Exploring Art Integration Learning in Science based on Students' Engagement, Performance, and 21st-Century Skill Development: A Scoping Review

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ABSTRACT

Arts integration is a contemporary approach that promote diverse learning methods, particularly in science education. This scoping review maps the empirical outcomes, methodologies, and limitations of arts integration in science learning. Guided by PRISMA-ScR and the Joanna Briggs Institute (JBI) framework, the study used Google Scholar and ERIC as the databases for searching articles published between 2014 and 2024. Seven articles met the inclusion criteria and were assessed to determine how arts integration supports science learning, contributions to students' academic and skill development through the project products and limitations of pervious studies were reported. The findings indicate that arts integration significantly enhances student engagement leading to improved academic results, also encourages active, hands-on learning, and fosters essential 21st-century competencies (creativity, critical thinking, collaboration, and communication). However, limitations reflected in the review articles include small-scale empirical research, a lack of control-group studies, and over-reliance on localized case-study profiles that cannot fully represent outcomes across education systems. Although art activities can increase students' motivation to learn science topics, challenges remain in applying arts integration in science learning, such as limited teacher training in integrated learning and time constraints. This could make the implementation of arts integration in science learning becomes difficult. The implications for future research suggest that science educators and other stakeholders can receive appropriate training to strengthen the arts integration approach in science education.

Keywords – Art Integration learning in Science, Learning by "doing", Students' engagement, 21st-century skills, Academic performance

INTRODUCTION

The global education system in the twenty-first century should better prepare students to confront challenges and develop the skills needed to face a continuously evolving world. To strengthen future workforce competencies, Malaysia's education system is pursuing innovative strategies to enhance student engagement, maximize academic performance, and cultivate 21st-century skills. In recent years, the traditional educational system, which heavily favors passive, elite-centric rote memorization, has shifted toward ensuring all students have a chance to learn, with diverse classrooms characterized by varying levels of student readiness and background knowledge (Adnan, 2018; Nahar et al., 2021). Consequently, current schooling encourages students to explore and engage in their studies, participate actively in the learning process, and work collaboratively with other students. As Eacute and Esteve (2000) state, the most crucial education system today is one in which students have equal opportunities to drive their own learning during lessons. Therefore, social

interaction is important because it helps students engage in learning by sharing ideas and communicating with others.

To facilitate this transition, implementing an integrated curriculum has emerged as a highly effective approach. An integrated curriculum combines different subject areas across academic disciplines (Drake & Reid, 2020). This approach is considered an effective teaching and learning method that should be implemented in the 21st century. With an integrated curriculum, students engage in a holistic learning experience, moving away from fragmented subject silos. By adopting the integrated curriculum in the education system, students' learning can be rooted in the principles of progressivism and experiential learning, allowing them to benefit from a well-rounded pedagogy that supports growth, knowledge and skills development, and even improves their ability to solve problems in life (Singh & Rashid, 2023; Drake & Reid, 2020).

Humphreys, Post and Ellis (1981) also stated that an integrated curriculum allows students to explore more diversely, drawing on knowledge from many academic disciplines that are subordinated to particular aspects of their environment. A student-centred learning approach promotes active learning in the classroom, encouraging students' participation in the learning process (Jacobs & Toh-Heng, 2013; Singh & Rashid, 2023). According to Morrisson (2021), in active learning approaches, the teacher serves as a guide to supervising students' learning activities, and thus needs to be active too in the learning process, just like the learner, by setting up a learning environment that promotes effective learning and social interaction among students.

To enhance student learning, integrated approaches seek to develop the whole child by building knowledge and skills during learning sessions and offering a distinctive learning experience (Tudor, 2014; Drake & Reid, 2020). Arts integration is a prominent contemporary approach that systematically incorporates artistic modalities into core academic subjects, including science, to enrich learning (Thote & Sen, 2019). However, empirical research shows that implementing arts integration in practice is often limited by systemic barriers, such as demanding instructional schedules, wide differences in students' artistic confidence, and a significant shortage of specialized teacher training. Moving beyond descriptive validations of the approach requires rigorous analysis of both the academic benefits and structural limitations of arts-integrated science learning.

OBJECTIVES AND QUESTIONS

This article presents a scoping review of arts integration in science learning. This study aims to examine the similarities between Science and Art that could cause these two disciplines to be integrated. It also examines the practical outcomes, inconsistencies, and pedagogical limitations of this arts-integration approach in science learning.

The Research Objectives (RO) guiding this scoping review are:

i)	RO1:	To contextualize the significance of an integrated curriculum in education.
ii)	RO2:	To identify the similarities between Science and Art that caused these two disciplines to be integrated.
iii)	RO3:	To map the empirical applications of arts integration across various science disciplines and educational levels.
iv)	RO4:	To examine the transformative impact of an integrated curriculum in science education regarding student engagement, academic performance, and 21st-century skill development.

The corresponding Research Questions (RQ) are:

i)	RQ1:	What are the potential impacts of an integrated curriculum on students' learning?
ii)	RQ2:	How can arts (visual arts or performing arts) be integrated into the science curriculum?
iii)	RQ3:	What are the limitations or challenges that are identified in applications of arts integration in science learning?
iv)	RQ4:	What empirical evidence supports the benefits of arts integration regarding student engagement, academic performance, and 21st-century skill development?

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METHODOLOGY

This paper employs a scoping review framework to map the existing literature on the integration of arts into science education and synthesise evidence concerning student engagement, academic performance, and 21st-century skill development. The structural workflow follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) guidelines (Tricco et al., 2018) to ensure transparency and rigour of the selection process.

1.1 Information Sources and Search Strategy

Literature searches were conducted using electronic search engines, focusing primarily on the databases of Google Scholar and the Education Resources Information Centre (ERIC), to capture peer-reviewed journal articles. The data collection process was carried out in October 2024. To capture contemporary pedagogical frameworks, the search was restricted to empirical literature published between 2014 and 2024. The search strategy for publications used combinations of Phrase Searching and Boolean Operators to optimise relevance and consistency. The focused keywords included:

- ("art integrated" OR "art integration") AND ("science learning" OR "science education")
- "art integrated" AND "in science"
- "learning science using visual art" OR "learning science with visual art"
- "integrating art into science education"
- "science learning with art"

1.2 Eligibility Criteria

To ensure the relevant selection of literature, studies were screened based on predefined inclusion and exclusion criteria:

- Inclusion Criteria:
    1. Peer-reviewed empirical articles with full-text availability.
    2. Peer-reviewed empirical articles should focus on primary, secondary, or higher education in the context of science streams.
    3. Studies examining the direct intersection of arts integration within science disciplines (physics, chemistry, biology, or general science).
    4. Research measuring at least one key outcome: student engagement, academic performance, or 21st-century skill acquisition.
- Exclusion Criteria:
    1. Articles focusing on arts education independent of science learning.
    2. Non-English publications.
    3. Articles that address an area not relevant to the research objectives.
    4. Dissertations or opinion pieces without empirical or systematic data

1.3 Selection and Critical Appraisal

The study selection process was executed systematically across the four distinct phases of the PRISMA framework: identification, screening, eligibility, and inclusion. In the preliminary screening process, 150

articles were yielded from the initial keyword search where those papers were screened by title and abstract to determine their relevance to the research objectives. The remaining full-text articles were then carefully assessed against the eligibility criteria, resulting in a final sample of eight empirical studies selected for in-depth thematic synthesis and summary. Following the Joanna Briggs Institute (JBI) guidelines for scoping reviews, a critical appraisal component was integrated into the evaluation of methodological limitations and contextual inconsistencies of the selected literature. Figure 1 shows the PRISMA flow chart that presents the breakdown of the screening process of articles.

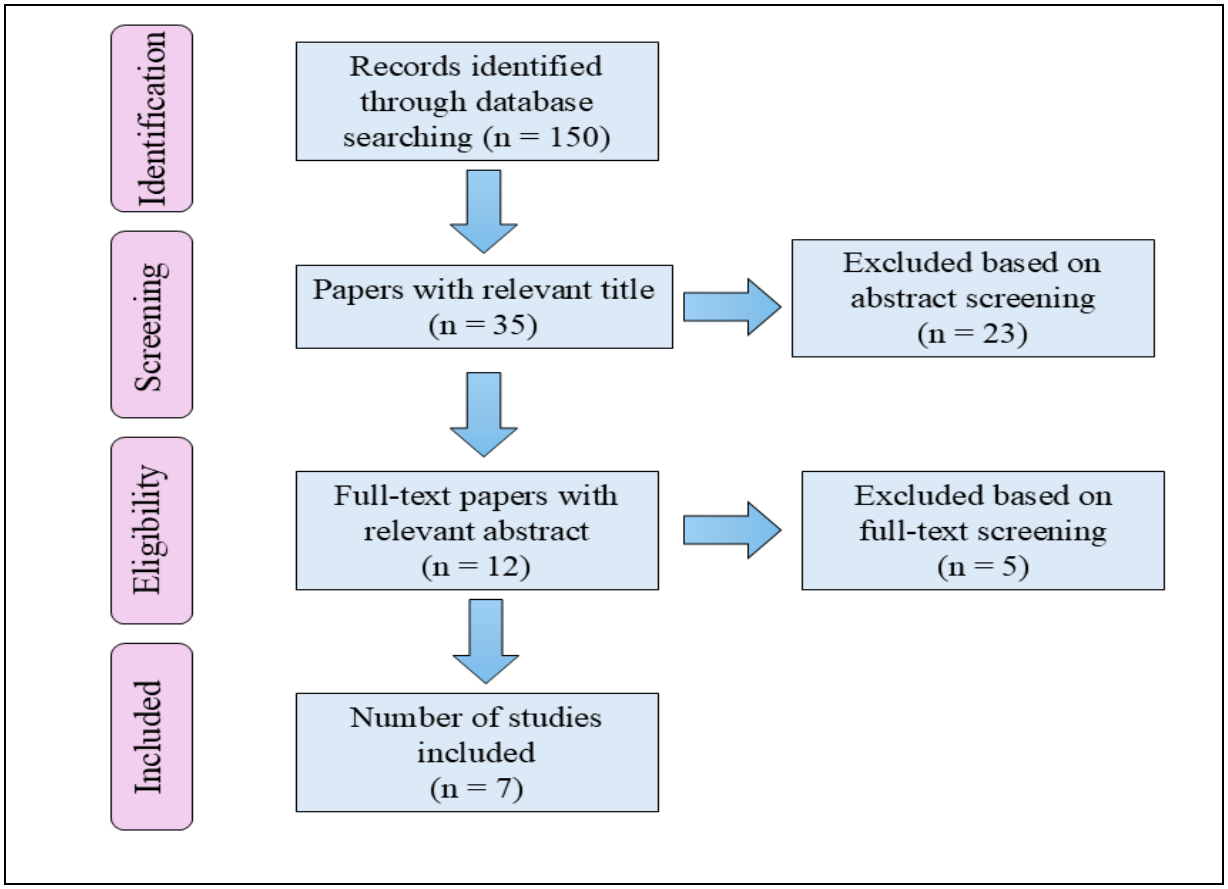

Figure 1. PRISMA flow chart

FINDINGS

This section shares and discusses some related findings, including integration of curriculum, the idea of Arts integration learning, the similarities between science and arts,

1.4 Curricula Integration

Recently, the importance of integrated curriculum has been emphasized in the education field. Curriculum integration refers to combining two or more subjects to cover a topic in a learning process (McPhail, 2020). This approach has a big impact on student learning, as it aims to support students' cognitive development as well as their social and emotional development (Beane, 1997 as cited in Wall & Leckie, 2017; Singh & Rashid, 2023). The curriculum has three main levels of integration models (Drake & Reid, 2020):

- multidisciplinary,
- interdisciplinary and
- transdisciplinary.

All three curriculum integration models are concerned with the integration of topics, themes and context that allows students to make connections to the content that they have learned (Wall & Leckie, 2017; Gürkan, 2021).

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In a multidisciplinary curriculum, each discipline is distinct in its content and assessment, but each topic shares a similar theme (Drake & Reid, 2020; Neendoor, 2023; Ling et al., 2024), as shown in Figure 2. Next, an interdisciplinary curriculum fuses subjects, teaching different disciplines through shared instruction and assessment to meet learning standards, as shown in Figure 3 (Drake & Reid, 2020; Ling et al., 2024). Third, the transdisciplinary curriculum is an integration model in which all distinct disciplines are integrated to become interconnected with one another. In transdisciplinary learning, a holistic approach is emphasised to support students' cognitive growth and improve students' learning (Gürkan, 2021; Neendoor, 2023). Figure 4 shows the diagram of the transdisciplinary integration curriculum.

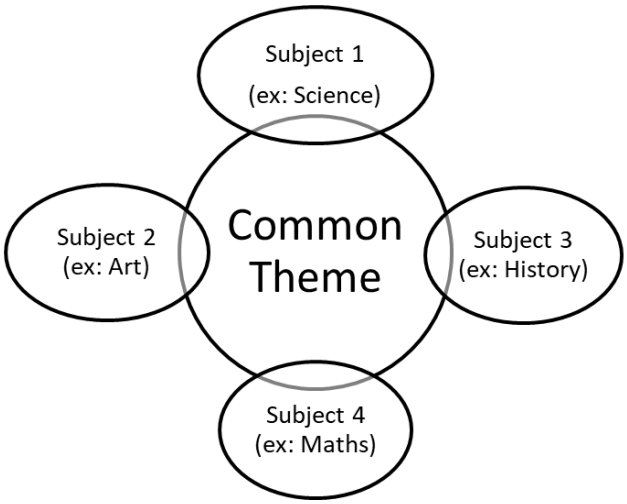

Figure2.Multidisciplinary integration curriculum

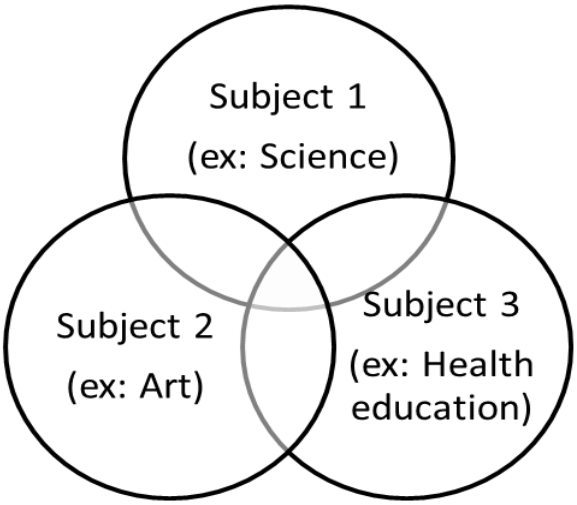

Figure3. Interdisciplinary integration curriculum

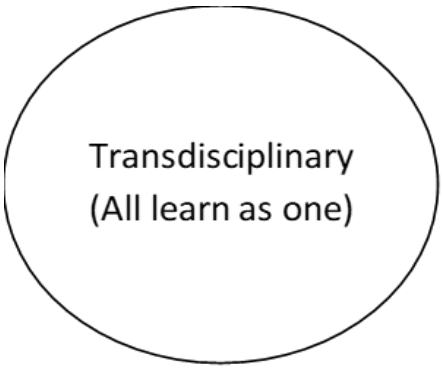

Figure 4. Transdisciplinary integration curriculum

An integrated curriculum breaks down the rules of traditional learning by providing a sustainable learning experience that helps students learn what they should learn and engage in the learning process (Drake & Reid, 2020). In the traditional approach, memorisation and rote learning become the key components that students use to learn and obtain knowledge, then interpret their understanding by answering examination questions and achieving high scores in standardised tests, a practice that has been considered spoon-feeding learning (Adolfsson, 2018; Antwi & Fredua-Kwarteng, 2022).

In contrast, an integrated curriculum is a new way of teaching and learning because it is a student-centred approach that requires students to self-assess their learning (Wall & Leckie, 2017; Gürkan, 2021). This new curriculum approach promotes progressive education rooted in students' learning experiences, encouraging engagement in the learning process and hands-on learning (McPhail, 2020). For the curriculum integration approach, students are offered the opportunity to learn better and improve their ability to draw connections between the knowledge they have learned throughout the learning activities; they are also able to develop skills such as creative thinking, problem-solving, collaborative work, and communication skills (Drake & Reid, 2020).

Martinez (2022) stated that 21st-century education was designed to prepare a skilled future workforce through a new approach and an academic curriculum that requires students to have strong learning experiences. According to Singh and Rashid (2023), people learn better in environments designed to help them accomplish goals independently. Hence, the learning environment they describe is student-centred learning that gives students opportunities to explore, promoting active learning.

In a nutshell, curriculum integration promotes deeper understanding of the interconnectedness of knowledge, fosters creativity and collaboration, and prepares students for the complexities of the modern world. By integrating curricula, students can explore connections between subjects and apply interdisciplinary knowledge and skills needed for the future.

4.2 Conceptual and Philosophical Framework of Arts Integration

Arts integration is a pedagogical approach that embeds artistic elements into the core of the academic learning process (Green et al., 2019; Thote & Sen, 2019). According to Duma and Silverstein (2014), arts integration uses art as a tool to teach and learn content from other subjects, helping students construct and demonstrate their understanding through art or by creating an artwork. Arts encourage the development of creative thinking, critical thinking, and enhance students' academic skills (Lathan, 2022). Integrating art into science is an active learning approach (Davidson, 2019) because it provides students with "hands-on" experiences. Philosophically, this approach is deeply rooted in John Dewey's theory, "Art as Experience" (Dewey, 1980), which posits that meaningful education is an active process of "doing and making" rather than passive "knowing" (Strakšienė et al., 2022).

Based on John Dewey's theory, arts integration provides hands-on experiences that merge sensory and aesthetic perceptions with cognitive development. By immersing students in the learning process through their own experiences, this arts integration approach fosters students' 21st-century skills (Davidson, 2019; Heiman, 2020). These 21st-century skills should be taught and embedded from childhood, with reinforcement gradually increasing throughout the learning journey. According to the literature, art can make learning more engaging because students acquire aesthetic experiences that bring a sense of satisfaction, fulfillment, and wholeness, strengthening their cognitive connection to the subject matter (Dewey, 1980; Stivaktakis, 2018).

Art integration learning can be performed in two forms: visual presentation such as drawing, painting, sketching, crafts, and performing arts such as drama, storytelling, and role-play (Stough, 2018; Davidson, 2019; Stivaktakis & Krevetzakis, 2018). Integrating art into the science classroom motivates students to engage in learning through artistic experiences. In the context of integration of art into others academic curriculum is really supportive and it could provide a clear view for the future education (Davidson, 2019).

4.3 The Similarities Between Science and Arts

Science and Art might seem like two different subjects that are not related; however, both Science and Art can be integrated as they have similarities that rational for combining these two subjects (Ibarra & Sommerstad, 2018). According to Stivaktakis and Krevetzakis (2018), there is a pedagogical rationale for connecting science curriculum with art because using art to learn science can help students immerse themselves, be creative for longer periods, share opinions, and see things differently based on their understanding or interpretations.

Science and art share a common aesthetic element, as stated by Tauber (1996), as cited in Stivaktakis and Krevetzakis (2018), and both subjects can be connected to support science learning through art. First, both science and art involve human activities, as both require human perception to understand and interpret the phenomena and things that exist in the environment (Wiggin, 1969; Stivaktakis & Krevetzakis, 2018). This statement is also supported by Hunkins (2019), as science and art involve hands-on, practical activities to learn by "doing." Collaborations between science and art offer a great opportunity for students to experience and express themselves and their ideas through the creation of an artwork (Schnugg & Song, 2020).

Secondly, Science and Art share a joint base in the foundation of inquiry (Wiggins, 1969; Hunkins, 2019) and creativity (Hadzigeorgiou et al., 2012; Stivaktakis & Krevetzakis, 2018). According to Alberts (2010), cited in Dhanapal et al. (2014), learning science through art, students can explore, create and imagine in their own ways in the learning process. As stated by Mcdougall et al. (2011), a learner can discover, know, and understand science by using the visual arts method, because Art acts as a way of knowing and supporting students in learning based on curiosity. Using art as a learning method, students can quickly understand science topics better (Stough, 2018).

Moreover, both science and art require observation (Stivaktakis & Krevetzakis, 2018; Ling et al., 2024). For example, an artist observes the world around them and then creates an artwork expressing their emotions about it; while, a scientist gets questions, does a test and then observes the results to find the answers (Hunkins, 2019). In both Science and Art, to learn the content, students must observe and draw inferences, then test them through many different creative solutions (Wiggins, 1969).

4.4 Empirical Applications of Arts Integration in Science

A scoping review of contemporary empirical literature (2014–2024) reveals a diverse array of visual and performing arts methodologies implemented across primary, secondary, and higher education science streams. Table 1 shows a summary of the previous literature on arts integration in science learning.

Table 1. Summaries of previous studies related to arts integration in science

Author (Year)	Participants	Science concept	Art Elements	Key Outcomes	Identified Limitations
Hunkins (2019)	Middle school students	Life science (Ecology & Cellular biology)	Visual arts (Nature journaling, watercolor, collage)	Strong cognitive connections; enhanced peer communication.	Relies heavily on students' prior drawing skills; time-consuming formatting.
Izadi (2017)	Middle & high school students	Water circulation; Stress & force	Visual arts (color, light); 3D engineering craft	Enhanced critical/ creative thinking; active problem solving.	Subjective assessment metrics; lack of control group comparison.
Ooms et al. (2018)	Elementary students (Grades 3–5)	Force & motion; Natural weather disasters	Structural design (Rollercoasters, shelters)	Significant pre- to post-test performance score gains; improved collaboration.	Small localized sample sizes; potential confounding variables in group dynamics.
Graham & Brouillette (2016)	Upper elementary (Grades 3–5)	Sun & Earth; Electricity; Circulatory system	Performing arts (dance, role-play, music)	Higher student motivation; improved academic test scores vs. traditional lectures.	High dependency on teacher training; resource-intensive execution.
Thote & Sen (2019)	No specific statement of students' level	Environmental science (Ecosystem conservation)	Recycled crafts (Tin lanterns, bottle banks)	Cultivated innovation; practical application of the 5 R's.	Primarily descriptive results; lacks empirical testing of long-term retention.
Dhanapal, Kanapathy, & Mastan (2014)	Grade 3 Malaysian students	General primary school science concepts	Drawing, painting, coloring, clay modeling, and crafts	Significantly boosted student motivation and creativity.	Relies strictly on subjective perceptions without objective academic testing.
Aghasafari (2024)	Emergent bi/multilingual high school students (ages 14–18)(n = 10)	Structures and Functions of an Animal Cell	Using "Artistic Reformatting" technique to create their arts	Construct deep biological concept, improve creativity, and nurture artistic and scientific skills	Relies on descriptive case study profiles; lacks quantitative longitudinal confirmation

By engaging with art in science learning, Hunkins (2019) conducted a year-long study tracking middle school science classrooms where visual arts—such as nature journaling, watercolor sketching, and self-portrait collages—were embedded into ecology and genetics units. In making a nature journal, students were asked to draw or sketch items such as rocks, leaves, shells, feathers, moving animals or insects, and anything they observed and encountered in their journal. From this activity, students gained the ability to recognise the natural world from their own point of view, and were able to make connections to their science learning through their artworks.

Besides nature journaling, they also integrated the topic of Cells with arts, where the students were asked to display a view of the concept of connection between cells, nucleus, DNA, and its organelles by using watercolor pencils to draw or cut the image out from the magazine to make a collage. Once the students completed their artwork, they shared their artworks with others in the classroom.

Based on the research, the results showed that the students gained a great experience in art integrated learning. They could use art to communicate their ideas; engagement from students to participate in science learning increased and enhanced their creativity, higher-order thinking skills and communication (Hunkins, 2019). However, Hunkins noted that year-long arts integration demands immense instructional time, often squeezing out other mandatory curricular requirements. Furthermore, a major affective barrier emerged: students who lacked basic drawing confidence experienced severe initial anxiety and task hesitation, indicating that variations in artistic skill can unintentionally hinder scientific expression.

Next, a study by Izadi (2017) investigated an arts-integrated initiative titled "Physics in Nature," where middle and high school students expressed their understanding of abstract physics topics through related visual artwork. They learned about Water Circulation by illustrating it using colour, light, water and glass, as shown in Figure 5. To conceptualize the principles of stress and force, students also designed functional paper bridges, tested their load-bearing capacities, as shown in Figure 6. Similarly, Ooms et al. (2018) examined the integration of structural art designs within elementary science units (Grades 3–5) focused on force, motion, and natural disasters, where students built physical models of rollercoasters and hurricane shelters.

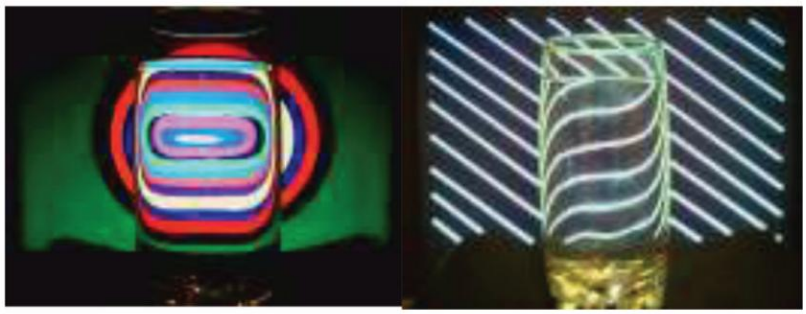

Figure 5. Making water circulation as artwork (Source from Izadi, 2017)



Figure 6. Modelling paper bridge (artwork) (Source from Izadi, 2017)

Both studies showed a significant impact on students' understanding of the topic and led to substantial improvements in their test scores. In other words, using art to build new knowledge led to higher academic performance and strengthened spatial reasoning. However, their analytical frameworks carry distinct limitations. Izadi's research relied heavily on qualitative documentation, making it difficult to isolate the exact cognitive parameters responsible for student success. Meanwhile, Ooms et al.'s experimental design was

constrained by a small sample size and did not account for the confounding effects of peer group dynamics, which can disproportionately inflate collaboration metrics during short-term interventions.

Moving into integration of learning science topics with artistic activities, Graham and Brouillette (2016) evaluated the San Diego Teaching Artist Project (TAP), which leveraged performing arts —including dance, music, and role-playing—to teach upper elementary students, Grades 3 to 5, about the topic of the Sun and Earth, electricity, and the circulatory system. In this project, they supported creative movement, which kept them highly motivated and engaged in the learning process. They were also able to score better than those students who used a traditional learning approach. Although the project claimed that art integration would make science learning more memorable through kinetic movement, this large-scale model reveals a systemic challenge where it depends heavily on professional teaching artists and extensive institutional funding. This is because traditional science educators often lack the specialized performance training required to manage a highly active, movement-based classroom while simultaneously preserving precise scientific accuracy.

In environmental and life science contexts, Thote and Sen (2019) introduced a hands-on project utilizing upcycled materials to teach sustainability. The project named "*Best Out of Waste*" activity which integrates environmental science with art. Through this theme, the students learned about the topic of Conservation of Ecosystem which mentioned about the awareness of protecting the environment and the Five R's concept: Refuse, Reduce, Reuse, Recycle and Recover. In the lesson, the students were asked to use the waste material to create crafts that are environmentally friendly and useful. Based on the outcome of the project, the researchers discovered that their students could create innovative models and art items from different waste products, as this shows the students able to develop their ability to create and develop an innovation. These creative art ideas showed that the students could think creatively and come up with mind-blowing new ideas. However, Thote and Sen's findings were strictly descriptive and lacked empirical testing to verify if these craft activities translated into long-term concept retention or understanding of ecosystem conservation. Figures 7 and 8 present examples of the creative items the students developed in the "*Best Out of Waste*" project.



Figure 7. Tin can Lanterns (Source from Thote and Sen, 2019). This picture shows how the students learned about the Five'R concept by creating the Tin can Lanterns.



Figure 8. Bottle Piggy Bank (Source from Thote and Sen, 2019). This picture shows how the students learned about the Five'R concept by creating a piggy bank from a used bottle.

A study by Dhanapal et al. (2014) aimed to investigate the use of visual arts to motivate students to learn science and the effectiveness of incorporating visual arts into science learning. The participants were Grade 3 elementary students, who used visual arts methods such as drawing and painting to learn about sience topics, for example, the insect life cycle and the parts of a flower. The results showed that using an arts-integration

learning approach would provide a positive learning environment that promoted students' eagerness to learn science concepts well and improved their understanding and motivation to learn science. However, the limitation of this study was that it relied on self-reported surveys to measure students' perceptions of their interest in learning a science topic through visual arts. The study's evaluation lacks objective, quantitative metrics, such as standardized test scores or a matched-control-group design, to demonstrate actual gains in scientific competency.

Another recent publication by Aghasafari (2024) evaluated the use of arts integration for emergent bilingual and multilingual high school learners navigating complex cell biology. The research used an initiative approach, "artistic reformatting," to allow students to express their understanding of animal cell components through visual arts. The research revealed that visual arts serve as a vital cognitive tool, enabling language-minority students to bypass English constraints and anchor abstract scientific frameworks in their own cultural memories, interests, and peer interactions. Examples of "artistic reformatting" created by those students include showcasing animal cell components as a fashion-designed dress, ring, postcard, and more. In this research, the researcher claimed that, through this visual art activity, students enriched their understanding, fostered engagement, and promoted creativity. However, the research relies solely on qualitative interpretations of small, highly specific case-study cohorts, leaving no quantitative metrics to verify whether these creative interventions can scale within highly standardized education systems.

In conclusion, integrating arts into the science curriculum not only promotes student engagement and encourages active participation in the learning process, but also supports the development of 21st-century skills (creativity, communication) necessary for students as they need these skills for adapting to a fast-changing world (Corbisiero-Drakos et al., 2021). In addition, art integration also improves students' academic performance (Leysath & Bronowski, 2016), where using art to learn science increased their interest and motivation (Beese & Martin, 2019) and led to better learning experiences. Arts integration in science education enhances interdisciplinary learning to support diverse learners, promoting a holistic and meaningful learning experience (Aghasafari, 2024).

DISCUSSION AND THEORETICAL SYNTHESIS

The synthesis of empirical literature from 2014 to 2024 shows that arts integration in science education has driven a transformative shift from passive, teacher-directed rote learning to active, student-centered inquiry. To address peer review mandates for greater analytical depth, this section contextualizes the mapped findings within three foundational educational frameworks: John Dewey's philosophy of experiential learning, the constructivist paradigm, and sociocultural interaction theory, presented in Figure 9.

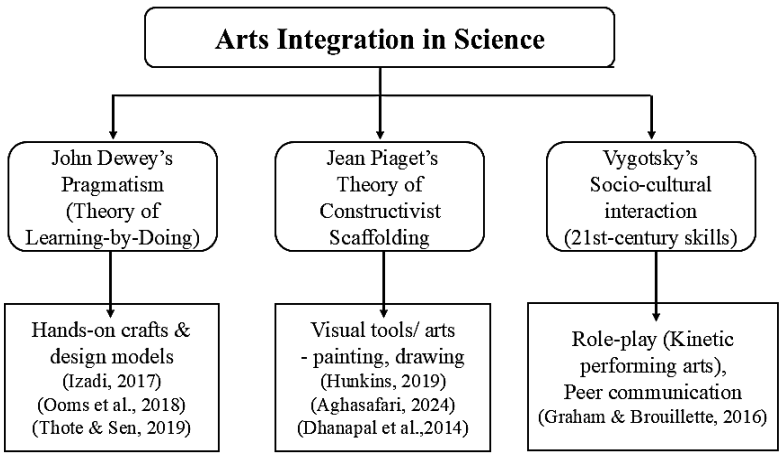

Figure 9. The mapping of the theory embedded in the relevant studies.

5.1 Experiential Learning and John Dewey's Pragmatism

In John Dewey's philosophy of pragmatism, the theory focuses on "Learning-by-Doing," in which learners must be practical and experience the learning process in order to make it meaningful (Dewey, 1980). John

Dewey's seminal works, *Art as Experience* (1934) and *Experience and Education* (1938), argue that learning is an active process grounded in meaningful physical and sensory interaction with the environment. In other words, students learn better when they are doing rather than just watching or listening, because learning by doing provides a sense of completion that leads to better cognitive retention.

Dewey believed that every person is an artist who lives an artful life and engages with the world. The word "Pragmatism" comes from a Greek word meaning "practical" and learned through action (Shawal, 2015). The reviewed scoping data show that arts integration is directly linked to John Dewey's Pragmatism. Accordingly, applying Dewey's theory to art-based learning helps explain how art-based or art-integrated learning can enhance student learning through hands-on activities such as crafting, drawing, role-playing, and acting (Dhanapal et al., 2014; Stough, 2018; Hunkins, 2019).

Hunkins (2019) emphasizes that art integration in science can help to improve student engagement, as the students will participate in the learning process. Those studies that involved hands-on, inquiry-based artistic activities—including building functional paper bridges to test load-bearing metrics (Izadi, 2017), constructing roller coaster models (Ooms et al., 2018), and creating operational artifacts from recycled waste (Thote & Sen, 2019)—reflect studies informed by John Dewey's theory of pragmatism. This theory emphasizes how students engage with concrete scientific concepts through artistic activities and transformed into memorable, lived experiences.

5.2 Constructivist Scaffolding

The constructivist approach to learning by Jean Piaget and Lev Vygotsky, holds that learners do not passively absorb information. Instead, they construct new knowledge structures on the basis of their pre-existing cognitive schemas. In science classrooms, students often encounter abstract entities at the micro or macro level (e.g., cell organelles, molecular bonds, gravitational fields) that cannot be seen with the naked eye, often resulting in conceptual disinterest or frustration. However, with the help of the art forms of learning activities, it encouraged the students to build their cognitive understanding by visualizing these concepts.

In the study of Hunkins (2019), the year-long nature journaling and multimedia cell collages enabled students to make their internal mental models into visible graphics, enabling peer review and self-correction. In addition, Aghasafari (2024) found that integrating the arts into science learning helps students overcome vocabulary barriers by using visual art elements to link cell biology functions to personal cultural memories and cognitive insights. Lastly, Dhanapal et al. (2014) found that integrating visual arts allows learners to represent their knowledge in their own way through sketches, paintings or clay models. This gives them a wider range of tools with which to communicate and enables them to construct the science concepts before they have fully mastered formal technical vocabulary. Students who transform knowledge and information into an art form can reflect their understanding and help them remember it more easily (Hunkins, 2019; Halverson & Sawyer, 2022).

5.3 Theory of Socio-Cultural Interaction

The theory of Sociocultural was proposed by Lev Vygotsky (1978) and emphasizes the importance of social interaction in learning, where learning occurs when a group of learners interact with one another in the context of human development and learning (Allam, 2020; Drew, 2023). From a socio-cultural perspective, cognitive development depends heavily on social interaction among learners. Arts integration systematically triggers these collaborative environments, directly fostering essential 21st-century skills. A study by Graham and Brouillette (2016), using kinetic performing arts programs such as dancing, role playing, to express their understanding of the movement of the planets or the flow of electricity enables students to be constantly communicating with each other, negotiating roles and coordinating their physical actions as a team.

In developing 21st-century skills that will be useful in the future, another skill that also crucial to growth is communication (Nazifah & Asrizal, 2022). Art integration can help in developing communicative skills (Corbisiero-Drakos et al., 2021). This communicative skill can be explained in two ways: conversation among group members (verbal) and expressive demonstration (non-verbal), such as creating artworks (Brouilette,

2010 as cited in Corbisiero-Drakos et al., 2021). Consequently, arts integration works brilliantly at bridging the gap between creative imagination and empirical logic. However, arts-integrated learning environments require massive amounts of instructional time for planning, execution, and cleanup, leading to intense friction for teachers who work under rigid, exam-driven curricula (Turkka et al., 2017).

RECOMMENDATION

In Malaysia, low student performance in Science is still an issue for the current situation (Law et al., 2022) where this situation is caused by the use of traditional learning approaches in science lessons which is a less effective strategy for learning (Roehrig et al., 2021). Thus, with the less effective traditional learning approaches, it will lead to low interest and motivation to learn in the students as they are not given opportunities to engage in the learning activities and interact with the learning materials and others students that could promotes an active learning environment (Dhanapal et al., 2014; Freeman et al., 2014).

6.1 Future of Integrated Learning in Science

In the future, it is recommended that integrated learning should be designed and used because it is crucial, as it brings advantages to the students. Integrated Science provides students with a better understanding of the content and prepares them for future careers (Roehrig et al., 2021). Science can be integrated not only with Arts, but also with History, Language, Technology, Health education, Music, and so on (Skorton & Bear, 2018; Hustad, 2022). With this integrated science learning, it provides a deep learning strategy instead of surface learning because it provides a whole learning experience for the students to explore, participate, and develop a positive attitude toward science (Mao et al., 2021).

Therefore, in Integrated science learning, students will have a sense of engagement in the learning process that triggers their interest and motivation to learn science by using any integrated learning method or activities that will help to improve their achievement in science learning (Law et al., 2022). As Zheng et al. (2019) stated, students' interest in science education was positively associated with their achievement in science tests. According to Zhang and Tang (2017) as cited in Law et al. (2022), “interest” is the aspect of the positive attitude toward science learning that is represented by the emotions and feelings of the learner on how they treat their learning process in science class. "Science, itself was a form of Art" (Dewey, 1929). As stated by John Dewey, “Art as Experience” which means the students will have an aesthetic experience that will help the students to have a meaningful experience that fulfils the needs of fundamental learning.

Once the students have the positive attitude toward science where they are interested and motivated to learn science with integrated learning strategy, the students will not only obtain knowledge but also have a better understanding on what they are learning, and develop social skills and life skills from that particular learning activity. Thus, integrated learning not only improves students’ science achievement but also enhances the development of 21st-century skills. According to Rusdin and Ali (2019) and Nazifah and Asrizal (2022), they proved that integrated practices or activities used in science learning could help foster the 21st-century Four C’s skills: creativity, critical thinking, collaboration, and communication.

In summary, integrated learning has the potential to create more engaging, relevant, and interactive learning experiences. Learning science by integrated learning model helps to equip students with the skills and knowledge needed for future careers and fosters a deeper understanding of science.

CONCLUSION

This scoping review systematically mapped contemporary empirical literature (2014–2024) across seven studies to evaluate the application, academic dividends, and systemic challenges of arts integration within science education. The findings confirm that incorporating visual arts or performing arts into science learning

offers strong potential for students’ learning and skill development. It also significantly enhances student engagement, improves academic performance and cultivates vital 21st-century skills, such as creativity and collaboration. In a student's learning journey, it should not focus only on outcomes or results; it should pay

more attention to gains and development during the learning process (Feynman, n.d., as cited in Rosie, 2022). Thus, learning does not happen in just flipping over a book, being a passive receiver in class or memorizing information; but the main point of learning is that learners need to engage and interact with other individuals and with the learning material by anchoring those theories of learning (Freeman et al., 2014; Nazifah & Asrizal, 2022).

However, the review highlights that implementing arts integration in science education faces several challenges, including a critical lack of specialized teacher training, time constraints, and limited sources of integrated learning. In the future, it would be beneficial for elementary and secondary teachers in Malaysia to take a training course on art integration to prepare them to plan and apply this approach in their lessons. This could help teachers generate more ideas for learning activities by using art to teach other subjects, such as Mathematics, History, and Language, and support students' growth in content knowledge and skills development. Through art, students can connect with their academic studies, become more creative, and think critically as they create artwork; they also develop the interpersonal skills needed for the 21st century. As a result, the values, attitudes, and attributes students develop will serve them well in the future, whether in the workplace or in their lives.

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Conflicts of Interest

The authors declare there are no conflicts of interest.

REFERENCES

1. Adnan, M. M. (2018). Effective Learning Through Moodle Management, Social Media, and Peer-Guided Learning. In S. Tang & C. Lim (Eds.), *Preparing the Next Generation of Teachers for 21st Century Education book series* (pp. 89-108). IGI Global. https://doi.org/10.4018/978-1-5225-4080-9.ch006
2. Nahar, N., Safar, J., Hehsan, A., Jima'ain@Ajmain, M. T., Junaidi, J., Haron, Z., & Hussin, M. F. A. (2021). Active learning through student-centered activity in the instruction of islamic education teachers as an implementation of the 21st century learning: A case study. International Journal of Academic Research in Business and Social Sciences, 11(11), 936–950
3. Drake, S. M., & Reid, J. (2020). 21st century competencies in light of the history of integrated curriculum. Frontiers in Education, 5. https://doi.org/10.3389/feduc.2020.00122
4. Singh, G. K. S., & Rashid, S. I. binti A. (2023). An Integrated Curriculum Design for Preschool Education in Malaysia: A Conceptual Paper. International Journal of Academic Research in Business and Social Sciences, 13(7), 465 – 475. http://dx.doi.org/10.6007/IJARBSS/v13-i7/17450
5. Humphreys, A.H, Post, T. R., & Ellis, A. K. (1981). Interdisciplinary Methods: a Thematic approach.https://experts.umn.edu/en/publications/interdisciplinary-methods-a-thematic-approach
6. Jacobs, G. M., & Toh-Heng, H. L. (2013). Small steps towards Student-Centred learning. Proceedings of the International Conference on Managing the Asian Century (pp. 55–64). https://doi.org/10.1007/978-981-4560-61-0_7
7. Morisson, G. S. (2021). HighScope: a constructivist approach. https://www.education.com/download-pdf/reference/26196/
8. Tudor, L. S. (2014). Primary School Skills Development through Integrated Activities. Procedia - Social and Behavioral Sciences, 127, 722–727. https://doi.org/10.1016/j.sbspro.2014.03.343
9. Thote, P., & Sen, R. K. (2019). Experiential learning: inclusive art education for joyful learning. International Journal of Research Granthaalayah, 7(11), (pp. 111–115).

https://doi.org/10.29121/granthaalayah.v7.i11.2019.3717
10. Tricco, A.C., Lillie, E., Zarin, W., O'Brien, K.K., Colquhoun, H., Levac, D. et al. (2018) PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. Annals of Internal Medicine, 169(7), 467–473. Available from: https://doi.org/10.7326/M18-0850
11. McPhail, G. (2020). An introduction to curriculum integration. THE EDUCATION HUB. https://theeducationhub.org.nz/an-introduction-to-curriculum-integration/
12. Wall, A., & Leckie, A. (2017). Curriculum Integration: An Overview. Current Issues in Middle Level Education, 22(1), 36–40. https://files.eric.ed.gov/fulltext/EJ1151668.pdf
13. Gürkan, B. (2021). Transdisciplinary Integrated Curriculum: An Analysis of Teacher Experiences through a Design Model within the Framework of IB-PYP. Participatory Educational Research, 8(1), 176–199. https://doi.org/10.17275/per.21.10.8.1
14. Neendoor, S. (2023). Why Curriculum Integration Should Be A Priority In Education. Hurix Digital. https://www.hurix.com/why-curriculum-integration-should-be-a-priority-in-education/
15. Ling, N. K., Samsudin, S., Saad, M. I. M., Daud, A. N. M., Rahim, N. S. A., Arif, H. A., & Jusoh, N. (2024). Development of Malaysian Science Standard Document for Teaching Year Four Student according to Neoteric Approach Curriculum: A Concept Paper. Journal of Education and Practice, 8(2), 28–50. https://doi.org/10.47941/jep.1801
16. Adolfsson, C. H. (2018). Upgraded curriculum? An analysis of knowledge boundaries in teaching under the Swedish subject-based curriculum. The Curriculum Journal, 29(3), 424–440. https://doi.org/10.1080/09585176.2018.1442231
17. Antwi, M., & Fredua-Kwarteng, E. (2022). Spoon-feeding is bad for students – and their countries. University World News. https://www.universityworldnews.com/post.php?story=20220831083631622
18. Martinez, C. (2022). Developing 21st century teaching skills: A case study of teaching and learning through project-based curriculum. Cogent Education, 9(1). https://doi.org/10.1080/2331186x.2021.2024936
19. Green, K., Trundle, K. C., & Shaheen, M. (2019). Integrating the arts into science teaching and learning: A literature review. Journal for Learning Through the Arts, 14(1). https://doi.org/10.21977/d914140829
20. Duma, A. L., & Silverstein, L. B. (2014). A View into a Decade of Arts Integration. Journal for Learning Through the Arts, 10(1). https://doi.org/10.21977/d910119197
21. Lathan, J. (2022). Why STEAM is so important to 21st century education. https://onlinedegrees.sandiego.edu/steam-education-in-schools/#history
22. Davidson, S. (2019). Artistic Classroom Activities: What Skills Can Students Learn? Journal for Learning Through the Arts. 14(1) https://doi.org/10.21977/d914136830
23. Dewey, J. (1980). Art as experience. New York: Perigee Book. https://archive.org/details/deweyjohnartasanexperience/mode/1up
24. Straksiene, G., Ben-Horin, O., Espeland, M., & Robberstad, J. (2022). Towards a rationale for science-art integration as a transdisciplinary signature pedagogy. Cogent Education, 9(1). https://doi.org/10.1080/2331186x.2022.2087459
25. Heiman, A. (2020). Benefits of Arts Integration: Rationale and Recommendations for Arts Integration in Academic Coursework. [MA thesis]. Catholic University of America. ERIC. https://files.eric.ed.gov/fulltext/ED618694.pdf
26. Stough, A. (2018). Art in the science classroom: Art integration. In ScholarWorks@BGSU. Honors Projects.https://scholarworks.bgsu.edu/honorsprojects/336
27. Stivaktakis, S., & Krevetzakis, K. (2018). Learning Science through the Arts: The Theory and the Educational Possibilities. Journal of Advances in Education Research. https://doi.org/10.22606/jaer.2018.31007
28. Ibarra, L., & Sommerstad, A. (2018). Notes from Artists: Making the Invisible Visible and Art as the Bridge to Science and Interconnectedness. In Springer eBooks (pp. 151–159). https://doi.org/10.1007/978-981-13-2880-0_10
29. Wiggin, R. G. (1969). Art and Science Core. Art Education, 22(7), 19. https://doi.org/10.2307/3191377
30. Hunkins, M. M. (2019). The Art of Science; An Exploration of Art Integration in a Science Classroom. Middle Grades Review, 5(2). https://scholarworks.uvm.edu/mgreview/vol5/iss2/6

31. Schnugg, C., & Song, B. (2020). An Organizational Perspective on Art Science Collaboration: Opportunities and Challenges of Platforms to Collaborate with Artists. Journal of Open Innovation, 6(1), 6. https://doi.org/10.3390/joitmc6010006
32. Hadzigeorgiou, Y., Fokialis, P., & Kabouropoulou, M. (2012). Thinking about Creativity in Science Education. Creative Education, 03(05), 603–611. https://doi.org/10.4236/ce.2012.35089
33. Dhanapal, S., Kanapathy, R., & Mastan, J. (2014). A study to understand the role of visual arts in the teaching and learning of science. Asia-Pacific Forum on Science Learning and Teaching, 15(2), 1-25. The Education University of Hong Kong, Department of Science and Environmental Studies.
34. Mcdougall, M., Bever, B., & Seper, R. (2011). Art as a way of knowing. San Francisco: Exploratorium, 1-33. [Conference Report]. https://annex.exploratorium.edu/knowing/pdfs/ConferenceReport.pdf
35. Izadi, D. (2017). Arts in science education. Canadian Journal of Physics, 95(7), xliii–xlvi. https://doi.org/10.1139/cjp-2016-0590
36. Ooms, E. C., Wu, T. M., Kokemuller, A. R., Montgomery, S. E., & Rule, A. C. (2018). Arts integration into elementary science: Force and motion and natural disasters. Journal of STEM Arts, Crafts, and Constructions, 3(2), 77-100. https://scholarworks.uni.edu/cgi/viewcontent.cgi?article=1026&context=journal-stem-arts
37. Graham, N., & Brouillette, L. (2017). Using Arts Integration to make science learning memorable in the Upper Elementary Grades: A Quasi-Experimental Study. Journal for Learning Through the Arts, 12(1). https://doi.org/10.21977/d912133442
38. Aghasafari, S. (2024). Creative Visual Arts and Biology Processes: Examining Emergent Bi/Multilingual High Schoolers Meanings. European Journal of Arts Humanities and Social Sciences, 1(3), 200–209. https://doi.org/10.59324/ejahss.2024.1(3).18
39. Corbisiero-Drakos, L., Reeder, L., Ricciardi, L., Zacharia, J., & Harnett, S. (2021). Arts integration and 21st century skills: A study of learners and teachers. International Journal of Education & the Arts, 22(2). http://doi.org/10.26209/ijea22n2
40. Leysath, M., & Bronowski, C. (2016). An adventure in full art integration. Art Education, 69(6), 28-34.
41. Beese, J. A., & Martin, J. L. (2019). Csikszentmihaliyi's concept of flow and theories of motivation connection to the arts in an urban public high school. Journal for Learning Through the Arts. https://doi.org/10.21977/d915135480
42. Dewey, J. (1938). Experience and education. In J. A. Boydston (Ed.), The collected works of John Dewey, 1882–1953: The later works, 1925–1953 (13, 1–62). Southern Illinois University Press.
43. Shawal, M. (2015). Pragmatism in Education: Study Notes. Your Article Library. https://www.yourarticlelibrary.com/education/pragmatism-in-education-study-notes/69152
44. Halverson, E., & Sawyer, K. (2022). Learning in and through the arts. Journal of the Learning Sciences, 31(1), 1–13. https://doi.org/10.1080/10508406.2022.2029127
45. Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Cambridge, MA: Harvard University Press.
46. Allman, B. (2020). Socioculturalism. In R. Kimmons & S. Caskurlu (Eds.), The Students' Guide to Learning Design and Research. EdTech Books. https://edtechbooks.org/studentguide/socioculturalism
47. Drew, C. (2023). Sociocultural Theory of Learning in the Classroom. Helpful Professor. [Online Article] https://helpfulprofessor.com/sociocultural-theory-education/
48. Nazifah, N., & Asrizal, A. (2022). The Effect of STEM integrated modules on knowledge and students' 21st century skill in science and physics learning: A meta analysis. International Journal of Progressive Sciences and Technologies, 34(1), 441. https://doi.org/10.52155/ijpsat.v34.1.4527
49. Turkka, J., Haatainen, O., & Aksela, M. (2017). Integrating art into science education: a survey of science teachers' practices. International Journal of Science Education, 39(10), 1403–1419. https://doi.org/10.1080/09500693.2017.1333656
50. Roehrig, G. H., Dare, E. A., Ellis, J. A., & Ring-Whalen, E. (2021). Beyond the basics: a detailed conceptual framework of integrated STEM. Disciplinary and Interdisciplinary Science Education Research, 3(1). https://doi.org/10.1186/s43031-021-00041-y
51. Law, H. H., Sharif, S., & Han, C. G. K. (2022). Analyzing the science achievement test: perspective of classical test theory and rasch analysis. International Journal of Evaluation and Research in Education, 11(4), 1714–1724. https://doi.org/10.11591/ijere.v11i4.22304

52. Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. Proceedings of the National Academy of Sciences, 111(23), 8410-8415.
53. Skorton, D. J., & Bear, A. (2018). The Integration of the Humanities and Arts with Sciences, Engineering, and Medicine in Higher Education. In National Academies Press eBooks. https://doi.org/10.17226/24988
54. Hustad, E. (2022). How music can be Integrated into life science teaching in a way that enhances scientific and musical learning in middle school. School of Education and Leadership Student Capstone Projects. DigitalCommons@Hamline. https://digitalcommons.hamline.edu/hse_cp/852
55. Mao, P., Cai, Z., He, J., Chen, X., & Fan, X. (2021). The Relationship between Attitude toward science and academic Achievement in Science: A Three-Level Meta-Analysis. Frontiers in Psychology, 12. https://doi.org/10.3389/fpsyg.2021.784068
56. Zheng, A., Tucker-Drob, E. M., and Briley, D. A. (2019). National gross domestic product, science interest, and science achievement: a direct replication and extension of the Tucker-Drob, Cheung, and Briley (2014) study. Psychol. Sci. 30, 776–788. doi: 10.1177/0956797619835768
57. Rusdin, N. M., & Ali, S. R. (2019). Practice of Fostering 4Cs Skills in Teaching and Learning. International Journal of Academic Research in Business and Social Sciences, 9(6), 1021–1035. http://dx.doi.org/10.6007/IJARBSS/v9-i6/6063
58. Rosie. (2022). The Feynman learning technique. Farnam Street. https://fs.blog/feynman-learning-technique/