National Art Education Association
ADVISORY
Rebecca Stone-Danahy, EDITOR
901 Prince Street, Alexandria, VA 22314 | www.arteducators.org
Spring 2018

ART & MATH INTEGRATION

Theorems in Visual Art: Art and Math Teacher Collaboration toward Creative Leadership

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Integration: From Desperate Advocacy to Joy in Finding New Relationships

An artist and a mathematician meet. The authors of this article, one an art education professor and the other a mathematics professor, collaborated to conduct research as a team, examining perceptions of K-12 art teachers regarding art and math integration. Because of changes in education such as the implementation of the Common Core State Standards and the Every Student Succeeds Act, some educational policymakers, administrators, and teachers have expressed interest in integrated curricula (Davis, Sumara, & Luce-Kapler, 2008; Franco & Unrath, 2014; Wexler, 2014). Recent research supports the positive impact of visual art learning on students' test scores. For example, research outcomes from the Turnaround Arts Initiative indicated that the schools participating in the arts initiative demonstrated a 22.55% improvement in math proficiency (Turnaround: Arts Creating Success in Schools, 2016).

In this Advisory, we want to share what we have learned from our partnership and exploration of visual art and math integration to help art teachers collaborate actively and efficiently with math teachers in their schools. Our project started with real-world problems. As parents of school-age children, we shared our concerns about changes in the math curriculum based on the Common Core State Standards and the uncertain status of art education in the public school system in our state. Conversations about these issues led us to devise an interdisciplinary research project about art and math integration. Our collaboration enabled us to work together and expand our knowledge and understanding, sometimes beyond our comfort zone, and to find new ways of practicing our disciplines.

Our research findings indicated that many of the participating teachers did not think they were collaborating with math teachers enough. Out of the 206 responses, only 41 art teachers (19.9%) reported that they were working with math teachers in their school. This result suggests that it is not easy for art teachers to collaborate with math teachers for curriculum planning and classroom instruction in K-12 schools. La Haye and Naested (2014) support this finding and state that connecting art to other subjects does not occur regularly in the elementary classroom, even though there is an increasing number of models of, and approaches toward, integrated learning. Also, mathematics teaching remains mostly traditional, despite active discussions about the reform-oriented teaching of math (La Haye & Naested, 2014), and this tendency may make integration with other disciplines more difficult to be implemented. However, recent research suggests that there are many similarities

between artists and mathematicians, and educators in these fields have already proposed diverse ideas and suggestions for the art and math intersection (Bickley-Green, 1995; Edens & Potter, 2007; Jarvis & Naested, 2012). The exploration of these approaches may provide art teachers with opportunities to rethink their collaboration with math teachers and eventually to work more efficiently with them.

Theorems in Art: Relationship between Artists and Mathematicians

During our collaboration, we realized that in both mathematics and art education, researchers seek to expand their understanding of truth, even though the two fields differ in the methodology used to gain knowledge. Both mathematics and art education rely on evidence to support a claim. Mathematicians use the term "theorem" to state a claim, and proof of this theorem is based on other theorems already developed and proven by other mathematicians. Once proven to be correct, a theorem is accepted by all mathematicians; no other opinions are allowed, regardless of the passage of time. Mueller (2003) explained that an artist's work of art could give a viewer "the same kind of 'Oh!' that a mathematician might experience when discovering a uniqueness theorem" (p. 252). To him, artists' notions of "harmony, unity, and precision" often come from mathematical sources (p. 251).

In his book, *Fragments of Infinity: A Kaleidoscope of Math and Art*, Peterson (2001) showcased many exciting examples of the art and math intersection, using the concepts of truth, essence, subtraction, infinity, fragments, and beauty. In the "Theorems in Stone" chapter, he highlighted the practice of Helaman Ferguson, a mathematician and sculptor, who claimed, "I find that sculpture is a very powerful way to convey mathematics, and mathematics is a very powerful design language for sculpture" (p. 31). Peterson described how mathematicians venture into visualization to understand the patterns and relationships they discover during their mathematical investigations, developing new ways of seeing. He introduced a remark by Bertrand Russell, a mathematician and philosopher:

> Mathematics, rightly viewed, possesses not only truth, but supreme beauty—a beauty cold and austere, like that of sculpture, without appeal to any part of our weaker nature, without the trappings of paintings or music, yet sublimely pure, and capable of stern perfection such as only the greatest art can show. (Russell as cited by Peterson, 2001, p. 4)

In the words of Nat Friedman, the founder of the International Society of the Arts, Mathematics, and Architecture, artists and mathematicians are both interested in discovering relationships, because "creativity is about seeing from a new viewpoint" (Friedman as cited by Peterson, 2001, p. 6). Howard Levine expressed the importance of creativity in the art and math integration, stating:

> Mathematicians and artists are engaged in the ultimate creative activity—creating something out of nothing. We need to do more than simply understand the affinity these two disciplines share for each other. We need to incorporate their *modus vivendi* into our lives. For how else are we to define the good life and live it with grace if we leave the creative act and appreciation of beauty to specialists? (Levine as cited by Peterson, 2001, p. 218)

Let's move to the teachers' perspectives. La Haye and Naested (2014), a math educator and art educator who collaborated as a team, pinpointed the problems that today's math teachers are facing:

> Although art educators fear their discipline is not valued enough, mathematics educators contend with criticism that school mathematics is not useful and that mathematics teaching often fails to address the diverse learning styles of students, making few connections to the real world. (p. 188)

As a pedagogical solution to these difficulties, the two educators suggested integrating art and math as a way to help address the concerns of both disciplines. While team teaching with preservice elementary teachers, they developed the *mutual interrogation* model to "help combat discipline stereotypes and convince preservice teachers not to take the easy way out" (p. 190). Supported by recent research in ethnomathematics as a framework, this approach focused on a natural and effective way to implement interdisciplinary learning and viewed the integration of art and math as a celebration of the different perspectives the two disciplines bring.

Transdisciplinary Integration Toward Creative Leadership

La Haye (2013) confessed that, as a math professor, she did not realize that her lessons connecting math and art were math activities with crafts added on to make the math a little more appealing. These "math crafts" did not provide the true value of an integrated curriculum. Similarly, Watson (2016) insisted that "[u]tilizing art supplies in a project exploration is not integrating art" (p. 8). Mueller (2003) also warned that the links between contemporary art and math/science had been highlighted in "the service of some democratic 'popularization' and the associations that they make have almost always been exaggerated" (p. 251).

We believe that these responses reveal the need for actual transdisciplinary practices in art and math integration (Klein, 2004; Liao, 2016; Marshall, 2014). Harden (2000) presented the integration ladder as a tool for curriculum planning and assessment. The integration ladder consists of 11 steps: isolation, awareness, harmonization, nesting, temporal co-ordination, sharing, correlation, complementary, multi-disciplinary, inter-disciplinary, and transdisciplinary. In the last stage, transdisciplinarity, the integrated curriculum transcends individual disciplines. Whitehead's definition of transdisciplinary integration illustrated in his 1929 writing provides a significant implication for today's educators:

> The solution which I am arguing is to eradicate the fatal disconnection of subjects which kills the vitality of our modern curriculum. There is only one subject matter for education, and that is Life in all its manifestations. (Whitehead as cited by Harden, 2010, p. 555)

Through a transdisciplinary approach to art and math integration, students can make both disciplines part of their real-world experience. And, eventually, reaching this level of integration can lead art and math teachers to avenues of creative leadership through a meaningful collaboration and to provide an innovative example of leadership for teachers of other disciplines in their school (Rolling, 2013). ■

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Author Note

This article was supported by a grant from East Carolina University Interdisciplinary Research Awards.