INDIAN JOURNAL OF SCIENCE AND TECHNOLOGY

ORIGINAL ARTICLE

Check for updates

OPEN ACCESS

Received: 25/04/2026

Accepted: 06/05/2026

Published: 30/05/2026

Citation: Tupas FP, Arambola JS, Abenir MCM, Asis AM, Padronia RZ, Saban LLZ (2026) STEAM Approach: Enhancing Early Childhood Education Through an Interdisciplinary Approach. Indian Journal of Science and Technology 19(20): 1351-1361. https://doi.org/10.17485/IJST/v19i20.677

* **Corresponding author**.

ftupas@nisu.edu.ph

Funding: None

Competing Interests: None

Copyright: © 2026 Tupas et al. This is an open access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Published By Indian Society for Education and Environment (iSee)

ISSN
Print: 0974-6846
Electronic: 0974-5645

STEAM Approach: Enhancing Early Childhood Education Through an Interdisciplinary Approach

Fernan P Tupas[1]*, Joselyn S Arambola[2], Maria Carol M Abenir[3], Alden M Asis[3], Razel Z Padronia[3], Leyla Leah Z Saban[4]

1 Science Education, College of Education – Science Department, Northern Iloilo State University, Ajuy Campus, Iloilo, Philippines
2 Faculty, Bachelor of Elementary Education, Northern Iloilo State University, Ajuy Campus, Iloilo, Philippines
3 Faculty, College of Education, Northern Iloilo State University, Conception Campus, Iloilo, Philippines
4 Teacher, Susan Gray School Vanderbilt University, USA

Abstract

Objectives: This study aims to identify the different strategies and methods of STEAM integration in nurseries, kindergartens, and Grades 1 and 2 in the Philippines. **Method:** This study utilized a descriptive survey design to examine the implementation of the STEAM approach in early childhood education. The respondents of this research were 150 purposively selected early childhood educators from nursery, kindergarten, and grades 1, 2, and 3 in the Municipality of Ajuy, Iloilo, Philippines. Descriptive statistics (mean and standard deviation) were computed to determine the frequency and level of STEAM-related activities by grade level and agency. The Kruskal–Wallis test was used to examine significant differences across grade levels. **Findings:** In nursery school 6, the STEAM activities were ranked at very high frequency, with mean scores ranging from 3.57 to 3.90. In kindergarten, 14 activities were considered high frequency, with mean scores ranging from 2.13 to 3.70. In grade 1, three activities were described as very high frequency, with mean scores of 3.73 and 3.87. While in grade 2, the puzzle was ranked very high with a mean score of 3.50, and the rest were of high frequency. And for grade 3, all were translated as very high frequency. The art craft had the highest mean score of 3.90. For the inferential statistics, none were significant except for puzzle, which showed a significant difference between groups. These results indicate that teachers progressively intensify and diversify activities as pupils advance, aligning instructional practices with learners' developmental needs. **Novelty:** The study highlights both the prevailing strategies for STEM integration and the need for targeted support, particularly in cognitively enriching tasks. It underscores the effectiveness of current practices and the importance of sustained teacher training, resource provision, and curriculum development to maintain the quality of early childhood education in the Philippines.

Keywords: Preschool; Nursery; Grades 1 and 2; Teachers; Science; Technology; Engineering and Mathematics; Skills

1 Introduction

The global landscape of science education shifted from discipline-based instruction to a focus on Science, Technology, Engineering, and Mathematics, and then evolved to integrate the arts, becoming STEAM. This integration focuses on fostering creativity and contextualized relevance by recognizing that real-world problems are complex and require interdisciplinary thinking, innovations, and communication. Despite these advancements, implementation remains uneven, particularly in early childhood education, which is the formative stage of learning. In many education systems, including the Philippines, STEM concepts are introduced very late. They also taught the concept in fragmented ways, limiting young learners' chances to develop curiosity, problem-solving skills, and consolidative thinking during the critical developmental stage.

Recent research shows that early exposure to integrated STEM, or even STEAM, through inquiry-based, hands-on activities improves cognitive flexibility and early numeracy, as well as foundational scientific reasoning [1]. Also, STEAM subjects promote creativity and problem-solving through hands-on, project-based, and thematic learning [2]. Another finding is that children viewed STEM activities in early childhood education positively, and they recognized the future economic benefits [3]. In addition, STEAM innovations help connect science with real-world and cultural context [4].

But in the context of the Philippine education system, teachers are utilizing STEAM activities across various curricula, yet there is a lack of documentation on which specific STEAM activities are employed. Thus, one study suggests that teacher training is important for improving STEAM implementation and enhancing early childhood development outcomes [5]. Some challenges include the fact that STEAM is mostly local and lacks robust empirical validation. Also, this study confirmed that the evaluation of STEAM use in the classroom remains limited. Various studies are descriptive rather than comparative [4]. In addition, another study exposed a lack of resources, time, training, and confidence in teaching STEM. Another challenge was a lack of structured instructional design, underdeveloped assessment tools for measuring creativity and interdisciplinary learning, and the absence of studies on local culture [5]. Thus, there is a need for better teacher training, clearer guidance on STEM curricula, and parent support in facilitating children's learning [3]. However, the Department of Education (DepEd) has already adopted STEAM integration into the basic education curriculum, but very few schools follow suit. Thus, professional development must be implemented for the success of this approach.

It is important to assess early childhood teachers' understanding of STEAM to develop structured instructional designs that enhance children's cognitive, creative, and problem-solving skills. Based on this, appropriate assessment tools can be created to measure skill development, and teacher training workshops can be conducted to strengthen the effective implementation of STEAM compared to other teaching approaches. STEAM implemented through collaborative, project-based learning can improve learners' social skills and empathy by promoting cooperation, communication, and peer interaction. It highlights STEAM as both a cognitive and social learning approach that supports children's real-life context [6]. This also supports the need to develop young learners' social competence and compassion early in education.

This study addresses these gaps by systematically examining how the STEAM approach can enhance early childhood education through an interdisciplinary lens. By identifying effective strategies, challenges, and opportunities for integrating STEAM in nurseries, kindergartens, and early primary grades, this research seeks to contribute novel insights into how early learners can experience a richer, more connected form of education. In doing so, it responds to the global call to prepare young children not only with foundational STEM skills but also with creativity, collaboration, and problem-solving abilities essential to the demands of Society 5.0. Thus, this study aims to identify the different strategies and methods of STEAM integration in nurseries, kindergartens, and Grades 1 and 2 in the Philippines.

Figure 1 presents the study's conceptual framework, illustrating how the STEAM approach is applied in nurseries, kindergartens, and Grades 1 to 3 in the Philippines. The framework outlines the key components, processes, and expected outcomes of integrating Science, Technology, Engineering, Arts, and Mathematics in early childhood and early primary education.

STEAM Education is a term derived from STEM and a movement that emerged in the early 1990s. STEAM is a combination of science, technology, engineering, arts, and mathematics that supports meaningful learning. These learning approaches enhance learners' creativity, scientific inquiry, communication, critical thinking, and problem-solving skills, all of which connect to real-life situations. This allows learners to apply what they learn in daily experiences through interactive, interdisciplinary learning [7]. This is also confirmed by other findings that working with interdisciplinary and STEAM-based approaches can help enhance education and sustainability [8]. STEAM strategies help young children develop a wider range of creative thinking skills. In early childhood education, especially for ocean literacy and sustainability, STEAM provides meaningful, hands-on, inquiry-based learning experiences that actively engage students [9]. STEAM learning in infancy and toddlerhood supports spontaneous discovery through curiosity, play, and interaction. Activities such as using wind tunnels and scarves can spark insight and enhance creativity. This highlights that creativity develops through engagement with people and the environment, emphasizing the importance of sensory and aesthetic experiences in early STEAM education [10]. Activities

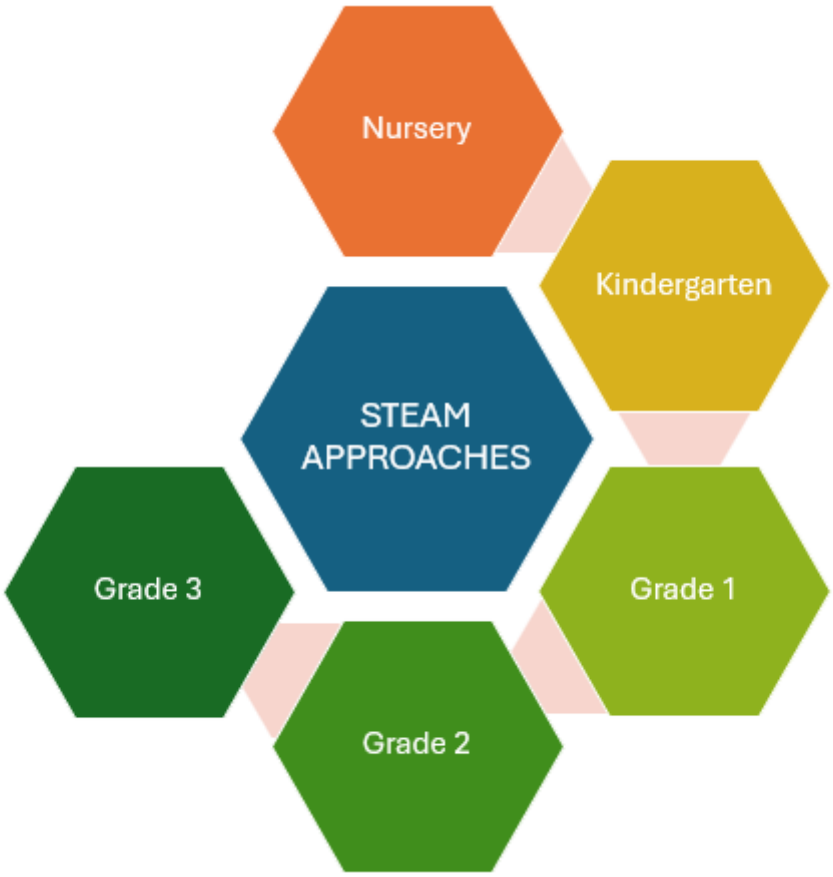


Fig 1. The study's conceptual framework illustrates how the STEAM approach is used in early childhood education in the Philippines

such as puzzles and games have been shown to improve students' mastery of concepts, boost academic performance, and enhance long-term knowledge retention, particularly in chemistry[11]. Thus, the literature provides both a strong theoretical basis and practical guidance for designing STEAM-focused curricula that prepare young learners to become innovative thinkers and responsible stewards of the environment. These circumstances emphasize how, at a very young age, children develop thinking and creativity through hands-on experience under an adult's guidance.

The gap this study seeks to address is how specific instructional designs, measurable creativity outcomes, and teachers' practices are tailored for young learners. Another gap is that much research focuses on benefits and general outcomes, but not in the context of local culture and children's everyday experiences. And providing a validated tool to assess creativity and interdisciplinary learning in early childhood education. The novelty of the paper lies in its focus on using a structured interdisciplinary STEAM approach. Thus, this study underscores that integrating various activities can directly enhance creativity, such as flexible, innovative, elaborative, and fluent thinking among young learners. Also, this study offers practice-based insights for teachers on creating developmentally appropriate, real-world, connected STEAM activities that bridge theory and classroom practice. Hence, this study provides vigorous evidence that art integration, play-based exploration, and interdisciplinary methods can foster cognitive and affective development in early learners.

2 Methodology

2.1 Research Design

A descriptive cross-sectional survey design was utilized in this paper to analyze the extent and patterns of STEAM implementation in early childhood education in the Philippines. This approach enabled the study to describe current teaching practices and compare STEAM integration across grade levels and types of institutions.

2.2 Participants and Setting

The setting of this study is the Municipality of Ajuy, in the 5th District of Iloilo, Philippines, where nursery, kindergarten, and grades 1, 2, and 3 teachers from the Department of Education (DepEd) and the Department of Social Welfare and Development (DSWD) participated. They were purposively selected because they met the following criteria: currently teaching in early childhood education, with at least 1 year of teaching experience, and actively implementing STEAM-related activities in their classroom.

Thus, 150 teachers participated in the study, with 30 per grade level. The questionnaires were distributed; all were retrieved and deemed usable. The participation of the selected early childhood educators yielded 100% response rate. Participants varied in teaching experiences, educational qualifications, and institutional affiliations, providing a diverse representation of early childhood educators in the locality. However, their profile was not included in this research paper because the main purpose of the study was to determine how frequently they used STEAM activities in their teaching and learning processes.

2.3 Instrumentation

The data were collected using a researcher-developed questionnaire based on a preliminary pre-survey and relevant literature on STEAM integration. The instrument consisted of a series of STEAM-related activities. These items were measured using a 5-point Likert scale. For frequency, the scale ranged from 1 (Never) to 5 (Always). This instrument was validated by a panel of specialists in early childhood education and STEAM pedagogy. To ensure reliability, internal consistency was assessed using Cronbach's alpha, yielding acceptable indices ($\alpha \geq 0.70$) across all subscales. This indicates that the instrument was suitable for measuring the intended constructs.

2.4 Research Procedure

Prior to data collection, ethical clearance and approval were obtained from the Office of Research and Development Services of Northern Iloilo State University (NISU) at the Ajuy Campus. Formal requests were submitted to the DepEd and DSWD offices to secure permission to conduct the study.

Data collection was conducted from January 2024 to September 2025. The researchers personally administered the questionnaires during school visits to ensure consistency in data collection procedures. Instructions were clearly explained, and respondents were given sufficient time to complete the instrument. On-site retrieval of questionnaires was implemented to minimize non-response and ensure complete data.

2.5 Data Analysis

Descriptive statistics, including mean and standard deviation, were used to summarize the level and frequency of STEAM-related practices and perceived challenges. To examine differences across grade levels, the Kruskal–Wallis H test, a nonparametric alternative to one-way ANOVA, was employed because the data were ordinal and normality assumptions were not met. When significant differences were detected, post hoc pairwise comparisons were conducted to identify specific group differences. Statistical significance was set at $p < 0.05$.

2.6 Data Availability Statement

The datasets generated and analysed during the current study are available from the corresponding author upon reasonable request, subject to institutional data-sharing policies and ethical considerations.

3 Results and Discussion

Table 1 presents how 30 nursery teachers integrate the STEAM approach into their teaching, based on how frequently they use different activities.

Table 1. The Responses of Nursery Teachers on How They Integrate the STEAM Approach into their Teaching and Learning Practices

Category	N	Mean	SD	Interpretation
Puzzles	30	3.87	.51	Very High Frequency
Board games	30	3.27	.98	High Frequency
Building Toys	30	3.67	.71	Very High Frequency
Asking Question	30	3.47	.90	High Frequency
Art Crafts	30	3.57	.82	Very High Frequency
Dance	30	3.40	.97	High Frequency
Drama	30	3.43	.97	High Frequency
Memory Game	30	3.00	.96	High Frequency
Obstacle Course	30	2.43	1.16	Moderate Frequency
Relay	30	2.83	1.23	High Frequency
Sack Race	30	2.63	1.00	High Frequency
Maze	30	2.67	.84	High Frequency
Inspire Thinking	30	3.27	1.11	High Frequency
Dress Up with Your Imagination	30	3.10	1.12	High Frequency
Role Play	30	2.97	1.30	High Frequency
Nursery Rhymes	30	3.73	.58	Very High Frequency
Using ICT	30	2.70	.95	High Frequency
Drawing	30	3.90	.30	Very High Frequency
Coloring Books	30	3.80	.55	Very High Frequency
Number Games	30	3.17	1.08	High Frequency

Interpretation: 4.0 - 3.5 – Very High Frequency; 3.49 – 2.50 – High Frequency; 2.49 – 1.50 Moderate Frequency; 1.49 – 1.0 - Low Frequency

The findings for nursery teachers show a strong, consistent integration of STEAM through creative, play-based activities. The drawing (M=3.90), puzzles (M=3.87), coloring books (M=3.80), nursery rhymes (M=3.73), building toys (M=3.67), and arts and crafts (M=3.57) were all interpreted as very high frequency. The results align with the existing literature that emphasizes the vital role of creative expression in early childhood education. This is confirmed by a prior study that drawing supports early literacy development, communication, and symbolic thinking among young learners [12]. STEAM is widely used in early childhood education for developing skills such as creativity and problem-solving, but these are often treated as unexamined "buzzwords." Some of these ideas have biased historical roots and may shift education toward economic productivity rather than holistic development. The perspective calls for redefining STEAM concepts to be more inclusive, socially just, and focused on fostering empathy and connections with the world [13]. Thus, the current findings reinforce the claim that teachers rely heavily on visual and artistic activities as primary entry points for STEAM integration.

But compared with studies advocating a more balanced, interdisciplinary STEAM strategy, the results show a critical limitation. While teaching, creative and exploratory tasks, activities that promote physical engagement, like obstacle races (M=2.43), and inquiry-driven learning (M=3.47) are less emphasized. This diverges from research suggesting that effective STEAM integration requires the simultaneous development of cognitive, physical, and problem-solving skills through different teaching strategies. The low use of movement-based activities shows that young learners are not yet ready for physically engaging STEAM experiences. On the contrary, contemporary early childhood frameworks argue that kinesthetics learning is essential for holistic development. This implies a mismatch between current practice and theoretical recommendation. Moreover, additional studies confirmed teachers favor play-based and child-centered methods, but a closer analysis suggests that such implementation may remain at a surface level [14]. Frequent STEAM activities do not guarantee effective integration, as they are often disconnected and overly focused on the arts, underscoring the need for more balanced, intentional lesson design.

Table 2 shows how 30 kindergarten teachers integrate the STEAM approach into their teaching practices using different learning activities.

Table 2. The Responses of Kindergarten Teachers Regarding the Integration of the STEAM Approach in Teaching and Learning

Category	N	Mean	STD	Interpretation
Puzzles	30	3.40	1.22	High Frequency
Board games	30	2.63	.93	High Frequency
Building Toys	30	2.77	.77	High Frequency
Asking Question	30	2.03	.61	Moderate Frequency
Art Crafts	30	3.47	1.04	High Frequency
Dance	30	3.43	.97	High Frequency
Drama	30	1.87	.90	Moderate Frequency
Memory Game	30	2.70	.80	Moderate Frequency
Obstacle Course	30	2.13	.73	Moderate Frequency
Relay	30	2.87	.78	High Frequency
Sack Race	30	2.90	.66	High Frequency
Maze	30	3.33	.96	High Frequency
Inspire Thinking	30	3.27	1.17	High Frequency
Dress Up with Your Imagination	30	1.93	1.20	Moderate Frequency
Role Play	30	2.80	.61	High Frequency
Nursery Rhymes	30	3.40	.97	High Frequency
Using ICT	30	1.90	.88	Moderate Frequency
Drawing	30	3.70	.60	Very High Frequency
Coloring Books	30	3.67	.66	Very High Frequency
Number Games	30	3.70	.60	Very High Frequency

Interpretation: 4.0 - 3.5 – Very High Frequency; 3.49 – 2.50 – High Frequency; 2.49 – 1.50 Moderate Frequency; 1.49 – 1.0 - Low Frequency

For kindergarten, the results show a patterned but uneven integration of the STEAM approach. The results reveal a dominance of creative and academically oriented undertakings, with a moderate use of inquiry-based, technological, and imaginative tasks. Activities such as drawing, number games, and coloring books, with mean scores of 3.73, 3.70, and 3.67, respectively, were implemented at very high frequency. This implies that teachers strongly emphasize foundational literacy and numeracy skills through creative expression. Also, activities that are focused on physical and game-based activities, such as relay races, sack races, and role-play, further support this interpretation. Although these activities are generally rated as high frequency, their relatively high standard deviations indicate inconsistent teacher ratings. This inconsistency contrasts with the more stable use of structured and creative tasks, suggesting that less traditional or more dynamic STEAM activities may depend heavily on individual teacher confidence, resources, or training. This aligns with previous studies suggesting that STEAM supports cognitive, motor, and aesthetic development in early learners [5]. Moreover, previous studies report that teachers often have limited familiarity with STEAM but are willing to adopt it. But the study reveals that learners show strong interest in hands-on, inquiry-based, and experimental STEAM activities [15].

Table 3 presents how 30 Grade 1 teachers integrate the STEAM approach into their teaching practices using different learning activities.

The results for grade 1 teachers indicate that STEAM integration is generally well established. Almost all activities are at high frequency, and several reach very high frequency. These are evident in number games (M=3.87), coloring books (M=3.77), and puzzles (M=3.73). The results reflect a strong emphasis on foundational academic skills such as numeracy, fine motor development, and structured cognitive tasks. These results are consistent with previous findings highlighting STEAM's effectiveness in improving students' knowledge, skills, and engagement in primary school [16]. While the current findings align with the literature, emphasizing the value of interdisciplinary and arts-integrated learning. The results also exposed a more structured, academically oriented method than is typically promoted in student-centered STREAM frameworks.

The present study shows that inquiry-based practices, such as asking questions (M=3.01), are less consistently implemented than expressive and physically engaging activities, such as sack races (M=2.45), drama (M=2.63), and role play (M=2.50). This divergence proposes that, although STEAM is present in Grade 1 classrooms, it is often delivered through controlled, teacher-

Table 3. The Replies of Grade 1 Teachers on How they Integrate the STEAM Approach into their Teaching and Learning Practices

Category	N	Mean	STD	Interpretation
Puzzles	30	3.73	.45	Very High Frequency
Board games	30	3.33	.76	High Frequency
Building Toys	30	3.00	.79	High Frequency
Asking Question	30	3.01	.91	Moderate Frequency
Art Crafts	30	2.83	.53	High Frequency
Dance	30	2.90	.84	High Frequency
Drama	30	2.63	.67	High Frequency
Memory Game	30	3.27	.87	High Frequency
Obstacle Course	30	2.73	.58	High Frequency
Relay	30	2.53	.57	High Frequency
Sack Race	30	2.45	.68	Moderate Frequency
Maze	30	2.77	.73	High Frequency
Inspire Thinking	30	3.20	1.16	High Frequency
Dress Up with Your Imagination	30	2.73	.98	High Frequency
Role Play	30	2.50	.90	High Frequency
Nursery Rhymes	30	3.17	1.02	High Frequency
Using ICT	30	2.83	.70	High Frequency
Drawing	30	3.13	.90	High Frequency
Coloring Books	30	3.77	.50	Very High Frequency
Number Games	30	3.87	.34	Very High Frequency

Interpretation: 4.0 - 3.5 – Very High Frequency; 3.49 – 2.50 – High Frequency; 2.49 – 1.50 Moderate Frequency; 1.49 – 1.0 - Low Frequency

guided activities rather than open-ended exploration. Such a pattern points to a gap between theoretical models of STEAM, which emphasize creativity, collaboration, and learner autonomy, and actual classroom practices that may still lean toward structured instruction.

Moreover, the use of board games, building toys, drawing, and memory games was interpreted as high frequency. The results, both quantitative and qualitative, found that board games can improve students' engagement, motivation, and understanding in STEM education [17]. But activities such as inquiry-based, physical, and ICT-driven approaches are less emphasized due to constraints on time, resources, and classroom conditions. However, effective use of digital tools has been shown to enhance learners' engagement and understanding, especially when supported by proper planning and teacher training [18].

Table 4 displays the responses of Grade 2 teachers on how they integrate the STEAM approach into their teaching and learning practices.

Grade 2 demonstrates a highly uniform and systematic implementation of STEAM, with all activities at high frequency and puzzles achieving the highest mean score (M = 3.50). This reflects consistent classroom delivery compared to earlier grades, with more variation. However, the similar use of activities suggests a "one-size-fits-all" approach that may limit flexibility, differentiation, and deeper skill development. Although ICT, creative, and physical activities are well represented, their comparable mean scores indicate broad but shallow integration. Inquiry-based activities such as "asking questions" (M = 3.07) and "inspiring thinking" (M = 2.90) are present but less emphasized, suggesting that higher-order thinking is less deeply embedded than recommended in STEAM education. Overall, implementation is consistent but lacks depth and strong instructional focus.

This aligns with studies that emphasize that structured, repeated exposure to STEAM activities can enhance students' creativity, problem-solving, and the real-world application of knowledge [19]. Also, the prominence of puzzles as the only very highly implemented activity provides an important point of comparison with existing studies. Prior research confirms that puzzle-based learning significantly enhances cognitive skills, including reading, problem-solving, and retention [20].

Table 5 presents the responses of Grade 3 teachers regarding the integration of the STEAM approach in teaching and learning.

The findings for Grade 3 demonstrate a markedly intensive integration of the STEAM approach, with all activity categories achieving very high frequency (M=3.50–3.90). This represents a clear progression from earlier grade levels, where execution was generally high but not maximized. Such a pattern proves developmental perspectives, suggesting that as learners mature

Table 4. The Responses of Grade 2 Teachers on How they Integrate the STEAM Approach into their Teaching and Learning Practices

Category	*N*	*Mean*	*STD*	*Interpretation*
Puzzles	30	3.50	.73	Very High Frequency
Board games	30	3.17	.95	High Frequency
Building Toys	30	3.30	.75	High Frequency
Asking Question	30	3.07	.75	High Frequency
Art Crafts	30	3.23	.77	High Frequency
Dance	30	3.23	.90	High Frequency
Drama	30	2.87	.82	High Frequency
Memory Game	30	3.10	.76	High Frequency
Obstacle Course	30	2.83	.87	High Frequency
Relay	30	2.83	.91	High Frequency
Sack Race	30	3.03	.72	High Frequency
Maze	30	2.70	.75	High Frequency
Inspire Thinking	30	2.90	.92	High Frequency
Dress Up with Your Imagination	30	3.00	.95	High Frequency
Role Play	30	2.93	.87	High Frequency
Nursery Rhymes	30	2.87	.97	High Frequency
Using ICT	30	3.20	.89	High Frequency
Drawing	30	3.07	.87	High Frequency
Coloring Books	30	2.80	.85	High Frequency
Number Games	30	3.10	.71	High Frequency

Interpretation: 4.0 - 3.5 – Very High Frequency; 3.49 – 2.50 – High Frequency; 2.49 – 1.50 Moderate Frequency; 1.49 – 1.0 - Low Frequency

Table 5. The Responses of Grade 3 Teachers Regarding the Integration of the STEAM Approach in Teaching and Learning

Category	**N**	**Mean**	**STD**	**Interpretation**
Puzzles	30	3.60	.67	Very High Frequency
Board games	30	3.57	.72	Very High Frequency
Building Toys	30	3.63	.56	Very High Frequency
Asking Question	30	3.80	.55	Very High Frequency
Art Crafts	30	3.90	.30	Very High Frequency
Dance	30	3.77	.50	Very High Frequency
Drama	30	3.83	.46	Very High Frequency
Memory Game	30	3.87	.34	Very High Frequency
Obstacle Course	30	3.70	.53	Very High Frequency
Relay	30	3.87	.34	Very High Frequency
Sack Race	30	3.50	.73	Very High Frequency
Maze	30	3.73	.45	Very High Frequency
Inspire Thinking	30	3.73	.52	Very High Frequency
Dress Up with Your Imagination	30	3.83	.38	Very High Frequency
Role Play	30	3.77	.43	Very High Frequency
Nursery Rhymes	30	3.57	.57	Very High Frequency
Using ICT	30	3.73	.58	Very High Frequency
Drawing	30	3.80	.41	Very High Frequency
Coloring Books	30	3.63	.67	Very High Frequency
Number Games	30	3.77	.43	Very High Frequency

Interpretation: 4.0 - 3.5 – Very High Frequency; 3.49 – 2.50 – High Frequency; 2.49 – 1.50 Moderate Frequency; 1.49 – 1.0 - Low Frequency

cognitively and socially, teachers are more able, and perhaps more confident, to implement a wider range of complex and interactive activities. This aligns with studies highlighting the effectiveness of structured STEAM models, such as the 6E framework, in enhancing both conceptual understanding and creative thinking among elementary learners [21]. This contrasts with theoretical models that stress quality, integration, and alignment of activities with specific learning outcomes.

Moreover, the strong presence of both inquiry-based activities (e.g., asking questions, M=3.80; inspiring thinking, M=3.73) and expressive or experiential tasks (e.g., drama, role play, dance) suggests a more holistic implementation of STEAM compared to lower grade levels. This aligns with the literature advocating interdisciplinary and student-centered approaches. The study found that STEAM improves students' science skills, communication, collaboration, and engagement. It also shows that integrating art and design helps deepen understanding and enjoyment of learning. Overall, STEAM is an effective approach for developing scientific literacy in elementary education [22]. STEAM integration is strongest in Grade 3, with earlier grades receiving less depth, and there is a need for a more balanced, responsive implementation across all levels.

Table 6 presents the results of the Kruskal–Wallis test assessing differences in the integration of the steam approach across grade levels.

Table 6. The Results of the Kruskal–Wallis Test Assessing Differences in the Integration of the STEAM Approach Across Grade Levels

Category	Chi-squqre	df	Asymp. Sig	Interpretation
Puzzles	7.032	4	.134	Significant Difference
Board games	18.051	4	.001	No Significant Difference
Building Toys	32.507	4	.000	No Significant Difference
Asking Question	55.414	4	.000	No Significant Difference
Art Crafts	42.514	4	.001	No Significant Difference
Dance	18.482	4	.000	No Significant Difference
Drama	67.035	4	.000	No Significant Difference
Memory Game	33.546	4	.000	No Significant Difference
Obstacle Course	67.035	4	.000	No Significant Difference
Relay	40.722	4	.000	No Significant Difference
Sack Race	27.879	4	.000	No Significant Difference
Maze	37.968	4	.000	No Significant Difference
Inspire Thinking	11.935	4	.000	No Significant Difference
Dress Up with Your Imagination	41.855	4	.000	No Significant Difference
Role Play	35.579	4	.000	No Significant Difference
Nursery Rhymes	17.142	4	.002	No Significant Difference
Using ICT	53.024	4	.000	No Significant Difference
Drawing	30.749	4	.000	No Significant Difference
Coloring Books	37.546	4	.000	No Significant Difference
Number Games	27.66	4	.000	No Significant Difference

The Kruskal–Wallis test shows that most STEAM activities differ significantly across grade levels, indicating inconsistent implementation, whereas only puzzle activities show no significant difference, indicating consistent implementation across grades. This is supported by one study that found that puzzle activities significantly improved children's cognitive development, as shown by higher post-test scores. The findings indicate that puzzle play enhances logical thinking, focus, independence, and problem-solving, with teachers playing a key supportive role [23]. Another study showed that puzzles were the only activity to show significant variation, emphasizing their importance in developing problem-solving, sequencing, and analytical thinking skills, consistent with prior research [24]. Puzzles are the only activity that varies, likely due to differences in planning and resources, suggesting overall uniform but less responsive implementation.

In addition, one finding suggests that integrating design thinking into STEAM significantly enhances creativity, analytical reasoning, and motivation, while also supporting informed career choices through real-world, learner-centered problem-solving [25]. Hence, helping teachers develop an interest in and implement STEAM education is a vital component of this approach's success.

4 Conclusion

The findings show that STEAM integration in early childhood education is implemented at consistently high levels with a clear developmental progression from nursery to grade 3. In terms of quantitative results, most activities fall within the high frequency range, with mean scores between 2.50 and 3.49, and within the very high frequency range, with mean scores between 3.50 and 4.00. But with all the grade l3v3l, grade 3 was where all activities reached a very high frequency with a mean score of 3.50 to 3.90. Inferential results showed that only the "puzzles" category exhibited a statistically significant difference ($p < 0.05$), while all other activities showed no significant difference ($p > 0.05$), indicating strong uniformity in implementation. These results showed that STEAM integration is widely institutionalized. The study makes a valuable contribution by showing that such uniformity may reflect standardization rather than full differentiation. The differences in puzzle activities highlight how cognitively demanding tasks can be influenced by teachers' readiness, access to resources, and instructional confidence. This finding extends beyond previous studies that primarily focus on adoption levels. The study's strength lies in its comprehensive cross-grade analysis and in the use of descriptive and inferential approaches. This methodology provides a clearer, more nuanced understanding of STEAM implementation patterns. However, limitations include reliance on self-reported data, a focus on frequency rather than instructional quality or learner outcomes, and limited consideration of contextual factors such as teacher training and resource availability. These constraints point to important areas for further investigation, including the impact of STEAM practices on student learning outcomes, the role of teacher competence in shaping implementation, and the need for differentiated approaches across developmental levels. In addition, the findings suggest that efforts should shift from maintaining uniform implementation towards depth, intentionally, and contextual relevance. Based on the findings, the study suggests that professional development should focus on strengthening teachers' capacity for inquiry-based, technology-integrated, and cognitively demanding activities. Schools should also invest in contextual and real-world learning environments to enrich STEAM experiences, while curriculum developers must ensure a more balanced integration of all STEAM domains. Overall, this study underscores that effective STEAM education is not defined solely by the frequency of activities, but by the quality, differentiation, and meaningful application of learning experiences, thereby offering a more refined direction for advancing early-grade STEAM education.

5 Acknowledgments

The author sincerely expresses gratitude to the Office of Research and Development Services (ORDS), NISU Main Campus, Estancia, Iloilo, Philippines, for the financial support of this study. Appreciation is also extended to the evaluators and participants for their valuable time and contributions to the research process.

6 Contribution of the Authors

Fernan Peniero Tupas: Conceptualization, funding acquisition, creating the comic strips, validation, formal analysis, writing—original draft preparation, writing—review and editing, project administration

Joselyn G. Arambola: Writing the instrument, in charge of the validation, and pre-survey

Maria Carol M. Abenir: Creating methodology, validation of the data, and providing resources

Jocelyn A. Arambola: Validation of paper, instruments, and other materials

Alden M. Asis**:** Statistical Analysis, Review, and editing

JRazel S. Padronia: Formal analysis, methodology, and editing of the manuscript

Leyla Leah Z. Zaban: Review the content of the introduction and analysis of statistical results

References

1) Leung V. STEM education in early years: challenges and opportunities in changing teachers' pedagogical strategies. *Education Sciences*. 2023;13(5):490. 10.3390/educsci13050490.
2) Li J. Effective strategies for interdisciplinary integration in steam curriculum design. *Transactions on Social Science, Education and Humanities Research*. 2024;8:99–105. https://doi.org/10.62051/gvesha87.
3) Wan ZH, Jiang Y, Zhan Y. STEM education in early childhood: A review of empirical studies. *Early Education and Development*. 2021;32(7):940–962. https://doi.org/10.1080/10409289.2020.1814986.
4) Türk A, Akcanca N. An example implementation of STEM in preschool education: Magnets. *Journal of Educational Leadership and Policy Studies*. 2021. Available from: https://files.eric.ed.gov/fulltext/EJ1308453.pdf.
5) Laga DG. Teachers' use of STEAM and its impact on kindergarten developmental skills in the Matatag Curriculum. *Journal of Interdisciplinary Perspectives*. 2025;3(7):100–112. https://doi.org/10.69569/jip.2025.291.

6) Zahrah A, Mazidah NA, Aini N, Oktavia R, Bandara KMNTK, Jr RFU, et al. Reframing STEAM in early childhood education: A qualitative study of its role in fostering social competence in Indonesian kindergarten contexts. *Nak-Kanak: Journal of Child Research*. 2026;3(1):41–50. https://doi.org/10.21107/njcr.v3i1.208.
7) Hong JC, Ye JH, Ho YJ, Ho HY. Developing an inquiry and hands-on teaching model to guide STEAM lesson planning for kindergarten children. *Journal of Baltic Science Education*. 2020;19(6):908–922. https://doi.org/10.33225/jbse/20.19.908.
8) Gómez S, Garriga A, Bosch MT, Bosch M, Villasante S, Salazar J. Ocean literacy in managing marine protected areas: Bridging natural and cultural heritage. *Frontiers in Marine Science*. 2025;12:1540163. https://doi.org/10.3389/fmars.2025.1540163.
9) Atikah C, Biru LT. STEAM-based learning to enhance early childhood creativity. *International Journal of STEM Education for Sustainability*. 2024;4(1):164–175. 10.53889/ijses.v4i1.303.
10) Tsuchiya K, Gyobu I. Activating STEAM learning in young children through aha-experiences: Supporting Creativity and aesthetic sensitivity in infants and toddlers. *Education Sciences*. 2025;15(2):117. 10.3390/educsci15020117.
11) Adzape JN, Otor EE, Akpoghol TV. Effects of chemistry-based puzzles on senior secondary school chemistry students' achievement and gender in chemical. *Education and Linguistics Research*. 2020;6(2):88–100. https://doi.org/10.5296/elr.v6i2.17836.
12) Havigerová JM, Pohnětalová Y, Strnadová K, Kocourková K, Podubecká D. Preschool children's drawings: Frequency and theme analysis. *International Journal of Education & Literacy Studies*. 2021;9(3):70–77. http://dx.doi.org/10.7575/aiac.ijels.v.9n.3p.70.
13) Günther-Hanssen A, Areljung S, Magnusson LO, Lindqvist A. From problem-solving, innovation and creativity to empathy, connection and care? Troubling the use of STEAM buzzwords in early childhood education research. *Contemporary Issues in Early Childhood*. 2025;27(1):1–6. https://doi.org/10.1177/14639491251330301.
14) Mullick J, Wang Q, Vlcek S, Sikder A. The possibility of meeting the needs of all children: A framework for enhancing inclusive STEAM pedagogy in early childhood settings. *International Journal of Educational Research*. 2025;133:102705. https://doi.org/10.1016/j.ijer.2025.102705.
15) Veziroglu-Celik M, Ozkaya S, Kacar G, et al. STEAM in Early Childhood: An Analysis Towards Teachers' and Children's Perspectives. *Early Childhood Education Journal*. 2026;54:1027–1039. https://doi.org/10.1007/s10643-025-01897-9.
16) Yim IHY, Su J, Wegerif R. STEAM in practice and research in primary schools: a systematic literature review. *Research in Science & Technological Education*. 2025;43(4):1065–1089. https://doi.org/10.1080/02635143.2024.2440424.
17) Adaya J, Boquila JM, Jerusalem JB, Kilat BMG. Technology integration in kindergarten classroom: A boon or a bane. *International Journal of Research and Innovation in Social Science*. 2025;IX(VI):1705–1723. https://dx.doi.org/10.47772/IJRISS.2025.906000134.
18) Nguyen TTKN, Ngo TPA, Pham AT, Nguyen DD, Cheng PH, Nguyen VB. Let's play! Transforming STEM education with board games. *EURASIA Journal of Mathematics, Science and Technology Education*. 2024;20(8):em2494. https://doi.org/10.29333/ejmste/14920.
19) Sasmita FE, Hidayati N, Aslam PF. Integration of STEAM approach in mathematics learning to enhance creativity of elementary school students. *Journal of Innovative and Creativity*. 2025;5(2):7830–7842. Available from: file:///C:/Users/ASUS-User/Downloads/Integration_of_STEAM_Approach_in_Mathematics_Learn.pdf.
20) Idika MI, Oluwaseyi MP. The impact of puzzle game and video-based puzzle strategies on students' achievement and retention in periodicity. *Journal of Mathematics and Science Teacher*. 2024;4(2):em061. https://doi.org/10.29333/mathsciteacher/14366.
21) Gustiana AD, Agustin M, Djoehaeni H. Enhancing early literacy: The effectiveness of the picture word inductive model with smartphone assistance in the early childhood to elementary transition. *Al-Ishlah: Jurnal Pendidikan*. 2025;17(1):319–330. https://doi.org/10.35445/alishlah.v17i1.6017.
22) Jongluecha P, Worapun W. Developing grade 3 student science learning achievement and scientific creativity using the 6E model in STEAM education. *Journal of Educational Issues*. 2022;8(2):142–151. https://doi.org/10.5296/jei.v8i2.20049.
23) Alvionita N, Narasaki N, Julia H. The Effectiveness of the STEAM Approach in Developing Scientific Literacy of Elementary School Students. *JOBE: Journal of Basic Education*. 2025;1(1):30–42. Available from: https://journal.zmsadra.or.id/index.php/fej/article/view/80.
24) Safitri AR, Rizqiyani R. Puzzle-based instruction to improve cognitive development in early childhood education. *Human Psychology & Behavior*. 2025;1(1):6–11. https://doi.org/10.58920/etflin000000.
25) Skovronskyi B, Sipii V, Morin O, Ohrimenko Z, Khrenova V. Design thinking in STEAM education curricula: development and evaluation of effectiveness. *Revista Eduweb*. 2025;19(3):184–198. https://doi.org/10.46502/issn.1856-7576/2025.19.03.12.