

Anatomy 3.0: Rediscovering Theatrum Anatomicum in the wake of Covid-19

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Abstract

The Covid-19 pandemic has challenged medical educators internationally to confront the challenges of adapting their present educational activities to a rapidly evolving digital world. In this article, the authors use anatomy education as proxy to reflect on and remap the past, present, and future of medical education in the face of these disruptions. Inspired by the historical Theatrum Anatomicum (Anatomy 1.0), the authors argue replacing current anatomy dissection laboratory (Anatomy 2.0) with a prototype anatomy studio (Anatomy 3.0). In this studio, anatomists are web-performers who not only collaborate with other foundational science educators to devise meaningful and interactive content but who also partner with actors, directors, web-designers, computer engineers, information technologists, and visual artists to master online interactions and processes in order to optimize students' engagement and learning. This anatomy studio also offers students opportunities to create their own online content and thus reposition themselves digitally, a step into developing a new competency of stage presence within medical education. So restructured, Anatomy 3.0 will prepare students with the skills to navigate an emergent era of tele and digital medicine as well as help to foreshadow forthcoming changes in medical education.

KEYWORDS

anatomy laboratory, anatomy studio, Covid-19, gross anatomy education, medical education

INTRODUCTION

The recent Covid-19 pandemic has been widely characterized as having a “forever altering” impact on health care (Fontanarosa and Bauchner, 2020; Mehrotra et al., 2020; Zhang et al., 2020), medical education (Kim et al., 2020; Rose, 2020; Thakur et al., 2021), and sociopolitical life in general (Papakyriakopoulos et al., 2020; Wagerman et al., 2021). One key element in this ongoing turbulence has been the shift in the language of interactions from face-to-face and “real” to one alternatively characterized as “virtual” and “distanced.” In an equally epistemic shift, early and more optimistic “back-to-normal” incantations have been replaced by an unsettlingly undefined “new-normal” (d’Orville, 2020; Sá and Serpa, 2020).

In this article, the gaze is narrowed to the world of medical education and a signature footprint within that disrupted landscape, anatomy

education, and cadaver dissection. The focus of this perspective article is more on the fate of the traditional laboratory experience rather than the particulars of emerging new pedagogical strategies. The authors argue that the “new anatomy” being reformulated in the wake of Covid-19 requires faculty and students alike to become more “media savvy” and that this digital/technical sophistication will require new ways of thinking about the production, delivery, consumption, and purposes of both anatomy and, in turn, medical education writ large. In exploring these emergent reimaginations, arguments were structured across three portals: (1) How anatomy teaching and assessment already has been impacted by the pandemic's arrival (Present); (2) how this reshaping returns us to an important epoch in anatomy's pedagogical past—the anatomy theater (Past); and (3) what pedagogical steps should be considered going forward as anatomy seeks to move into a yet-to-be fully charted studio-esque future (Future).

THE PRESENT: ANATOMY 2.0

The arrival of the Covid-19 pandemic has fueled a flood of articles, commentaries, and even a few empirical studies detailing changes across the full scope and trajectory of health sciences education (Jiménez-Rodríguez et al., 2020; Srivastava et al., 2020; Camargo et al., 2020; Frankl et al., 2021). Anatomy is no exception (Pather et al., 2020; Harmon et al., 2021; Nguyen et al., 2021; Owolabi and Bekele, 2021). One of the most dramatic identity-shifts for anatomy during this time was the large-scale suspension of body donation program (Ravi, 2020; Manzaneres-Céspedes et al., 2021) and anatomy laboratory activities including cadaver dissection (Lim, 2020; Longhurst et al., 2020; Smith and Pawlina, 2021). Traditional anatomical materials and practices were strategically reimaged and reinvented in real time as they joined a plethora of technologies ranging from not-so-new imaging tools [e.g., digitized sections of cadavers (Van Dijck, 2000; Tang et al., 2010; Ackerman, 2016), three-dimensional (3D) printing (McMenamin et al., 2014; Li et al., 2017; Smith et al., 2018)] to more avant-garde examples of technologized pedagogies [e.g., virtual, augmented, mixed reality and stereoscopic immersive 3D systems (Bork et al., 2019; Erolin et al., 2019; Kurul et al., 2020; Duncan-Vaidya and Stevenson, 2021; Moro et al., 2021)]. Less visible within this adaptive flurry was the fate of nontechnical skills—also known within anatomy circles as NTDIS or nontraditional discipline-independent skills (Evans et al., 2018; Evans and Pawlina, 2020). These skills, including elements of humanism, professionalism, teamwork, ethics, and leadership, had helped to redefine contemporary (Anatomy 2.0) anatomy training in the opening decades of the 21st century (Escobar-Poni and Poni, 2006; Gregory et al., 2009; Johnson et al., 2012; Hildebrandt, 2016; Goss et al., 2019; Chan and Pawlina, 2020). However, discussions of how anatomy might move forward in the wake of Covid-19 have been relatively silent (with few exceptions; see Jones, 2021) on how to preserve, or even grow, these seemingly “core” curricular elements.

Within this highly fluid and sometimes phrenetic interplay of disruptions and redeployments, three rather formative tensions began to emerge. The first centers on student performance and outcomes, but at an organizational level. Whatever else the anatomists may have seen as core to their assessment responsibilities, administration wanted to know how their Covid-disrupted learners were performing compared with previous years (Tucker and Anderson, 2021). The bellwether here was standardized test scores with a primary—sometimes singular—gauge being the National Board of Medical Examiners® (NBME®) subject examinations. “Trivial” slippages, no change, or the ecstatically received increase in test performance spelled “!!SUCCESS!!” Anything else invited scrutinous eyebrows. Nonetheless, and whatever the actual outcome, a potential trap was taking shape—just off-stage. Formed by the interlocking jaws of academic performance versus cost, and driven by longstanding concerns about the relatively high budgets of anatomy instruction, lurked the administratively attractive siren-call that a shortened, online, dissection-free, and less-expensive anatomy course might indeed be impervious to academic “downsides”

(Evans and Pawlina, 2021; Jones, 2021; Maloney et al., 2021). This possibility, in turn, raised for anatomists a disquieting uneasiness that test scores would show little to no impact via board performance metrics and thus little to no threat to a school's academic reputation—or ranking (Hafferty et al., 2020) all of which would give administration the ammunition it needed to preemptively cut anatomy instructional budgets.

The second tension was more enigmatic. The abrupt (in some cases) shift to online-virtual instruction brought a shocked awareness to some in medical academia that the uploading of talking-head videos via outdated curriculum management platforms in an age of Facebook, Twitter, Instagram, YouTube, WhatsApp, or TikTok was stop-gap at best and an embarrassment of digital unsophistication at worse. If anatomy education was to have a cutting-edge digital presence within this ever-evolving era of media sophistication, than something other than traditional knowledge/skills-mastery and related assessment practices would need to occupy center stage.

The third tension was related to technology, but more about culture than content. Other educational arenas have long courted both the parlance and practices of teaching as a “performance art” (Rives, 1979; Redington, 1983; Dawe, 1984; Pineau, 1994; Whatman, 1997; Brent, 2005; Hart, 2007; Schmenner, 2013), and with education as functioning within a “performance culture” (Gleeson and Husbands, 2004). Elsewhere, classrooms have been reimaged as “theaters” with teachers encouraged to develop new “acting skills” in service to their learners (Griggs, 2001; Tauber and Sargent Mester, 2007). Meanwhile, medicine, long ensconced within a cultural identity of science, fact, and objectivity, (Taylor, 2003) seemed relatively sympathetic to viewing content as king and context experts as the chief drivers of any educational engine. Although there is a nascent literature on the intersections of medicine/medical education and the performing arts (Hobson et al., 2019), most target-specific topics such as empathy (Dow et al., 2007; Eisenberg et al., 2015; Gao et al., 2019), conflict resolution (Wolfe et al., 2018), racism (Manzi et al., 2020), or more general curricular competencies such as humanism, ethics, or communication skills (e.g., Shapiro and Hunt, 2003; Coleman and Dick, 2016; Hoffmann-Longtin et al., 2018) and with particular theateresque vehicles such as improvisation and readers theater (Savitt, 2010; Watson, 2011) commanding a starring role. Alternatively, broader framings depicting clinical medicine as theater, (Gormley and Murphy, 2018) or physicians as actors, (Larson and Yao, 2005) are rare. Nonetheless, within this overall thematic space, and with a certain degree of historical irony, anatomy stands as a significant historical touchpoint given its cultural roots within the *Theatrum Anatomicum*.

THE PAST: ANATOMY 1.0

If nothing else (but it was indeed so much more), early anatomical teaching was a highly scripted interplay of performance as pedagogy (Davison, 1969; Winkler, 1993; Beecher, 2006; Klestinec,

2011). The first documented public dissection was performed in Bologna in 1315 by Mondino de' Liuzzi, a University of Bologna professor in which de' Liuzzi, perched on a large, elevated chair above the dissection table, provided instructions to a demonstrator who performed the actual dissection, (Papa et al., 2019) while an ostensor (an exhibitor) pointed out the specific organs being examined for the attendees (Di Matteo et al., 2017). The earliest temporary anatomical theatres originated from Italy in the 16th century, where the term "Theatrum Anatomicum" was coined (Schumacher, 2007). In 1594, the first permanent anatomical theatre was opened in Padua (Macchi et al., 2014; Papa et al., 2019), and it quickly became the architectural blueprint for many anatomical buildings, some of which are still in existence today. As a social practice, dissections often were sanctioned by the crown, open to the public, dramatic in dialogue (lectures in Latin), dramatically role specific (dissection by a barber/surgeon under the direction of the professor/speaker), and sometimes accompanied by food, music, and related "distractions" to mask the odor of the decomposing body. Outside, street vendors competed with jugglers, minstrels, and dancing bears for the attention and patronage of those additionally gathered (Brockbank, 1968; Davison, 1969; Schwarte, 2005; Schumacher, 2007; Bleeker, 2008). Over time, these theaters also took their architectural form and performance cues from the emerging popularity of more "lay" theatrics (e.g., drama, comedy, music) with the rise of the Elizabethan era's London's Rose theater (1587) and the Globe (1599); along with Renaissance Europe's Teatro Olimpico in Vicenza (1580) and the Teatro all'Antica in Sabbioneta (1590). Also contextually important was the emergence of poet/playwrights (e.g., Shakespeare 1564–1616) as public figures. In short, anatomical dissection-as-theater, its sensationalistic and taboo elements notwithstanding, was less a back-street oddity than a socially sanctioned staple of 16th- and 17th-century European urban life (Sawday, 1995; Schumacher, 2007). By the 18th century, with advances of medical sciences in France (with its nucleus in Paris), the "Parisian manner" of student participation with hands-on dissection of human bodies had begun to revolutionize the way dissection was performed in medical teaching institutions worldwide (Gelfand, 1972). By the 19th century, anatomy began to disappear behind closed doors with access restricted to a privileged few, with instruction "reduced" to targeting anatomical form and body morphology (Anatomy 1.0), and with the anatomy laboratory itself becoming a more sanctified rite of medical school passage (Hafferty, 1991; Bender, 2002).

THE FUTURE: ANATOMY 3.0

Although anatomy educators have long faced both external and internal pressures to reconceptualize the role of anatomy within the medical curriculum (Pawlina, 2009; Smith et al., 2016; Klement et al., 2017), Covid-19 did trigger more of a survivor mode for both faculty and students. Faced with the prospect of limited to

no dissection, along with the deployment of "distanced" learning and balky technologies, students felt both socially isolated and pedagogically abandoned (Sokolovskaya, 2020; Hamza et al., 2021). Meanwhile, faculty, with little time for strategic planning or even considered decision-making, felt equally overwhelmed and estranged (Evans et al., 2020).

Although the particulars moving forward remain understandably opaque, over the past year, anatomy educators worldwide have begun to anticipate calls both to reduce anatomy's curricula footprint and to transfer content to more specialized training venues (e.g., surgery) (Moxham, 2021). Within this space, they imagine a more digital-based anatomy laboratory grounded in a high-quality, real-time, live-feed learning and with digital technologies extending far beyond videotaping lectures or providing 3D anatomical schemas. These live-feed sessions will mimic the experience students might have of being present in the anatomy laboratory to participate in a dissection and communicate in real time with the anatomist (Bailey and Dean, 2020; Bhute et al., 2021). They also foresee students as more engaged partners, and curricula co-creators as educators push previously deployed team-based learning, blended learning, and flipped classroom strategies into these reimaged studio-based learning encounters.

These shifts in anatomy teaching will demand structural and cultural reconfigurations of the anatomy laboratory as we know it. In its most general form, the anatomy laboratory will need to be reborn as the "anatomy studio," ready to welcome the anatomist and student as co-performers capable of both receiving and delivering live content. This anatomy studio must be well equipped with audiovisual equipment, flexible in connectivity to records from multiple specialized sources (i.e., operating room laparoscopic cameras, radiological and microscopic images, etc.), and prepared to accommodate onsite and synchronous or asynchronous online learning activities (Stewart, 2017). In comparison with the traditional anatomy laboratory, the anatomy studio will offer medical students their first opportunity to investigate the human body from vantage points (multiple cameras capturing different angles, magnifications, hard to see locations) not available in traditional dissection-focused settings. Meanwhile, virtual reality technologies will allow anatomists to supplement students "dissection activities" while integrating in a ludic way the subjects of anatomy, radiology, embryology, histology, and physiology (Zorzal et al., 2019; Uhl et al., 2021). In a not-to-distant future, 3D printers will enable medical students not only to emulate their supervisors in performing home-based dissections of "plastic" specimens but also with "tissue" mimicking the tactility of human tissue (Bezek et al., 2020; Miramini et al., 2020).

This modern anatomy studio will be more than just a technologized hive of exotic mechanizations. It will demand the collaboration among an expanded range of experts. Designers, mathematicians, computer engineers, information technologists, visual artists, directors, basic scientists, and health professionals will co-create this new learning studio. Faculty will need to reach out to web-designers and editors to better understand what has been learned about internet users over the last 30 years (Amaral

and Brites, 2019). Knowing how internet users from different generations engage with online content will inform the development of interactive, synchronous, and asynchronous learning activities. Meanwhile, artificial intelligence and machine learning experts will help to generate algorithms to scaffold and evaluate students' performance in real time, which can be used to create individual learning trajectories and to provide help in assessment of students' performance to optimize students' and teachers' time (Roll and Wylie, 2016; Zawacki-Richter et al., 2019). Such collaborations will demand open minds and active imaginations to create and innovate in designing this studio of the future. The educational "team" will be reimagined. The modern anatomists, who must be knowledge experts, will need to reinvent themselves as cool, web-based masters-of-communication who wield magic wands of virtual engagement. Similar to its conceptual cousin, the architectural design studio (Dutton, 1991; Koch et al., 2002), Anatomy's 3.0 must undergo a similar reimagination of learning in an age of social media (Wang, 2010; Vyas et al., 2013; Güler, 2015).

One important step in this direction will be to imagine an expanded partnership between anatomy and theater. Although successful anatomy teachers already know how to "read" the body language and gaze of their trainees, and thus consequentially modulate and improve their performance in real time (Chan and Pawlina, 2020), teaching online is different. There is a delay in facial expressions. Eye contact with "the audience" is problematic. Students turn off their cameras. Following chat dialogues is an extra burden. Most importantly, both faculty and students face the challenge of reconciling verbal and nonverbal communication, the latter accounting for 70% of all messaging (de Carvalho Filho et al., 2020).

In the face of these challenges, anatomists can greatly benefit from interacting with and learning from actors who are used to perform in front of the cameras as well as with audiences at-a-distance. Actors can teach them how to read (and adapt to) ever more indirect and distant audience cues—something the theater world calls "scenic intelligence" (de Carvalho Filho et al., 2020). Directors, in turn, can help teachers to find other forms of gathering feedback and regulating their performance (Grotowski, 2010) nurturing their reflection-in-action skills (Schön, 1984, 1987). However, the most important lesson to take from the scenic arts is its culture of creativity, imagination, collaboration, and flexibility. A "theater world" nurtures a mindset that is capable of improvising and adapting "scripts" that are being modified in real time in response to changing environmental inputs including "audience" receptivity (Spolin, 1999; Boal, 2002). Going online to lead this transformation will be easier if anatomists learn how to grow this mindset. Actors and related expertise from the theater arts can help. Faculty development activities based on arts, especially theater, while not a novelty in medical education, can be adapted to target the development of these qualities and mindsets.

This new anatomy studio also will generate new anatomy students. In addition to the challenges of co-creating learning, students also will need to master novel presentation-of-self. Regardless of the telemedicine realities that await them as practitioners (Frankl

et al., 2021; Muntz et al., 2021), today's anatomy students may (and perhaps should) be called upon to demonstrate competencies and deliver performance metrics virtually. In doing so, memorization will give place to creation and application of knowledge. In these respects, the online environment not only will challenge teachers to create various "scripts," with different levels of engagement and with different opportunities to develop students' decision-making skills but also will challenge learners to design their own "proofs" of mastery.

The new anatomy student also will join the effort to create new online materials to nurture their own learning. This atmosphere of online collaboration will prepare students to strive as team players (Huitt et al., 2015). Moreover, the creation of online learning communities based on trust and solidarity feeds the students' identities with values that are important for becoming good doctors.

Students will also have the opportunity to reflect on their present and future digital identities and the nuances of online interactions that must be considered when dealing with peers, superiors, and patients. Learning how to be respectful and trustworthy online is one of a range of new professional competencies that needs to be mastered (Reinhart et al., 2021). Understanding how to protect patients' and body-donor privacy and interests within the cacophony of digitized exchanges that will dominate both classroom and clinic is critical. Online interactions, like online learning, while functionally necessary, are still only proxies for the intensely interpersonal and literally face-to-face engagements that have-long dominated medicine's learning environments. As but one example, digitized role models can be both literally present and easily distanced with the click of a keystroke. In addition, anatomy, with its oft-cited identity entrée into the world of medical education, will need to both address and newly identify many of these challenges.

So reimagined, the new anatomy studio can help not only to reformulate anatomy's long cherished identity as a rite-of-passage into the larger educational enterprise but also to serve as a harbinger for how that broader educational milieu may reimagine its own digitized, distanced, and virtual future. In doing so, the anatomy studio will continue to mark students' trajectories of identity and expertise within an educational milieu where imagination and reality are interdependent and emergent, and where learning is at one challenging, meaningful, and fun.

CONCLUSIONS

Covid-19 has triggered cataclysmic change across society, health care, and medical education. The fact that medicine faces a sharply divided political landscape, as well as a deeply distrustful public (Young, 2021), means that the future training of physicians must reimagine itself both to the task of professional preparation and to its social contract with society. One piece of this new pedagogical order will consist of converting the old (*Theatrum Anatomicum*) into the new Anatomy 3.0 as the anatomical science seeks to move

beyond “the laboratory” and into “the studio.” Within this emergent future, anatomy faculty, students, and administrators must imagine new technologies and partnerships, including that we envision, the theater and theater arts to help bring both anatomy and medical education into the ellipsoidal (a.k.a. “Leko”) spotlight of center stage (Kennedy Center, 2021). In rising to this challenge, Anatomy 3.0 will launch students into the new era of tele and digital medicine as it also helps to usher in a new era of medical education.

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