

Volume 14 (2025), pp. 75-86
*American Journal of STEM Education:
Issues and Perspectives*
© Star Scholars Press
<https://doi.org/10.32674/g5bgs750>

Drawing with Code: How Digital Illustration Merges Art, Math, and Technology

Aimee Lawrence Slagle
Tennessee Tech University, USA

Jeremy Blair
Tennessee Tech University, USA

ABSTRACT

Digital illustration combines traditional hand-drawn techniques with modern technology, evolving from early algorithmic art to tools such as MacPaint, Illustrator, and Photoshop. The rise of accessible tablets such as the iPad and Wacom further expanded their role in design, entertainment, and fine art. This article explores how digital illustration bridges the gap between traditional and digital art practices, supporting STEAM education. Integrating computer science, visual art, and math, it promotes interdisciplinary learning and computational thinking. Strategies for incorporating digital illustration into STEAM curricula are examined, emphasizing its power to combine creativity with problem-solving. Drawing from the authors' experiences, the article highlights how digital tools support storytelling, document cultural identity, and enable expressive, hybrid forms that blend photography with digital illustration.

Keywords: Algorithm, Bézier Curves, Digital Illustration, Pixel Manipulation, STEAM Education

Submitted: March 7, 2025 | **Revised:** May 29, 2025 | **Accepted:** June 24, 2025

INTRODUCTION

The origins of digital art can be traced back to the early 1980s when computer engineers developed a pioneering paint program used by digital artist Harold Cohen (Tate, 2025). This program, known as AARON, was designed as an artificial intelligence-driven system that autonomously created large-scale drawings. As technology advanced, Cohen continuously refined AARON's capabilities, demonstrating the potential for AI to generate complex and evolving artistic compositions. Around the same time, digital tools became more accessible, allowing artists to experiment with computer-generated, scanned, or hand-drawn images using digital tablets and a mouse (Tate, 2025). By the 1990s, improvements in digital technology enabled artists to manipulate video footage and digital photographs on computers, unlocking new creative possibilities in animation, illustration, and visual storytelling.

Digital illustration has undergone a dramatic evolution, merging traditional hand-drawing techniques with modern digital tools. Its roots extend as far back as the 1950s, when early algorithmic art emerged, characterized by geometric patterns and abstract compositions (Fuchs & Wenz, 2022). A significant breakthrough came in the 1960s with Ivan Sutherland's Sketchpad, a program that introduced digital drawing using a light pen, laying the foundation for contemporary illustration software (Llach, 2013). The 1980s saw the advent of transformative programs such as MacPaint, Adobe Illustrator, and Photoshop, which revolutionized the field by enabling artists to incorporate hand-drawn aesthetics into digital compositions (Doyle et al., 2018). As digital illustration continues to evolve, its integration of mathematical principles, algorithmic processes, and technological advancements has positioned it as a powerful tool for artistic creation and interdisciplinary education, particularly within STEAM fields.

The rise of personal computers and graphic tablets further democratized digital illustration, making it accessible to both professional artists and hobbyists alike. As hardware and software advanced, digital tools became more intuitive and widely available, allowing creatives to experiment without the traditional constraints of physical media. The introduction of accessible drawing tablets like the iPad and the Wacom tablet in the 2000s further cemented digital illustration's role in commercial design, entertainment, and artistic expression (Smith, 2017). These devices, combined with the increasing affordability of digital art software, opened new opportunities for illustrators, animators, and designers to refine their craft with precision and efficiency. Today, programs like Procreate, Photoshop, and Illustrator have lowered the barriers to digital artistry, making professional-grade tools available to a wider audience. This accessibility has not only encouraged new generations of artists to explore digital illustration but has also expanded the possibilities for artistic collaboration, online sharing, and creative innovation (Kennedy, 2024).

In the age of New Media, the discussion surrounding digital illustration as an art form remains complex. While digital illustration preserves much of the handmade quality valued in traditional art forms, it exists within a screen-based environment, relying on mathematical constructs such as pixels and vectors. Bitmap images, or binary digit maps, are composed of individual pixels, but vector illustration, born from the advent of computer technology, utilizes a geometry-based approach to image creation (Lewis & Luciana, 2020). Vector programs generate images through mathematical descriptions of points, lines, and shapes rather than fixed pixel arrangements (Lewis & Luciana, 2020). This method offers several advantages, including the ability to rotate, skew, and recolor elements with ease. More importantly, vector images maintain their clarity regardless of scaling, ensuring that resizing does not degrade visual quality. Whether regarded as an innovative artistic medium or a technologically driven form of reproduction, digital illustration represents an evolving fusion of art and mathematics that continues to reshape creative expression. These innovations have created a distinct medium separate from traditional hand-drawn illustration, making digital illustration a unique artistic evolution of the last generation.

THE ROLE OF ALGORITHMS IN DIGITAL ILLUSTRATION

Digital illustration is a unique intersection of visual creativity and mathematical precision, where art is shaped not only by imagination but also by algorithms (Klette & Rosenfeld, 2004). An algorithm is a set of step-by-step instructions or rules designed to solve a problem or perform a task, often executed by computers to process data and generate outcomes (Louridas, 2020). In the context of digital illustration, mathematical algorithms allow artists of all ages and skill levels to engage in a creative process where computational thinking supports and enhances artistic expression, resulting in intricate and visually compelling works (Joswick et al., 2023). These algorithms empower illustrators to manipulate form, color, and texture in ways that traditional tools alone cannot achieve. One foundational example is the Bézier curve, an algorithmic tool that enables the creation of smooth, flowing lines and complex shapes based on mathematical equations (Wolf, 2011).

Bézier Curves: The Backbone of Precision in Illustration

The Bézier curve is fundamental to many forms of digital illustration, particularly in vector-based drawing software like Adobe Illustrator (Wolf, 2011). Created by French engineer Pierre Bézier in the 1960s for computer-aided design in the automotive industry, Bézier curves are parametric curves that use mathematical equations to generate smooth and scalable lines (Wolf, 2011). Unlike raster graphics, which rely on pixels, Bézier curves are defined by anchor points and control handles, allowing for infinite scalability without loss of quality. These

curves function by interpolating or approximating a path between points, with control handles dictating the direction and steepness of the curve (Parkeh, 2019). This system provides illustrators with precise control over shapes, enabling the creation of fluid, natural forms that would be difficult to replicate with freehand drawing alone. Artists use Bézier curves to construct everything from simple outlines to complex, organic forms, such as the delicate curves of a leaf or the contours of a human face. Beyond aesthetics, Bézier curves are integral to a variety of digital applications, including typography, animation, and motion graphics (Salomon, 2006). The ability to control these curves with mathematical precision fosters creative exploration while maintaining technical accuracy, making them an indispensable tool in digital illustration and design.

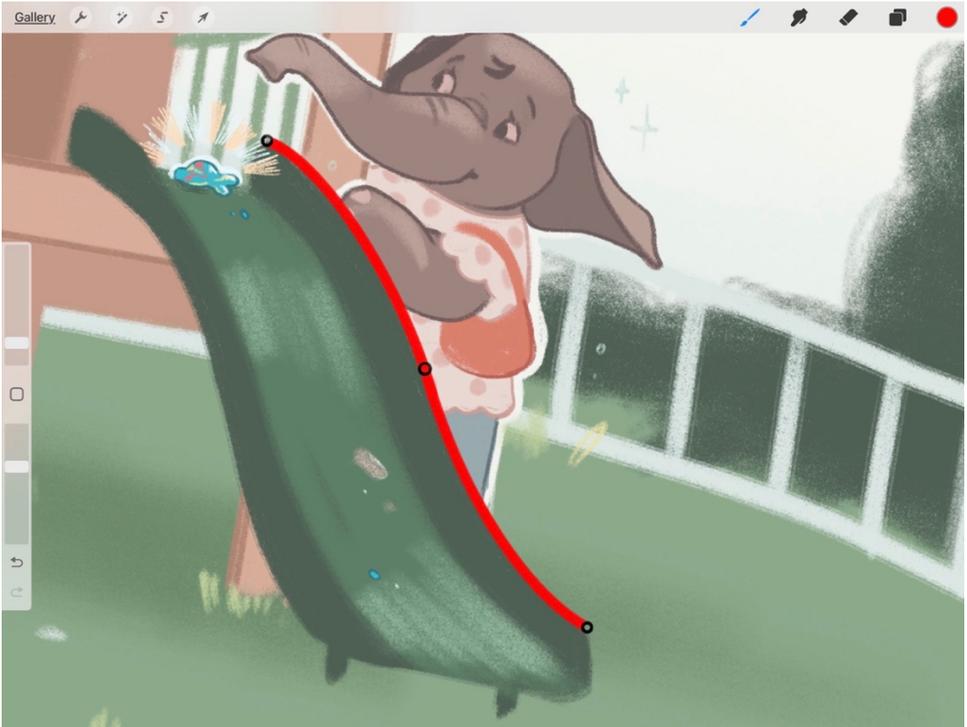


Figure 1: Bézier Curve.

Pixel Manipulation: Control Over Detail and Texture

Another vital algorithmic aspect of digital illustration is pixel manipulation, which allows artists to achieve intricate detail and texture by directly modifying the individual pixels that make up an image. This technique is essential across various fields, including game development, graphic design, photo editing, and social media content creation. Essentially, any profession that involves image

editing relies on pixel manipulation to enhance, refine, or transform visual content (Shearer, 2020). Pixels, the smallest units of a digital image, function as building blocks of color and luminosity (Smith, 2021). Pixar cofounder Alvy Ray Smith said, “The tiny pixel is the 'big idea' that ties all digital imaging together, transforming art, entertainment, and the world as we know it (Hackford, 2022).” By modifying pixels, artists gain precise control over shading, blending, and textural effects that would be difficult to achieve through traditional media (Wolf, 2011).

Pixel manipulation is especially crucial in digital painting, where each stroke is composed of layers of pixels that can be refined through tools such as opacity adjustments, brush settings, and layering techniques (Lin, 2018). Artists can create smooth gradients, seamless tonal transitions, and complex textures that mimic natural materials like watercolor, oil paint, or charcoal. Additionally, pixel-based editing tools allow for selective alterations, such as sharpening fine details, applying blur effects, or modifying individual color values without affecting the entire composition (Shearer, 2020). Pixel manipulation also plays a role in special effects, digital restorations, and photorealistic illustrations. The ability to edit at the pixel level offers artists the flexibility to experiment, refine, and perfect their work, making it a fundamental component of digital illustration.

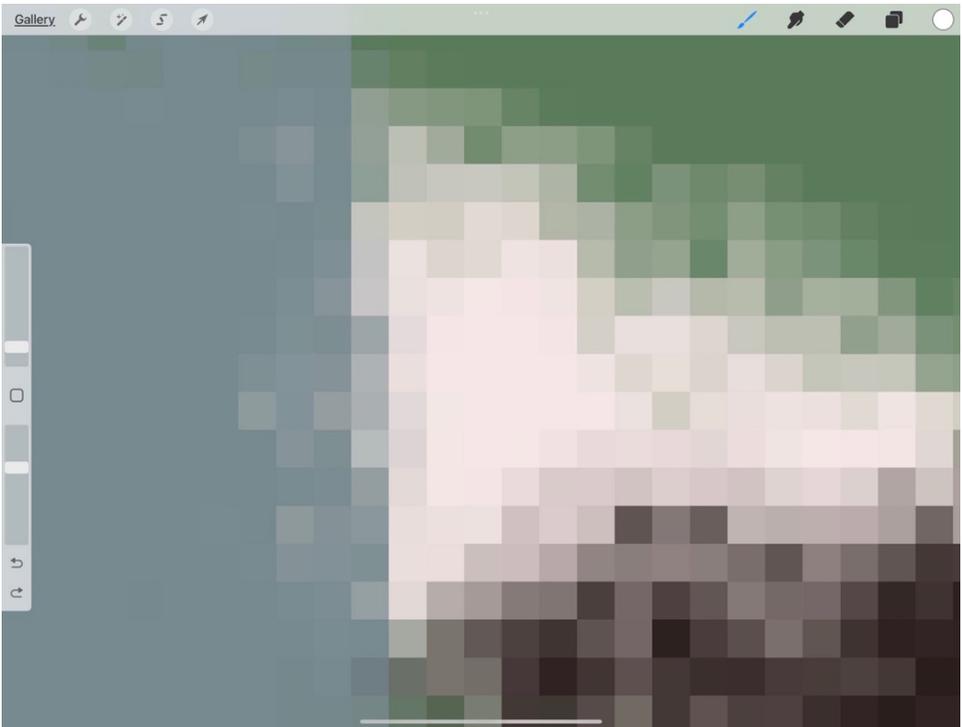


Figure 2: Pixel Manipulation.

DIGITAL ILLUSTRATION IN STEAM EDUCATION

Digital illustration is a powerful tool for STEAM Education (Science, Technology, Engineering, Art, and Math), seamlessly blending artistic creativity with technical precision (Needles, 2020). By integrating mathematical concepts such as algorithms and pixel manipulation with visual storytelling and composition, digital illustration enables students to apply problem-solving skills in both artistic and scientific contexts (Grünberger, 2022). This interdisciplinary approach not only strengthens students' understanding of mathematical principles but also breaks down traditional barriers between the arts and sciences, fostering a holistic learning experience.

One of the clearest examples of this fusion is the use of Bézier curves in digital illustration. These mathematical constructs allow students to explore geometric principles such as symmetry, angles, and proportions while manipulating curves to enhance their artistic compositions (Hopper, 2021). This hands-on engagement with mathematical structures deepens students' appreciation for both disciplines, illustrating how artistic creativity and mathematical reasoning inform one another. Moreover, as students refine their use of Bézier curves, they gain insights into fundamental concepts relevant to fields such as computer science, architecture, and engineering.



Figure 3: Bézier Curves in Digital Illustration.

Beyond mathematics, digital illustration introduces students to the iterative design process, a cornerstone of STEAM education (Wintemberg, 2024). Like traditional media, digital tools encourage experimentation and revision, allowing students to refine their work through trial and error. This iterative approach mirrors real-world innovation, where problem-solving requires adaptability, persistence, and critical thinking. By engaging with digital illustration, students develop a growth mindset, learning to embrace failure as part of the creative and technical learning process. Additionally, digital art and illustration help make complex mathematical and technological concepts more engaging and accessible (Handy, 2023). Through direct interaction with algorithms and pixel-based editing, students not only explore geometry, graph theory, and computational thinking but also gain experience with industry-relevant digital tools (Louridas, 2017). This practical application demystifies abstract mathematical ideas, reinforcing their real-world significance and demonstrating how technology can enhance artistic expression.

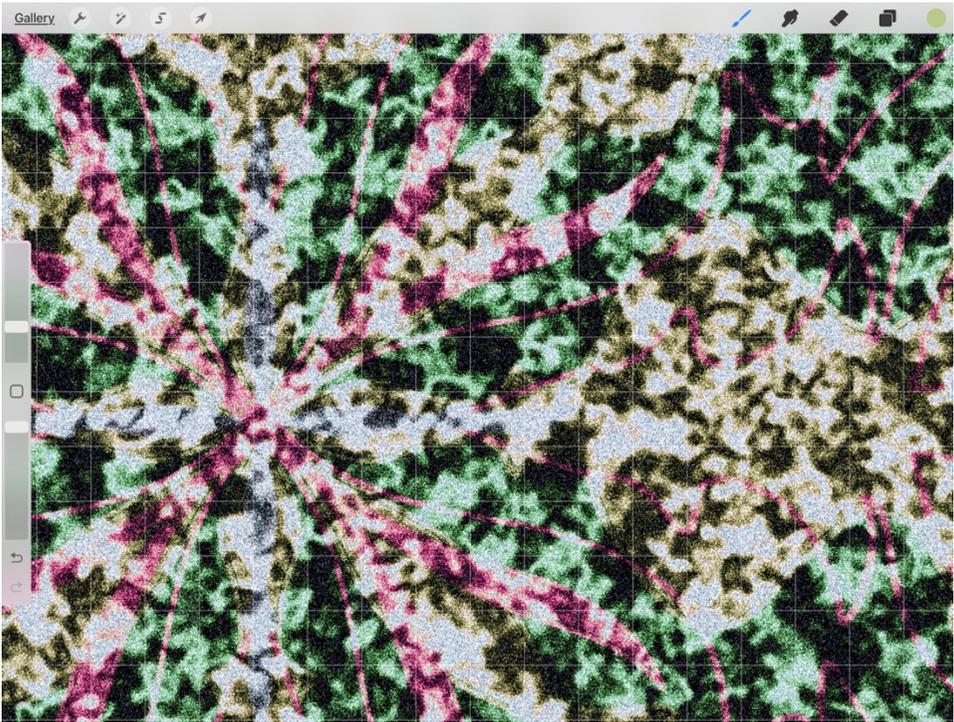


Figure 4: Algorithms and Pixel-based Editing.

In the STEAM framework, digital illustration serves as a bridge between disciplines, equipping students with a versatile skill set that combines creativity with technical proficiency. By working with algorithms, digital brushes, and advanced design tools, students refine both their artistic vision and problem-solving abilities. This interdisciplinary approach cultivates the kind of flexible, innovative thinking that is essential in today’s rapidly evolving digital landscape. Whether students pursue careers in the arts, sciences, or technology, the skills they develop through digital illustration—critical thinking, adaptability, and creative problem-solving—prepare them to thrive in a world where these fields increasingly intersect.

CONCLUSION

The evolution of digital illustration can be traced back to the early experiments in digital art, notably Harold Cohen’s AARON, an AI-driven program designed in the 1980s to autonomously create large-scale drawings (Tate, 2025). AARON demonstrated the potential of digital tools to merge artistic creativity with computational processes, laying the foundation for future advancements in digital illustration. Since then, digital illustration has evolved from a niche artistic practice into a dynamic medium that seamlessly integrates art, mathematics, and technology. Its progression from early digital tools to sophisticated software has expanded the creative possibilities available to artists, educators, and students alike.

The role of algorithms in digital illustration, particularly in structuring patterns and enhancing automation, demonstrates how mathematical principles underpin digital creativity (Jackson, 2015). Bézier curves, a cornerstone of precision in digital illustration, exemplify this fusion by allowing artists to manipulate lines and shapes with mathematical accuracy, reinforcing geometric and algorithmic thinking. Similarly, pixel manipulation offers unparalleled control over detail and texture, enabling artists to refine their work at the smallest scale and explore innovative visual effects.

Beyond its artistic applications, digital illustration is a powerful tool in STEAM education, fostering interdisciplinary learning and digital fluency by bridging creative expression with analytical problem-solving. (Deák & Kumar, 2024). Students engaging with digital illustration not only develop artistic proficiency but also strengthen their understanding of geometry, computational thinking, and iterative design—skills essential in fields ranging from computer science and engineering to animation and graphic design. As technology continues to evolve and become more accessible, the potential for digital illustration in both education and professional practice will only expand. By integrating digital illustration into STEAM curricula, educators can equip students with the skills and mindset necessary to navigate a future where art and technology are deeply interconnected. This ongoing fusion of disciplines will inspire the next generation

of artists, innovators, and problem-solvers who will shape the evolving landscape of digital creativity.

REFERENCES

- Deák, C., & Kumar, B. (2024). A systematic review of STEAM education's role in nurturing digital competencies for sustainable innovations. *Education Sciences*, 14(3), Article 226. <https://doi.org/10.3390/educsci14030226>
- Doyle, S., Grove, J. G., & Sherman, W. (2018). *History of illustration* (1st ed.). Bloomsbury Publishing.
- Fuchs, M., & Wenz, K. (2022). Introduction: Algorithmic art. Past and contemporary perspectives. *Digital Culture & Society*, 8(2), 5–12. <https://doi.org/10.14361/dcs-2022-080202>
- Grünberger, C. (2022). *The age of data: Embracing algorithms in art & design* (1st ed.). Niggli Verlag.
- Hackford, H. (2022, August 18). The true history of the pixel. *CHM*. <https://computerhistory.org/blog/the-true-history-of-the-pixel/>
- Handy, K. (2023). The mathematical magic of digital art and design: Exploring the intersection of creativity and calculation. In *Cracking the code: The art of blending mathematics and digital design*. ArtStation. <https://www.artstation.com/blogs/dioeye/zwWv/the-mathematical-magic-of-digital-art-and-design-exploring-the-intersection-of-creativity-and-calculation>
- Hopper, J. (2021). *Learning vector illustration with Adobe Illustrator: Through videos, projects, and more* (1st ed.). Bloomsbury Publishing Plc. <https://doi.org/10.5040/9781350047914>
- Jackson, W. (2015). *Digital illustration fundamentals: Vector, raster, waveform, new media with DICE, DAEF and ASNMF* (1st ed.). Apress. <https://doi.org/10.1007/978-1-4842-1697-2>
- Joswick, C., Lee, J., Jocius, R., & Pole, K. (2023). Reading, coding, and crafting: Introducing computational thinking to young children. *YC Young Children*, 78(4), 38–46.
- Kennedy, K. R. (2024). *Introduction to digital art: Basics of art & design with Adobe Creative Cloud* (K. Smith, Ed.). Lemoore College. <https://lemoorecollege.edu/oer/documents/2024-introduction-to-digital-art-art-020a-oertextbook.pdf>
- Klette, R., & Rosenfeld, A. (2004). *Digital geometry: Geometric methods for digital picture analysis* (1st ed.). Elsevier Science & Technology. <https://doi.org/10.1016/B978-1-55860-861-0.X5000-7>
- Lewis, R., & Luciana, J. (2020). Vector drawing and illustration. In *Digital media foundations* (1st ed., pp. 186–205). Routledge. <https://doi.org/10.4324/9781315226125-11>
- Lin, J. (2018). Painting pixels: Mapping the sublime philosophy and capital

- attraction onto a technological landscape. *Scholarship @ Claremont*.
- Llach, D. C. (2013). Algorithmic tectonics: How Cold War era research shaped our imagination of design. *Architectural Design*, 83(2), 16–21.
<https://doi.org/10.1002/ad.1546>
- Louridas, P. (2017). *Real-world algorithms: A beginner's guide*. MIT Press.
- Louridas, P. (2020). *Algorithms*. MIT Press.
<https://doi.org/10.7551/mitpress/11884.001.0001>
- Needles, T. (2020). *STEAM power: Infusing art into your STEM curriculum* (1st ed.). International Society for Technology in Education.
- Parkeh, R. (2019). *Fundamentals of graphics using MATLAB* (1st ed.). CRC Press.
- Salomon, D. (2006). *Curves and surfaces for computer graphics* (1st ed.). Springer. <https://doi.org/10.1007/0-387-28452-4>
- Shearer, S. (2020, December 6). Editing images using pixel manipulation. *Medium*. <https://sebastianshearer.medium.com/editing-images-using-pixel-manipulation-37907a01>
- Smith, A. R. (2021). *A biography of the pixel*. MIT Press.
<https://doi.org/10.7551/mitpress/13470.001.0001>
- Smith, E. (2017, September 21). Wacom graphics tablet history: Touch computing's early icon. *Tedium*. <https://tedium.co/2017/09/21/wacom-tablet-history/>
- Sproull, R., & Brock, D. C. (2023). Interview of Ivan Sutherland. *IEEE Annals of the History of Computing*, 45(1), 1–29.
<https://doi.org/10.1109/MAHC.2023.3244258>
- Tate. (n.d.). *Digital art*. Art term: Digital art. Tate Modern. Retrieved from <https://www.tate.org.uk/art/artterms/d/digitalart>
- Wintemberg, R. (2024). Digital technology in the art room: Breakfast cereal box design. In N. Walkup & T. Hunter-Doniger (Eds.), *STEAM Education: Transdisciplinarity of art in the curriculum* (pp. 88–99). National Art Education Association Publishing.
- Wolf, P. J. (2011). *Graphic design, translated: A visual dictionary of terms for global design* (1st ed.). Rockport Publishers.

AIMEE LAWRENCE SLAGLE is an undergraduate Bachelor of Fine Arts student at Tennessee Tech University, pursuing a double major in Art Education and Digital Design. Her work focuses on digital illustration and exploring the intersections of STEAM education through creative teaching practices. Email: aklawrence42@tntech.edu

JEREMY BLAIR, PhD, is an Associate Professor of Art Education in the School of Art, Craft & Design at Tennessee Tech University. His visual art practice,

teaching, and scholarship investigate the intersections of art and science, with a particular focus on STEAM Education. Email: jmblair@tntech.edu

Acknowledgment Section

The authors would like to acknowledge the use of OpenAI's ChatGPT in [assisting with the drafting and editing of this manuscript / generating text / refining language / ensuring clarity and coherence throughout the article]. The AI tool provided [support/assistance / valuable insights] in [generating text, refining language, and ensuring clarity and coherence]. The contributions made by ChatGPT were [invaluable / significant / helpful] in enhancing the overall quality of this work.

Volume Editors:

Dr. Sahar Aghasafari

Assistant Professor of Art and Graphic Design University of South Carolina
Lancaster, USA

Dr. Jeremy Blair

Associate Professor of Art Education
Tennessee Tech University, School of Art, Craft & Design, USA

