

The History of Anatomical Engagement

Abstract

The public's fascination with anatomy has evolved over time and progressed from avoidance of the tainted yet saintly corpse, to their fascination with cabinets of curiosities. The current narrative review explores public engagement (PE), from its potential origins as cave paintings, to the rise of the disciplinarity of anatomy. Historical insights show how the public engaged *in* anatomy and *with* anatomy evolved alongside educational trends and advances ethics. Teaching modalities have shifted as resources have fallen out of favor, become unappealing, illegal or logistically challenging to deliver. Historical changes have resulted in newer approaches coming into the limelight, often moving from the anatomy classroom into the public eye. The public's curiosity with anatomy was satisfied through the organized violence of vivisections and dissections, cabinets of curiosity and permanent museums. Today, the driver of PE is research, education and motivation for learning in the hope of improving people's understanding of their bodies. PE has shifted from spectacles to active participation and collaboration. Looking forward, the authors also propose an adaptive interdisciplinary model for PE in anatomy.

Keywords: Anatomy, public, engagement, history

INTRODUCTION

The structure of the human body has fascinated scholars and the public in general through the ages. With more than 200 known cell types, close to 40 trillion cells, an average of 640 muscles, and thousands of miles of blood vessels,^{1,2} the human body continues to impart curiosity. Curiosity, by

definition, is the inherent desire to approach or engage with what is unknown with the goal to better understand.³ Anatomy as a discipline is riddled with novelty and complexity, both of which serve as stimuli that makes us curious and to counter boredom.⁴ Curiosity can also be viewed as an intolerance of uncertainty and drives some individuals, such as members of the public, to know and understand the mysterious nature of things.⁴

In the past, the public's curiosity with anatomy was satisfied through public dissections, anatomical wax works, paper mâché models, prosected specimens, and articulated skeletons.^{5,6} Vividly and shockingly, anatomical museums displayed anatomical curiosities during the eighteenth and early nineteenth centuries.⁷ Such exhibits were not only aimed at artists, medical professionals, anatomists and philosophers, but also afforded the lay public an opportunity to attend lectures.^{5,7} These anatomical displays served as a platform for public engagement (PE), also known as citizen engagement, and community engagement. Throughout history, the true motives of PE in anatomy varied between education and theatricality, more recently moving from the latter to the former. Anatomy, in all its forms, became a commodity with an opportunity to profit.⁸ Anatomical and pathological collections were commercial assets which could be sold and where public lectures were a commercial enterprise.^{9,10} Today, the public is afforded virtual reality and augmented reality experiences and multimodal approaches (including dissection) on the structure of the organs and the human body.

PE with and in science, and anatomy within the current context, has become a prerequisite for personal and institutional advancement in academia, especially towards research funding.¹¹ It has also been placed in the limelight due to the perceived ever-increasing gap between science and society.¹² PE, according to the UK's National Co-ordinating Centre for Public Engagement, can be defined as "the myriad of ways in which the activity and benefits of higher education and research can be shared with the public".¹³ It is a bidirectional process that involves communication and listening with the ultimate goal of mutual profit.¹⁴ However, PE can also be defined based on: its objectives (e.g. to achieve

inclusivity and increased visibility), the intended audiences (e.g., children and citizen scientists), its role for the public (e.g. gaining input regarding best practices), the relationship between science and the public (e.g., promoting mutual benefit), and its activities (e.g., interviews with newspapers and public lectures).¹² PE motives, as alluded to the idea that public anatomies were commercial, can range from democratization, innovation, education, legitimation and serving as inspiration.¹² Throughout history, these motives have manifested in one form or another.

Defining PE is especially important when considering the nature of its relationship with anatomy and the public's involvement. PE in anatomy, as we will discover and not unlike other scientific disciplines, has progressed from isolation among the experts to a heterogeneous entity aimed at inclusion, consultation, policy making and governance. It is also important to consider the facets of what is meant by the public within the current context. Publics-in-particular (PiP) are the members of the public that have "an identifiable stake" in technoscientific affairs and can be individuals from the media, individuals involved in marketing campaigns and public relations, and campaigners or political actors.¹⁵ Publics-in-general (PiG) can be viewed as the ordinary people or the "masses" and represents individuals who are sometimes evaluated negatively as ignorant or disillusioned with science. In the narrative review, the authors will trace the historical origins, nature, and evolution of public engagement *with* and *in* anatomy, as well as the lessons learnt, and best future practices. The first section will explore the rise of the disciplinarity of anatomy, the second will consider the public and public dissections, and the third will review the role of anatomical museums (framed under medical museums). The final section will consider current and future approaches to PE in anatomy and propose an adaptive interdisciplinary model for PE in anatomy.

DARING THE TAINTED CORPSE

The human form has been the subject of study ever since and has been visually captured in many formats, the oldest of which are cave paintings.¹⁶ These cave paintings might represent the public's first artistic exposure to anatomy and some cave paintings document natural experiences such as sexual intercourse, birth and death. These natural events have been documented in lithic art dating back to the Upper Paleolithic and upper periods onward. An example is the Later Neolithic cave painting discovered in İnkaya Cave, Balıkesir in Turkey, which captured fetal development *in vivo* and childbirth.¹⁷ Life's course is the domain of anatomical study throughout history. Anatomical study and its representation were not structured during the ancient period. For example, the cedar wood panels dating back to c. 2660BCE and depicting the various stages of life of Hesy-Ra, an ancient Egyptian official and dentist, did not follow rigid tenets of proportion and geometrical perspective.¹⁸

Furthermore, the interpretation of the human form rested upon superstition and false inferences. For instance, if a mother gave birth to an infant without a right hand, it was believed that the land would be struck by an earthquake.¹⁹ Such an example of a cultural construct and societal norms alludes to the public's perceived meaning of the human body. However, selected modalities of the visual arts such as sculptures, engravings and paintings captured the human form during the ancient and classical periods, becoming part of the visual culture of the period. Anatomy became a rightful and recognized branch of medicine around 500BCE and its development as a discipline can be traced back to Aristotle (384–322 BCE) and Hippocrates (c.450-380 BCE).¹⁶ A structured approach to anatomy was spawned in ancient Greece and saw the establishment of anatomical terms and methods to its study.²⁰ Herophilus (335-255BCE) of Chalcedon and his younger contemporary, Erasistratus (310-250BCE) of Cos, were the first to perform formal and structured anatomical dissections and they became known as the fathers of anatomy and physiology, respectively.²¹ Herophilus is believed to have dissected criminal corpses through royal permission of 30 to 40 years and his systematic approach would only be expanded during the Renaissance.²¹ It is believed that both Herophilus and Erasistratus performed vivisections on condemned criminals, and their supply was granted by the king's permission. Their

work was preceded by that of Aristotle who chiefly conducted anatomical studies on animals, though he did examine human fetuses as well.²² Upon his return to Athens in 335 BCE, Aristotle established a school which the public could attend in the evenings.²²

After Herophilus and Erasistratus crossed the threshold, systematic anatomical dissections of human bodies ceased for nearly a thousand years. Even Galen would later follow the Greek tradition of refraining to cut into a human body.²³ Bynum states that “the ancient Greeks disliked dissection of human bodies”. One probable reason for this can be traced to societal beliefs and practices that regulated ancient societies. Greek sacred inscriptions, preserved in stone and marble, portray the human corpse as a source of pollution for anyone who comes into contact.²³ The corpse as a potential pollutant to the public, society and religious statutes is exemplified by the ban of sexual intercourse, giving birth, dying, urinating, and defecating, in or around the sanctuary of a temple.^{23,24} The impurity of the body and human remains is further illustrated by an instruction from Cos, believed to coincide with the time of Herophilus, which asks for the purification of the community when a human bone is found in a public space.²⁵ The polluting agency or miasma of a corpse required mourners to abstain from community engagement for two to 41 days. The views of St. Augustine (354-430) who believed that anatomical dissections were an “inhumane interference in human flesh”, could have been an additional deterrent in advancement of anatomy.²⁶

The sanctity of the human body, as viewed by Confusion law, is a further cultural consideration. During the Han dynasty (202BCE to 220 AD), Confusion laws were adopted that considered the body compromised if dissected and thus contravened the law of filial piety – i.e. a child must “respect and worship their parents and ancestors”.²⁷ However, reference is made in the *Han Shu* which captures the history of the Han dynasty, as well as the dissection of criminal corpses.²⁸ The Confusion law of filial piety is believed to have stood until the eighteenth century.²⁹

The seminal work of von Staden provides further insights to the hiatus of public human dissections from ancient Greece until its reappearance in Italy in 1316.²³ A new medical school of thought, which relied on experience, rose and opposed the so-called rational and dogmatic views of Herophilus and Erasistratus. The newly founded Empiricists believed that human dissections were pointless.³⁰ The study of medicine and the public's exposure to medical science and anatomy occurred within a didactic setting. Bynum (2008) writes that the period from the fall of the Roman empire in 455AD to the Renaissance can be known as the period of *library medicine* where the object of inquiry was through ancient texts translated into Latin, the form of education was didactic, and aimed to facilitate patient recovery.³¹ The most famous of these libraries was that of Alexandria, Egypt, and it is believed to have housed 700,000 scrolls – some of which included contributions by Herophilus and other great minds of anatomy.³²

Animal dissections and vivisections took precedence to that of humans, and this was a public affair. Galen would refer to the public as spectators during these events, considering his demonstrations as a form of public entertainment.³³ Mattern in 2013 wrote that “the bloody, controlled violence of the vivisections, and their incontrovertible proof of man's mastery over animals, resembled the wild beast hunts so popular in the Roman arena—and especially in the capital city itself”.³⁴

Societal norms, dictated by sacred laws, placed the public at odds with the systematic study of human anatomy for roughly a thousand years. Public engagement with anatomy in ancient Greece, and during the Hellenistic period that followed, was that of avoidance of the human corpse. At the time, Herophilus and Erasistratus dared to cross the boundary of the impure corpse. The public and their engagement with anatomy was that of spectatorship but this waned due to dogmatic ideologies that stifled the scientific process. The establishment of the first universities in Europe, during the Middle Ages, would set a new course for anatomy.

PUBLIC DISSECTIONS AND PRESTIGE BY PROXIMITY

From the late Middle Ages onward, medical education became affiliated with universities.³⁵ The practice of anatomical dissection during this period was, and still is today, bestowed with prestige.⁶ Public witnesses of anatomical dissections were afforded this “prestige of proximity”.³⁶ The earliest record show that dissections occurred at universities in northern Italy at Bologna when Mondino de Luzzi (c. 1270–1326AD) published *Anathomia Mundini emendata per doctorem melerstat* in 1316.^{37,38} Not only was *Anathomia* the first illustrated and printed book on anatomy, but it also captured anatomical theories from the classical Greek, Roman and Arabic scholars.^{39,40}

Anathomia marked the return of a structured approach to anatomy in medical curricula and served as a guide to anatomical dissection for at least 200 years.^{37,41} Mondino performed the first public dissection after the hiatus left by Herophilus and Erasistratus.⁴² Open-air and public dissections were infrequent during the Middle Ages.³⁸ Religious and societal restrictions are believed to play a part and this held true in place in France during the time of Mondino.⁴³ Regardless, Mondino popularized dissections and others followed in Montpellier, Padua, Perugia, Prague, Venice, Firenze, and Lerida.⁴¹ However, the disciplinarity of anatomy and dissection was not restricted to scholars and the public were permitted to such events.

The revival of anatomical dissections did not come in leaps and bounds. A gradual shift occurred over time and one major nude came in the 1240 decree of Frederick II, Holy Roman Emperor, which mandated dissections at least once every five years. Universities, colleges, and guilds followed suit and mandated that only one or two dissections of plague victims were allowed per year.⁴⁴ Dissections became a requirement for surgeons in Venice from 1368 onwards and at least one dissection had to be performed.⁴⁵ Rules at Bologna and Florence at the time stated that only unknown bodies that came from a distance of at least 30 miles away, were to be dissected.^{46,47} Some scholars note that anatomical dissection, during the early twelfth century until the fourteenth century in Christian Europe was not

outlawed or prevented by cultural or religious hurdles as commonly believed.^{23,44} Park (1994) states that restrictions were due to familial respect of the deceased and burial practices as opposed to the “sanctity of the body”, or hinderance from the church.⁴⁴ Furthermore, interpretations of the 1299 bull *Detestande feritatis* by Pope Boniface VIII caused further confusion. The decree by Boniface did not prohibit autopsy or dissection; rather it addressed the funeral practice of dismemberment which allowed ease of transport of the deceased at the time.⁴⁴ However, it is known autopsies on private patients continued well before the 1500s in instances where the cause of death was unknown.⁴⁴ Contemporary misinterpretation of Boniface’s bull could explain why anatomical dissections were taboo. An additional point to consider is the dead being visible in public spaces, especially in Europe. The stigma associated with public dissections of condemned criminals, typically performed on a nude corpse as final indignity, served as a major deterrent to many.⁴⁴ This is completely understandable considering some of the grisly historic recordings of public dissections, even more so when vivisections were performed. One such case was recorded in 1475 by Jean de Roye, a notary in Paris, and related to an archer found guilty of larceny and sentenced to hang at the gallows.⁴³ The event took place some 160 years after Mondino’s public dissection of a female criminal corpse.³⁹ The Paris account mentions an appeal by the archer and subsequent petitions by the medical men Paris to cut open a living body to best understand and diagnose conditions such as painful intestinal maladies and bladder stones. The archer agreed to be anatomized with the hope of escaping execution. He survived the ordeal after his intestines were returned and the wound was sutured. The archer recovered within two weeks, and he not only received money and the best medical care by order of Louis XI, but his sentence was also pardoned.⁴⁸ Hartnell (2019) writes that this account is very atypical due to the social tensions between theoretically minded physicians and more “practically oriented surgeons” and anatomical observations would only follow in the mid-1490s in France.⁴³ Nevertheless, public anatomies such as this ghastly account explain in part the continued aversion to anatomy.

Anatomical dissections in Italy during the late Middle Ages followed a specific protocol which reflected the status of the medical school or college and relied on a reader on a highchair (Fig. 1), a dissector, and a demonstrator.^{49,50} The reader or professor would typically recite the works of Galen and any anatomical variations beyond the classical work of Galen would be considered as abnormal.⁵¹ The public were permitted to join, and each university or college followed their own set of rules.⁵² In addition to the need to source a body from outside without any relatives, a yearly schedule was followed with dissections being restricted to the cold of winter to prevent decay. Christian mass was read, and preparations were made for the burial of human remains. Scholars such as physicians and surgeons were also typically invited, and seating of the audience was arranged based on social standing. Spectators could speak, but this had to follow the predetermined rules.⁵²

Open air dissections paved the way for permanent factories, and they relied on demountable wooden theaters which became more accessible to the public.³⁸ The work of Alessandro Benedetti (ca. 1450–1512) would form the blueprint of anatomical theaters during the pre-Vesalian period and thereafter. His volume titled *Anatomice sive historia corporis humani* was published in 1502. In it he advocated for annual dissections and highlighted the importance of anatomical dissections in medical education.^{53,54} One chapter provided design considerations and the day-to-day operations of a temporary anatomy theater. His requirements included a raised table to permit visual access, an open space for fresh air, and surrounding seating for the audience. He also stipulated the need for two guards to control access and an admittance fee was charged to procure the required tools of the trade.⁵²

Please insert Fig. 1

Temporary anatomical theaters were established in churches (Bologna, circa 1540), universities (Montpellier in 1556), hospitals (Spain, circa 1550), and convents (Amsterdam, circa 1550). Anatomy became accessible to many, and permanent anatomical theaters, affiliated with universities, would

follow at Salamanca (1554), Padua (1584), Barcelona (1573), Leiden (1593) and Paris (1610).³⁸

Anatomical theaters embodied the rising prestige of anatomy during the sixteenth- and seventeenth centuries and some, in the case of Bologna, were adorned with decor beyond its functionality.⁵²

Linked to the spread of human dissections at medical schools across Europe was the public's curious presence. The format of public anatomies through dissection was linked to the curriculum of the guild, university, or licensing entity at the time. Invitations were typically issued in Latin and addressed to surgeons, sculptors, painters (thus the PiP) and the PiG. Some invitations, as with the opening of the Berlin anatomical theater in 1713, would be addressed to "all lovers of anatomy".⁵² The purpose was twofold: education through demonstration and social theatricality.⁵² Andreas Vesalius (1514-1564) noted in 1543 in *Fabrica* that a middle-aged individual, with an average body size, is the most suited for dissection.⁵⁵ He set himself apart from his contemporaries through his instruction whilst dissecting and by insisting that anatomy should be learned through direct observation. His primary approach to public anatomies relied on the inclusion of articulated skeletons, anatomical illustrations and animal specimens.⁵⁶ Vesalius' multimodal approach was a major innovation at the time.

The popularity of anatomy was further fueled by copper plate engravings and the printing of books.⁵⁷

Upon the backdrop of anatomy's advancement lies the predominant role of the criminal corpse that superseded animal dissections. The resurgence of human dissections came as a result of the emergence of the first universities in Europe and public dissections were typically ritualized.²⁹

Dissections received legal support across Europe, but restrictions existed in terms of the number of bodies that were allotted per annum. The same restrictions were enforced by Royal Charters and the supply of bodies to the Company of Barber Surgeons and Royal College of Physicians were also limited between the sixteenth- and eighteenth centuries.⁵⁸

In the United Kingdom, during the fourteenth to mid-eighteenth century, execution and public display of criminals were two sides of the same coin. Postmortem punishment, i.e. being anatomized, was

discretionary by order of the king and later became part of the penal stages of punishment through the Murder Act of 1752.^{36,59} The bodies of the condemned were perched at the confluence of anatomical knowledge, the public spectacle of dismemberment, and decay.³⁶ It is difficult to conceptualize the public's perceptions that were associated with these events; more so when live animal dissections were performed. Public outcry erupted when François Magendie (1783–1855) performed a public vivisection on a dog in England in 1824 to demonstrate the function of the facial nerve. To make matters worse, it was reported that the animal was nailed down on a table for the procedure and left overnight to allow the proceedings to continue the following day. The documented abuse and cruelty finally led to Cruelty to Animals Act of 1876 that cited Magendie's public dissection.⁶⁰⁻⁶²

The 1832 Anatomy Act would signal another turning point and public dissections came to an end. The demand for human bodies surpassed their supply and grave robbing became profitable.²⁹ The Body snatchers faced little or no legal punishment and as William Cobbett (1763-1835) wrote in 1832 "the law, as it now stands, makes it only a misdemeanor, that is to say, a crime punishable by fine and imprisonment" whilst "a sheep, or pig, or calf, or ox, or fowl of any sort, is a capital felony, punished with death".⁶³ 1828 marked a major turning point after the 16 known murders by William Burke and William Hare, and resulted in the public execution and dissection of William Burke. Edinburgh became the nexus of anatomical study during the nineteenth century and faced a shortfall in human bodies. Burke and Hare devised a means to regain their losses after a tenant died at Hare's lodging house without paying. They sold the body to Robert Knox (1791-1862) and their profits surpassed the tenant's outstanding rent. A series of murders ensued over a period of 10 months.⁶⁴

The Burke and Hare scandal in Edinburgh and subsequent public uproar, the spreading hysteria of "burking", and the panic of potential riots led to a legislative reform and the legalization of dissection by anatomists, surgeons, doctors and medical students.⁶⁴⁻⁶⁶ The Anatomy Act made provision for the use of pauper status or donated human bodies in a bid to prevent the unlawful trade of human

bodies.⁶⁴ The Anatomy Act changed the face of human dissection and as Brenna stated what was “once a celebrated public function – became a private affair”.²⁹ However, a surprising outcome of the Burke and Hare murders, as Bates (2006) noted, was the reinvigoration of public interest in anatomy.⁵ A new format of PE in anatomy surged with the establishment of institutional and private anatomical and pathological collections – the so called “cabinets of curiosity”.

CABINETS OF CURIOSITY AND ANATOMY FOR ALL

The nineteenth century saw a shift towards stringent education and professionalization of medicine. The study of anatomy and anatomical dissections moved away from public eyes.⁶⁷ Bender states that this shift “deprived the larger public of first-hand visual experience of the body’s interior and its immense variability from person to person”.⁶⁸

William Montague Cobb (1904-1990) noted in 1913 that “the advantage of association of a museum with an anatomical laboratory, today need no argument”.⁶⁹ Academic museums, such as anatomical and pathological museums, have declined in recent times due to the increased availability of online resources (including digital collections), textbooks and atlases.⁷⁰ The fifteenth century saw the establishment of “cabinets of curiosities” across Europe. The cabinets of curiosities were typically private collections or linked to a hospital, a town or district. They contained an array of artifacts ranging from geological specimens to body parts and wax models. These proto-museums aimed to present an encyclopedic collection of artifacts and some also included books and paintings and were seen as a symbol of wealth in the case of private assemblages.⁷¹

The historical evolution of academic anatomical museums coincided with the establishment of universities.⁷⁰ Anatomical dissections served as source material to museums and the oldest documented example is the articulated skeleton of Jakob Karrer. Karrer was executed on 12 May 1543

for attempted murder and Vesalius performed a public dissection on his remains. With the assistance of a local surgeon, Franz Jeckelmann, Vesalius articulated the osteological remains and the skeleton is currently on display at the University of Basel.^{72,73} Museums housing anatomical and pathological specimens, collectively known as medical museums, were established during the sixteenth- and seventeenth centuries as dedicated spaces for practical and tutorials sessions.⁷⁴ Some medical schools of the period established satellite museums at hospitals due to a lack of institutional space.⁷⁵

The legitimacy of anatomy continued to develop outside Europe during the Renaissance. Along with the rise of modern anatomy came attempts to understand the pathological basis of disease through the father of anatomical pathology, Giovanni Battista Morgagni (1682-1771).⁷⁶ The array of specimens that were collected after autopsies of surgical procedures were preserved in alcohol and most notably, the secret *liquor balsamicum* of Frederik Ruysch (1638-1731).^{71,77} The expansion anatomopathological museums would follow during the seventeenth century in Amsterdam, London, Padua, and Paris, and later in 1807, the first Hunterian museum in Glasgow in 1807.⁷¹ Historically, some of these museums were open to the general public and some examples include the Museum of the Royal College of Surgeons of Edinburgh (1832), Signor Sarti's and Kahn's Anatomical and Pathological Museum in London (1851), Präuscher's museum in Vienna (1871), and *Pathologisches Museum* in Berlin (1899).^{5,76,78,79} Around forty anatomical museums were established in London by the second half of the eighteenth century, though only a few were accessible to the public and they were either linked to an institution or privately owned.⁸⁰ Concurrently, human dissections would expand across the globe and were later conducted in Canada, China, Ottoman Empire, and United States followed during the eighteenth century.⁸¹⁻⁸⁴

Public eyes were afforded a close encounter with wax models, anatomical, embryological, surgical and microscopic preparations. The aim was to “to present the scientific observer with a general and correct view of the perfect and wonderful structure of the body”.⁸⁵ Exhibits showcasing any material that could offend, such as venereal diseases, were reserved for medical professionals in a separate

room.⁵ Public health concerns associated with smoking and diet were addressed during Kahn's lectures and surviving accounts of Victorian working class men were that they considered an outing to the museum as "a harmless day out".⁵ Anyone who could afford the 1-shilling admission fee were allowed to enter. Women, at the time believed to own a modest temperament, were allowed to enter but any offensive displays were removed.⁵ The selling point of these public exhibits, as in the case of Sarti's Anatomical Venus (Fig. 2), is to acquire knowledge, "understand the laws of health", and to appreciate the wonderful creation of the human body. Sarti's showcase goes so far to claim that the exhibit "offers an unanswerable argument against Atheism".⁸⁶

Please insert Fig. 2

Medical museums and their specific displays of wax models provided an alternative to the public with "...the desire to see, without feeling the nausea, and at close range, the various parts of the body...".⁴⁹ They served an educational purpose without the element of anatomical dissection.^{49,87} Real anatomical models were the element of shock to the public, more so when reproductive organs and venereal disease were on display.⁵ Sallam notes in 2019 that the post mortem narrative of an anatomical or pathological display is "subject to the viewer's own thoughts and interpretations".⁸⁸ Furthermore, the medical professionals at the time had a vested interest in closing down the "obscene" nature of anatomical museums through Lord Campbell's Obscene Publications Act of 1857.^{5,87} The first enforcement of the act came in 1860 against the anatomy museum in Leeds.⁸⁷ However, authorities in London remained neutral until the medical men of the time pushed for prosecution which ended all public anatomy museums.⁵ Anatomy became medicalized and anatomy museums became regarded as "a gloomy sepulcher of pathological horrors".^{5,89} The public's engagement with anatomy was largely driven by the expansion medical education across the globe. Historically, this advancement is largely Eurocentric. Anatomical education reached Australia and Africa towards the end of the nineteenth and early in the twentieth centuries respectively, as a result of the expansion of the British Empire.⁹⁰ Further European colonization of Africa saw the transfer

medical education to the colonies with only a small number of medical schools in existence by 1960.⁹¹ Over time, many of these medical schools started their own anatomical collections behind closed doors and away from public sight.

ENGAGEMENT IN ANATOMY TODAY

The arena of anatomical engagement today is very different. The driver is education and motivation for learning in the hope of improving people's understanding which in turn will help them understand their own physical health and wellbeing.⁹² Flexner's landmark report, published in 1910, highlighted the importance of basic medical sciences such as anatomy.⁹³ The importance of anatomy in health professions education is well understood and the modes of its facilitation has evolved over time.⁹⁴ Our lens through which we view the fabric of the humanity has similarly evolved. Ernst Ruska (1906-1988) and his work on electron optics allowed humanity to explore cell structure beyond the limits of conventional light microscopy.⁹⁵ Advances in medical imaging, such as Wilhelm Röntgen's (1845-1923) x-ray discovery in 1895, paved the way for scientific advances in diagnostic medicine, surgery, and molecular biology to name but a few.⁹⁶ Our view of the body changed through ultrasonography, computed tomography, and magnetic resonance imaging during the 1970s and 1980s.^{97,98} Whole body preservation through plastination has become a reality.⁹⁴ Most importantly, our ethical approach to human tissue has progressed to move away from the use of unclaimed individuals and the marginalized, and towards restitution and repatriation of human remains.

The tools of old, such as public dissections and exposure to the gruesome reality of the punishment of crime, have also advanced, where resources that enable mass learning, the infusion of fun, and enticing curiosity are now commonplace. Medical museums with their anatomical collections gave way to illustrated textbooks and atlases, online resources, and digital collections.⁷⁶ Physical space-

requirements, maintenance cost and curriculum time are further factors that have negatively impacted medical museums in modern times.⁷⁵

Posters and plastic models have been widely used in education and hands-on engagement for the public, enabling an appreciation of beauty and complexity of the human body. As a basic tool, they are robust and durable, compared to historical wax models, and can be used in most settings. Other advances with low fidelity resources have seen clay modeling and body painting bring a “wow factor” to the classroom and latterly public engagement in anatomy.^{99,100} The colors used in body painting along with the movement of the body bring functionality to life, moving on from the structural and recognition of things, to an appreciation of the role the structures depicted play within the body. Painting on of limb muscles and the subsequent flexion or extension of a joint shows how the muscles and their accompanying tendons alter their form, particularly when UV paints are utilized.⁹⁹

Many of the newer modes of anatomical engagement come from teaching modalities that have increased student engagement or knowledge retention, and the hope is that as we move forward the newer resources will continue to offer this to the wider public. Ultimately, the expectation is to reduce the burden on healthcare resources and help individuals make informed decisions about their bodies, and how to maintain them.

In recent years with the introduction of 3D printing, holograms and other more “personalize-able” resources have enabled the public to immerse themselves in more detail in and around the body, giving a much more immersive experience. Technological advances such as augmented or mixed reality show much potential in undergraduate anatomy education but remains to be tested in terms of their effectiveness.¹⁰¹ The same holds true for their use in PE. Some of these advances have arisen because of the Covid-19 pandemic, but are likely to remain, and be expanded upon, as they increase inclusivity and accessibility to populations who may have previously found engaging with such resources challenging.¹⁰²

The need for and availability of public engagement in anatomy continues to grow, research is demonstrating a significant lack of knowledge amongst the general public.¹⁰³⁻¹⁰⁶ Although there is a need for more, it is also a time for caution - the majority of the delivery falls on an already stretched anatomical workforce.¹⁰⁷ As we move to the next phase of public engagement, the role of games and gamified learning are likely to be a valuable resource, Organ Attack is a widely available game looking at the effect of various things on your body organs, although it has not been examined in terms of knowledge gain or retention. Other games which are more anatomical in focus have shown an increase in anatomical knowledge of the skull as well as being enjoyable and linking to real world activities and safety.¹⁰⁸

PE activities tend to be centered around one scientific discipline. Drawing on the work of Stott and Vicente (2024), this would imply that anatomists would engage the public on anatomy-related topics.¹⁰⁹ Such an approach could often be meaningless when the target audience represents a demographic proportion with cancer, thus the PiP. The questions posed by cancer patients will most likely be broad and beyond a single discipline.¹⁰⁹

Effective PE therefore could benefit from an interdisciplinary approach where a holistic view of a subject is presented. For this to succeed, existing interdisciplinary structures should be harnessed (e.g. across colleges or faculties), an overarching university structured PE initiative should be fostered (such as Warwick Institute of Engagement), and common spaces (such as a university museum, both physical and virtual) should be exploited.^{109,110}

A proposed framework towards an interdisciplinary approach is presented in Figure 3 and draws upon the work of Krick et al., Hambidge et al., and more recently Dueñas and colleagues.¹¹¹⁻¹¹³ From the onset, stakeholder engagement is required to identify a specific problem (e.g. cervical cancer) or a theme (such as body and organ donation awareness). The integration of education, research and practices would ensure that the stakeholder needs are met (Fig. 3).¹¹² The need to democratize

research and permit the PiG access to the knowledge that is generated is important.¹² In the case of body donations as theme for PE, an interdisciplinary approach would ensure a diverse set of skills and thought related to existing policies, procedures, and best practices. An interdisciplinary team could involve, but is not limited to the following: a faculty PE expert, teaching and technical staff, current and past students, a legal expert, a biomedical ethicist, social and/or medical anthropologist, a bereavement counselor/psychologist, an end of life caregiver, and previous relatives of body donors. A connection between local and global perspectives can be facilitated through the inclusion of international experts.¹¹² However, contextual factors such as regional donor profiles, the historical landscape, and societal norms should be considered in a bid to decolonize anatomy.¹¹⁴

Stakeholder awareness and participation (Fig. 3) of the PE event can be generated through radio and televised broadcasting, social media, and newspaper platforms. Dedicated television or radio segments have the potential to serve as a primer to the event.¹¹³ The event itself should rely on collaborative learning by both the facilitators and public (Fig. 3). Collaboration ensures interaction between all parties to attain a common goal. It also permits the PiG to have a voice and not “the empty vessel to be filled with scientific knowledge”.¹¹⁵ Collaboration also permits experts from the public, the PiP, to engage facilitators in a reciprocal manner that relates to nonfoundational knowledge.¹¹⁶ An element of cooperative learning might be embedded where foundational knowledge transfer is required to address “agreed-upon answers”.¹¹⁶ Mutual learning, by both the public and facilitators, that is transformative and experiential can be achieved through collaboration. Finally, critical reflection by the interdisciplinary team will permit reporting and evaluation. The feedback that is subsequently generated should drive the update and transformation of existing policies, scholarly research, and future PE activities.

Please insert Fig. 3

An example of such an interdisciplinary approach occurred on World Heart Day at Lady Pohamba Private Hospital on 29 September 2024 in Windhoek Namibia (Fig. 3). PE in anatomy was complemented by the opportunity for the public to have their blood pressure and cholesterol measured, their blood group identified, and learn about the history of auscultation. The public also gained an opportunity to view a real human heart and compare that to other animal specimens. In this instance, the objective was heart health. It included directed activities and permitted the public to explore the relationship between basic anatomical knowledge and its clinical application.

Please insert Fig. 4

Looking forwards and for PE to be successful, the facilitation has to be led by anatomy staff delivering teaching and research-led engagement. Support by engagement or partnership teams in higher education institutions and the wider healthcare sector is essential. The value of interdisciplinary PE lies in its consultation and collaboration. Collaborative PE is even more pertinent as the higher education environment undergoes its latest change in response to funding and other global challenges. The drive for delivering strategically valuable and high impact engagement becomes a necessity. Effective science communication is vital and communication training of academic staff must be encouraged.¹¹⁷ However, this adds to the existing array of responsibilities of health professions educators beyond their facilitation of students' learning, curriculum design and revision, being an assessment expert, and fulfilling leadership and management roles.¹¹⁸ Finally, PE in anatomy has to following the trajectory of advances in research, education, biomedical ethics, and current practices to remain relevant and impactful.

CONCLUSION

Public interest and their engagement in anatomy has waxed and waned throughout history. An understanding of the historical nature of PE in anatomy highlights the primary drivers of its engagement today. The professionalization of medicine, advances in anatomy education, and the shift in ethics of anatomical understanding underpins current approaches. The view of the human body has changed over time, not only through technological advances in imaging but also our ethical approach in deconstructing the human body. The public's understanding of the human body has progressed as a result of scientific advances in medicine as well as the implementation of ethical standards. PE has become increasingly important within higher education institutions in terms institutional impact and funding. Within the anatomical sciences, PE will Future research on PE in anatomy should consider its value on the improvement of the public's knowledge and understanding, the impact on healthcare improvement, and the facilitators of PE is warranted.

ETHICS STATEMENT

The authors confirm that there is no ethical requirement for this review article. The authors confirm that the article has been written by themselves with no utilization of AI or other external software or parties.

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FIGURE LEGENDS

Fig. 1. A medieval period dissection scene from *Fasiculo de Medicina* (Venice, 1495) depicting the typical protocol with the professor elevated on a highchair and the dissector or barber surgeon performing the dissection.

Fig. 2. The cover page of Signor Sarti's public display of an Anatomical Venus with selected days of admission of women and endorsement by contemporary medical men.

Fig. 3. A Conceptual model an interdisciplinary PE approach. The adaptive model relies heavily on reciprocal collaborative learning during engagement.

Fig. 4. An interdisciplinary approach to PE in anatomy during World Heart Day (Lady Pohamba Private Hospital, Windhoek, Namibia). On the left and clockwise, the layout offering members of the public free rapid cholesterol tests, blood pressure measurements, and blood type analysis. Various anatomical specimens of human and animal hearts were on display as well as historical artefacts such as a replica of René Laennec (1781–1826) first stethoscope.