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Coaching Preservice Teachers to Integrate the Arts in STEM Content

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Abstract

This article explores an innovative strategy for teaching preservice university freshmen to integrate the arts in STEM content. Based on theoretical foundations of brain science, and combined with the author's 15 years of experience as an elementary school teacher, and an additional 15 years in higher education, this approach represents a conceptual framework that includes coaching teacher candidates to write, teach, critique, and reflect on lessons that integrate the arts, and to effectively use arts-infused lessons throughout their academic program and their own reflective professional practice. This instruction includes early hands-on learning opportunities and experiences, enabling preservice teachers to learn from their own teaching, and the teaching of their peers, by using reflective reciprocal feedback to revise and improve lesson design and teaching skills. Possible implications for more effective educator preparation, arts integration in STEM content, and curriculum design and program development are discussed.

An innovative interdisciplinary approach to STEM education

An old proverb maintains: "Experience is the best teacher." While this adage is borne out in a variety of life settings and training contexts, it provides an essential and practical application in the realm of teacher preparation. When teaching university freshmen in an elementary education program, coaching them across the curriculum to integrate the arts into science, technology, engineering, and math (STEM) content yields numerous desired, and even some unexpected, positive outcomes. These experiential learning opportunities in the earliest possible phase of a teacher preparation program also give teacher candidates the necessary confidence to use engaging and integrative approaches in their upper-level courses as well as in their own professional practice. Building confidence in preservice teachers who are majoring in elementary education, and who are not specializing in art education, is particularly important. According to Moilanen and Mertala (2020), generalist teachers, such as those who practice in elementary education, often report a lower level of self-efficacy when teaching the arts than when addressing other components of the curriculum such as mathematics and reading. Moilanen and Mertala (2020) and other researchers suggest that these lower perceptions of self-efficacy may be due to the differences of identification between generalist educators and specialized art teachers. According to Hatfield, Montana and Deffenbaugh (2006), art teachers often see their identity as artists as an important part of their teacher identity, whereas the identity component of artist is usually not present in most elementary school educators who teach the general curriculum. As a result of this significant difference in how these two groups of educators see themselves, some generalists who may not perceive themselves as good singers or dancers or skilled painters or drawers might be reluctant to even try to perform these skills in front of an audience of children in the classroom. Consequently, many elementary level students miss out on the rich ways that integrating the arts can undergird and enliven the components of the general curriculum and increase their learning outcomes (Burnaford, 2007; Goff & Ludwig, 2013; Ludwig & Goff, 2013; Rabkin & Redmond, 2004).

Combining the arts with STEM and other curricular content provides preservice teachers with opportunities to experiment, to step outside their comfort zones and take some low-consequence creative risks in a safe and nurturing learning environment. Further, they have opportunities to reflect on and learn from their own teaching and that of their peers, while being guided, reinforced and challenged by a teacher educator who can encourage them and provide any needed course corrections and helpful suggestions. With so many resources now available online (e.g., see the Wolftrap Foundation for the Performing Arts website), teacher educators and elementary education majors can access an almost unlimited supply of ideas and strategies for integrating the arts across the curriculum. As Ludwig, Marklein & Song (2016) suggest, the encouraging outcomes of innovative interdisciplinary approaches to arts integration in all levels of education yield important implications for teacher education, arts

integration, and curriculum development. Additional review of the evidence of promising arts-integration outcomes by Ludwig, Boyle & Lindsay (2017) underscores the need for focused instruction in preservice preparation programs.

Integrating the Arts in an Elementary School Classroom

My background in teaching at the elementary school level in US public schools, and in teaching undergraduate and graduate students at the university level, has helped me to develop a better understanding of the kinds of pedagogical tools that preservice teachers need in order to be effective elementary classroom teachers. In my own experience teaching second and fifth grades, I often integrated music, movement and rhythm, and theater arts into the general curriculum. I found such an integrative approach to be particularly effective in teaching difficult mathematics concepts by using music and rhythm. For example, when teaching the steps of long division, students were taught to snap their fingers in a rhythm corresponding to a 4/4 musical time signature, that is four beats per measure. After demonstrating a couple of long division problems on the blackboard for the students, and listing each step in the sequence they were accomplished, I modeled the integrated approach. This consisted of starting the rhythm by snapping my fingers and, having established the beat, repeating the steps of long division in time to the rhythm. After modeling this for the students a couple of times, I invited the students to join in the snapping and repeating the steps: "Divide, Multiply, Subtract and Bring Down, Repeat / Divide, Multiply, Subtract and Bring Down, Repeat!" Within a few moments the students, who were now enjoying themselves immensely, had begun to respond enthusiastically and in chorus to my modeling example. By the time we stopped, the students had repeated the sequence of long division steps for several minutes. They had experienced what they perceived as an engaging approach to learning a valuable skill in mathematics. The use of music, rhythm and movement had effectively addressed a difficult mathematical concept in a way that captured and sustained their attention and, because they were having fun in the process, prompted them to continue practicing their new skill, even in contexts outside the classroom. Over time, this would enable them to retain the material and have it available for additional applications. The students had also been exposed to, and had begun to develop, another learning tool that could be used in other conceptual settings, especially when steps of a process or related sequential concepts were involved. Interestingly, when I observed my students later in the term, sitting for their standardized tests, I noticed many of them lightly tapping their fingers (since they could not make any noise while taking the test) and mouthing the lyrics silently as they responded to their math problems. The rhythmic movements they had linked to the steps of long division were actually facilitating their recall.

As another integration strategy for combining the arts and mathematics instruction, I used a song and line dance to model kinesthetically the geometric transformations of figures on a

graph. In fifth-grade geometry, students need to be able to recognize and perform geometric transformations. These transformations include reflections (flipping a figure from left to right or from top to bottom to produce a mirror image), slides or translations (moving a figure several units up or down or left or right), and turns (rotating a figure). To teach the concept of slides/translations, I first modeled a basic line dance that features moving from left to right by sliding one's feet. While performing this basic dance step, I sang, "Slide, slide, slide your boots, gently across the line. / To translate is to do the same thing each and every time." The students were then asked to stand and form parallel lines and sing the song while gradually learning to incorporate the dance moves. Once they were able to sing the "Slide, slide, slide" verse and do the basic slide step, we then worked on two other verses with their accompanying dance steps. These verses began with the words "Flip, flip, flip your boots" for the reflections (mirror image) transformation, and "Turn, turn, turn your boots" for the turns transformation. Of course, there were many starts and stops, especially as the students faced each other in their lines and sometimes confused right and left, which only added to the fun. The many repetitions that were necessary to "master" the dance moves served to reinforce the song lyrics containing the geometry lesson concepts. Students enjoyed the "Slide, Flip, Turn" activity so much that, even after the geometry unit had been completed, they often asked if we could do it as a warmup to other lessons. I had no idea that this approach to arts integration would become such an "evergreen" arts-integration activity, not only for the students who experienced it in the context of their geometry lesson while they were in my class, but also for my former students when I encountered some of them years later as young adults.

When difficult mathematical concepts are presented in engaging ways—integrating arts elements such as rhythm, movement, music and dance—students learn and retain the math concepts and skills, as well as the elements of the arts that have facilitated their learning. They also perceive their learning as fun activities that they want to keep on repeating even after their lessons are completed. As a result, many of them are able to appropriate these arts-integrated skills as tools that they can apply when learning other concepts, especially when sequences of operations are involved. Perhaps the most surprising outcome (especially for me) is that some of my former students have even looked back on these arts-integration learning experiences as pleasant memories of their formative years in elementary school, which they continue to carry with them, along with what they learned and how they learned it.

While researchers such as Nagdi and Roehrig (2020) and Gottschalk (2019) and others have reported various challenges experienced by some educators to integrating the arts across the curriculum (e.g., dealing with time constraints, encountering resistance from colleagues and administrators, lack of funding, and critiques from parents and even students), I did not experience these challenges. In fact, my team members embraced my efforts to integrate the arts in my classes. They whole-heartedly supported my creative and innovative approaches

and often offered suggestions and ideas for further implementation. The principal of our school was equally supportive of arts integration across the curriculum. A seasoned educator, he could be counted on to enthusiastically support any approach that helped the students understand and apply the concepts they were learning. Because of our principal's high level of respect among our students' parents, and his open and frequent communication with them in a variety of settings, he maintained an open and frequent conversation with them, genuinely valued their ideas and/or concerns, and provided substantial evidence that our only interest was in providing an excellent education for their children. This was substantiated by our school's consistent leadership in the district in End-of-Grade test scores.

In retrospect, I realize that my own elementary school context was close to being ideal for the integration of arts across the curriculum. I also want to acknowledge that a lot of the success of my programs could have been attributed to being able to practice consistently in a face-to-face setting. Educators who have had to contend with the challenges of the COVID-19 pandemic environment have had to deal with previously unimagined obstacles related to the inability to meet their classes face to face. As a teacher educator, I have been able to observe effective teaching that is being conducted in both hybrid and completely virtual environments. However, integrating the arts in these environments is accompanied by challenges that remain to be addressed.

Training Preservice Teachers to Integrate the Arts: A Function of Theory, Practice and Re-iterative Reflective Experience

The aforementioned examples of arts-integration are characteristic of the methods I used during my 15 years of elementary school teaching. When my teaching audience changed from fifth-grade students to undergraduates in an educator preparation program, I used my own experience and its reflective iterations and adjustments to ground my pedagogy, especially as this relates to integrating arts in STEM and other curricular content. This I saw as a viable application and extension of Experiential Learning Theory as influenced, founded, developed, and expanded by Dewey (Experiential Education), Piaget (Constructivism), Vygotsky (Zone of Proximal Development), Rogers (Self-Actualization through the Process of Experiencing), Follett (Learning in Relationship and Creative Experience) and others (e.g., Kolb & Kolb, 2017). I was well aware of how successful some of my approaches had been in achieving the desired student learning outcomes for elementary school students, so I shared these theoretical bases, conceptual frameworks, and practical strategies with my undergraduate students who were training to become elementary school teachers themselves. However, when I first started teaching a course to freshmen education majors called *Using the Arts in the Classroom*, I had little notion of the impact that a course like this could have on these new preservice teachers. In my own experience as a classroom teacher, I had often used music, visual arts, and theater arts to enhance my lessons and engage my learners. So, I knew the value of integrating the

arts into other content areas. Still, I had no idea how coaching preservice teachers at the the onset of their studies to integrate the arts into their lesson plans would shape them as future educators.

Early coaching and instruction on integrating the arts into STEM and other content areas positively affects Preservice teachers' abilities to plan, execute, and to reflect on, and adjust their own lessons, as well as how they coach their peers by providing meaningful feedback after participating in modeled lessons. My own observations over the past several years reveal that learning why the arts should be integrated in other subjects, how to integrate the arts, while also learning to develop lesson plans and teach lessons, has an observable impact on the quality of the arts integration, as well as on the quality of the content delivery overall. These positive effects on Preservice teachers extend throughout their own reflective practices and influence their effectiveness.

Why Integrate the Arts?

According to Salomaa and Mertala (2019), when it comes to the integration of the arts into STEM or other general curricular components, the "importance of the 'why' questions cannot be overemphasized, since intentionality and goal orientation are key characteristics of institutional education" (p. 155). To provide the "why" for integrating the arts into STEM, my undergraduate students read *From STEM to STEAM: Brain-Compatible Strategies and Lessons That Integrate the Arts* (Sousa & Pilecki, 2018) and discuss the importance of integrating the arts into science, technology, engineering, and mathematics content (STEM). This resource by Sousa and Pilecki represents a recent collaboration of two educators and brain science theorists who have established themselves as experts in digesting difficult neuroscientific theoretical constructs and distilling from them understandable and usable strategies and approaches that educators can use and test in their practice. During the first few weeks of the semester, students are learning about the brain science that provides the foundation for implementing the arts into STEM content. While gaining a working understanding of the theories and conceptual frameworks of how human anatomy influences learning, teacher candidates also begin to identify and learn to use the necessary components of an effective lesson plan, how to use the state standards to design a lesson plan using *Understanding by Design* (Wiggins & McTighe, 2008), and to design differentiated assessments and learning activities (Tomlinson & Moon, 2013). The instructor provides examples of clarifying the goals for the lesson through the use of what Tomlinson and Moon refer to as KUDs or what students will Know, Understand, and Do as a result of the lesson. Additional strategies for arts-based learning activities are discovered in McDonald's (2010) *Handbook for K-8 Arts Integration: Purposeful Planning across the Curriculum*.

Integrating the Arts: How Theory Informs Practice

Once the students have been introduced to the state standards for the arts, as well as the standards for all other content areas, our Preservice teachers take on the role of elementary school students and "become" third graders while the instructor teaches a demonstration science lesson integrated with dance or movement, and utilizing multiple learning activities and assessments. Then, upon lesson completion, and guided by the theoretical frameworks of Karatepe and Yilmaz (2018) and others (e.g., Chamosa, Caceres, & Azcarate (2012), who have emphasized the need for reflective reciprocal practice in teacher education, the instructor then models reflective practice by answering two questions that will be asked of each student each time they teach their own model lessons later in the semester: "What is one thing I really liked about my lesson?" and "What would I do differently if I taught this lesson again?" The instructor then models her reflection aloud for students. The next step is for students to share their thoughts about the lesson with the instructor. They are asked to share things they thought were effective or went well, as well as ideas they have for improvement. Early in the semester, their feedback is rather sparse and does not include much depth of thought; but as the semester progresses, and as students are teaching model lessons, it is amazing to see the change in their ability to reflect on their own lessons and to coach their peers as they participate in demonstration lessons. The ability to coach and receive coaching will benefit these prospective teachers long after their teacher training ends, and the ideas they gain from each other are used in lessons they teach to their peers later on.

Because I work with these same students as seniors later in their academic programs, I am able to see that they continue to effectively integrate the arts into their lessons, even when integration is not an expectation of a particular course. Because these students learned to integrate elements of the arts in their instruction when they first learned to write lesson plans, many of them have reported that they also learned to perceive such integration as a necessary component of effective lesson planning. They had developed a discipline for integrating arts into the curriculum, not merely as an add-on or "decoration" (LaJevic, 2013). Rather, they saw the arts as providing an engaging context for sustaining students' attention, motivating them to learn and stay on task, providing the hospitable learning environment where the student feels safe to take some risks, building their levels of confidence, improving student learning outcomes, and maximizing retention of STEM and other general curricular concepts. Once students discover *why* it is important to integrate the arts into other content areas by understanding the foundational theories and conceptual frameworks, and they receive training on *how* to integrate the arts and write an effective lesson plan, they begin to feel ready to practice using arts-integration in their own lesson plans and teaching. This requires the introduction of resources that can be used for effective integration of the arts across the curriculum.

Donahue and Stuart (2010) present ways to deepen understanding of science content through the use of dance. Others, such as Goldberg (2012), also use movement and dance to teach

mathematical concepts such as shape, lines, parallel lines, symmetry, sequence and patterns. A study by Graham and Brouillette (2016) found that integrating movement and dance in STEM instruction helped upper-elementary school students "envision phenomena that they could not directly observe" (p. 1), which enabled them to extend beyond concrete thinking to more abstract models. The researchers also discovered that students who were exposed to lessons that incorporated other arts aspects demonstrated a higher level of improvement on physical science benchmark assessments than students who received the STEM-only instruction in physical science (Graham & Brouillette, 2016). As important as movement and dance and other arts elements are in increasing the effectiveness of STEM instruction, integrating dance seems to be particularly concerning to Preservice teachers, especially since some students do not perceive themselves as good dancers and, therefore, are reluctant to perform even basic dance steps in front of their peers. For this reason, we practice integrating dance very early in the course to enable students to have the opportunity to work through their anxiety and practice lesson-related movements in a safe and accepting environment. This enables the students to experience the process of learning in a safe environment and to take risks of small consequence to develop their skills. They then reflect on this whole experience and share their perceptions with each other. As the semester progresses, the students realize that they are using a process as they learn to be teachers, which will serve them well as they one day teach their own students, guiding them into new areas of knowledge and skill development.

In the next phase of instruction, students sign up to teach several (usually 4) lessons to their peers. While my classes have been small (usually from 6 - 12 students), and it is easy to have individuals teach lessons of 30-45 minutes each, this idea is scalable for larger classes. The lessons could be shorter in length so that more than one lesson can be taught in a single class session. The instructor could also have students work with a partner or in small teams to design and teach their lessons. One additional idea is to have students teach the lessons outside of the class setting and post videos for peers to view and provide written feedback.

Reflective Reciprocal Coaching in Arts Integration

To demonstrate one of the necessary catalysts for Experiential Learning, Gonen (2016) described the benefits of reflective reciprocal peer coaching in educator preparation programs. His study discovered that feedback from peers in a non-threatening learning environment helps to sharpen skills of observation and analysis, in addition to improving teaching skills through collaborative engagement. In *Using the Arts in the Classroom*, our Preservice teachers are coached during the entire process of writing their lesson plans, and they are provided instructor feedback and several opportunities to revise their plans. Class time for the remainder of the semester follows a predictable flow and includes lessons taught by students, reflection from the Preservice teacher, and feedback from the class. The instructor also provides coaching to benefit the student teacher as well as the students who were a part of the

peer-instructed "classes" in an effort to learn from their lessons and to implement improvements for their next lessons.

In their first four lessons, students write lesson plans that integrate one of each of the four domains of the arts: dance, visual arts, music, and theater arts. This means that all students are working on the same arts domain at the same time and the instructor can continue to coach them and help with resources and instruction for each of the domains while students are designing their lessons. Sometimes this includes providing videos of current master teachers who are integrating a particular domain of the arts like those found on the *Teaching Channel* (2020) website. Another example is the use of websites like *Reading Rockets* to provide resources to help with using Readers Theater (2020).

For beginning teacher candidates, developing and teaching that first lesson to the instructor and peers can be quite intimidating. To address this issue, the instructor continually offers support and encouragement and reminds students that they are practicing, and, most importantly, that everyone is learning from each other. This training context is not unlike the potential coaching situation new teachers may find themselves involved in, and it can help them to see their teaching as an ever-evolving practice. The ability to become comfortable in coaching relationships can help to make the relationship more beneficial, as Preservice teachers are strengthened in their practice.

Model lessons are taught by students for approximately 12 weeks over the course of a 16-week semester. During this time, the coaching involves anything from using teacher "voice" and classroom management to engaging learners though the use of strategies and learning activities that meet the needs of diverse learners. The lesson plan requires differentiation for diverse learners, so we prepare as though our audiences include English Language Learners, students with learning disabilities, and students who are gifted. During one semester, when we had a student with a severe visual impairment, students had to differentiate each lesson to meet this student's needs. This opportunity not only helped the students who were teaching the visually impaired student, but it also helped the student as she learned the importance of appropriate differentiation and as she experienced the personal benefits of differentiated practice. Throughout her academic program, this same student achieved a very high level of mastery in implementing the arts across the curriculum. She also excelled in lesson plan development, differentiated instruction and assessment, and coaching her peers to develop high levels of skills in these areas. Despite the challenges of her visual impairment, she often outdistanced her peers in many aspects of our educator preparation program, and by the end of her training, she received recognition for her achievements and was awarded Student Teacher of the Year for our state's Association of Teacher Educators.

Changes and improvements have been made to *Using the Arts in the Classroom* over the past

eight years or so, but one theme that emerges in student feedback each year is that even though some of the students might have been terrified when they had to teach their first model lessons, they always share that they felt strongly supported as they "practiced." In fact, senior students close to graduation often affirm that *Using the Arts in the Classroom* was their favorite course in the program. Just as important from the perspective of program and course evaluation is that the growth observed over the course of the semester is nothing less than amazing. Students gain confidence in their ability to plan and execute an effective lesson plan, and their use of effective teaching strategies and engaging learning activities improves exponentially. This is especially true of the students' ability to integrate aspects of the arts in their STEM instruction as well as across the curriculum.

Conclusion

By the end of the semester in *Using the Arts in the Classroom*, all students have written a total of six lesson plans that focused on STEM, infused with the four domains of the arts. Their portfolio of lessons provides a clear picture of their progress over the semester, and the wall that displays visual arts projects, anchor charts, and other artifacts, shows the variety of learning activities that were used by these students to teach often quite difficult STEM concepts. Each year, scores on rubric-evaluated lesson plans indicate improvement over the course of the semester as students demonstrate their ability to design standards-based lessons with meaningful arts-integrated learning activities and effective assessment. Preservice teachers who successfully complete the course, with its portfolio of lessons, continue to improve and have high levels of success on the state-required pedagogy exam that includes lesson design, teaching and assessing, and reflection and analysis.

Lengel, Kuczala, and Madigan (2010) discuss the importance of developing class cohesion activities in Preservice educator preparation that encourage whole-group unity. One additional positive effect of having Preservice teachers develop and teach arts-integrated lessons to their peers is that each group of freshmen bonds as a cohort of friends and teacher candidate colleagues who have coached each other and who remain supportive of each other as they continue their journey toward becoming teachers. So, in the case of creating and teaching lesson plans that integrate the rich elements of the arts to effectively facilitate student learning and retention across STEM subjects, and a variety of other curricular components, experience truly is the best teacher. The experiences of these Preservice elementary education students continue to foster their own learning as they develop the tools that they will one day use in their own classrooms. These aspects of experiential learning from their own Preservice training will also powerfully influence the ways in which they guide the learning in their own classrooms, even from the very beginning of their tenure of professional practice.

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