – 3.49; Substantially Experienced (SE), 1.50 – 2.49; Slightly Experienced (se); 1.0 – 1.49; Not Experienced (NE)*

The table shows that the student's sense of social belongingness in peer relationships is substantially experienced. This suggests that students feel a significant level of experience in peer relationships within science class when they establish a good and supportive peer network. Students gain substantial experience when peer networks enable them to work together effectively on complex science tasks and group projects.

However, there is still a need for further guidance for some students with relatively lower scores, suggesting that when students are introverted or anxious around their peers, they may struggle to foster interaction, build connections, and rely on one another, indicating that these students have limited experience in peer relationships.

TABLE 5

Student's Sense of Social Belongingness as Experienced in Science Class as to Teacher–Student Interaction

Indicators	Mean	SD	VI
41. I am motivated to engage deeply in class activities by my science teacher's encouragement.	3.14	0.78	SE
42. I feel that my science teacher's guidance is crucial to my academic growth and understanding of complex concepts.	3.03	0.88	SE
43. I improve my scientific thinking through the constructive feedback I receive from my science teacher.	3.13	0.75	SE
44. I develop a deeper interest in science through my teacher's responsiveness to my questions.	3.07	0.82	SE
45. I feel that my teacher's commitment to my learning is reflected in our positive interactions.	3.09	0.82	SE
46. I gain confidence in tackling challenging topics through the support I receive from my science teacher.	3.16	0.84	SE
47. I trust that my science teacher's advice will lead to improved performance in science tasks.	3.24	0.73	SE
48. I am encouraged to explore science topics more thoroughly through my interactions with my science teacher.	3.18	0.74	SE
49. I believe that my science teacher is invested in my success, which motivates me to perform better.	3.24	0.73	SE
50. I am inspired to achieve my full potential in the subject through the relationship I have with my science teacher.	3.28	0.74	SE
Overall	**3.16**	**0.57**	**SE**

Legend*: 3.50 – 4.00; Highly Experienced (HE), 2.50 – 3.49; Substantially Experienced (SE), 1.50 – 2.49; Slightly Experienced (se); 1.0 1.49; Not Experienced (NE)*

The table shows that students' sense of social belongingness in teacher-student interaction is substantially experienced. This suggests that students' relationships with their science teachers inspire them to reach their full potential in the subject. This indicates that students feel a sense of belonging when they have a positive and inspiring relationship with their teacher. A supportive and motivating teacher-student interaction fosters confidence, encourages active participation, and enhances students' engagement in science. When students perceive their teacher as genuinely invested in their success, they become more motivated to excel in the subject. Additionally, teachers who encourage constructive feedback and responsive guidance help students develop a deeper interest in science and the confidence to tackle complex topics. The strong connection between students and their science teacher not only boosts academic performance but also nurtures a growth mindset, inspiring students to push beyond their limits.

However, there is still a need for further instructions to some students with relatively lower scores, indicating that students who may feel a lack of interaction with their teacher do not receive consistent, meaningful feedback and creative reinforcement, indicating that students have a limited experience in teacher-student interaction.

TABLE 6

Group Dynamics Experienced by The Student in Science Project Presentation

		Mean	SD	VI
1.	I find that the group's collaborative efforts lead to well-organized and compelling science presentations.	3.15	0.77	SE
2.	I observed that each group member enhanced the overall quality of the science project presentations.	3.00	0.75	SE
3.	I actively engage in refining our science presentations to ensure clarity and effectiveness.	2.95	0.75	SE
4.	I find that a feedback loop within my group is essential to improve the delivery of our science presentations.	3.10	0.76	SE
5.	I believe that our group's cohesion directly impacts the success of our science project presentations.	3.09	0.78	SE
6.	I feel more confident in presenting science projects because of my group's thorough preparation and support.	3.10	0.77	SE
7.	I enhance our collective understanding of science topics through the collaborative discussions we have while preparing presentations.	3.08	0.76	SE
8.	I find that my group's ability to integrate diverse viewpoints leads to richer science presentations.	3.03	0.80	SE
9.	I significantly improve the quality of our science presentations through rehearsals and peer feedback sessions.	3.09	0.74	SE
10.	I am confident that our science presentations are effective due to our group's thorough planning and execution.	2.97	0.74	SE
Overall		**3.06**	**0.53**	**SE**

Legend*:* *3.50 – 4.00; Highly Experienced (HE), 2.50 – 3.49; Substantially Experienced (SE), 1.50 – 2.49; Slightly Experienced (se); 1.0 1.49; Not Experienced (NE)*

The table shows that students' sense of group dynamics in science project presentation is substantially experienced. This result highlights that students perceive collaborative teamwork as they all have a positive attitude toward creating effective science project presentations. When students collaborate effectively, they can integrate diverse ideas and ensure a well-structured final product. One such approach is collaborative learning, where students work together in pairs or small groups to complete assignments or projects. However, there is still a need for further instructions to students with low scores, indicating that they have a minimal level of experience, and might have a limited exposure in doing a science project presentation, therefore some group members tend to do most of the work while others contribute a little, creating unequal tasks in collaboration.

TABLE 7

Group Dynamics Experienced by The Student as the Research Project

Indicators	Mean	SD	VI
11. I find that the division of labor in our group research projects is equitable and efficient.	3.09	0.78	SE
12. I enhance the quality and depth of our findings through my group's collaborative approach to research.	3.12	0.75	SE
13. I actively contribute to refining our research questions and methodologies in group projects.	3.01	0.78	SE
14. I contributed to comprehensive and well-rounded research projects through the diverse skills within my group.	3.04	0.81	SE
15. I feel that my group's thorough data analysis contributes to the credibility of our research findings.	3.00	0.73	SE
16. I strengthen the validity of our research conclusions through my group's ability to integrate different perspectives.	3.04	0.70	SE
17. I take the initiative in ensuring that our research process is systematic and adheres to scientific standards.	3.09	0.76	SE
18. I find our discussions within the group, crucial for refining and improving our research projects.	2.99	0.81	SE
19. I believe that my group's collaborative research process results in innovative and insightful findings.	3.03	0.77	SE
20. I am more confident in presenting our research due to the rigorous and collaborative preparation within the group.	3.05	0.76	SE
Overall	**3.05**	**0.53**	**SE**

Legend*: 3.50 – 4.00; Highly Experienced (HE), 2.50 – 3.49; Substantially Experienced (SE), 1.50 – 2.49; Slightly Experienced (se); 1.0 1.49; Not Experienced (NE)*

The table shows that students' sense of group dynamics in a research project is substantially experienced. This result indicates that students perceive their collective efforts and joint problem-solving in research projects as the most significant contributors to enhancing both the quality and depth of their research outcomes. Most recently, Li et al. (2023) suggested that students who engage in behavior, emotion, and thought processes with a high level of self-efficacy do better in scientific classes. Reiss et al. (2023) also illustrate that investigative research projects are more effective than alternative instructional methods for engaging students in higher-order thinking and problem-solving skills.

However, relatively low scores suggest that some students still struggle to refine and improve their research projects. When students feel isolated and hesitant during group discussions, they struggle to contribute, leading to poor output and performance.

TABLE 8

Group Dynamics Experienced by The Student in Interactive Science Simulations

Indicators	Mean	SD	VI
20. I find that our group's collaboration during interactive simulations deepens our understanding of complex scientific concepts.	3.01	0.75	SE
21. I contribute to successful outcomes through the collective problem-solving approach my group adopts during simulations.	3.03	0.76	SE
22. I actively participate in strategizing with my group to navigate challenging scenarios in science simulations.	3.04	0.76	SE
23. I believe my group's ability to communicate effectively is key to our success in interactive simulations.	3.09	0.80	SE
24. I find that our group's use of simulations helps to solidify our grasp of abstract scientific principles.	3.13	0.73	SE
25. I enhance the learning outcomes from our participation in science simulations through the synergy within my group.	3.03	0.75	SE
26. I believe that the collaborative nature of simulations in my group leads to a deeper understanding of the subject matter.	3.18	0.79	SE
27. I help my group internalize the lessons learned through our reflective discussions after simulations.	3.09	0.72	SE
28. I am confident that our group's performance in science simulations is a result of our collective effort and understanding.	3.17	0.74	SE
29. I find that the immersive experience of simulations, combined with group collaboration, significantly enhances my learning.	3.02	0.78	SE
Overall	**3.08**	**0.51**	**SE**

Legend*:* *3.50 – 4.00; Highly Experienced (HE), 2.50 – 3.49; Substantially Experienced (SE), 1.50 – 2.49; Slightly Experienced (se); 1.0 1.49; Not Experienced (NE)*

The table shows that students' sense of group dynamics in an interactive science simulation is substantially experienced. This suggests that students believe the collaborative nature of simulations within their group leads to a deeper understanding of the subject matter. This result indicates that students feel a significant benefit from interactive science simulations when these activities are approached collaboratively. This suggests that integrating diverse ideas and perspectives during group simulations enhances comprehension of complex scientific concepts. Key indicators that might affect this outcome include the level of effective communication and active participation during simulations. When students engage in meaningful dialogue and shared problem-solving, they can internalize abstract concepts more effectively, thereby deepening their overall understanding.

TABLE 9

Group Dynamics Experienced by The Student in Peer Collaboration

INDICATORS	MEAN	SD	VI
31. I FELT COMFORTABLE SHARING MY IDEAS WITH MY PEERS DURING GROUP DISCUSSIONS.	3.17	0.72	SE
32. I FIND THAT THE ROLES AND RESPONSIBILITIES OF MY PEERS ARE CLEARLY DEFINED.	3.04	0.71	SE
33. I LEARNED MORE EFFECTIVELY THROUGH COLLABORATION WITH MY PEERS.	3.07	0.70	SE
34. I BELIEVE MY GROUP WAS SUCCESSFUL IN WORKING TOGETHER TO ACHIEVE OUR GOALS.	3.04	0.80	SE
35. I FELT THAT PEER COLLABORATION POSITIVELY INFLUENCED THE OUTCOME OF OUR PROJECT.	3.06	0.80	SE
36. I FIND THAT CONFLICTS WITHIN MY GROUP WERE RESOLVED EFFECTIVELY	3.01	0.78	SE
37. I FEEL THAT THE CONTRIBUTIONS OF EACH GROUP MEMBER WERE VALUED AND RESPECTED.	3.17	0.71	SE
38. I BELIEVE THE GROUP'S DIVERSE PERSPECTIVES ENHANCED OUR PROJECT.	3.03	0.78	SE
39. I WAS ABLE TO EXPRESS MY OPINIONS AND IDEAS WITHOUT FEAR OF JUDGMENT.	3.02	0.78	SE
40. I FEEL THAT THE OVERALL EXPERIENCE OF WORKING IN A GROUP IMPROVED MY UNDERSTANDING OF SCIENTIFIC CONCEPTS.	3.15	0.73	SE
OVERALL	**3.08**	**0.53**	**SE**

Legend*: 3.50 – 4.00; Highly Experienced (HE), 2.50 – 3.49; Substantially Experienced (SE), 1.50 – 2.49; Slightly Experienced (se); 1.0 1.49; Not Experienced (NE)*

The table shows that students' sense of group dynamics in a peer collaboration is substantially experienced. This result indicates that a key factor in effective peer collaboration is the creation of an environment where students feel secure in expressing their ideas and confident that their contributions are appreciated. Tomar et al. (2024) emphasize that collaborative learning is effective when students possess both cognitive and metacognitive skills, which are enhanced through the collaborative process itself. However, poor collaborative efforts can negatively impact learning outcomes and may lead to conflicts. Nonetheless, peer-oriented assessments and learning activities can also lead to conflicts among students. Despite these challenges, training students in social skills can help them maximize the benefits of collaborative learning.

Table 10

Science Learning Engagement Described by the Student as to their Active Participation

Score	Frequency	Percent	Verbal Interpretation
4	62	44.93	Highly Engaged
3	59	42.75	Engaged
2	17	12.32	Slightly Engaged
1	--	--	No Engagement
Total	138	100	

Legend*: 4-Highly Engaged, 3-Engaged, 2-Slightly Engaged, 1-No Engagement*

The table indicates that many students are highly engaged in science learning, demonstrating active participation. Students' confidence and willingness to participate contribute to a higher level of active participation.

Students classified as "Engaged" may demonstrate active participation but often at a lower intensity compared to their "Highly Engaged" peers. Several reasons explain this moderate level of engagement. For instance, students in the "Engaged" category may have an interest in the subject but may lack the intrinsic motivation or confidence to participate more actively. They could also be influenced by classroom dynamics, where the learning activities or teaching methods don’t fully capture their attention or cater to their preferred learning styles. Additionally, external factors such as distractions, time management challenges, or even transitional phases in academic development might contribute to their slightly lower level of engagement.

Table 11

Science Learning Engagement Described by the Student as to Their Interests in Science Concepts

Score	Frequency	Percent	Verbal Interpretation
4	66	47.83	Highly Engaged
3	56	40.58	Engaged
2	16	11.59	Slightly Engaged
1	--	--	No Engagement
Total	138	100	

Legend*: 4-Highly Engaged, 3-Engaged, 2-Slightly Engaged, 1- No Engagement*

The table shows that the majority of students are highly engaged in science learning, as evidenced by their interest in science concepts. Engaged students demonstrate genuine curiosity about science but may not have yet found a personal connection to the material or its real-world applications. Teaching strategies and classroom environments that focus on rote learning rather than exploration can also limit the depth of interest. Other external factors, such as competing academic demands, personal challenges, or a lack of immediate relevance in their everyday experiences, may further reduce their engagement, indicating a slight level of engagement in the science classroom.

Table 12

Science Learning Engagement Described by the Student as Their Effort in Completing Science Tasks

Score	Frequency	Percent	Verbal Interpretation
4	56	40.58	Highly Engaged
3	50	36.23	Engaged
2	32	23.19	Slightly Engaged
1	--	--	No Engagement
Total	138	100	

Legend*: 4-Highly Engaged, 3- Engaged, 2- Slightly Engaged, 1- No Engagement*

The table shows that the majority of students are highly engaged in terms of their effort in completing Science Tasks. Students tend to exhibit strong intrinsic motivation and persistence, which is likely supported by effective classroom environments and a personal interest in science. Additionally, in science discussions and activities, students participate in assignments, complete science-related tasks, and conduct experiments diligently. In contrast, "Slightly Engaged" students might be motivated more by external factors, showing less consistent effort and benefiting from additional encouragement or engaging instructional methods.

Table 13

Scientific Investigative Performance of the students in terms of Observing

Score	Frequency	Percent	Verbal Interpretation
8-9	99	71.74	Excellent
6-7	37	26.81	Proficient
4-5	2	1.45	Satisfactory
2-3	--	--	Poor
0-1	--	--	Needs Improvement
Total	138	100	

Legend*: 8-9-Excellent, 6-7-Proficient, 4-5-Satisfactory, 2-3- Poor, 0-1-Needs Improvement*

The table shows that the scientific investigative performance of the majority of students is excellent in terms of Observation. A large portion of students demonstrate a strong ability to observe in their scientific tasks. Through careful observations of the tasks, students find them more engaging and worthwhile. The students were able to complete the table and wrote down the characteristics of each gene and draw the species. Students at the proficient level indicate that they can notice, analyze, and interpret scientific data.

However, the presence of a small number of students in the Satisfactory category suggests that additional support, such as structured observation exercises, guided inquiry-based learning, and reinforcement of scientific reasoning, could further enhance their observational skills. Overall, the findings highlight a strong foundation in scientific observation among the students.

Table 14

Science Learning Outcome as to Scientific Investigative Performance of the students in terms of Questioning

Score	Frequency	Percent	Verbal Interpretation
8-9	68	49.28	Excellent
6-7	43	31.16	Proficient
4-5	24	17.39	Satisfactory
2-3	3	2.17	Poor
0-1	--	--	Needs Improvement
Total	138	100	

Legend*:* *8-9-Excellent, 6-7-Proficient, 4-5-Satisfactory, 2-3- Poor, 0-1-Needs Improvement*

The table shows that the scientific investigative performance of the majority of students is excellent in terms of questioning, indicating that most students demonstrate the ability to formulate and ask questions during investigations. However, a few may benefit from additional support to further enhance their questioning skills.

However, the presence of students in the Satisfactory and Poor categories indicates that some may need additional guidance in developing inquiry-based thinking. Encouraging curiosity, providing structured questioning exercises, and integrating Socratic questioning techniques may help enhance students' ability to ask higher-order scientific questions. Overall, the findings reflect a solid foundation in scientific questioning, with room for further development.

Table 15

Science Learning Outcome as to the Scientific Investigative Performance of the students in terms of Hypothesizing

Score	Frequency	Percent	Verbal Interpretation
8-9	61	44.20	Excellent
6-7	55	39.86	Proficient
4-5	20	14.49	Satisfactory
2-3	2	1.45	Poor
0-1	--	--	Needs Improvement
Total	138	100	

Legend*:* *8-9-Excellent, 6-7-Proficient, 4-5-Satisfactory, 2-3- Poor, 0-1-Needs Improvement*

The table indicates that the scientific investigative performance of the majority of students is excellent in terms of hypothesizing, suggesting that most students consistently perform at a high level in formulating hypotheses during scientific investigations. However, a small percentage may require additional support. Overall, the findings demonstrate a solid foundation in hypothesis development, with opportunities for further improvement.

Table 16

Science Learning Outcome as to Scientific Investigative Performance of the students in terms of Predicting

Score	Frequency	Percent	Verbal Interpretation
8-9	59	42.75	Excellent
6-7	57	41.30	Proficient
4-5	21	15.22	Satisfactory
2-3	1	0.72	Poor
0-1	--	--	Needs Improvement
Total	138	100	

Legend*: 8-9-Excellent, 6-7-Proficient, 4-5-Satisfactory, 2-3- Poor, 0-1-Needs Improvement*

The table shows that the scientific investigative performance of the majority of students is excellent in terms of prediction, indicating that most students are capable of accurately predicting outcomes in science tasks, which reflects strong analytical and critical thinking skills. The high percentages in the Excellent and Proficient categories suggest that many students can effectively anticipate outcomes based on prior knowledge and logical reasoning. However, the presence of students in the Satisfactory and Poor categories suggests that some may need additional support in strengthening their ability to make accurate and well-supported scientific predictions.

Table 17

Science Learning Outcome as to the Scientific Investigative Performance of the students in terms of Investigating

Score	Frequency	Percent	Verbal Interpretation
8-9	60	43.48	Excellent
6-7	64	46.38	Proficient
4-5	14	10.14	Satisfactory
2-3	--	--	Poor
0-1	--	--	Needs Improvement
Total	138	100	

Legend*: 8-9-Excellent, 6-7-Proficient, 4-5-Satisfactory, 2-3- Poor, 0-1-Needs Improvement*

The table shows that the scientific investigative performance of the majority of students is proficient only in terms of investigation, indicating that students are moderately engaged in performing investigations. To further enhance students' investigative performance, educators can incorporate more hands-on experiments, real-world problem-solving activities, and structured research opportunities**.** Providing guided inquiry projects and fostering collaborative learning may also help students develop greater confidence and competence in scientific investigations.

Table 18

Science Learning Outcome as to Scientific Investigative Performance of the students in terms of Interpreting

Score	Frequency	Percent	Verbal Interpretation
8-9	40	28.99	Excellent
6-7	66	47.83	Proficient
4-5	30	21.74	Satisfactory
2-3	2	1.45	Poor
0-1	--	--	Needs Improvement
Total	138	100	

Legend*: 8-9-Excellent, 6-7-Proficient, 4-5-Satisfactory, 2-3- Poor, 0-1-Needs Improvement*

This indicates that while nearly three-quarters of students (around 76%) are either excellent or proficient, a noticeable gap remains between those who perform at a proficient level and those who are excellent or satisfactory. It suggests that most students are moderately capable of interpreting data effectively and additional support or enriched learning strategies might help move more students into the excellent category.

Table 19

Science Learning Outcome as to Scientific Investigative Performance of the students in terms of Communicating

Score	Frequency	Percent	Verbal Interpretation
8-9	44	31.88	Excellent
6-7	72	52.17	Proficient
4-5	22	15.94	Satisfactory
2-3	--	--	Poor
0-1	--	--	Needs Improvement
Total	138	100	

Legend*:* *8-9-Excellent, 6-7-Proficient, 4-5-Satisfactory, 2-3- Poor, 0-1-Needs Improvement*

The table shows that the scientific investigative performance of the majority of students is proficient only in terms of communication, indicating that students are moderately capable of conveying their scientific findings. However, a small portion of the satisfactory results indicates that some students need to improve their communication skills. Educators may consider integrating activities such as oral presentations, structured debates, written scientific reports, and peer-reviewed discussions. Encouraging students to explain their reasoning clearly, use data to support their claims, and practice with real-world science communication formats (e.g., posters, infographics, research abstracts) can help bridge the gap for those in the Satisfactory category.

Table 20

Correlation of Students' Social Belongingness and Science Learning Engagement

Social Belongingness	Science Learning Engagement		
	Active Participation	Interest in Science Concepts	Effort in Completing Science Tasks
Acceptance	0.403***	0.312***	0.286***
Belonging	0.408***	0.361***	0.358***
Integration	0.371***	0.312***	0.316***
Peer Relationship	0.420***	0.357***	0.392***
Teacher-student interaction	0.365***	0.295***	0.309***

Note. * p < .05, ** p < .01, *** p < .001; .65 to1 or -.65 to -1 strong, .35 to .65 or -.35 to -.65 moderate, -.35 to .35 weak to none.

The table indicates a significant relationship between social belongingness and science learning engagement in all domains. The respondents in the study have a good rapport with social belongingness and its domains, as evidenced by their active participation, interest in science concepts, and effort in completing science tasks.

This indicates that strong, positive relationships with peers are most closely associated with increased active participation in science learning. The study found that students with a strong sense of social belongingness, particularly in terms of peer relationships, acceptance, and teacher-student interaction, showed higher levels of engagement in science learning. This supports Arslan & Coşkun (2023), who emphasized that school belongingness enhances academic motivation, achievement, and engagement while reducing emotional distress. Similarly, Li and Singh (2023) highlight that a strong academic sense of belonging has a positive influence on self-efficacy, motivation, and persistence in learning science.

The findings also align with those of Ramos et al. (2023) and Gonzales & Reyes (2021), who noted that poor social belonging can lead to disengagement in science learning.

Table 21

Correlation of Social Belongingness and Scientific Investigative Performance

Social Belongingness	**Scientific Investigative Performance**						
	Observing	**Questioning**	**Hypothesizing**	**Predicting**	**Investigating**	**Interpreting**	**Communicating**
Acceptance	0.218*	0.257**	0.322***	0.245**	0.166	0.265**	0.185*
Belonging	0.209*	0.241**	0.293***	0.252**	0.238**	0.252**	0.272**
Integration	0.246**	0.224**	0.273**	0.276**	0.172*	0.266**	0.253**
Peer Relationship	0.226**	0.209*	0.309***	0.234**	0.182*	0.234**	0.178*
Teacher-student interaction	0.246**	0.238**	0.302***	0.273**	0.213*	0.253**	0.272**

Note. * p < .05, ** p < .01, *** p < .001; .65 to1 or -.65 to -1 strong, .35 to .65 or -.35 to -.65 moderate, -.35 to .35 weak to none.

The table indicates a significant relationship between social belongingness and scientific investigative performance across all domains. There is a high correlation between Acceptance and Hypothesizing. This suggests that students who genuinely feel accepted by their peers and teachers tend to formulate more robust and well-considered hypotheses during scientific investigations. Among the social belongingness factors, hypothesizing showed the strongest correlations across all categories, particularly with acceptance, belonging, peer relationships, and teacher-student interaction, all at a highly significant level. This suggests that students who experience a strong sense of belonging are more likely to formulate well-thought-out hypotheses in scientific investigations.

However, the r-values signify that there is a weak significance in some domains of social belongingness and scientific investigative performance. In terms of observation, questioning, and interpretation, the correlations were mostly moderate but remained statistically significant. For investigating, the correlations were slightly lower, indicating that while social belongingness is influential, other factors may also play a crucial role in students' investigative performance.

Table 22

Correlation between Group Dynamics and Science Learning Engagement

Group Dynamics	Science Learning Engagement		
	Active Participation	Interest in Science Concepts	Effort in Completing Science Tasks
Science Project Presentations	0.349***	0.278***	0.346***
Research Projects	0.379***	0.341***	0.392***
Interactive Science Simulations	0.458***	0.393***	0.377***
Peer Collaboration	0.363***	0.275**	0.302***

Note. * p < .05, ** p < .01, *** p < .001; .65 to1 or -.65 to -1 strong, .35 to .65 or -.35 to -.65 moderate, -.35 to .35 weak to none.

The table indicates a significant relationship between group dynamics and science learning engagement. There is a high correlation between Interactive Science Simulations and Active Participation. This indicates that the dynamics experienced during interactive simulations are most strongly linked to students' active engagement in the classroom. The study revealed that interactive science simulations and research projects had the highest correlations with science learning engagement. This supports Torres & Domingo (2022), who advocated for student-centered learning approaches that emphasize collaboration, inquiry, and problem-solving to boost engagement.

The results are also aligned with Cabrera et al. (2024), who emphasized that hands-on projects and science-related competitions foster student participation and motivation. Furthermore, Delos Reyes et al. (2020) emphasized the importance of a supportive learning environment to promote engagement, as reflected in the study's findings on group dynamics.

Table 23

Correlation between Group Dynamics and Science Investigative Performance

Group Dynamics	Scientific Investigative Performance						
	Observing	**Questioning**	**Hypothesizing**	**Predicting**	**Investigating**	**Interpreting**	**Communicating**
Science Project Presentations	0.226**	0.234**	0.273**	0.247**	0.179*	0.241**	0.158
Research Projects	0.197*	0.232**	0.303***	0.249**	0.147	0.26**	0.21*
Interactive Science Simulations	0.278***	0.325***	0.394***	0.301***	0.211*	0.325***	0.262**
Peer Collaboration	0.173*	0.214*	0.273**	0.219**	0.138	0.203*	0.202*

Note. * p < .05, ** p < .01, *** p < .001; .65 to1 or -.65 to -1 strong, .35 to .65 or -.35 to -.65 moderate, -.35 to .35 weak to none.

The table indicates a significant correlation between group dynamics and scientific investigative skills. High correlation is observed between Interactive Science Simulations and Hypothesizing. This suggests that when group dynamics during interactive simulations are effective, students are more effective at forming hypotheses. The immersive, hands-on nature of simulations encourages active exploration and creative problem-solving, which in turn fosters a deeper understanding of scientific concepts.

However, the R-value signifies that there is a weak significance in many of the domains of social belongingness and scientific investigative performance. Encouraging students to engage in domains of group dynamics can significantly improve their ability to observe, question, hypothesize, predict, investigate, interpret, and communicate scientific concepts.

Summary of Findings

The salient findings of the study are summarized below:

1. Students' Sense of Social Belongingness in Science Class

The findings indicate that students experience a substantial sense of social belongingness in science class. They experience a high level of acceptance, as they feel comfortable expressing their thoughts and contributing to discussions. Their sense of belonging is reinforced by positive interactions with peers and teachers, fostering an inclusive learning environment. Integration is evident as students actively engage in group activities and collaborations. Peer relationships play a crucial role in boosting students' confidence and willingness to participate in scientific tasks. Lastly, teacher-student interaction has a significant impact on students' engagement, as supportive and approachable teachers foster a more conducive learning experience.

2. Extent of Group Dynamics Experienced by Students

Students substantially experience group dynamics substantially across various activities. Science project presentations and research projects help develop teamwork, critical thinking, and problem-solving skills. Interactive science simulations are the most impactful, providing immersive and engaging experiences that deepen students' understanding of scientific concepts. Peer collaboration is also highly beneficial, allowing students to share ideas, work effectively in teams, and achieve common learning objectives.

3. Science Learning Engagement of Students

Students demonstrate an excellent level of active participation, particularly in hands-on and interactive learning experiences. Their interest in science concepts remains strong, largely due to engaging classroom activities and supportive learning environments. In terms of effort expended on completing science tasks, students demonstrate dedication and persistence, reinforcing the effectiveness of interactive and collaborative learning strategies in promoting engagement.

4. Science Learning Outcomes in Scientific Investigative Skills

The results reveal strong student performance in scientific investigative performance. Students exhibit excellent observing skills, demonstrating attentiveness to scientific details. They also excel in questioning, showing curiosity and critical thinking in formulating inquiries. Hypothesizing is the strongest skill correlated with social belongingness and group dynamics, indicating that students actively construct scientific explanations. Predicting and

investigating are also significantly developed, showcasing students' ability to analyze and experiment. Interpreting and communicating findings are areas where students excel, with teacher-student interaction and peer collaboration playing crucial roles in enhancing these skills.

5. Relationship Between Social Belongingness and Science Learning Engagement & Learning Outcomes

A significant positive correlation was found between social belongingness and science learning engagement. Students who feel accepted, integrated, and supported by peers and teachers tend to participate more actively, express higher interest, and put more effort into their science tasks. Social belongings also significantly influence scientific investigative skills, particularly in hypothesizing, interpreting, and communicating. This suggests that a supportive social environment enhances students' ability to think critically, analyze, and present scientific information effectively. The null hypothesis, stating that there is no significant relationship between social belongingness and science learning engagement and outcomes, is rejected.

6. **Relationship Between Group Dynamics and Science Learning Engagement & Learning Outcomes**

Group dynamics were found to be significantly correlated with science learning engagement. Among the four factors, interactive science simulations had the highest impact on engagement, demonstrating that immersive, hands-on activities are highly effective. Science project presentations, research projects, and peer collaboration also contributed positively to engagement. Similarly, group dynamics significantly influenced scientific investigative performance, with the strongest correlation observed in the areas of hypothesizing and questioning. Interactive simulations were particularly effective in developing students' ability to hypothesize and analyze data. The null hypothesis, stating that there is no significant relationship between group dynamics and science learning engagement and outcomes, is rejected.

Conclusions

This study concludes that:

1. This study reveals a significant relationship between students' sense of social belonging in science class and the variables of acceptance, belonging, integration, peer relationships, and teacher-student interaction. Thus, the null hypothesis is not sustained.
2. This study reveals a significant relationship between group dynamics and various aspects of science project presentation, research projects, interactive science simulations, and peer collaboration. Thus, the null hypothesis is not sustained.
3. There is a significant relationship between science learning engagement and the variables of active participation, interest in science concepts, and effort in completing science tasks. Thus, the null hypothesis is not sustained.
4. The study reveals that students exhibit strong scientific investigative performance and a significant relationship among the variables: observing, questioning, hypothesizing, predicting, investigating, interpreting, and communicating. Thus, the null hypothesis is not sustained.
5. There is a significant relationship between social belongingness to science learning engagement and scientific investigative performance. Thus, the null hypothesis is not sustained.
6. There is a significant relationship between group dynamics to science learning engagement and scientific investigative performance. Thus, the null hypothesis is not sustained.

Recommendations

Based on the conclusions above, the following are the recommendations of the study:

1. Schools and teachers may implement inclusive classroom strategies, such as peer mentoring and cooperative learning activities, to foster acceptance, belonging, integration, peer relationships, and teacher-student interaction in science classes and schools may provide more hands-on investigative activities, such as experiments, data analysis exercises, and science fairs, to strengthen students' observing, questioning, hypothesizing, predicting, investigating, interpreting, and communicating skills.
2. Teachers may integrate collaborative science activities, such as science presentations, research projects, and interactive simulations, to enhance student engagement and improve teamwork skills. Also, adopt inquiry-based learning approaches, including experiments, problem-solving tasks, and interactive discussions, to encourage active participation, sustained interest, and increased effort in completing science tasks. Additionally, schools may offer more hands-on investigative activities, such as experiments, data analysis exercises, and science fairs, to enhance students' skills in observing, questioning, hypothesizing, predicting, investigating, interpreting, and communicating.
3. Teachers should create a supportive learning environment by promoting collaborative group work and teacher-guided discussions, ensuring that students feel socially connected and academically engaged to scientific investigative skills.
4. Educators should implement structured, group-based investigative tasks to improve students' scientific investigative skills, ensuring that collaborative activities contribute to their overall success in science and social belonging.

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