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Art-Integrated Chemistry Education: Bridging Abstract Concept and Aesthetic Literacy Through Qualitative Inquiry

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Abstract

In this research paper, we focus on how different arts are used in chemistry education. We have employed a qualitative reflective research design to explore how five distinct art forms engage students in chemistry education. The study utilized purposive sampling, including reflections from five teachers and five students across different academic levels. The data analysis follows the steps of qualitative research, demonstrating how the abstract nature of chemistry can be explained to students through the arts. This study shows that linking art with chemistry has a greater impact on learning and that students are also more interested in art. The finding suggested that art-integration fosters chemical literacy and aesthetic value, bridging the gap between abstract scientific concepts and public understanding. Therefore, art-based learning is necessary to inform policy and classroom practices.

Keywords: Chemistry Learning, Art-based learning, Integrated-learning, STEAM learning, Reflective practice

Introduction

Teaching-learning activities are evolving to include challenges and complex actions in response to the variety of global problems, learners' interests, and an interdisciplinary Science, Technology, Engineering and Mathematics (STEAM) approach (Rafiq-uz-Zaman, 2025). Thus, the learner can face challenges in navigating the growing body of pedagogical thought globally while meeting diverse learning needs and motivations. In recent years, there has been a rapidly growing interest in the relationship between the arts and the sciences. Similarly, this journal seeks to integrate and analyze the relationship between chemistry learning and different forms of art.

The integration of arts and the infusion framework is arts-based learning. It means that it incorporates both arts-infused learning essential for process and skill development in an art form, such as art disciplines of visual arts, dance, drama, music, and media arts, and integrated learning experiences embedded in learner's daily experience to generate rich meaningful cognitive and affective connections to other disciplines (STEAM) into the classroom (Parajuli, 2024a). Philosophically, it is Postmodernism's transgressive criticality, rather than Modernism's creativity, that it is envisioning the emergence of personal and collective agency through art (white, 2006). Additionally, the arts-based learning students can work "in advance of themselves" and show that they can work "as if" they are artists, scientists, presidents, singers, rock stars, etc.through the arts, which is a natural and intrinsically stimulating medium. The arts-integrated pedagogy also affords imitative and collective learning activities that enable learners to learn playfully, activating body and mind in "rehearsal for real-life" experiences that advance development (Parajuli, 2023).

According to Connery et al. (2010), learners actively construct knowledge of themselves, the art medium, and the world around them as they sing and paint, dance, and draw. And, similarly, the art which includes knowledge, skills, culture, processes, and dispositions, is also known as multiple literacies (Cope & Kalantzis, 2009). These characters of art or arts-based pedagogical activities are very relevant in chemistry learning because in science/ mathematics/ STEAM learning, we must be motivated learners to engage in imitative and collective activities of learning for learners to learn playfully, activating body and mind in real-life problems and experiences (Roy et.al., 2015). Moreover, the sociocultural perspective of learning focuses on relationships with a teacher, or between a learner and an environment experienced by the learner (Subedi, 2021). Similarly, the arts help integrates learners' meanings and contexts through artistic ways, symbols, and transmission.

However, this approach to learning creates opportunities for concrete and meaningful experiences (Fosnot, 2005). Additionally, in this approach, students were able to create projects that went far beyond the initial scope of what we had imagined, due to the scaffolder and sociocultural learning environment (Vygotsky, 1978). Similarly, in such approaches (Arts-integrated approach/ STEAM approach), learners learned from context and with their peers, and differentiated projects to meet individual interests and visions. Hence, arts-integrated pedagogy is the actual representation of learners' context, cultures, and individual interests in science/ mathematics/ STEAM education (Taylor, 2016).

Another important aspect of art is beauty and harmony, which serve to fulfill common aesthetic needs or values in life. As human beings, learners also have cultural, temporal/ historical, natural, etc., meanings relating to common biological and aesthetic values. Still, in our chemistry learning, such values are of lower priority for learners. Hence, chemistry learning also involves aesthetic operations beyond rote learning and structural laboratory work. As chemistry educators, we were persuaded that art-based chemistry education fosters a more creative and artistic learning environment, which is frequently bolstered by cooperation with a more skilled coworker, art educator, parent, or community arts group. As a result, different forms of art can integrate with science pedagogy through drawing, art-based inquiry, writing (poems, stories), practical works (performance arts), etc.

Moreover, we can integrate various forms of arts into the pedagogy. They make learning more meaningful, like "performance art enables students to learn the curriculum of academic culture from the perspective of their personal memories and cultural histories. In doing so, performance art represents the praxis of postmodern theories in art and education" (white, 2006, p. 1). Arts-based pedagogy is a bridge between theory and praxis, and it facilitates teachers to play together with STEM and various art materials. Teachers can enhance their attention to sensory information and realize their growing curiosity, wonder, and playful self. In this context, the teacher acts as a guide to an artist partner (learner), empowering learners' creative thinking (Subedi & Timilsena, 2025). In the researcher's opinion, we need to manage the science classroom/ laboratory as an art lab, with the teacher motivating learners to develop multiple forms of art and creativity; however, this appears to be the most challenging aspect. Booth (2001) argues that transformation begins when the teacher embraces the belief that all humans are creative.

More specifically, art pedagogy is positioned as a form of intervention aimed at addressing a condition of reification that occurs in the habits of mainstream learners' culture, interests, behavior, and values (Garoian et.al., 2006). Furthermore, it appeals to those same contemporary sentiments that have been exploited through a 'self-actualization' 'be all that you can be,' 'have it your way' commodity culture. To sum up, it focused on a critical engagement with personal experience and three fundamental concepts: the spectacle, the dialogic encounter, and civic engagement (Garoian et.al., 2006). Hence, different kinds of arts, such as performative arts, fine arts, visual arts, language arts, and liberal arts, play a more important role in learning. In the context of chemistry learning, Whites' (2006) argument, "*performance art is a form of pedagogy and pedagogy is a form of performance*" (P.115), is highly relevant because all of the science activities are performance art and are highly experiential learning.

Research Design and Methodological Approach

The study uses an **interpretive approach,** grounded in the interpretation of different forms of art integrated into chemistry, reflection on their application, and a literature review of pedagogical processes for integrating art into chemistry. Its purpose is to examine the integration of different pedagogical processes based on art in the chemistry subject. Through the process of gathering and examining different school teachers' and pupils' responses, perspectives, and reflections on integrating art in chemistry.

This study aimed to comprehend how students learn through the integration of art in the chemistry subject. Employing narrative and conversational analysis methodologies, the exploration thoroughly examines the integration of STEM into curricula and narratives that lead to change in their academic experience (Parajuli & Subedi, 2023). This system enables the acquisition of students' changing perspectives in the environment of chemistry literacy. Only five students' and five school teachers' reflections were included in the sample of the study, as it was designed that one pupil from each academic year was intentionally named. Reflective journal and informal interaction were conducted to probe the case. The conversational analysis included both formal and informal dialogue, tone- reflection over time, and exchanges of ideas in tea shops, under the large tree, and on the ground, etc. There was no time limit on exchanges of the actor's perspectives on the textbooks, stories, drama, lyrics, songs, studies, and the collected qualitative data, which were examined in relation to the study's objects. Gathering information through methodical observation of students' and preceptors' actions, relations, and engagement in the classroom for experimental data gathering (Acharya, 2024). The researcher observed students' responses during the class period to inform their classroom dynamics and educational approaches for integrating different art forms grounded in chemistry.

Examine the various pedagogical activities in chemistry teaching, such as academic programs, student assignments, and students' and teachers' reflections, which were recorded. In addition, verbatim analysis is employed to identify and interpret recurring themes and patterns within the information. And the authors' reflections, informed by their unique perspective as both former students and current school teachers, serve as a precious data source, adding depth and originality to the study.

The information was integrated across different arts (fine arts, performance art, visual art, music, painting, sculpture, etc.) in education, which presents postmodern theories in art-based education. It is not specifically a theoretical text that enables students to learn curricular and other activities/creativity; it can be utilized for corporeal, psychological, and social learning, and for the emergence of personal and collective agency through art. However, our existing pedagogical practices are driven by this tract (Subedi, 2021). Thus, to ensure the academic culture from the perspective of their personal memories and cultural histories, it is very important for science learning.

After analyzing and interpreting the information gathered for this research, we realized that arts integration in chemistry learning comes in various forms, from approaches that employ easy illustrations of academic topics to others that enhance metacognitive skills. According to Silverstein and Layne (2010), opinion art integration is "an approach to teaching in which students construct and demonstrate understanding through an art form. Students engage in a creative process, which connects an art form to another subject area and meets evolving objectives in both" (para. 3). Finally, they (different forms arts) integration in science pedagogy through art-infused learning activities, teacher act as role of artist, classroom management focus in the multi-artistic science lab, learner as artiest, learning activities are performing arts, and fine arts, poem, story, drawing, etc. are the learning materials. Besides these actions, this study tries to empower culturally responsive pedagogy and art integration in teaching and learning (Green et. al., 2018).

Results and Discussion

Through this study, the researcher realized that science learning empowered through the arts is very important, and that our learning environment should be changed towards practical arts-based learning. Thus, like Prajapati and Pachauri's (2025) argument, it tries to explain how different kinds of art can be integrated into chemistry learning to foster holistic education and emotional well-being, and to conceptualize it.

Performing Arts (Drama, Dance, Role-play, etc.) and Chemistry Learning
Firstly, performing arts (drama, dance, role-play, etc.) are very important in science learning. in our class we discussed several papers about art-based pedagogy and integration of arts learning or pedagogy. The different types of performance arts integrate with pedagogy and how it acts as an important role in education. Furthermore, the relationship between performing arts and pedagogy are very close because both leads to skills, in where the skill of artists used memory and cultural history to critique dominant cultural assumptions and to develop self-identity and learning. The art-based performance helps to works collectively that engage in the practice of critical citizenship and radical forms of democracy which have significant implications for teaching and learning in the schools as well as classrooms (White, 2006). Hence, art-based pedagogy is strongly associated with chemistry learning to empower the cultural, contextual, and real-world-based learning of learners. But in the case of science learning, we need to develop multitalented learners and engage the learner in multiple ways, thus, it is very significant in science learning. Hence, in the overall analysis, while we integrate the performance art in pedagogy learners are aware of critical awareness of the subject of learning and empower meaningful learning through the appreciative learning culture.

In this work, we show some performance arts integration in science learning. for example: In the teaching-learning activities about the concept of atomic structure and some types of chemical reaction we can design the different perform-based arts for example, in initial stage learners divide into different groups then divide different role and motivate to students for performing their role accordingly with design activities. also, re-enacting their movement through objects with drama. Following this activity, in pairs students perform an atomic structure role play (nucleus, shell, electron, valence electron, etc.), finally engage and understand for the demonstration of the concepts. They had to discuss practical examples, applications, and relevance of the theoretical concepts of their reflections.

In chemistry learning to clarify the orbital motion and other different kinds of orbitals can be taught by performance art like role play name is “The Atomic Pulse” to taught this topic first of all make a building the core “Nucleus” (Center Stage): Choose 4-6 students, who would play the role of Protons and Neutrons. They are in a small circle lying back-to-back with arms interlocked and they produce different sound like Protons resonate in a low monotonous note, whereas Neutrons are silent but offer the physical mass to the structure. During this activities teacher clear that and to show that the nucleus is compact, centrally-located and occupied by most of the mass of the atom. Moreover, then make “The Shells” in where build students and allocate students into various orbits (Energy Levels) to clarify the concept of the Electrons. In this time student kept in multiple layer of circle like K, L, M, N shell and the students in the inner circle move slowly; the students of the outer circles move faster and more erratically to depict energy levels. It means that activities did provide students with increased lived experience. Before the implementation of the project, there was little visual art, theater, or dance instruction in these schools. Hence, a large number of activities of chemistry learning can design performance art-based activities. These activities were encouraged to reduce the barriers of learning for any student to ensure inclusion, structural based learning and teacher-dominated classroom. It also reduces learners’ hegemony through differences in caste, gender, language, subaltern group, religious/ethnic background, socio-economic status, disability; etc.

Poetry and Chemistry Learning

According to Lawrence-Lightfoot and Davis (1997) poetry and science are closer and he argued that both fields are human endeavor and creativity. Similarly, Midgley, Kaplan, and Middleton, (2001) made exactly the same point: Provided science is not conceived as a “strange, imperialistic, isolating ideology,” then “our visions (our ways of imagining the world)” can be validly expressed either as poetry “which express(es) those visions directly, in concentrated form” or “less directly in all our thoughts and actions, including scientific ones” (p. 1). In the context of science learning, poetry is very important at the primary level for better experiential learning which focused on vision in our minds and heart. Peacock (2008) advocated this argument, beginning with an experience of the natural world, focus, and deepened sensitivity—the perfect combination of science and poetry (as cited in Donald & Barker, 2016).

It increases the potential for focused on observation and careful creative communication. Like the above arguments, we also agreed with these perspectives, poetry is very useful to chemistry learning to develop learners’ multiple aspects (cognitive, affective or emotional, psychomotor, creativity, etc.) For example, most of the students felt difficult to learn concepts about the first twenty elements, however, the following poems about the recall first twenty elements and make it easier to learn and motivated learners.

THE FIRST TWENTY ELEMENTS (A Poem)

Hydrogen and Helium become the lighter

Third Lithium, fourth Beryllium second period fighter.

Carbon has Boron as his friend and neighbor.

On Nitrogen and Oxygen, we are reliant.

Fluorine reactive and Neon passive,

Sodium and Magnesium are light massive.

Aluminum, Silicon, Phosphorus, as well,

Sulfur and Chlorine waiting to call.

Argon is silent noble old man.

Potassium and Calcium are golden bone.

Storytelling and Chemistry Learning

First of all, in our traditional Gurukul and Harikatha styles of instruction and storytelling have been widely used for a long time ago, well before western education influenced the education system (Mercer, 1995). Mercer (1995) explains that the storyteller (guru) would explain texts to the students, who did most of the learning by rote and this method was intended to provide students with access to knowledge. Nowadays stories are widely used especially in the teaching and learning various subjects apart from mathematics and science. Stories are not only used as a teaching and learning tools it also stimulates to other learning and teaching activity. For example, stories can lead to other arts based like as dance, drama, art, design, scientific investigations, or other various types of activities.

Furthermore, Mallan (1991) argued that stories can be used in teaching ideas as they provide a way for children and teachers to engage in creative and imaginative learning. Wells (1986) believed that "stories provide a major route to understanding". Similarly, in chemistry learning process learners are exposed to stories it may develop positive thinking, attitudes, thoughts, etc. towards learning. Because stories are easily accepted and memorized by students and feel happy to learn. We showed following example of a part chemistry story.

Birth of the Atom or Atomic View: A Chemistry Story

Once upon a time, the Greek philosopher Democritus generate the idea of the atom originally emerged from conversations among ancient Greek philosophers. Atomism came to be associated with. He believed that the universe consisted of elementary particles of matter that were in constant motion. These particles might differ in terms of shape, size, and mass, but all of them were ultimately indivisible. Democritus once claimed, "… in reality, there are only atoms and the void." The philosopher Aristotle disagreed. According to Aristotle, the atomist position was absurd. In particular, Aristotle questioned the belief in a void completely absent of matter through which atoms could travel. In Aristotle's views of physics, objects required constant force to keep them moving in a straight line. In a void, there would be nothing pushing against the atoms, so they should not be able to move. The debate between supporters of Aristotle's physics and Democritus' atoms persisted for centuries. During much of that time, the Aristotelian view was accepted. Eventually, a new group of scientists began to consider old questions during the Scientific Revolution (Reid-smith, 2013).

> *By the time of Chadwick's work, the atom had undergone a radical transformation from the ideas first proposed by Democritus. Even Dalton would hardly recognize an atom that could be divided into three fundamental particles (electrons, protons, and neutrons). While ideas about the structure of the atom have evolved over time, the desire to understand the matter at its most basic level has remained a constant motivation. This search has driven scientists to collaborate internationally to establish a common vocabulary and standards of evidence……(Reid-smith, 2013).*

Integration of Music in Chemistry Learning

Another world accepted art is music and song. For the understanding music and songs students explore variety of instruments. If we integrate the music in chemistry learning looked at the physical working of the instruments to create sounds, and then linked the aesthetic to the representational of sounds, final looking at the aesthetic vision of performance (Roy et.al., 2015). Like this argument, we also agree with music that creates motivation and a deep understanding of science learning. It also touches the learners' affection and emotion, which leads to actual learning. Furthermore, it enhances our brains process and interprets emotions, and each other as well as indigenous knowledge and ethno-chemistry (Parajuli, 2023). In science learning, I/we need to empower the learner to create and singing the song with music, which makes chemistry learning very interesting. For example, in the chemistry classroom this small part of teej song enhance learner's concept about state of matter and student singing this song in group and easily interpret their concept to each other. Hence, it shows that the little integration of art also enhance creativity, collaboration, communication. A small part of teej song implemented in classroom practice is mentions below;

Chorus: Dance my friends, it's the time of the year, Science and Teej together, let's spread some cheer!)

"Small as an atom or large as the matter,

"Solid, liquid, and gas all are better."

BARILAI

"Solid, liquid, and gas all are better."

Soil, water, air.

Matter (are) everywhere!"

BARILAI

Matter (are) everywhere!"

BARILAI

"Matter (are) everywhere!"

Role of Language Arts in Chemistry Learning

The next important art in chemistry learning is language art. There are several kinds of language arts are found such as listening, talking, reading, writing, viewing, and visually representing, etc. Mainly, they exist oral, written, and visual mode, it means in learning they facilitate in multimode. The introduction of reading and writing act as a more significant role in science literacy (Yore & Treagust, 2006). According to Wallace et.al. (2004), reading and writing are essential activities that all students of science need to engage in to completely focus on their scientific understanding. Consequently, we also believed that chemistry learning more effective while learners must be proficient in the discourses of science, which includes reading, writing, and talking science.

The main goal of language arts' is to be able to use language proficiency in order to develop communication and deep understanding. In recent times our main discourse is concerning with 21st-century skills. Out of them, communication is a more important skill, without it, we cannot imagine better learning thus language arts are very useful in all subjects. So, for effective chemistry teaching and learning teachers integrate different instruction including opportunities for students to uses all six types of language art (listening, talking, reading, writing, viewing, and visually representing) everyday classroom practices. Which makes chemistry learning more interesting and leads communicative skills. However, language is a tool for the communication; it shapes our perceptions of society, religious, justice, and acceptance.

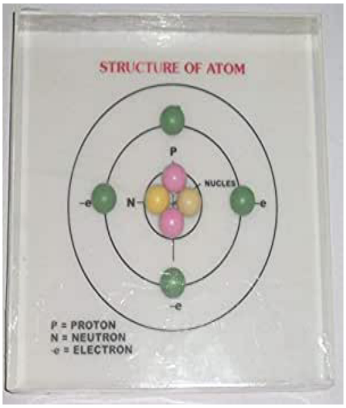
In the present time, all subjects recommended by curriculum of Government of Nepal [GoN]' learning is growing towards critical literacy which focuses on the empowering role of language in learning. In science learning, language arts are used to communicate language, solve problems, and other actions. It also focusses the interactions among students in the classroom, and classroom relationship between language and students in the context like as scientific concept, ethnic or cultural science, and society. Similarly, according to critical pedagogy theory that suggests that teachers and students should ask fundamental questions about knowledge, justice, and equity (Wink, 2010). Like this argument, to empower a dialogic environment in the science classroom, language arts act as an important role. Beyond it, chemistry learning is not complete. We also emphasize language art in the chemistry classroom through writing, reading, listening, questioning, etc. In the context of chemistry classroom, it shows the rich language verity for aqueous, (g) for gas, (l) for liquid, → for reaction, □ for reversible process, and other units also included in the complied form of signified and signifiers. Moreover, in the chemistry related topics there is the use the symbol. The short form used there stands for the atom of a specific element also (Parajuli, 2024b).

Additionally, Freire and Macedo (1987) argues that language arts instruction doesn't take place in a vacuum; the content that teachers teach and their instructional approaches occur in a social, cultural, political, and historical context i.e. leads transformation. This leads the critical learning beyond the traditional concept of language arts i.e. traditional language arts covers almost all subjects and the skills in an interesting and living way that kept the learners' attention.

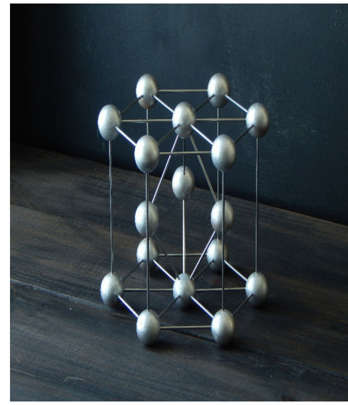
In sum up, language arts become a means for social action. In the case of science learning, we use different language arts to increase the inclusion of social and cultural diversity in our society. For example: write up your daily life science activities relation with the lesson (chemical reaction, material use in daily life, acid base and salt, etc.). explain chemical reaction on paragraph, providing reading material about science and scientist history, creating discussion about content, context, and applicability of science, etc. and motivate to listening skills, phonics or beginning reading skills, rhyming the words and its meaning, writing sentence structures or writing skills of learners, use of signs and symbols, reading comprehension, writing composition, sharing, speaking, etc. We also agree with Pearson et.al. (2010) argument like "…when science literacy is conceptualized as a form of inquiry, reading and writing activities can be used to advance scientific inquiry, rather than a substitute for it. When literacy activities are driven by inquiry, students simultaneously learn how to read and write science texts and to do science" (pp. 459-460).

Visual Arts and Chemistry Learning

There are different kinds of visual arts such as Drawing, Painting, Printmaking, Photography, Computer-arts, Sculpture, etc. They are often called the most important form of visual art. Drawing and painting represent putting colors on a canvas or a wall. Both of them become very important in chemistry learning, where they were covered with scenes, content, and concept of everyday life as well as chemistry learning outcomes. Similarly, to develop an effective learning tool printmaking and photography also very useful to chemistry's concept learning. Furthermore, in the context of chemistry learning, sculptures are very useful to engage learners beyond the science lab because they are three-dimensional pieces of art that are created by shaping various kinds of material. Among the most popular are stone, steel, plastic, ceramics, plastic, and wood. Also, it enhances the reuse of waste recycled material and improvised material. Consequently, it seems that very beneficial for school level and higher-level chemistry learning. Some examples of visual arts in chemistry learning showing below.



Model: Atomic Structure



Sculptures: Unit crystal lattice

Sculptures: Structure of Benzene

Photo: Litmus test photo

Conclusions

The 21st century, or any period of human history, is characterized by the development of Science, Technology, Engineering, Arts, and Mathematics (STEAM). Meanwhile, learning develops the place of the human workforce in tasks that involve routine cognitive, psychomotor, and manual input. In our view, art-based pedagogy or arts-integrated pedagogical practices focused on the learners' analytical thinking, sophisticated communication skills, artistic innovation, and talk about socio-scientific issues. Thus, in chemistry learning, the different art-based tasks promote learners' curiosity, dialogic situation, inquiry-based, and project-based learning. And finally, it leads learners as inventors. Furthermore, it cultivates the chemistry learning as the greater human performance, societal, creative, and an inquiry mindset that connect to feelings of happiness and productivity. However, in more factual data of chemistry it is complicated to convert artistic work of corresponding content.

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