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Dance Magic Dance

A Case Study of AR and VR/360 Video and the Performing Arts

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Barnard College, Columbia University, has a nationally recognized Department of Dance, and library administrators in collaboration with faculty piloted media and digital tools for dance research, performance, and composition. This chapter highlights three projects: the use of an augmented reality (AR) app, VR/360 video, and long-exposure LED photography as it relates to dance education and the performing arts at Barnard College. While these technologies are new and still in the exploratory stages, this descriptive case study supports the idea that AR and VR/360 tools can offer innovative methods for recording, scholarship, and instruction around the performing arts.

These three projects were the result of a collaboration between Barnard dance faculty members and Barnard IMATS (Instructional Media and Technology Services). While each project was different in technology and scope, all three had a similar goal: to capture, represent, and experience dance in new and innovative ways. This includes (a) giving audience members an opportunity to view dance pieces via an AR mobile application that also incorporated archival photographs and site specificity; (b) offering an immersive and viewer-directed method to watch dance via VR/360 video; and (c) recording dance scales through time-lapse technology, representing movement through an original method. All three projects have implications for dance education and scholarship. In addition, all of these projects were made possible through a supportive environment that encourages piloting and experimentation.

In a broad sense, the state of technology and higher education is one of "great disruption"[1]; while there are many anxieties and concerns related to the intersection of technology and education,[2] there are also many possibilities and affordances.[3] In the current moment, AR/VR (augmented reality and virtual reality) occupies significant interest and development. The reach of these

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emerging technologies includes video games and digital entertainment (the Oculus Rift and HTC Vive); mobile applications (Pokémon GO and Google Daydream); and film (*Dear Angelica*, which premiered at the 2017 Sundance Film Festival's New Frontiers exhibit). The application of these tools in library or educational settings is currently atypical; these technologies occupy a space where little has been researched or implemented, so there are no "best practices" or guidelines for their use. There is the chance that AR/VR will be viewed as a trend or a "flash in the pan" in the future, but there are rich instructional possibilities around immersive realities and visualizations.[4] This case study supports the fact that these tools have educational affordances, especially in relation to movement-based activities such as dance.

BACKGROUND

Virtual reality (VR) is a technology that has been "new" since its inception in the 1980s; one best-selling book from 1993 by Ken Pimentel and Kevin Teixeira titled *Virtual Reality: Through the New Looking Glass* is echoed in similar language over 20 years later, such as a 2015 article in the *New York Times*, "A Virtual Reality Revolution, Coming to a Headset Near You." The application of VR at Barnard College, via 360-degree video, is through the capture and creation of "three-dimensional realities" experienced through a VR headset or cardboard viewer; this form and function reflects the VR definition from over 25 years ago.

Augmented reality (AR), as Ronald Azuma defines it, "allows the user to see the real world, with virtual objects superimposed upon or composited with the real world . . . AR supplements reality, rather than completely replacing it."[5] The widespread adoption of smartphones and mobile devices has allowed AR to become more accessible, and currently hundreds of AR mobile applications are available for Android and iOS, such as Augmented Car Finder (to help users find their car in a parking lot) or Google SkyMap (to identify stars, planets, and constellations based on phone location and camera). AR is increasingly used in several industries, such as the design, architecture, and construction fields, in order to visualize plans before execution.[6]

Subject areas that combine space, movement, and visualizations would seem a "natural" fit for AR/VR technologies, as they apply the affordances of these tools. Because dance and the performing arts involve space, movement, and visuals, there are many possibilities with AR/VR, especially when considering teaching and archiving. (Consider the possibilities of learning dance from another continent, such as 360-degree recordings from Africa or

other locations, without needing to physically travel to those locations.) AR/VR is not widespread in dance education, but there have been some projects such as a pilot by Yan and colleagues using the tool OutsideMe (incorporating an Oculus Rift headset). Dancers wore head-mounted displays that created an "external self-image" so they had a 360-degree view of their own performances; dancers were also able to train with a virtual dance partner (either as a lead dancer or extra dancer).[7] Preliminary results demonstrated greater practice efficiency, where eight participants self-reported their dance practice efficacy as higher with OutsideMe as opposed to regular training. In another project incorporating AR/VR and performance, Mazzanti and colleagues introduced the concept of the "augmented stage," outlining metrics to create an interactive experience. The "augmented stage" allows audience members to perceive virtual objects superimposed with the performance stage, via their mobile devices; audience members also have the ability to input and manipulate information, real-time, which in turn contributes to the performers and the stage.[8]

Again, these are new and emerging technologies, and there is a dearth of literature in the research related to AR/VR and education, particularly in relation to higher education, libraries, dance, and the performing arts. This case study aims to contribute to the growing body of knowledge around VR/AR as it relates to these topics.

SETTING

Barnard College is a women's liberal arts school located in New York City. It is proximal to and a partner with Columbia University. Founded in 1889, Barnard remains an institution dedicated to women's education and advancement. There are approximately 2,500 undergraduate students, with 28 academic departments and 20 academic programs. The academic library, or Barnard Library and Academic Information Services (BLAIS), has a focus on certain collections, such as the Zine collection, and includes archives, as well as a personal librarian program where all undergraduate students and faculty are assigned a research and instruction librarian.

At BLAIS, there is a performing arts librarian as well as an Archives and Special Collections, which collects the history of dance at Barnard, as well as special collections relating to dance. Barnard collects dance materials at a research level for Barnard and Columbia; collection materials from the library and archives include books, periodicals, media, and other materials (such as paper programs). Barnard's institutional archival dance collections

include documentation and recordings of the Dance Uptown series; special collections include the Gloria Fokine Dance Collection, and the American Ballet Theater and NYC Ballet programs, newsletters, and repertory notes. The Archives and Special Collections collects recordings of Barnard dance performances in digital and analog formats. These materials are accessible to researchers.

Instructional Media and Technology Services (IMATS) is a department within the organizational structure of BLAIS. The core purpose of IMATS is to use technology and media to serve research, instruction, and learning at Barnard. There are two units of IMATS: Audiovisual Technology Services (AVTS) and Instructional Media Services (IMS). AVTS offers audio and visual services, equipment, and operators for classrooms, conferences, lectures, and other campus events. IMS includes an equipment room that manages over 800 checkouts per semester; this is a service available to all Barnard and Columbia faculty, staff, and students (figure 8.1). The equipment room offers a wide range of video cameras (from handi-cameras to advanced 4k camcorders), audio equipment (shotgun microphones, Tascam recorders, XLR cables), lighting, digital cameras, projectors, screens, portable speakers, and other items. It is staffed by approximately 20 Barnard undergraduate student workers. IMS also fulfills video recording services for the college, producing over 100 videos each semester of events, classes, conferences, and so forth; this has led to several flipped classroom projects. Periodically there are more "produced" video projects that are scripted or documentary, at times including green-screen, animation, and other intensive post-production work.

IMATS works extensively with faculty, such as consulting on syllabi and curricula; utilizing Canvas (Barnard's learning management system); teaching workshops in courses on digital tools and software such as podcasting, Adobe Photoshop, or video editing; assisting with research data collection and analysis; and other types of projects. IMATS is uniquely positioned to test out and experiment with new educational technologies. This intersection of media equipment and digital production, instruction and research, and administrative staff and faculty members has led to fruitful cross-disciplinary projects, including the ones outlined below involving IMATS staff and the Barnard Department of Dance. Additional examples of cross-disciplinary collaborations include working with a German course on a unit for which students produced German soap operas (involving scripting, shooting, and editing); producing interactive videos with embedded quiz questions for a flipped classroom project with a chemistry professor; and teaching students how to create interactive maps and "walking tours" related to the Harlem Renaissance for an art history course.

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Figure 8.1. One section of the Barnard IMS equipment room, which handles over 800 checkouts per semester. *Barnard College.*

PROJECT 1: BARNARD AUGMENTED (AR)

In 2014, the Barnard College Department of Dance offered a site-specific composition course that invited students to integrate archival research and AR technology in their choreographic processes. Conceived by Professor Paul Scolieri and performance-based artist Adam Weinert, the course asked students to select dance photographs from the college archives and interpret them in two-minute (125 seconds), site-specific compositions.

This project received internal funding from Barnard through a COOL (Committee on Online Instruction) grant. An external developer was hired using these funds, and through the customization of the open source Dance-tech app (hosted by the Aurasma platform), the Barnard Augmented app was created. Barnard Augmented allowed users to scan archival images located at specific locations on the Barnard campus, which made the dances associated with the site appear on the viewer's smartphone (figure 8.2). The project culminated in a multi-day event, "125 Barnard Dances," where students, alumni, and other guests were invited to participate in this AR project with the assistance of tour guides and audio guides. 125 Barnard Dances was part of broader campus

Figure 8.2. The Barnard Augmented mobile app, built on the open source Dance-tech app, licensed from Aurasma. *Barnard College*.

programming related to Barnard College's 125th anniversary, including readings, music performances, lectures, screenings, and other events.

Upon reflection, the Barnard Augmented project received positive qualitative feedback from viewers and students as to its creative approach and innovation. For example, in a video produced about the project, one student comments: "There's an interesting experience that happens being in a physical space and watching something that happened in that same space but at a different time, and in a slightly different context." The artist Adam Weinert offers, "It's a nice opportunity to both look back into Barnard's history but also bring it into the 21st century."[9] While no formalized assessments were conducted in relation to this project, staff members present during the 125 Barnard Dances event recollected how participants were engaged with a novel approach to a campus tour and viewing archival materials.

There were also constraints and limitations. Thorny questions arose while developing content, such as how does one choreograph for an iPhone, or what does it mean to adjust and experiment with scale and have performance shrink to such a small size. There were technical considerations: Will all participants have smartphones? Is the app compatible for both iOS and Android? Is the cellular or Wi-Fi network strong enough to stream the performance without lags, pauses, and crashes? There was also user-experience "friction"

involved in the project, which included downloading the app, scanning the archival images (as one would scan a QR code) and, at the time of its implementation, the image-recognition capabilities of the software were imperfect. For example, the mobile phone had to be held very still over the image for the app to work properly; there were also delays between the scan time and the video loading time.

Dance and the performing arts are embedded in the history of Barnard College, and this AR project was interdisciplinary in its combination of dance, technology, and historical archives. Site-specific events—inherent characteristics of both dance and AR—call attention to a location, its histories, and other spaces, both real and imagined. This project invited the viewer to reflect on and interact with the history of Barnard College—the physical campus and institution, as well as students past and present (figure 8.3). There are many implications and possibilities with AR and archival materials, and this project brought images into conversations and wider circulations. It highlights the ways in which AR can link archives and inaccessible cultural heritage to broader audiences and spaces, and how historical archival material can be "brought to life" in new and innovative ways. The future potential for projects involving AR, archival materials, and the performing arts is compelling.

Figure 8.3. A user interacting with Barnard's campus via the Barnard Augmented app. *Barnard College.*

PROJECT 2: VR/360 VIDEO

In fall 2016, IMATS and the Barnard Department of Dance collaborated on a VR/360 video pilot. We used a Ricoh Theta 360-degree camera, which is pocket-sized, lightweight, and relatively inexpensive (currently priced below $300). Our experience with this camera was that it was relatively easy to use; the recording function just entails an off/on switch (with no settings to customize white balance, frame rate, exposure, and so forth). The post-production process with 360-degree video includes "stitching" the footage from the two lenses together (figure 8.4), then running through a "spatial media metadata injector," and uploading to YouTube, which is free and supports VR/360 video. Viewers then use a VR headset (we had $15 cardboard viewers) (figure 8.5) with their mobile phone, and this creates an immersive experience in which viewers can look up, down, or in any direction and perceive a "3D" environment.

Barnard College offers a wide range of dance faculty, courses, and genres to students. This was an optimal context to try VR/360 video, and we were fortunate to have high levels of cooperation among faculty. We visited several different dance classes and student clubs, and recorded tap, ballet, modern dance, improvisation, classical Indian dance, hip-hop, ballroom, and other genres. We recorded dance warmups, showcased rehearsals, and improvised routines. The number of dancers in these recordings ranged from four to over twenty. We tested different angles with the 360-degree camera, and attempted various tripod positions, from elevated angles to low-to-the-ground perspectives. These videos all have their own qualitative value and textures, but through trial and error we decided our "best practice" for recording

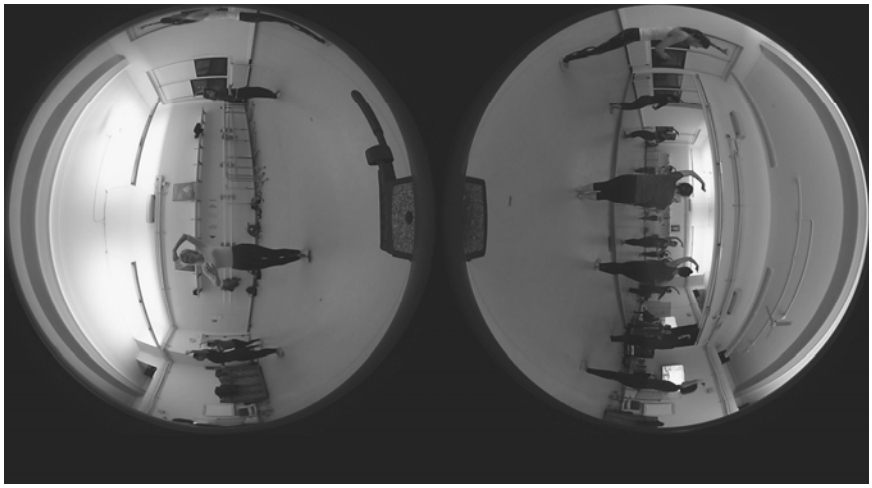

Figure 8.4. Raw footage of a dance rehearsal from a 360-degree camera, before it is stitched together and uploaded online. *Barnard College.*

360-degree video of dance entails (a) positioning the camera in the center of the room, so that it is in the middle of the performance and at a slightly lower height than eye level, and (b) using a tripod (recording tests where participants danced while holding the camera led to dizzying footage).

We considered the VR/360 videos of dance footage to be exploratory, untied to measured outcomes. However, these recordings were used to review rehearsal performances for shows at New York Live Arts by the choreographers in order to gain additional feedback on which sections needed more practice. Because of the dynamic "3D" experience of 360-degree video, there are significant implications for the recording and notation of choreography. There are also implications for learning dance, and the ability to "see" dance and movement in a new way. With VR/360 video, the viewer is able to focus on specific dancers or on specific choreography—this is in contrast to "flat," two-dimensional video recordings.

At this point in time, there are certainly drawbacks. The technology is still "early" and low-resolution. VR/360 gives some people motion sickness.[10] The most technologically advanced virtual reality systems—even if powerful supplemental instructional tools—will never fully replace real-time, person-to-person instruction in dance. Yet there are many powerful affordances of this tool, which were evident from the earliest test shoots. First of all, there are documentary and archival implications of VR/360, especially considering all of the rich sensory details that are captured, some of which we might not even be cognizant of, and what value they might have for future generations to

Figure 8.5. A cardboard viewer for watching VR/360 video. *Barnard College.*

review. The immersive qualities of VR/360 can also offer transportive experiences; examples might include giving someone disabled or in a wheelchair the firsthand perspective of what it is like to ballroom dance, or expanding the live-streaming "portal" to dance performances such as the New York City Ballet and the American Ballet Theatre to audience members unable to afford a ticket. VR/360 video could also be used to help dancers rehearse choreographed routines, and could cut down on rehearsal times and/or rehearsal spaces. We plan to continue future projects and research regarding the instructional media aspects of VR/360 video and dance, especially as the technology continues to improve in terms of higher-resolution cameras and capture systems that allow for smoother and even more immersive experiences.

PROJECT 3: LED MOVEMENT SCALES

A third project example of using digital tools and media in dance research and performance is an LED Movement Scales project. Under the same thread as the VR and AR pilots, this endeavor used technology to capture and represent dance/movement in an original way. AR allows a viewer to access a dance recording in conjunction with an on-campus site and archival photographs; VR allows a viewer to experience a dance performance in a first-person, 360-degree perspective. While the LED images are more abstract, they visualize dance and movement in a provocative way.

This pilot was a collaboration between IMATS and Barnard dance faculty member Paul Scolieri, inspired by the "Visualizing Space Harmony" project (visualizingspaceharmony.com) led by Marie Percy, movement analyst and assistant professor in residence at the University of Connecticut. The LED Movement Scales was a test of long-exposure photography and light-painting video to capture movement scales based on the work of Rudolf Laban, a pioneer in modern dance. Laban created a movement theory and practice called Space Harmony or Choreutics.[11] Choreutics/space harmony scales follow sequential patterns, and end in the same place where they begin; principles of countermovement, parallelism, symmetry, and repetitions are at the core.

Students in Scolieri's movement analysis course were willing participants for this pilot. We were able to use a completely light-proof space in a production studio, and set up a DSLR (digital single lens reflex) camera with a manual, long-exposure photography setting. We also used the free iPhone app Pablo, which captures light-painting videos. The student dancers affixed LED gloves and bands around their wrists, arms, and legs; the lights varied in color, and some could be customized to flash at slow or fast intervals. One by one, students performed movement scales (ranging from 10 seconds to 45 seconds) (figures 8.6 and 8.7), which were recorded as still images and light-painted videos.

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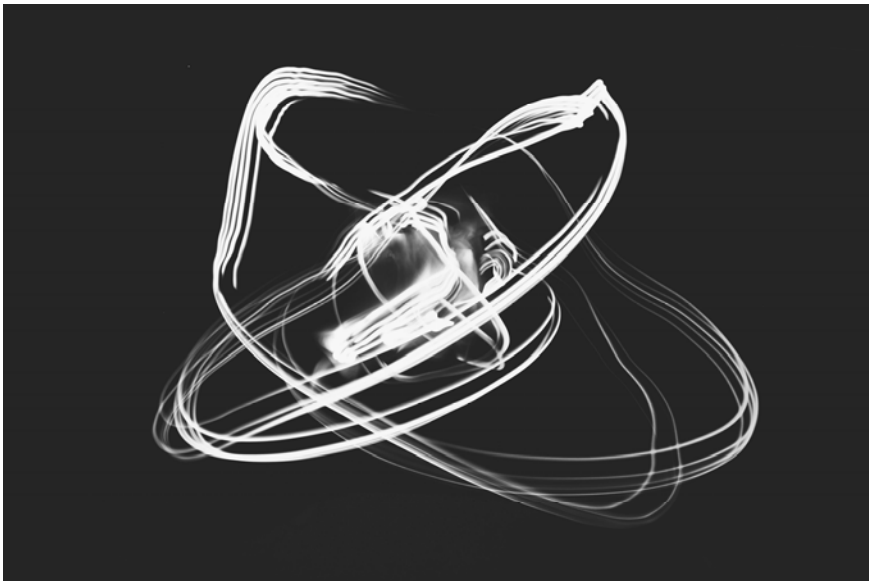

Figure 8.6. Long-exposure photograph of an LED movement scale, approximately 10 seconds. *Barnard College.*

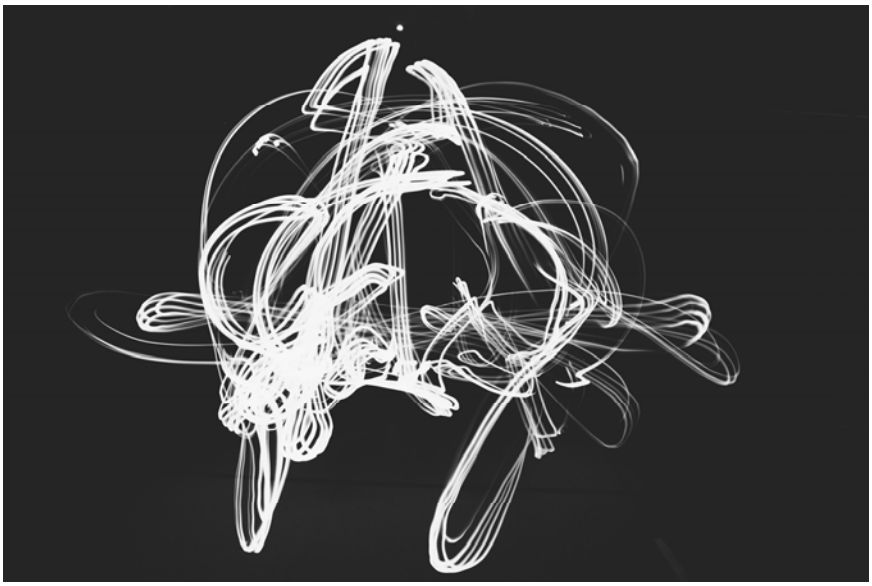

Figure 8.7. Long-exposure photograph of an LED movement scale, approximately 30 seconds. *Barnard College.*

The resulting full-color videos and images elicited positive responses based on anecdotal, firsthand experiences. This project generated interest among colleagues at the Columbia University library; there are current discussions for creating a similar project with sign language and possibly other forms of nonverbal communication. The LED photographs and videos also sparked interest with the Barnard development office and led to a collaboration on an LED light-painting video for a fundraising event.

This was a short-term pilot project, but these abstract "movement paintings" created during this session raised questions and implications. For example, is this technique allowing us to see something we might not see otherwise? If two dancers performed the same movements, but different images emerged, what implications might that have? Do these images reflect forms of dance notation, and could therefore be a record of choreography? Does the ability to visualize movements (such as space harmony scales) help students with the learning, comprehension, and performance of dance? While this pilot raises more questions than offers findings, it was something that led to cross-department partnerships. It was also a project that was an inexpensive undertaking, both in time and materials.

TAKEAWAYS

Here we summarize some of the main outcomes from three projects at Barnard College. These are not meant to be conclusive "results," but rather summations from these projects and suggestions for other institutions interested in implementing these tools or continuing further research into AR/VR applications.

- The three pilot projects were able to occur in an environment supportive of collaboration and experimentation.
- Augmented reality (AR) and dance are inherently site-specific, and there are affordances in the ways AR combined with dance can call attention to a location, its histories, and other spaces, real and imagined.
- VR/360 has implications for learning dance, and the ability to "see" dance and movement in a new way (e.g., the ability to focus on specific dancers or on specific choreography).
- AR and VR/360 currently have user experience friction considerations, such as app loading times and motion sickness.
- The LED Movement Scales project led to additional cross-campus collaborations.
- VR/360 Video and the LED Movement Scales projects were inexpensive in materials, time, and post-production.

AR/VR offers accessibility affordances and constraints. On one hand, there are limitations with AR/VR technologies for those who have visual impairments, and some AR applications may not be fully accessible to those with motor impairments. There are also financial barriers to entry in terms of equipment (such as mobile smartphone devices, headsets, headphones)—but libraries can mitigate this by offering equipment for patron checkout. This is something Barnard IMATS has been piloting, by adding 360-degree cameras and VR headsets to the equipment inventory, available for free checkout to all Barnard and Columbia patrons. As far as the learning curve for production and creation, VR in our context has proved to be quite accessible, with low barriers to entry for producing a VR/360 video. Conversely, AR in our context was fairly complicated to produce and required outside development assistance.

More broadly, VR has implications for accessibility, as it offers immersive experiences of other environments. This is an affordance that sets it apart from other technologies, and can offer engagement in new ways. As a basic example, users can experience a place that they would never have been able to visit, such as experience what it's like to be under a glacier in Antarctica. VR can open up spaces unavailable to those limited by economics or physical disabilities, such as what it's like to be scuba diving or what it's like to view dance performances in European theaters. This is not to offer a false equivalence between experiencing something firsthand and experiencing something via simulation, but this immersive potential is relevant for other fields, including journalism, geography, and the social sciences.

CONCLUSION

A collaboration between Barnard IMATS (Instructional Media and Technology Services) and Barnard dance faculty led to three projects involving the use of new technologies to record and engage with dance and the performing arts. A key factor for these projects was collaboration with the Barnard Library (of which IMATS is a part) and the Department of Dance. These would not have been possible without a supportive administration willing to try new tools and experiment in this realm (especially because some of these technologies are very recent and have no "best practices"). It is also of note that both the LED Movement Scales and VR/360 projects were not very costly.

These three projects included Barnard Augmented, an AR mobile application that was an interdisciplinary project involving historical archival college photographs and site-specific dance performances; VR/360 video, a pilot project where multiple dance courses and genres were recorded, offering an

"immersive" record of performance; and time-lapse photographs and light-painting videos of LED movement scales. These projects offer qualitative support that AR/VR has significant affordances in relation to the teaching, learning, and scholarship around dance and the performing arts, and that, as these tools continue to improve and proliferate, more opportunities will surface for future applications. Nothing will replace physical presence, especially in relation to dance, and there is no "one way" to learn the performing arts, but movement-based activities offer interesting possibilities with virtual and augmented reality.

NOTES

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2. David R. Johnson, "Technological Change and Professional Control in the Professoriate."
3. New Media Consortium, *The Future of Higher Education: How Technology Will Shape Learning*.
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7. Shuo Yan et al., "OutsideMe: Augmenting Dancer's External Self-Image by Using a Mixed Reality System."
8. Dario Mazzanti et al., "Augmented Stage for Participatory Performances."
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11. Rudolf Laban, *The Language of Movement: A Guidebook to Choreutics*.

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