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INSTEAD OF AN INTRODUCTION: STREAM AS LIFE AN INTEGRATED APPROACH TO INSTRUCTIONAL DESIGN USING SCIENCE, TECHNOLOGY, READING, ENGINEERING, ARTS, AND MATH IN EARLY LEARNING

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INTRODUCTION

STREAM is a method of instruction that allows Science, Technology, Reading, Engineering, Arts, and Math to be taught using an integrated approach rather than teaching individual subjects in isolation (Mariana & Kristanto, 2003; Nuangchalerm et al. 2020). Subjects taught in isolation focus on mastery of individual skill sets rather than focusing on the intersectionality of content and its application to real-life scenarios that fit the ever-changing and rapidly evolving environments in which they live. This is especially true for very young learners. To this end, reading and writing skills are emphasized within the STREAM-based approach (Sun & Zhong, 2024). While reading solidifies a student's knowledge base and supports their knowledge acquisition, writing allows students to process and authentically communicate their learning (Nuangchalerm et al., 2020; Suteu et al., 2024; Sun & Zhong, 2024).

STREAM OVERVIEW

In primary and elementary settings, STREAM focuses on introducing basic principles of scientific thinking and mathematical processing, fostering curiosity in the world around students, and developing foundational language and literacy skills (Li & Talib, 2024; Phang et al., 2023). As students progress through their academic programs, learning becomes more structured, integrating a variety of disciplines appropriate to the query, promoting problem-solving, critical thinking, and collaboration between peers. This critical shift in development has profound implications for not only the individual's learning but for all children, regardless of ability level within each peer group (Phang

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et al., 2023; Prommaboon et al., 2022). Of importance are the concepts of both technical skills within each discipline, but also an emphasis on soft skills like critical thinking, communication, collaboration, and creativity. While technical skills are important, researchers are finding that these skills alone, without the ability to communicate and collaborate are less valuable to the future marketplace. These 21st-century skills, including digital literacy, are critical to the fundamental success of students who are ready to engage in a global world where complex problems will often require complex but creative solutions (Kitamura, 2024; Rickey et al., 2023; Starciogeanu, 2023; Wilson et al., 2021; Xiaodong & Chengche, 2024).

As our world becomes more dependent on technology, and each industry becomes more globally and technologically interdependent, the implications of offering a STREAM-based approach to learning become magnified. As we strive to provide career-ready students, we must realize that the careers of today will dynamically shift by the time young learners reach maturity and enter the workforce. Essentially, we do not only prepare our students to be career-ready, but also future-ready, by giving them the tools they need to problem-solve, collaborate, and investigate rather than teaching written facts (Phang et al., 2023; Yang & Hsueh, 2024).

By including STREAM programs in educational systems, especially in the younger years, nations make themselves more competitive in the global marketplace. To effectively do this, we must also consider the preparation of our teaching force to meet the needs of our future-ready students. This requires an intentional development of the teaching force to include pedagogical techniques, base knowledge, and intellectual and physical resources necessary to facilitate high-level teaching and learning in the early years (Li & Talib, 2024; Phang et al., 2023).

HISTORICAL CONTEXT

Late in the 20th century, STEM fields reemerged as a critically important area within the global economy. As technology created interconnectedness through commerce and communication, STEM fields began to become increasingly important in national and international relations (Brada et al., 2023; Topalska, 2021). As early as 1986, the National Science Board in the United States released a report emphasizing the importance of STEM education (Yang & Hsueh, 2024). As technology boomed, so did the need for and interest in these fields. By the early 21st century, the concept of STEM education expanded to include the arts, yielding the beginning of the STEAM movement which was designed to promote a more interconnected approach to problem-solving (Brada et al., 2023;

Mertala et al., 2004; Oladele & Ndlovu, 2024). In 2006, the first mention of STEAM education as an integrated approach to curriculum development was included as an initiative at the Rhode Island School of Design to emphasize art and design (Oladele & Ndlovu, 2024).

Shaw et al. (2021) asserted that one distinct advantage of utilizing an integrated approach that includes the arts focused on the ability of a student to think about a problem both technically and creatively, making room for the uncertainty of the inquiry process, yielding a more transversal thinking process, actively utilizing both sides of the brain, and focusing on teamwork and communication (Starciogeanu, 2023). The inclusion of literacy strategies as a foundation of STREAM education is a recent development within the integrated approach that combines both technical and soft skills to support students as they navigate a landscape where technology can simultaneously help and hinder societies.

HOLISTIC APPROACH TO LEARNING

While a traditional approach to learning includes a compartmentalized approach to curriculum development and deployment, STREAM is integrated. This integrated approach to teaching and learning provides a more holistic and student-centered focus, which breaks down silos between disciplines. The traditional, siloed approach to education can hinder a child's ability to make connections between concepts in other disciplines, which in turn, creates barriers to the application of knowledge across disciplines (Starciogeanu, 2023). A STREAM-based approach to education involves the interconnectedness of concepts and the impact of each facet of a problem on the eventual solution (Olivato & Silva, 2023). Students are encouraged and expected to take a 360-degree view of any problem to analyze all potential impacts before posing a solution. This multidisciplinary approach to teaching, learning, and thinking allows students to connect theoretical concepts to real-world scenarios (Mariana & Kristanto, 2023; Oladele & Ndlovu, 2024; Rickey et al., 2023). This constructivist approach to learning promotes autonomy in learning, as well as a sense of agency. Students are moved from a passive to a highly participatory role in learning, engaging their knowledge and allowing for the application of knowledge to occur more readily (Rickey et al., 2023; Xiaodong & Chengche, 2024).

Inherent to the nature of STREAM-based pedagogy is the ability to promote differentiation and choice in learning. By creating a learning environment that is engaging and inquiry-rich, STREAM-based pedagogical approaches promote differentiation amongst learners. Teachers who structure STREAM-based

classrooms appropriately can scale instruction up for more advanced learners as well as down to reinforce content for those who may need remediation (Mariana & Kristanto, 2023; Xiaodong & Chengche, 2024). One particular approach, Problem-Based Learning (PBL) is particularly well suited to provide a platform for teachers to cater to the diverse and varied needs of the learners in their classrooms (Oladele & Ndlovu, 2024, Olivato & Silva, 2023). By scaling the expectations, the focus of the content, product, or process of the learning to meet the level of a learner, teachers can customize learning experiences to a variety of needs within a single classroom, allowing students to work towards mastery and enrichment side by side (Starciogeanu, 2023; Wilson et al, 2021). Coupled with the multiple and varied ways in which the integration of literacy elements such as writing and communication of ideas, students are empowered to demonstrate mastery in which they have a choice (Nuangchalerm et al., 2020; Shaw et al., 2021). Students are encouraged to leverage their areas of strength and creativity when working to increase their foundational skills in any given content area.

PEDAGOGICAL APPROACHES IN STREAM

Research indicates that the most effective pedagogical approaches in STREAM-based education revolve around experiential learning (Shaw et al., 2021). Inquiry-based instruction where students are allowed to explore, fail, and try again is critical to developing the critical thinking skills and resilience that are often associated with this method of instruction (Oladele & Ndlovu, 2024; Suteu et al, 2024). Inquiry is a foundational element of STREAM-based learning (Kitamura, 2024). Kitamura (2024) suggests that inquiry transcends the framework of individual content, and allows students to connect pertinent elements of any STEM-based content to real-world situations while integrating creative and artistic elements. Suteu and colleagues (2024) determined that there were two dimensions of cognition relevant to STREAM-based instructional methods. The first is the metacognitive dimension, in which a student becomes aware of his or her learning preferences, actual knowledge, and where he or she needs to strengthen the knowledge base. The second dimension, metacognitive regulation, is the one in which a student is actively engaged in the learning and utilizes their actual knowledge as well as their knowledge of their learning processes and preferences, and is actively engaged in strategizing ways in which to overcome difficulties experienced during the learning (Kitamura, 2024). Not only is a student empowered to deepen their understanding of content, he or she acquires knowledge of how he or she learns best; which can be applied to multiple situations across content and real-world settings.

Two additional techniques that are similar but distinct approaches are Problem-based Learning and Project-based Learning. Many professionals use PBL to describe both methods, but the two have distinct features and are not interchangeable. Project-based Learning incorporates a real-world problem into the curriculum which students then attempt to pose a solution for, using investigation, exploration, and hands-on learning. Project-based Learning is an overarching theme that allows for integration across multiple disciplines and takes an extended period to fully investigate and complete. In line with preparing students who have mastered 21st-century skills, Project-based Learning focuses on communication through collaboration and an active role in the learning (Olivato & Silva, 2023). Problem-based Learning is equally effective at blending technical and 21st-century skills, along with developing soft skills like creativity and communication while allowing for engagement and agency in the learning (Oladele & Ndlovu, 2024; Xue, 2022). While both approaches are highly student-centered, there are some distinguishing features. Problem-based Learning (PBL) tends to be more structured and has a narrower focus on a specific problem that must be solved. Project-based Learning (PjBL) allows for a more student-directed approach and a wider framework in which to navigate (Xue, 2022; Yang & Hsueh, 2024). PBL frequently focuses on a specific solution to a clearly defined problem, whereas PjBL allows students to demonstrate mastery of learning through creative expression and the completion of a project (Yang & Hsueh, 2024). Assessment in PBL is focused on a successful solution to a problem, whereas PjBL provides an opportunity for creativity, has a wider range of criteria on which the assessment is based, and includes competency in 21st-century skills. Other instructional methods appropriate for younger learners include the incorporation of drama-based activities, storytelling, gamification of learning, and competency-based educational models (Bertling & Galbraith, 2024; Juntakoon et al., 2004a; Juntakoon et al., 2004b; Kasvary & Geza, 2024; Oladele & Ndlovu, 2024).

When structured appropriately, PBL and PjBL are appropriate for all learners even our youngest ones. There are, however, methods that work best with older learners. Methods such as blended learning, a hybrid approach, involve utilizing both in-person and online learning to enhance student mastery of knowledge (Cai, 2023). Additionally, the utilization of a flipped classroom could also be impactful for older learners. A flipped approach to learning generally refers to students who access curated materials online before a class meeting and engage in application activities during a class session (Oladele & Ndlovu, 2024). This approach is best suited for learners who have access to an online learning platform as well as those who are self-directed enough to prepare for an in-class session before each meeting. Finally, the integration of creative and visual materials is critical to the overall impact of STREAM-based

education. Students must be able to utilize real-world materials, practice critical analysis of digital materials, and apply their analytical skills to photographs, maps, and art to develop the skill set needed to engage effectively in a multidisciplinary environment that reflects the real world (Shaw et al., 2021).

ASSESSMENT METHODS IN STREAM

While some instructional methods embed assessment criteria within the framework of the instruction (e.g. PBL/PjBL), others require consideration for an appropriate approach. Some of the most effective methods of assessment in a STREAM environment include authentic assessments, performance-based assessments, and student self-assessments (SSA) (Mariana & Kristanto, 2023; Rickey et al., 2023; Wilson et al., 2021). Authentic Assessment relies heavily on simulating a real-world environment, focuses on the application of knowledge, and involves the direct application of knowledge (Rickey et al., 2023). Performance-based assessments rely on the demonstration of mastery of knowledge in a variety of disciplines to communicate a final result. This is an ideal method of assessment in a STREAM classroom due to the opportunity to include creative expression and allow for student direction in the production of the final product (Wilson et al., 2021). SSA is a method of assessment that taps into a student's metacognitive knowledge (Rickey et al., 2023). A student can include reflection, goal setting, creation of prototypes, self-testing, and communication with peers and assessors (Rickey et al., 2023).

THE ROLE OF THE EDUCATOR IN STREAM

To facilitate a high-quality STREAM-based environment, teachers require specialized support and development. Initially, teachers must learn how to transition from the role of a gatekeeper of knowledge to a facilitator of learning and must have strong pedagogical knowledge and skills in STREAM concepts (Li & Talib, 2024; Oladele & Ndlovu, 2024; Olivato & Silva, 2023; Phang et al., 2023; Wilson et al., 2021). Not only must they have expertise in structuring the learning environment and processes, but also in identifying struggling learners and providing scaffolding opportunities for them (Brada et al., 2023; Gulhan, 2024; Shaw et al., 2021; Oladele & Ndlovu, 2024; Wilson et al., 2021).

There are factors outside the control of a classroom teacher. Teachers must have a supportive administration that provides professional development. Current information in both pedagogy, as well as content, is critical to the function of a high-quality STREAM program. Additionally, teachers must have access not only to physical materials in the room appropriate to the age of students in

their care, but also technological platforms, instructional technology, and access to stakeholders with real-world connections to ensure that children can actively and fully engage in a STREAM program (Zan et al., 2024). Some challenges that teachers face in implementing STREAM education include teacher expertise and confidence, limited resources, time constraints, and efficacy with assessments appropriate to an interdisciplinary curriculum (Brada et al., 2023; Phang et al., 2023; Shaw et al., 2021).

CONCLUSION

STREAM-based education is a novel approach that engages students in a variety of cognitive and physical ways. Students are empowered, have agency in the learning, and can determine the direction of their inquiry. However, these processes all take time and intensive structure to ensure that they are implemented in a way that is beneficial to students. STREAM is a critical approach to developing students who can meet the needs of a workforce that does not exist yet, to engage with complex problems that their generation will face, and to pose complex and critically analytical solutions to those problems. Offering STREAM programs provides opportunities for content development and the holistic development of a child and his or her ability to navigate a complex and difficult world, especially in the early years.

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