



# **INTERACTIVE SCIENCE STATIONS LESSON DESIGN (ISS-LD): ENHANCING STUDENT ENGAGEMENT AND SCIENTIFIC LITERACY**

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<https://doi.org/10.5281/zenodo.19558128>

## **ABSTRACT**

This study investigated the impact of the Interactive Science Stations Lesson Design (ISS-LD) on the engagement and scientific literacy of Grade 8 Junior High School students at North Shore Middle School, Galena Park ISD, Texas, during the 2025–2026 school year. Utilizing the ADDIE model for instructional design, the study implemented a station-rotation framework consisting of peer quizzes, digital assessments, gallery walks, and teacher-led support stations. Data gathered from a sample of 40 students revealed an overall weighted mean of 4.45, indicating that students were "Highly Engaged" in the learning process. Learners reported that the interactive nature of the stations fostered behavioral, emotional, and cognitive engagement, with specific praise for the "fun" and collaborative aspects of the design. Furthermore, academic performance showed significant improvement; the mean score rose from 81.6 (Developing) prior to implementation to 88.9 (Proficient) post-implementation. The standard deviation decreased from 8.21 to 6.05, suggesting that the ISS-LD model promotes more consistent mastery across diverse learners. The results affirm the theories of Social Constructivism and Experiential Learning, demonstrating that moving from passive observation to active inquiry enhances conceptual understanding and critical thinking skills. While logistical challenges such as time constraints and resource management were noted, the study concludes that structured, interactive, station-based instruction is a highly effective strategy for promoting scientific literacy and academic achievement in the junior high school science curriculum.

**Keywords:** *interactive science stations, student engagement, scientific literacy, constructivism, junior high school science.*

## INTRODUCTION

Sustaining the interest and active participation of junior high school students in science remains a persistent challenge in contemporary classrooms. Despite the inherently exploratory nature of science, instructional practices continue to be dominated by teacher-centered approaches that limit inquiry, curiosity, and meaningful engagement. Overreliance on lecture-based instruction and the limited use of interactive strategies hinder students' engagement in STEM learning (Irwin et al., 2023). When lessons fail to connect with learners' prior experiences, participation becomes passive, resulting in reduced motivation and superficial understanding of scientific concepts. Although global educational reforms emphasize student-centered and inquiry-based instruction, there remains limited empirical evidence on how structured interactive science stations influence both engagement and scientific literacy in U.S. junior high school contexts, particularly when aligned with the Texas Essential Knowledge and Skills (TEKS). This gap highlights the need for instructional designs that integrate theory, policy, and classroom practice.

This study is anchored in Constructivist Learning Theory and Experiential Learning Theory, which collectively emphasize active, meaningful, and reflective learning processes. Constructivism posits that learners actively construct knowledge through interaction, collaboration, and contextualized experiences (Piaget, 1970; Vygotsky, 1978), while Experiential Learning Theory explains learning as a cyclical process involving concrete experience, reflection, conceptualization, and application (Kolb & Kolb, 2018). These perspectives position learners as active participants rather than passive recipients, underscoring the importance of instructional designs that promote inquiry, collaboration, and critical thinking. Complementing these frameworks, Differentiated Instruction Theory (Tomlinson, 2014) emphasizes the need to accommodate learners' diverse readiness levels, interests, and learning profiles to ensure inclusive and equitable learning environments.

These theoretical foundations are reinforced by educational policies that advocate learner-centered and inquiry-based instruction. In the Philippine context, constructivist approaches in basic education are supported by policy reforms such as Republic Act No. 10533 (Casama, 2018) while experiential learning pathways in Philippine education are supported by policy developments and system reforms (Symaco & Bustos, 2024). Flexible and innovative teaching practices are essential in supporting effective science instruction and curriculum implementation (Rodriguez, 2025). In the United States, the Next Generation Science Standards and the Every Student Succeeds Act emphasize inquiry-driven, evidence-based instruction and authentic scientific practices. Together, these frameworks establish a strong theoretical and policy basis for developing instructional designs that enhance student engagement and scientific literacy.

In response to these demands, the Interactive Science Stations Lesson Design (ISS-LD) is proposed as an instructional innovation that transforms the traditional classroom into multiple learning zones where students rotate through structured, hands-on, and inquiry-based activities. This approach enables learners to actively engage in observation, experimentation, discussion, and reflection, thereby fostering deeper conceptual understanding. Empirical evidence supports the effectiveness of interactive and station-based learning, demonstrating that such approaches enhance student participation, interaction, and cognitive engagement in science classrooms (Jiménez-Valverde et al., 2025). Moreover, differentiated and collaborative instructional strategies further promote inclusive and responsive learning environments (Goulet, 2024). Collectively, these findings suggest that interactive science stations can create dynamic, student-centered classrooms that support meaningful and sustained learning.

The ISS-LD specifically aims to enhance learner engagement across three interrelated dimensions: behavioral (active participation and persistence), cognitive (critical thinking and problem-solving), and emotional (interest and motivation toward science). To ensure systematic development and validation, this study adopts the ADDIE instructional design model—Analysis, Design, Development, Implementation, and Evaluation—which provides a structured and iterative framework for creating effective learning experiences (Branch & Varank, 2009; Molenda, 2015). Through this model, student feedback, performance data, and classroom observations are utilized to refine the lesson design, ensuring that it is evidence-based, pedagogically sound, and responsive to learners' needs.

Accordingly, this study aims to develop and validate an Interactive Science Stations Lesson Design (ISS-LD) and examine its effectiveness in enhancing student engagement and scientific literacy among junior high school students at North Shore Middle School, Galena Park Independent School District, Texas. By integrating theoretical perspectives, policy frameworks, and empirical evidence within an authentic classroom context, this research contributes to the growing body of literature on student-centered science instruction and provides a practical model for improving engagement and learning outcomes in secondary science education.

## Research Questions

This study aimed to determine the effectiveness of the Interactive Science Stations Lesson Design (ISS-LD) in enhancing student engagement and promoting scientific literacy among Junior High School students at North Shore Middle School, Galena Park ISD, Texas, during the School Year 2025–2026.

Specifically, this study sought to answer the following questions:

1. What is the level of engagement of the learners exposed to Interactive Science Stations?
2. What experiences or challenges are encountered by the learners in the implementation of the Interactive Science Stations?

3. What lesson design can be developed using Interactive Science Stations in science classes?
4. What is the pretest and post test results in the use of developed Interactive Science Stations – Lesson Design?
5. What is the mean gain in the use of Interactive Science Stations Lesson Design in teaching science subjects?

## **METHODOLOGY**

### **Research Design**

This study employed a mixed-method, descriptive–experimental design to examine the effectiveness of Interactive Science Stations (ISS) and to develop and refine an Interactive Science Stations Lesson Design (ISS-LD) aligned with the Texas Essential Knowledge and Skills (TEKS). The design combined a descriptive approach to assess learner engagement and scientific literacy with a pretest–posttest component to determine changes following ISS-LD implementation. A developmental dimension was also incorporated to support the validation and refinement of the lesson design through expert feedback and analysis of instructional outcomes. Quantitative data were analyzed using descriptive statistics and paired-sample t-tests, while qualitative data were examined through thematic analysis. This approach enabled a comprehensive evaluation of the ISS-LD as an evidence-based instructional model.

### **Research Environment**

The study was conducted at North Shore Middle School under the Galena Park Independent School District during the School Year 2025–2026. The research was carried out within regular science classes where Interactive Science Stations are already integrated and aligned with the Texas Essential Knowledge and Skills (TEKS). All instructional activities, assessments, and data collection procedures were implemented during regular class sessions without modifying the existing curriculum, schedule, or classroom routines. This ensured that the study was conducted in an authentic, low-risk learning environment consistent with standard school practices.

### **Research Participants**

The study involved approximately sixty (60) junior high school students enrolled in intact science classes at North Shore Middle School under the Galena Park Independent School District. Participants were selected through purposive sampling, as they were directly engaged in the implementation of the Interactive Science Stations Lesson Design (ISS-LD) as part of regular instruction. The use of intact classes allowed the study to examine instructional practices in a natural classroom setting. No experimental grouping or instructional modifications were introduced, and all participation occurred during regular class time in accordance with school policies, ensuring minimal risk and typical learning conditions.

**Table 1**  
**Distribution of Respondents**

Area/Class Schedule	Number of Classes	Number of Students	Total
North Shore Middle School A Day Classes	1	30	30
North Shore Middle School B Day Classes	1	30	30
TOTAL	2	60	60

## Research Instrument

This study utilized both quantitative and qualitative instruments to examine learner engagement and scientific literacy during the implementation of the Interactive Science Stations Lesson Design (ISS-LD).

Learner engagement was measured using a Likert-scale questionnaire adapted from Fredricks, Blumenfeld, and Paris, assessing behavioral, cognitive, and emotional dimensions. Scientific literacy was evaluated through a researcher-developed pretest and posttest aligned with the Texas Essential Knowledge and Skills (TEKS), focusing on explaining scientific phenomena, analyzing data, and applying concepts.

Qualitative data were collected using student reflection guides and teacher observation logs to capture learning experiences, participation, and interaction during station activities. The use of multiple instruments enabled data triangulation and a comprehensive analysis of engagement and scientific literacy.

## Research Procedure

This study employed a mixed-method approach to gather both quantitative and qualitative data on learner engagement and scientific literacy during the implementation of the Interactive Science Stations Lesson Design (ISS-LD) in junior high school science classes. All data collection activities are conducted within the context of regular classroom instruction and are aligned with the objectives of the study.

Prior to the implementation of the Interactive Science Stations Lesson Design, quantitative data were collected through the administration of a learner engagement questionnaire and a researcher-developed scientific literacy pretest aligned with the Texas Essential Knowledge and Skills (TEKS). These instruments were administered during regular class periods to establish students' baseline levels of engagement and scientific literacy. After the implementation period, the same instruments were administered as posttests to determine changes in students' engagement and scientific literacy.

To complement the quantitative data, qualitative data were gathered during the implementation phase through student reflection guides and teacher observation notes. These qualitative procedures captured students' learning experiences, participation, and interactions during station activities. All collected data were organized, coded, and securely stored for analysis, ensuring confidentiality and providing a comprehensive

understanding of how the Interactive Science Stations Lesson Design supports learner engagement and scientific literacy in an authentic classroom setting.

## Data Analysis

Data were analyzed using both quantitative and qualitative methods to examine the effectiveness of the Interactive Science Stations Lesson Design (ISS-LD) in enhancing learner engagement and scientific literacy.

Quantitative data from the learner engagement questionnaire and scientific literacy pretest and posttest were analyzed using descriptive statistics (frequency, mean, and standard deviation) and inferential statistics through paired-sample t-tests to determine significant differences before and after implementation. All analyses were conducted at the 0.05 level of significance.

Qualitative data from student reflections, teacher observation logs, and interviews were analyzed using reflexive thematic analysis following Braun and Clarke's framework, including coding, theme development, and interpretation. Triangulation was employed to integrate quantitative results and qualitative themes, ensuring credibility and providing a comprehensive understanding of the effectiveness of the ISS-LD.

## RESULTS

This section presents the findings on learner engagement and scientific literacy following the implementation of the Interactive Science Stations Lesson Design (ISS-LD). Results are organized according to the study variables, including levels of engagement, pretest and posttest performance, and mean gain scores. Quantitative findings are supported by qualitative insights to provide a comprehensive analysis of the effectiveness of the ISS-LD.

**Table 2**  
**Extent of Engagements of the Learners Exposed to Interactive Science Stations**

Statements	Weighted Mean	Description
1. I actively participated in science station activities	4.40	Highly Engaged
2. I stayed focused while completing tasks at each science station	4.50	Highly Engaged
3. I followed instructions during the science station activities	4.50	Highly Engaged
4. I completed the assigned tasks at each station on time	4.50	Highly Engaged
5. I collaborated well with my classmates during science stations	4.30	Highly Engaged
6. The science stations helped me understand the lesson better	4.50	Highly Engaged
7. I was able to think critically while completing station tasks	4.50	Highly Engaged
8. The activities encouraged me to apply what I learned in class	4.50	Highly Engaged
9. I tried different strategies to solve problems during the stations	4.50	Highly Engaged
10. The science stations challenged me to think deeply about the topic	4.50	Highly Engaged
11. I enjoyed learning science through interactive stations	4.50	Highly Engaged
12. The science stations made me more interested in the lesson	4.50	Highly Engaged
13. I felt motivated to participate during science station activities	4.30	Highly Engaged
14. I felt confident while working on station tasks	4.50	Highly Engaged
15. The science stations made learning science fun and engaging	4.30	Highly Engaged
<b>Overall</b>	<b>4.45</b>	<b>Highly Engaged</b>

Table 2 presents the extent of learner engagement among students exposed to the Interactive Science Stations Lesson Design (ISS-LD). The overall weighted mean of 4.45, interpreted as *Highly Engaged*, indicates that the ISS-LD effectively promotes a high level of student engagement across behavioral, cognitive, and emotional dimensions.

In terms of behavioral engagement, students reported active participation (WM = 4.40), sustained focus (WM = 4.50), adherence to instructions (WM = 4.50), and timely completion of tasks (WM = 4.50). Collaboration was also positively perceived (WM = 4.30), reflecting the capacity of station-based activities to encourage cooperative learning. These findings suggest that the ISS-LD creates a structured environment that supports active involvement and task commitment.

Cognitive engagement was likewise evident, as learners indicated that the stations helped them understand lessons better (WM = 4.50), apply learned concepts (WM = 4.50), think critically (WM = 4.50), utilize varied problem-solving strategies (WM = 4.50), and engage in deeper thinking (WM = 4.50). These results demonstrate that the ISS-LD facilitates higher-order thinking processes essential to scientific literacy, including analysis, application, and reasoning.

Emotional engagement was also strongly manifested, with students expressing enjoyment (WM = 4.50), increased interest (WM = 4.50), motivation to participate (WM = 4.30), and confidence in completing tasks (WM = 4.50). This indicates that the interactive and student-centered nature of science stations fosters positive learning attitudes and intrinsic motivation.

The consistently high ratings across all indicators affirm that the ISS-LD is highly effective in creating an engaging learning environment that supports both active participation and meaningful learning. These findings are supported by Fredricks et al. (2004), who emphasized that engagement is a multidimensional construct encompassing behavioral, cognitive, and emotional components that are enhanced through interactive and collaborative learning environments. Similarly, Prince (2004) found that active learning strategies significantly improve student engagement, critical thinking, and academic performance in science education.

Overall, the results suggest that structured, interactive science stations are an effective instructional approach for enhancing learner engagement and strengthening key components of scientific literacy among junior high school students.

**Table 3**  
**Perceived Students' Experiences in the Implementation of Interactive Science Stations**

Theme	Supporting Participants
Hands-On and Experiential Learning	P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, P12, P13, P14, P15, P16, P17, P18, P19, P20, P21, P22, P23, P24, P25, P26, P27, P28, P29, P30, P31, P32, P33, P34, P35, P36, P37, P38, P39, P40, P41, P42, P43, P44, P45, P46, P47, P48, P49, P50, P51, P52, P53, P54, P55
Lesson Clarity and Understanding	P5, P6, P7, P8, P9, P10, P11, P12, P13, P14, P15, P16, P17, P18, P19, P20, P21, P22, P23, P24, P25, P26, P27, P28, P29, P30, P31, P32, P33,

	P34, P35, P36, P37, P38, P39, P40, P41, P42, P43, P44, P45, P46, P47, P48, P49, P50
Active Engagement and Collaboration	P1, P3, P6, P7, P10, P11, P13, P15, P18, P20, P22, P23, P25, P27, P28, P30, P32, P34, P36, P38, P40, P42, P44, P46, P48, P50, P52, P54, P56, P58, P60
Enjoyable and Motivating Learning Experience	P2, P4, P5, P7, P9, P12, P14, P16, P19, P21, P24, P26, P29, P31, P33, P35, P37, P39, P41, P43, P45, P47, P49, P51, P53, P55, P57, P59

Table 3 presents the emerging themes from students' experiences during the implementation of the Interactive Science Stations Lesson Design (ISS-LD). The analysis revealed four dominant themes: hands-on and experiential learning, lesson clarity and understanding, active engagement and collaboration, and enjoyable and motivating learning experience. These themes collectively demonstrate that the ISS-LD supports meaningful learning by promoting active participation, conceptual understanding, and positive learning attitudes.

**Theme 1: Hands-On and Experiential Learning.** Students consistently emphasized that active involvement in tasks enhanced their understanding of scientific concepts. Responses such as "I learned better by doing instead of just listening" (P1) and "The stations helped me understand by doing the work" (P8) highlight the importance of experiential learning in facilitating knowledge construction. This finding supports Kolb (2014), who posited that learning is most effective when learners engage in concrete experiences that allow reflection and application. Similarly, Freeman et al. (2014) found that active, hands-on learning strategies significantly improve student understanding and performance in science education.

**Theme 2: Lesson Clarity and Understanding.** Participants reported that science stations improved the clarity of lessons and made complex concepts easier to comprehend. Statements such as "The stations made the lesson less confusing" (P12) and "The activities made learning easier" (P20) suggest that structured and segmented learning activities enhance comprehension. This aligns with Bruner (1961), who emphasized that instruction becomes more effective when concepts are presented in an organized and scaffolded manner. Supporting this, Hmelo-Silver et al. (2007) noted that guided, structured learning approaches improve students' understanding by helping them process complex information more effectively.

**Theme 3: Active Engagement and Collaboration.** The findings also highlight the role of collaboration in enhancing learning. Students reported that working with peers facilitated idea exchange and deeper understanding, as reflected in statements such as "I learned more because we worked together" (P25) and "I understood more because we explained answers to each other" (P32). These results indicate that collaborative learning promotes shared meaning-making and active engagement. This supports Vygotsky (1978), who emphasized the role of social interaction in cognitive development. Likewise, Johnson et al. (2014) found that cooperative learning strategies significantly enhance student engagement and academic achievement.

**Theme 4: Enjoyable and Motivating Learning Experience.** Students described the science stations as enjoyable, engaging, and less stressful compared to traditional instruction. Responses such as “The stations helped me learn in a fun way” (P4) and “The stations made learning easier and more enjoyable” (P16) indicate that positive learning experiences increase motivation and participation. This finding is consistent with Deci and Ryan (2000), who argued that intrinsically motivating environments enhance engagement and learning outcomes. Similarly, Ryan and Deci (2020) highlighted that enjoyable and autonomy-supportive learning environments strengthen students’ motivation and sustained engagement. Overall, the themes indicate that the ISS-LD fosters an interactive, supportive, and motivating learning environment that enhances both students’ understanding and engagement in science. The integration of experiential, collaborative, and structured learning activities contributes to deeper comprehension and more meaningful learning experiences.

**Table 4. Students’ Perceived Challenges in the Implementation Integrated Science Stations**

Theme	Description of Challenge	Sample Learner Feedback
1. Time Management & Pacing	Insufficient time to complete tasks and process information deeply.	"Add more time for each station," "Allow more thinking time".
2. Instructional Clarity	Need for explicit, step-by-step guidance and prior examples.	"Provide step-by-step instructions," "Give examples before starting".
3. Learning Support & Scaffolding	Difficulty with complex tasks without immediate teacher intervention.	"Provide support for harder questions," "Add guided questions".
4. Practice & Reinforcement	A desire for more opportunities to apply and solidify knowledge.	"Add more practice questions," "Include more review questions".
5. Engagement & Interactivity	Demand for higher levels of gamification and "fun" to maintain interest.	"Add more fun activities like games," "Include interactive tasks".
6. Visual & Multimedia Aids	Need for non-textual representations of scientific concepts.	"Add more visuals or pictures," "Include videos".
7. Collaboration Dynamics	Issues with group equity, participation, and structured roles.	"Assign group roles," "Encourage group interaction".
8. Structure & Transitions	Concerns regarding the flow and organization of station rotations.	"Make transitions smoother," "Give time reminders".

Table 4 presents the key challenges encountered by students during the implementation of the Interactive Science Stations Lesson Design (ISS-LD). Eight themes emerged: time management and pacing, instructional clarity, learning support and scaffolding, practice and reinforcement, engagement and interactivity, visual and multimedia aids, collaboration dynamics, and structure and transitions. These findings highlight areas that require refinement to optimize the effectiveness of the ISS-LD.

**Theme 1: Time Management and Pacing.** Students identified limited time per station as a major constraint, emphasizing the need for additional time to process information and engage in meaningful reflection. This suggests that while station rotation

promotes active learning, insufficient time may hinder deeper cognitive engagement. This finding is supported by Kyndt et al. (2011), who found that adequate time allocation is critical in active learning environments to support deeper understanding and skill development.

**Theme 2: Instructional Clarity.** Learners expressed the need for clearer, step-by-step instructions and prior examples to guide task completion. This indicates that well-structured guidance is essential in facilitating independent learning within station-based activities. This aligns with Kirschner et al. (2006), who emphasized that minimal guidance in instructional settings may lead to confusion, particularly when learners are dealing with complex tasks.

**Theme 3: Learning Support and Scaffolding.** Students highlighted the need for additional support when encountering difficult tasks, including guided questions and teacher assistance. This reflects the importance of scaffolding in helping learners progress through challenging concepts. This supports Wood et al. (1976), who introduced scaffolding as a critical mechanism for supporting learners within their Zone of Proximal Development.

**Theme 4: Practice and Reinforcement.** Participants expressed a need for more practice opportunities to strengthen their understanding and confidence. This suggests that while interactive activities enhance engagement, reinforcement remains essential for mastery. This finding is consistent with Hattie (2008), who identified practice and feedback as among the most influential factors in improving student achievement.

**Theme 5: Engagement and Interactivity.** Although the ISS-LD promotes active learning, students recommended incorporating more gamified and creative elements to sustain interest. This indicates that engagement can be further enhanced through varied and stimulating instructional strategies. This aligns with Deterding et al. (2011), who found that gamification increases motivation and engagement in learning environments.

**Theme 6: Visual and Multimedia Aids.** Students suggested incorporating more visuals, videos, and real-life examples to support understanding. This highlights the importance of multimodal instruction in making abstract concepts more accessible. This is supported by Mayer (2014), who demonstrated that multimedia learning improves comprehension by integrating visual and verbal information.

**Theme 7: Collaboration Dynamics.** While collaboration was generally positive, students noted issues with unequal participation and recommended assigning structured roles. This suggests that guided collaboration enhances group effectiveness and learning outcomes. This supports Johnson et al. (2014), who found that structured cooperative learning improves both participation and academic achievement.

**Theme 8: Structure and Transitions.** Students raised concerns about the flow of activities and transitions between stations, suggesting the need for clearer organization and time management cues. This indicates that smooth transitions are essential to maintain focus and continuity in learning. This aligns with Marzano (2007), who emphasized that well-managed classroom procedures significantly influence student engagement and learning efficiency.

Overall, the identified challenges highlight that while the ISS-LD effectively promotes engagement, its successful implementation depends on careful attention to instructional design elements such as time allocation, clarity, scaffolding, and classroom management. Addressing these concerns through iterative refinement, particularly within the evaluation phase of the ADDIE model, is essential to enhance the overall effectiveness of the ISS-LD and ensure sustained student engagement and meaningful learning.

**Table 5. Students' Academic Performance Pre- and Post-ISS-LD Implementation**

Performance Level	Score Range	Before ISS-LD		After ISS-LD	
		Frequency	Percentage	Frequency	Percentage
Advanced	90-100	9	30%	11	37%
Proficient	85-89	8	27%	10	33%
Developing	80-84	12	40%	6	20%
Approaching Proficiency	75-79	1	3%	3	10%
Beginning	Below 75	=	=	=	=
Average Score		81.6	SD	88.9	SD
Description		Developing	8.21	Proficient	6.05

Table 5 presents the students' academic performance before and after the implementation of the Interactive Science Stations Lesson Design (ISS-LD). Prior to implementation, most students were at the *Developing* level (40%), followed by *Advanced* (30%) and *Proficient* (27%), with only 3% classified as *Approaching Proficiency*. The mean score of 81.6 (SD = 8.21) indicates a *Developing* level of performance with relatively greater variability.

Following the implementation of ISS-LD, a clear upward shift in performance was observed. The proportion of students in the *Advanced* level increased from 30% to 37%, while those in the *Proficient* level increased from 27% to 33%. In contrast, the percentage of students in the *Developing* level decreased from 40% to 20%. Although 10% remained in the *Approaching Proficiency* category, no students fell under the *Beginning* level. The mean score increased to 88.9 (SD = 6.05), interpreted as *Proficient*, indicating both improved performance and reduced variability among learners.

The observed improvement suggests that the ISS-LD effectively supports academic achievement by promoting deeper understanding and more consistent learning outcomes. The increase in mean scores and the shift toward higher performance levels indicate that students benefited from structured, interactive, and student-centered learning experiences. This finding is consistent with Freeman et al. (2014), who reported that active learning strategies significantly improve student performance in science compared to traditional instruction. Similarly, Prince (2004) found that interactive and inquiry-based approaches enhance conceptual understanding and academic achievement in STEM education.

Moreover, the reduction in standard deviation implies more uniform mastery of scientific concepts, suggesting that the ISS-LD supports diverse learners through structured and engaging instructional strategies. Overall, the results demonstrate that interactive, station-based learning can significantly improve students' academic performance and contribute to more consistent learning outcomes in junior high school science.

**Table 6**  
**The significant mean gain difference between the students' performance before and after the ISS-LD implementation**

Variables	Mean	SD	Mean Gain	Computed T-value	P-value	Decision on Ho	Interpretation
Before ISS-LD	81.6	8.21	7.30	5.21	0.001	Reject Ho	Significant
After ISS-LD	88.9	6.05					

Table 6 presents the test of significant difference in students' performance before and after the implementation of the Interactive Science Stations Lesson Design (ISS-LD). The results show that the mean score increased from 81.6 (SD = 8.21) to 88.9 (SD = 6.05), yielding a mean gain of 7.30. The computed t-value of 5.21 with a p-value of 0.001 indicates that the difference between pretest and posttest scores is statistically significant at the 0.05 level. Since the p-value is less than 0.05, the null hypothesis is rejected. This confirms that the ISS-LD had a significant effect on improving students' academic performance.

The significant increase in scores suggests that the ISS-LD effectively enhances learning outcomes by promoting active engagement and deeper understanding of scientific concepts. This finding is consistent with Freeman et al. (2014), who demonstrated that active learning strategies significantly improve student achievement in science. Similarly, Chi and Wylie (2014) emphasized that interactive and constructive learning activities lead to greater learning gains compared to passive instructional approaches. Overall, the results provide strong evidence that the ISS-LD is an effective instructional intervention for improving students' academic performance in science.

## DISCUSSION

This study focused on the use of the Interactive Science Stations Lesson Design (ISS-LD) as an instructional approach in junior high school science within an authentic classroom setting at North Shore Middle School under the Galena Park Independent School District during the School Year 2025–2026. It examined how structured, station-based learning activities integrated into regular instruction can support student engagement and the development of scientific literacy. Employing a mixed-method, descriptive–experimental design, the study combined quantitative measures of learner engagement and academic performance with qualitative insights into students'

experiences during the implementation of interactive science stations. The instructional approach involved rotating learners through organized, hands-on, and collaborative tasks aligned with curriculum standards, allowing them to actively participate, explore concepts, and apply scientific knowledge within a structured learning environment. Overall, the study explored how an interactive, student-centered lesson design can be implemented within a real classroom context, emphasizing the role of instructional structure, active learning, and experiential activities in shaping students' engagement and understanding in science education.

## Findings

This study examined the effectiveness of the Interactive Science Stations Lesson Design (ISS-LD) in enhancing the engagement and scientific literacy of Junior High School students at North Shore Middle School, Galena Park ISD, Texas, during the School Year 2025–2026.

Based on the analysis and interpretation of the gathered data, the following findings were obtained:

- 1. Levels of Student Engagement.** Learners reported an overall weighted mean of 4.45, indicating they were "Highly Engaged" across behavioral, emotional, and cognitive domains. Students specifically noted high satisfaction with their ability to stay focused (WM = 4.50) and follow instructions (WM = 4.50) while enjoying the "fun" and interactive nature of the tasks. Students actively participated in tasks, followed instructions, collaborated with peers, and remained focused while completing activities. The results further indicated that the science stations supported the development of scientific literacy, as students were able to think critically, apply scientific concepts, and explore different problem-solving strategies during the activities.
- 2. Students' Experiences and Challenges in the Interactive Science Stations.** The results also revealed that students generally had positive learning experiences during the implementation of the science stations. Many students reported that the activities made science learning more interesting, interactive, and enjoyable. However, some challenges were also encountered during the implementation. These included limited time to complete activities, occasional confusion regarding instructions at certain stations, and minor difficulties in group coordination. Despite these challenges, the majority of learners expressed positive perceptions toward the use of science stations as an instructional strategy.
- 3. Students' Academic Performance Before and After the Implementation of ISS-LD (pretest and post-test results).** The results revealed that students' academic performance improved after the implementation of the Interactive Science Stations Lesson Design. Before the implementation, the majority of students were classified at the Developing level, with a mean score of 81.6, indicating moderate mastery of scientific concepts. After the implementation of ISS-LD, the mean score increased to 88.9, which corresponds to the Proficient

level. The percentage of students in the Advanced and Proficient levels increased, while the number of students classified under the Developing level decreased. This improvement indicates that the science station activities helped students better understand and apply scientific concepts.

- 4. The significant mean gain difference between the students' performance before and after the ISS-LD implementation.** The computed t-value of 5.21 with a p-value of 0.001 indicates that the difference between the pre-test and post-test scores is statistically significant at the 0.05 level of significance. Therefore, it can be concluded that the implementation of ISS-LD significantly improved the scores of the participants. There is a significant increase in the scores after the implementation of ISS-LD, indicating that the intervention was effective in improving learners' performance.

## Conclusions

The implementation of the Interactive Science Stations Lesson Design (ISS-LD) at North Shore Middle School proves to be a highly effective pedagogical intervention for Junior High School students. The study successfully demonstrates that shifting from traditional, passive learning to a structured, station-based approach significantly elevates both student engagement and academic performance. While the study identified minor logistical challenges such as time constraints, instructional clarity, and resource management - the overall "mean gain" is a profound shift toward active inquiry. By deconstructing complex topics into tactile, manageable challenges, the ISS-LD model allows students to take ownership of their learning. Ultimately, the research affirms that a structured, constructivist, and differentiated station-based environment is a powerful tool for enhancing scientific literacy and collaborative agency in the junior high school setting.

## Recommendations

Based on the findings of this research, Interactive Science Stations Lesson Design (ISS-LD), here are five recommendations to further enhance student engagement and academic performance:

- 1. Improve Time Allocation for Station Activities.** Teachers implementing science stations need to carefully plan the duration of each activity to ensure that students have enough time to complete tasks. Proper time management strategies and clear rotation signals should be used to facilitate smooth transitions between stations.
- 2. Strengthen Instructional Scaffolding with Visual Aids.** Since some students found initial instructions confusing, enhancing the clarity of station directions is vital for maintaining flow. Supplement written instructions with clear, step-by-step visual diagrams or short video demonstrations accessible via Google Classroom. This helps prevent "learned helplessness" and allows students to start their investigations immediately without waiting for teacher intervention.
- 3. Foster Positive Interdependence and Group Accountability.** To resolve issues where not everyone participates equally, groups should have more structured

roles. Assign specific responsibilities within groups (e.g., Lead Scientist, Data Recorder, Resource Manager) to ensure Positive Interdependence. This prevents the "Passenger/Hog" dynamic and ensures every student creates the vital kinesthetic "memory anchors" necessary for learning. This will help improve group coordination and ensure that all students actively participate in the science station activities.

4. Integrate Technology to Support Station Activities. Teachers may incorporate digital tools such as Google Classroom, Pear Assessment, and Desmos to provide additional support for station activities. These platforms can allow students to complete unfinished tasks, review instructions, and access learning materials outside the classroom.
5. Conduct Further Research on Interactive Science Stations Future researchers may replicate this study using larger sample sizes, different grade levels, or other science topics to further examine the effectiveness of Interactive Science Stations in improving engagement and scientific literacy.

### **Compliance with Ethical Standards**

This study adhered to ethical standards in educational research. Permission was obtained from school authorities prior to data collection, and participation was voluntary with informed consent and student assent secured. Participants were assured that their involvement would not affect their academic standing and that they could withdraw anytime. Confidentiality and anonymity were maintained by coding all data and excluding identifiable information. Data were used solely for academic purposes and surely stored.

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**APA Citation:**

Cabang, C. C., & Millanar, V. C. (2026). INTERACTIVE SCIENCE STATIONS LESSON DESIGN (ISS-LD): ENHANCING STUDENT ENGAGEMENT AND SCIENTIFIC LITERACY. *Ignatian International Journal for Multidisciplinary Research*, 4(4), 576–591.  
<https://doi.org/10.5281/zenodo.19558128>

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