**The hidden curriculum of utilisation of imaging and unregulated digital resources within clinical education**

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**Keywords:** hidden curriculum, social media, teaching resources, unregulated resources, pedagogy, education, students, learners, medical education, healthcare education, technology-enhanced learning

**Abstract**

Clinical education has changed dramatically over the last 30 years. The increasing use of imaging and visualisation technologies within medical, dental and other healthcare sciences education curricula is taken for granted, with little consideration given to the agenda behind the colonisation of the basic sciences curricula with these technologies or their ultimate utility with regards to patient care. Sufficient critique is rarely given prior to the incorporation of imaging modalities into teaching and learning, and the hidden curriculum remains deeply buried under the impetus to ‘move with the times’. Coupled with increasingly easily accessible but unregulated streamed digital teaching resources widely utilised in healthcare professions’ curricula, there remains a danger that future generations of clinicians may be exposed to erroneous information that could ultimately impact on the safety of their patients. Educators must develop a reflective approach, and together with institutions develop a collective responsibility to integrate and map evidence-based and clinically-relevant approaches within the respective curricula, rather than bombard undergraduates with the latest technology and never-ending (and sometimes unreliable and unregulated) information without awareness of the potential dangers lurking within their preferred teaching methods and ideologies. Healthcare professionals must subject teaching resources utilised within their curricula to the same scrutiny that textbooks undergo, with content accuracy and endorsement via reputable sources, preferably peer reviewed and traceable, taking precedence.

**1 Uncovering the digital hidden curriculum**

The mantra that healthcare provision must be evidence-based or, at the very least, based on the best available evidence out there seemingly does not always extend to medical or clinical education. A quick review of the variety of teaching delivery and curricular types across medical and healthcare institutions reveals disparity and diversity that is not easily reconcilable with a clear evidence base. Institutions prefer to maintain a degree of independence and do things in their own way and, particularly, to have the freedom to deliver teaching in methods which best fit in with their own strategy and agenda. And, as such, this is understandable. Despite the vocational nature of many of the healthcare professions, many are delivered at higher education institutions, where the delivery and scope of educational attainment is required to be wider and, more necessarily, not limited to delivery of specific learning outcomes within a narrow frame of delivery methodology. Even the regulatory bodies’ (General Medical Council - GMC, General Dental Council - GDC, Nursing and Midwifery Council - NMC, etc.) refrain from providing prescriptive guidance for attaining graduate-level achievements across a wide spectrum of desired outcomes, indicating by their absence of clear guidance that institutional independence and variation in educational delivery is acceptable.

Educators rarely stop to explore the reasons behind the slow but determined steer towards the incorporation of newer pedagogical methods in higher education institutions (Finn and Matthan 2019). Within healthcare education, two phenomena have risen seemingly out of nowhere over the past twenty years, namely the voluminous use of imaging within healthcare professions -related curricula and the more recent trend to utilise virtually any resources available on the World Wide Web (WWW or internet), without due consideration to the reasoning for the seemingly irresistible move in this direction. It may be time for educators to take a step back and look at the wider view behind these popular trends. Educators need to ask themselves whether their institutions persist in reforming clinical education without *actual* change, an idea postulated by Bloom (1988). Several simultaneous winds of change within the healthcare educational sector have contributed to a change in stance. These are the cultures of commercialism and professionalism, and a loss of autonomy and discretion for physicians in the clinical decision-making process (Hafferty 1988). Focusing on the need to reform has at times shifted educators’ gaze away from the learning that occurs in curricula outside that what is offered by the formal course, i.e., the hidden curriculum.

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| **Definition:** The hidden curriculum refers to the tacit, implied, unwritten, unofficial, and often unintended behaviours, lessons, values, and perspectives that students learn during their education. |

As early as 1930s, John Dewey (1938) remarked that “*Perhaps the greatest of all pedagogical fallacies is the notion that a person learns only the particular thing he is studying at the time. Collateral learning in the way of formation of enduring attitudes, of likes and dislikes, may be and often is much more important than the spelling lesson or lesson in geography or history that is learned*”; this idea has taken hold and been developed within the education community since the 1970s. Today, it is acknowledged that there is a clear and fundamental distinction evident between the taught curriculum delivered to students, and that which they learn. Three types of curriculum have been identified: (1) that which is explicit (or the stated curriculum), (2) that which is hidden (or the unofficial curriculum), and (3) that which is absent or null (or the excluded curriculum). It is important to clarify the use of the term ‘hidden’ curriculum in the context of this article (Lawrence et al, 2018). Within the first few years that the term was used in relation to medical education (Hafferty and Franks 1994; Hafferty 1998; Hafferty et al 2015), it was distinguished by Hafferty (1998) from ‘informal curriculum’ (which is “*unscripted, predominantly ad hoc, and highly interpersonal form of teaching and learning that takes place among and between faculty and students*”). Hafferty (1998) clarified the ‘hidden curriculum’ to specifically incorporate “*the commonly held ‘understandings,’ customs, rituals, and taken-for-granted aspects of what goes on in the life-space we call medical education.*” According to these definitions, the terms are not synonymous but overlap (Lawrence et al 2018). In this article, there is some overlap with ‘hidden’ and ‘informal’ curriculum (although Lawrence and colleagues do caution against it) and by hidden curriculum is meant the predominantly unacknowledged and unintended learning that occurs within the learning process. Usually this relates to absorption of values and perspectives within the routine environment, the attitudinal and social relationship interplay that occur unintentionally within the learning and teaching environment. These serve to inadvertently reinforce norms prevalent in the environment, norms that are often unquestioned and avoid scrutiny. While these usually refer to social norms, such as those that may influence a student’s character and convey a moral message to them, institutional choices and curricular models can also reinforce other messages, not necessarily evident. Haffety (1998) recommended uncovering four areas of institutional hidden curricula to help understand the flow of current ‘pedagogical winds’. These areas are (1) institutional policies, (2) evaluation activities, (3) resource-allocation decisions, and (4) institutional "slang" (Hafferty 1988). In lay terms, the hidden curriculum is sometimes regarded as learning ‘they way we do it around here’ (Hafferty and Finn 2015).

Within education, the hidden curriculum has long been discussed (Snyder 1971; Hafferty 1988), primarily as critique of implicit reproduction of inequalities, unequal opportunities and use of power in educational institutions (Edwards 2015). It is understood primarily as those things selected and enacted as part of a formal curriculum that provide hidden messages to certain groups and types of students to ‘keep them in their place’, maintain social hierarchies and power position, primarily as a form of inadvertent reinforcement of social injustice. From its inception in education, the hidden curriculum has evolved within medical education to mean that there is a significant difference in what is being *taught* and what is actually being *learned*; in effect, the hidden curriculum is that which creates the difference between these two. The hidden curriculum, however, may not have solely negative effects (although most use it with underlying negative connotations; Lawrence et al 2018), and can be used to promote social change (Edwards 2015; Cotton et al 2013).

There will always be hidden aspects of curricula and the issue is more a question of the legitimacy of what actually remains hidden (Edwards 2015). Educators should aim to bring these to the forefront so the full implications of educational choices made by them and/or their institutions are appreciated. The digitalisation of modern education must be scrutinised in the same manner as other educational interventions. With the move into a digital era, the future projections of which show no signs of abating, it should be noted that every encounter with a digital resource exposes the learner to a hidden curriculum. As depicted in Figure 1, potential sources of the hidden curriculum are observed in, for instance, (1) behaviour, (2) presentation, (3) support, (4) access, (5) best practice, and (6) ethics.

**\*\*\*\*INSERT FIGURE 1 HERE\*\*\*\*\***

Let’s consider a worked example utilising Figure 1, that of streaming an openly available Youtube anatomy video which contains cadaveric dissection. For context, you are a teacher and select this video to demonstrate a concept within a lecture theatre. There are many potential sources of tacit messages that are at play in this situation, these could be considered under the headings presented in Figure 1. Firstly, in this example, the source is openly available, but that is not an explicit pass to play the video for an audience. Is this a copyright violation? Where did the cadaver in the video originate from? Was it legally obtained? Is filming cadaveric permitted in that country? Did the donor consent? Has the donor’s anonymity been preserved? Does the dissection distress the audience? Were the audience given any warning shots and expecting it in this context? Does the procedure uncover a pathology that may cause an audience member distress? Remember, it might not be the video itself but the topic - for example, a tumour may be more emotive if someone has a family member with a recent cancer diagnosis. Have you got appropriate support in place should there be emotional distress evident in your audience? You did not make the video but the instructor featured in it is not wearing appropriate personal protective equipment (gloves, etc.) during the dissection - what does this role-model to students? The video contains an element of macabre humour, everyone laughs but is this really signposting appropriate behaviour or is it appropriate in this setting? How can you role-model what is appropriate behaviour? The video uses all the relevant terminology and achieves the anatomical learning outcome you intended so, just in case the video gets taken down, you export it using online software.

You might ask what is the point of this example? Well, it is to demonstrate that even the seemingly innocent act of watching a Youtube video within a teaching session can expose students to many unintended learning outcomes - both positive and negative. Streaming this video creates an unintended curriculum, one which, for the most part, is hidden. Nonetheless, the subliminal messages are there - donor consent doesn’t matter, copyright does not matter, appropriate use of occupational humour does not matter, etc., etc. We may never know if the students picked up on the negative role-modelling in the video, but it is a risk and thus careful consideration is required before educators unleash digital resources. Chen (2015) cautions against turning a blind eye to the hidden curriculum, so we do not perpetuate its messages through our deliberate ignorance; everything cannot be ‘unhidden’ or remedied by adding in more lectures, coursework, reflective exercises, or evaluations into the formal curriculum but we must closely look at the systems within which we operate. To counter the detrimental effects of the hidden curriculum, educators need to “*use our moral imagination and develop our practical wisdom*”, without a “*reactionary swing from one extreme to the other*” and demonstrate courage to students in that we are capable of setting appropriate boundaries and communicating difficult information (Chen 2015).

**2 Hidden curriculum in imaging**

With the recent (over)use and expansion of the term hidden curriculum in medical education, some have postulated that its continued utility in medical education is questionable (Lawrence et al, 2018). Still, as it is widely thought that the effects of the ‘hidden curriculum’ are more influential than the formal curriculum itself (Lawrence et al 2018), it is worth aiming to expose ‘that which is hidden’ to attempt to action those practices which might be considered detrimental or reinforcing bias / bad practice. In fact, McLeod (2015) recommends that the medical community move from aiming to repeatedly identify perceived hidden issues to tackling what can be considered ‘now-visible practices’ (McLeod 2015). A broader and perhaps more useful definition in the context of today’s overexposed medical education curricula is the definition by Balboni et al (2015) who have defined the hidden curriculum as “*the process ... which instills behaviors, attitudes, and values among trainees in tension with the ideals of the medical profession*”; it is with this in mind that the hidden curriculum of imaging is examined.

Utilisation of imaging in clinical education is riddled with little acknowledged hidden curricula. Some circumspection and debate has always surrounded the incorporation of imaging into clinical curricula. Little or no national regulatory guidance exists for any of the healthcare professions as to the level of imaging knowledge required at graduation. The GDC, GMC and NMC all provide only vague recommendations, mainly perhaps because imaging is a specialist skill requiring several years of dedicated training for radiology trainees to acquire competence in. Institutions, programmes of learning and educators continue to experiment and implement sometimes disproportionate amounts of radiology teaching into the curriculum, with no clear idea of how much knowledge a graduate actually requires, how valuable the imaging utilised in teaching potentially is or of the unintended messages silently relayed to the student body through this modality.

It is clear that, in many parts of the world within the healthcare industry, imaging is the bread and butter of clinical medicine and the final word in diagnostics, with an unacknowledged or perhaps unvoiced suggestion that its usage is more reliable than a clinician’s acumen. Imaging modalities, it is widely believed, trump those findings revealed by careful observation by the experienced clinician. It is clear that many findings are ultimately and conclusively revealed by imaging technology but an overreliance on visualisation technology to diagnose a patient has its downsides, and a hidden message. The unwritten message not merely to the patient but to the doctor treating patients, and by extension to the entire healthcare team, is that acumen alone is not enough. To prevent litigation, one must have the diagnosis clearly spelled out in shades of gray, which in part legitimises the practice of defensive medicine. This shift from development of solid clinical acumen to that which an expensive machine can reveal in seconds, says much about the state of modern clinical curricula. It reveals an agenda that has wider societal implications, one which has perhaps inadvertently impacted on curriculum development.

The intention at the inception of incorporating imaging into medical education was to exemplify living anatomy and clinical relevance, but the hidden message may be that however much one learns anatomy and clinical skills, one’s skills are never going to be as good as the diagnostic imaging tool and that, to avoid litigation, you need to practice defensive medicine and utilise these modalities. Leask (2009) has shown that incidental lessons learned about what and whose knowledge is valued (the imaging modality?) and what and whose knowledge is not valued (the clinician’s acumen), as well as power and authority, are some of the incidental lessons reinforced by the hidden curriculum.

To exemplify some of the potential hidden curriculum messages lurking within imaging utilisation in teaching, imagine this scenario referring back to Figure 1: You are an obstetrics consultant and have two medical students shadowing you for the week. Each day is spent doing different tasks and much of your day is interrupted providing expertise to your junior colleagues in clinic or in theatre. On one day, you are doing imaging investigations on pregnant mums, some of which are tricky and require your full attention. The students are sat in the corner of the darkened room as patients come in one after the other. Most patients look at the students and are quickly told who they are and the imaging continues with them on the bed. Sometimes, patients walk in (it is after all a busy clinic and is running late) and the students are not mentioned or introduced. Have you considered issues to do with consent, not just in clinic but when using these patient imaging results in your teaching practice? Are you taking the time to role model good practice in obtaining the images (and consent for having the students shadow) as part of the process? When something worrying or unusual comes up on the screen, do you automatically start discussing it with the students without discussing it with the mum/parents first? Are you looking at the screen when you are talking or at the the mum? If you are looking solely at the screen, what does this role model to the students? Are you role modelling a caring attitude even when there is an image to look at and not treating the image and the parent present as an abstract concept to diagnose? At the end of each consultation, do you assist with wiping off lubricating jelly on the mother’s abdomen or do you continue to focus on the image in front of you? If the latter, what does this say about your relationship with the living breathing person in front of you and what do you think your students take away from this scenario? When you are interrupted by your registrar about something they are struggling with in another consultation room, do you give them your full attention or do you explain your role and apologise to the patient in front of your first? Do you take care to cover the patient and the image on screen to protect confidentiality? Do you discuss the imaging findings of the other patient your registrar is discussing with you openly in front of the students and your patient? Have you considered consent issues for your other patient as well as well as your own professional conduct? In the doctor’s office, your students are exposed to several images that stay on the screen, as you and your colleagues have not switched them off. They can see the patient details from them, none of which the students have been consented for. Your colleagues are all relating a funny story about a finding on the screen and the ‘odd’ patient they had. Do you pause to think whether it is okay to discuss other patients and their imaging findings in an open forum and the message it relays to the students present? You also then get an urgent phone call from another colleague in a different specialty who requests that you urgently review their patient (under their care but who is pregnant). They want imaging to be done to get a conclusive diagnosis. You review the patient and your clinical acumen tells you the diagnosis and you do not need to subject your patient and the unborn child to radiation. Do you trust your clinical acumen or do you consent to the imaging request ‘just to be on the safe side’?

Much of what you do and the way you react to situations conveys unintended messages to your students. An abstract and distant approach with a focus primarily on getting the image up on screen and then going through it with your full focus may convey a message that you have not intended, namely that the patient in front of you with their array of complexities and messy feelings and questions is not your primary focus. These inadvertent messages may speak louder to the students than anything else they imbibe during shadowing week. It is thus of paramount importance that we realise that a critical step to impacting on the next generation of healthcare professionals in this digital era is for faculty to examine their own behaviours and expectations, constantly reflect and assess their interactions and be willing to avoid taking ‘electronic shortcuts’ that may compromise security (Mostaghimi 2017; Fuks et al 2018): “*until the culture of the hospitals and teams within which students function is changed, students will continue to receive conflicting messages on what is “ethical” and “professional.””* (Mostaghimi 2017).

**3 The use of unregulated internet resources - are we teaching our students to be discerning?**

The temptation to use fast and easy-to-use digital resources is ever-present, and not merely for students. No longer do even the most dedicated researchers use conventional print as their primary sources; an abundance of knowledge has been accumulated and is available on the internet at one’s fingertips, a source not for lamentation but delight (Silberg et al 1997). The internet after all is not all bad; not only has it opened out unlimited possibilities for everyone wanting to utilise its resources, it is user-friendly, graphically pleasing, and hosts a substantial number of high-quality resources, with seemingly endless opportunity to teach, inform, and connect people (Silberg et al 1997). Much like the new world was portrayed as the land of opportunity to the early pilgrims, the internet lured users with its abundance of opportunity. It does not discriminate against those with little or much wealth, is not interested in backgrounds, privilege (or lack of privilege) or ability, and can be considered quite inclusive and accepting. However, much like with the land of opportunity, a metaphorical ‘Wild West’ soon emerged.

The way in which society interacts changed dramatically since the deregulation of the internet in 1995 (Plant 2004). In this new unregulated and free-for-all world, knowledge, ‘fake-news’, dark webs and dodgy sites abound. In this landscape of plenty, few are able to navigate with ease without encountering some aspects of the ‘Wild West’. For educators and learners, it is difficult to be discerning with regards to freely available sources on the internet, a vast amount of which is unregulated and decentralised. With the demise of so-called antiquated methods of information gathering, the ability to discriminate between reliable and accurate sources, and what makes them thus, is lacking. Salpeter (2009) suggests there is a wider challenge to develop a generation of digital citizens able to operate in the unregulated online world, and it is not enough anymore for educators to demonise, for instance Wikipedia as an unreliable source - its accuracy has been pointed out by some to be comparable to Britannica and Encarta (Salpeter 2009) - instead, what is needed is a programme of education to ensure generations brought up with digital devices are trained to become digitally savvy and able to discriminate between those sources that are not peer-reviewed and those resources that have no basis in evidence-based investigation. This is even more important for those training to become healthcare professionals of the future. Cutting-edge medical information is now available not to a select few but to everyone with access to the internet, from the leisure of their homes, while on the move or from work (Okamura et al 2010). This has resulted in an explosion of unregulated and unscreened ‘health’ information, which may contain erroneous information, with potentially adverse outcomes for unsuspecting users; there is no shortages of internet scandals involving peddlers of magic potions and lotions. Healthcare professionals, and those training them, must be aware of the risks involved with a lack of engagement with developing the skill to be discerning; these skills may save their students as future healthcare practitioners and their patients. This skill can be developed and honed during higher education as part of a skills set required to function in the ever-digitalised world.

In the case of anatomy education, even a quick internet search on any anatomical subject reveals a plethora of websites, images, videoclips (cadaveric and animated) and 3D material that bombards the knowledge-seeker with its abundance. A google search (done on 23rd May 2019) using the word *‘platysma’* generated 605,000 results, 10,700 of these videoclips alone. A yahoo search revealed 371,000 hits for the same anatomical word. The volume of hits reveals a veritable minefield to the novice learner, and even the seasoned anatomist can become swamped. Using the internet to find accurate sources of information to learn about the platysma muscle resembles a ‘cocktail conversation’, not the effective communication and decision-making tool it could be in the hands of a discerning individual. Already in 1996, prior to the avalanche of information that swamped the internet in the following two decades, Achenbach (1996) identified the problem as not being that of too little information but too much, with vast amounts of the information misleading, inaccurate or incomplete. Silberg’s (1997) prophecy that the internet would have the ‘potential to become the world's largest vanity press’ has come to pass, with anyone able to publish anything online without accountability and with full anonymity. Technological brilliance, shiny and attractive sites, and the convincing content can lull the naive viewer into placing more value on the content than it necessarily merits (Silberg et al 1997). For the novice learner then, in this landscape of abundance and plentitude, with all manner of voices clamouring to be heard, to avoid the ‘Tower of Babel’ effect and getting hopelessly lost, the simple solution is often to navigate to the first and most popular site, in both of the browsers utilised it was Wikipedia, which, interestingly, students are time and again told not to use as a credible source, posing a dilemma even for the digitally savvy user.

How then can educators separate the wheat from the chaff, and the useful from the useless? How do we teach our students to be discerning and become discerning ourselves? Chen (2015) cautions against “*prohibiting or actively not engaging in social media and technology*” as this may leave students alone in their struggle with the challenges posed. Educators must remember that the bedrock on which technical tools and internet resources rest is their actual *content* (Silberg et al 1997); this must, in the healthcare professions arena, have sound educational value that is grounded in the best available evidence. Standards do exist by which to quality-control content, to enable the educator or learner to differentiate science from drivel, to discern advertising or promotion from education, and evidence from opinion (Silberg et al 1997); these are the tried and tested quality standards followed by peer-reviewed entities in print that should logically and reasonably also apply to the digital world. Accountability for the content accuracy and, consequently, for recommending or utilising sources or resources for the student body, rests not solely on the content providers but on the educator recommending or using them in their educational practice, and institutions which push for educational reform. Silberg and colleagues suggested four core standards of (1) authorship, (2) attribution, (3) disclosure, and (4) currency which are valuable but not automatically good proxies for assessing either quality or accuracy; they do, however, enable assessing validity of the information available with a clear framework, although achieving the rigorous standards prevalent in conventional print might be unattainable (Jadad and Gagliardi 1998). Adherence to and compliance with these standards suggests a completely new role for the educators as monitors of quality and content and information traffic directors (Silberg et al 1997), a challenging task in the digital world where not everyone plays by the rules and several may be driving their own agendas. It is important to remember that setting benchmarks for reliability is not a guarantee for quality (Silberg et al 1997), and there is much value to be gleaned from sources that are not the traditional professional sources, i.e., regulatory bodies, government agencies, journals, professional societies, universities and librarie.

Further, there are hidden signals relating to technological access. For example, do streamed resources require a particular internet speed connection, and what does that convey to those that might not have access to that? When are users expected to access it, and does that imply using mobile devices and/or data they’re expected to provide themselves? Perhaps these are things that one takes for granted, but these are all things that might have an exclusionary effect. It may seem a bit outdated when the presumption is everyone has device and data, but in an era where widening access and participation into Higher Education is top of the political agenda, it is not something that we can assume. Taking our thoughts back to Figure 1, we are making assumptions about access and there is a potential role-modelling issue to surround the use and display of (expensive) technology, for both students and teachers.

Guidelines-wise, the internet is a somewhat free-for-all space, reminiscent - as previously suggested - of the ‘Wild West’. Recommendations are dotted around in the maze that the internet is, in publications, and on websites but there is little clear regulated guidance, and - even more worryingly - no consequences for poor or dangerous practice. There have been attempts to regulate content but these have not been widely adopted. Consequently, several universities, societies, corporations and companies have developed their own internal guidance, an amalgamation of which we present in the textbox below, along with two examples of reputable sources for use in biomedical education (picked at random due to familiarity with content).

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| **TEXTBOX: Two examples of good practice in biomedical education resources** |
| ***Geeky Medics*** has a worldwide audience (68 million views and over 300,000 subscribers) for those interested in clinical education. Using a variety of platforms from a website, YouTube channel, blog and a smartphone app, the idea behind this diverse resource is to create accurate and relevant information that is freely available to clinical practitioners and students. Contributors go through a process of applying and being validated for content creation and they can range from medical students to more senior level clinicians. Published content ranges from clinical skills videos, exam guides, exam question bank, student notes and clinically-relevant anatomy content. Accuracy and reliability is paramount, with a process that quickly weeds out any erroneous information mapped into the management of the resource. The content authentication process varies depending on the content type. In the case of a *clinical skills* guide, a senior registrar or consultant in the relevant area is consulted to watch our video and review the written guide, then provide feedback. In these cases, information on who reviewed the guide and their credentials are placed at the end of the guide. At times when the reviewer does not want mentioning, a generic “reviewed by a cardiology (or whichever specialty it relates to) consultant” is placed at the end of the guide. In the case of other *clinical content* (e.g., a piece on a specific condition), the content is reviewed by a registrar and also referenced against guidelines in place nationally (NICE, etc.). In the case of *anatomy*, content is by an experienced anatomist and anatomy educator, who also has a clinical perspective. Content is clearly referenced to peer-reviewed and reputable anatomy texts.  *To improve reliability*: The anatomy review process is in its early stages and developing its robustness. The content gets a considerable amount of views, and the nature of the audience means they regularly flag issues they notice, after which they are checked and fixed rapidly.  ***AnatomyZone*** is an internet based resource platform founded on the idea that anatomy is necessarily interactive, three-dimensional and fun. Their vision is one of providing the best anatomy resource on the internet and ensuring it is always free to use, thereby making it a valuable resource for students. The content creators are medical doctors with wider interests in technology, medical education, neuroscience and musculoskeletal anatomy. Content ranges from bite-sized anatomy videos to questions, flashcards and tutorials and boasts over 30 million views and over 300,000 subscribers. The over 190 video tutorials it boasts are well made and predominantly accurate, with a system in place for corresponding with the content creators.  *To improve reliability*: Sources are difficult to locate on this site, and its credibility would greatly improve if references were available for every resource. |

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| **TEXTBOX: Points to consider when searching for reputable digital resources** | |
| **Audience**  *·Is the intended audience clear? Is this aimed at the general public, children, academics?*  *·Is it addressing the topic sufficiently to satisfy the target audience?*  *·Is it relevant to your area of interest?*    **Accuracy**  *·Are there evident typographical errors?*  *·Is the text easy to read, clear and concise?*  *·Has the material presented been through a process of peer review and editing?*  *·Are the cited sources verifiable?*    **Attribution and Referencing**  *·Is the content referenced at all times?*  *·Are the sources reputable and peer reviewed?*  *·Is the name of the publication evident?*  *·Does it ‘appear’ professional?*  *·Has the publication been referred to elsewhere?*  *·Is there a references / bibliography section?*    **Authorship and Traceability**  *·Is the author identified? If not, why have they remained anonymous?*  *·Can the authors be considered experts in their field?*  *·Is there enough information to establish credibility?*  *·Are the contributors openly acknowledged?*  *·Are the contributors’ affiliations openly acknowledged?*  *·Are the qualifications and relevant credentials of the contributors clearly stated?*    **Commercial considerations**  *·Is the source geared at making a profit?*  *·Is the source freely available or at a ‘reasonable’ cost?*  *·Are the tools utilised in making the resource paid for or freely sourced?*    **Content**  *·Is the process for content selection outlined and justified?*  *·Are the justifications for suitability of content creators, staff, reviewers, and advisory boards clearly articulated?*    **Copyright**  ·Are copyright issues duly considered? | **Currency**  *·Are the dates that the content was posted and/or updated clearly stated and updated regularly?*  *·Is it clear when the information was published?*  *·Are all links from the page functional?*    **Data protection**  *·Is the storage and usage of personal data clearly stated and justifiable?*    **Disclosure**  *·Is fully ownership and disclosure (including sponsorship, commercial arrangements, support, conflicts of interest and advertising) explicitly stated?*    **Domain**  *·Can you tell from the domain name (URL, web address) whether the information published is from a credible source?*    **Educational value**  *·Does the content accurate meet an accuracy analysis and compare with printed and other peer-reviewed sources?*  *·Is there any misleading content evident?*    **Endorsement**  *·Is the source externally endorsed or ratified by a reputable organisation?*  *·Is there a national regulatory body to whose standards contents must be matched, and is this clearly stated?*    **Feedback**  *·Is it possible to leave open feedback?*  *·Is there a route for contacting the authors?*    **Objectivity**  *·Is the author clear about biased opinions?*  *·Are arguments objective?*  *·Are personal opinions expressed and, if yes, stated as such?*  *·Has the website got a clear agenda - political, commercial or the like?*    **Regulatory bodies**  *·Is the content in line with that recommended by national / international regulatory bodies?*    **Quality Assurance**  *·Does the site have quality protocols that are part of a well-established editorial process?* |

**4 Anatomy education, the hidden curriculum and unregulated digital resources**

Anatomy education serves as an exemplar to elucidate some lesser discussed themes emerging from the hidden curriculum with increased use of imaging and the use of unregulated digital resources available on the internet. Anatomy education is rife with hidden agendas; these have been dealt with extensively elsewhere (Hafferty and Finn 2015) and thus are not the main focus here. Instead, we propose to, by polarising the more traditional use of cadaveric specimens with the increasing use of imaging in anatomy education, illustrate the oft-missed and little discussed implications evident in the trend to utilise digital resources when teaching about the human body. We acknowledge that polarisation is coarse and the arguments used perhaps provocatory by nature. Educational attainment using cadaveric or imaging or other educations sources is not the scope of this discussion; those too have been tackled elsewhere (Estai and Bunt 2016; McMenamin et al 2018; Pickering et al 2019; Hafferty and Finn 2015; O’Keefe et al 2019) The intention here is to utilise the hidden curriculum as a form of ‘gap analysis’ (Hafferty and Finn 2015) where polarisation is a tool for revealing that which is not evident; after all, in the high stakes environment of clinical education, students are constantly “*on the lookout for message gaps between what faculty formally tell them about course/learning standards versus what students come to learn (also from faculty) about what they “really should be doing” to “pass the course.””* (Hafferty and Finn 2015) It also serves to highlight some of the less considered consequences of widespread utilisation of visualisation in (anatomy) education, with the intention of starting a wider debate on the issue.

Clinicians and educators commonly consider anatomy to be the true foundation of medicine, perhaps even the foundation of all healthcare professions; it is, after all, the most concrete of all the sciences students encounter in their learning journey. Where dissecting the human body was a requirement (and to some extent also a rite of passage) for medical and dental students in earlier times, a move towards integrated curricula, a decrease in pure basic sciences teaching and an increase in clinical skills teaching in the early years, coupled with financial constraints, accessibility to donated bodies, a shortage of highly-qualified teaching staff, the requirement for expensive equipment to embalm and preserve the donated bodies in addition to stringent regulations around body donations has led to a downsizing and devolving of foundational anatomy teaching for healthcare students across the board. The implications have been far-reaching, impacted on anatomy knowledge - and by extension on clinical care.

Johnson and colleagues (2012) suggest that, through educational reform, the anatomy educator is now required to (1) teach students to understand and visualise the human body utilising a variety of tools available (touch for physical examination to for example imaging modalities, and (2) develop students’ clinical reasoning skills. The modern anatomy course, according to him, should include all of the following five of the elements, each of which has a supporting body of evidence; there are dissection/prosection, interactive multimedia (computer‐assisted learning), surface anatomy, clinical anatomy, and imaging (Johnson et al, 2012). Even still, with so many elements to incorporate into teaching, the basic anatomical subject matter taught to healthcare students has not changed significantly since earlier times. Competing for time with physiology, pharmacology, pathology, and practical clinical skills in healthcare curricula has, however, led to a drastic change in the tools available for students and educators. To replace full body dissections, prosection based teaching and, increasingly, technology modalities have now become firmly rooted in anatomy learning. In the arsenal of teaching tools are digital and paper anatomy textbooks, dissection atlases, plastic models, plastinated anatomy specimens, virtual reality glasses, 3D printing and social media channels. The internet is rife with anatomy video clips and tutorials (many of which lack clear consent details and for which the ethical process of utilising images is questionable) detailing the secrets of the human body not merely for healthcare professionals, but for anyone with access to the internet. Software applications for smartphones and computers are readily and freely available to enhance anatomical knowledge with both rapid access and ease; a veritable smorgasbord of choice for anyone.

Many healthcare educators disagree as to the best way to teach anatomy (which is increasingly challenging within the constraints mentioned above as well as significant time constraints allocated to anatomy teaching); this is not a debate we intend to elaborate on here as others have dealt with this extensively (McMenamin et al 2018; Pickering et al 2019). However, the widespread use of imaging and visualisation technologies in anatomy education does require some pause for thought. It is not contested that cadaveric anatomy confers numerous benefits to the healthcare student (Gunderman and Wilson 2005): (1) there is a tactile element which is not easily replicated by illustrations and virtual dissection simulations, (2) it encourages active exploration rather than passive observation (Gunderman and Wilson 2005), (3) it allows development of manual dexterity and instrument usage necessary for a significant number in their future careers (Wilson et al 2018), and it emphasises concretely to students that the human body is the foundation on which all subsequent knowledge rests on (Roach 2003).

Equally important arguments can be made to incorporate radiology in to anatomy education, and it is hardly worth contesting the fact that imaging offers much to the student of gross anatomy (Gunderman, 2005). With imaging, gross anatomy can come to life for the student, who through the imaging modality may see its relevance (Guttman et al 2003; Böckers et al 2014; Koens et al 2003) and anatomy within context, although there is some dispute as to how exactly relevance may be utilised in teaching (Bergman et al 2015). No more are students limited to the two-dimensional cross-sectional images that made their way into the healthcare arena in the 1970s. Today, radiographs, barium investigations, fluoroscopy, PET, CT and MRI imaging provide detailed internal anatomy images for clinicians as well as students. Some institutions have older CT scans for use in teaching and many have incorporated ultrasound into the teaching of anatomy in the undergraduate years (Griksaitis et al 2014). These allow both real-time, synchronous or asynchronous views of the inside of the human body, and functional PET and MRI scans can show minute metabolic alterations in, e.g., the brain and heart allowing for better prognostication and richer correlation between the structure and function of a organ; cinegraphic techniques enable changes in the structure of an organ, for instance the heart and the cardiac cycle, over time to be viewed (Gunderman and Wilson 2005). Pathology is easily viewed, albeit in shades of grey, through imaging, and in vivo anatomy can be inspected, greatly advantageous over the morbid and static cadaveric tool (Gunderman and Wilson 2005). Despite the wide range of available software and other virtual resources, most are aimed at medical specialties, not for instance nursing or dentistry (McHanwell 2015). Different resources can effectively confer different advantages when teaching anatomy (Sugand et al 2010; Ward and Walker 2008; Hackett and Proctor 2018), and cadaveric learning can be a effectively combined with technology (Biasutto et al 2006).

Clunie and colleagues (2018) have pointed out that technology-enhanced learning studies incorporating anatomy education are often not rigorous enough to draw recommendations and conclusions from; programmatic flaws cannot and must not be plugged with increasing use of technology (Finn and Matthan 2019), and imaging in particular, to try and bridge the gap between sound clinically-relevant teaching and the clamour for the newest gadget out available. The heavy and indiscriminate use of technology, imaging including, can lull both educators and students into complacency that they are learning when they are merely engaged or entertained, and a high level of vigilance is required to protect against the ‘magpie effect’ where new technology (or at least that which is not considered ‘traditional’ or out-dated’) appears shiny and new and is utilised widely without due respect to the evidence base for its usage. It is widely understood that cadaveric anatomy is not the only means of teaching anatomy (McHanwell 2015). Current evidence suggests that it may be no more or less effective than digital learning (McMenamin et al 2018; Wilson et al 2018), and the only logical conclusion one can draw from the diametrically opposite results in the literature are that *variety* could be key to enhancing learning when incorporating technology into anatomy teaching (Finn and Matthan 2019). In some areas of healthcare education (dentistry, notably), radiology may be studied as a separate discipline and not implemented within the anatomy curriculum. As students frequently experience conceptual difficulties when interpreting two-dimensional radiographic images in terms of three-dimensional anatomy, intermediary solutions of three-dimensional reconstruction facilities offered, such as the Visible Man software and newer technologies including augmented reality (Kugelmann et al 2018) offer solutions with making the leap from 2D to 3D. An array of newer technology has made its way into anatomy education: 3D printing, internet resources, virtual reality glasses and other forms of augmented reality anatomy learning; these provide educators with the educational tools from which to diversify their teaching (McMenamin et al 2016) but to avoid ill-considered consequences, it is worth adopting a cautious approach to widespread implementation of new technologies (Finn and Matthan 2019; McHanwell 2015) although innovation must remain an essential part of educators’ practice.

***4.1 The rise of imaging may be at the expense of expertise in the anatomical sciences***

Gunderman and Wilson (2005) identified numerous reasons for the rise and appeal of radiological imaging in anatomy education. Numerous institutions have downsized or closed anatomy departments; many anatomy departments have been subsumed into other departments, resulting in a paucity of anatomists available for teaching on the shop floor. Funding streams have moved away from the gross anatomy sphere into those that are have of a more ‘sex appeal’ with regards to newer biological sciences fields; attracting people to study anatomy is harder than previously, and the far-reaching effects of the funding cuts are predominantly on anatomy departments aiming to procure cadaveric resources and equipment to preserve them and space to utilise them. A hidden message relates to some of the scandalous revelations in the world of anatomy: if there are no anatomy departments, there can also be no scandals relating to the misuse of specimens and accountability issues to regulatory bodies, the negative effects of even one scandal can be devastating for an institution. Rather than invest in trained and competent staff, the lure is to utilise technology that may or may not have a significant impact on learning but at least through the usage of which, ‘risky’ material such as donated bodies, can be easily replaced and the space used to meet other growing institutional demands. Imaging after all rarely imposes on the wishes of patients’ families or the patients themselves, as they are usually obtained through pre-existing clinically utilised pathways where the patient’s consent is obtained, confidentiality maintained and their wishes fulfilled. Gunderman and Wilson noted in 2005 that the practical appeal of the rise of imaging as a tool for teaching gross anatomy, in part, ‘*rests on the decline of the field of anatomy in biology and medicine*’, a prophecy arguably come to fruition in the decade following its publication (Gunderman and Wilson, 2005). This is reflected in the aforementioned causes for decline but also in the incorporation of anatomy-specific assessment questions in undergraduate exams; increasingly, assessment questions are linked to imaging rather than to their clear relevance in other parts of the discipline (surgery, general practice, orthopaedics, etc.).

As a standalone approach in the teaching of anatomy, radiology has numerous limitations (Gunderman and Wilson, 2005), many of which serve to illustrate the underlying message being delivered to students (or some of its hidden curriculum). Where cadaveric encounters are practical and hands-on, and rarely leave the observer or learner ‘cold’, inspecting radiological images is an abstract endeavour, with no tactile feedback, no engagement of sensory feedback systems and can be completely free of emotions. Learning from prosections and dissections is messy business, preparing students for a career in which bodily fluids are ever-present and no encounter with a patient is completely free of this messiness. Radiological images by contrast are sanitised, dehumanized even, primarily as they are pictorial representations beneath the skin (Gunderman and Wilson, 2005). No incisions are made, no fluids are split, no pain is induced or even imagined. The viewer is somewhat god-like. Where the process of dissecting (or even learning from prosections) involves actually touching the cadaver or its parts - a key aspect relevant and necessary to most clinical professions - the viewer of images (or user of technology to learn anatomy) distances themself from this very human and clinical aspect of the profession and simply looks at images. Gunderman and Wilson (2005) suggests that this could render these existential encounters less substantial, and even deny ‘*the human form some of its natural substantiality*’. Imaging removes every aspect of sensory feedback other than vision: there is no tactile feedback from the images, no smells emanating from the screen, no auditory feedback when, for instance a dissector touches the lungs. In moving from cadavers to images and widespread use of technology, we may be sending our students the hidden message that it is not necessary to be an active explorer and to use all our senses to learn; it is sufficient to distance ourselves from the patient, look at images from a screen, refrain from touching, feeling, smelling - and make a cold clear diagnosis. The images on a screen are as far removed from a person as can be. Through engagement with cadavers, for instance, the natural link between human anatomy and the face of the person that once was lived and breathed (and donated their body) are more clearly observed (Hamilton, 1997) and the link with our own as well as our patients’ mortality is more powerful than with even the best available imaging technology used (Gunderman and Wilson, 2005); Magli (1989) suggests that the face marks our humanity more than any other body part. In losing this link with the face (i.e., the patient’s humanity), we risk losing, for our students and future practitioners, an immediate and natural connection between anatomy and the human form (Gunderman and Wilson 2005).

A further and deeper exploration into the limitations of using imaging in anatomy education (and by extension any technological or non-technological modality utilised to teach) to replace cadaveric anatomy links to the, for want of a better word, spiritual dimension (Gunderman and Wilson 2005). The dissecting room has long been associated with a closely guarded ‘secret’ of dead bodies, an area only available to those requiring extensive learning through access to them (dentistry and medical students, primarily). All the modern day rituals surrounding the secrecy of access and even discussion around encounters in the dissecting room hark back to this earlier time. Access is still limited, with smart cards or specific entry codes, windows are covered or the area is situated at the top floor or basement level where there is no fear of the general public peering in (and being distressed?). Although the reasoning has changed for this continued secrecy (e.g., regulatory bodies, distressing bystanders, respect for the dead, donor dignity, etc.) the primary goal of cordoning off an area for the purposes of dissection and inquiry using dead bodies is evidently to learn from them. A hidden component not so readily evident is the element of professionalism and confidentiality that goes hand in hand with this seemingly exclusive ritualistic and secretive behaviour. Healthcare professionals are required to hold the highest levels of professionalism; confidentiality is sacrosanct. What better way that to practice this skills so relevant in the living population through developing a sensitivity to it via the dead, in the early stages of training, thereby instilling in students the concept of professionalism and confidentiality through role-modelling it in the dissecting room? This is not an area that learning through images ventures near. Linked to this is the evident wonder that having access to donated bodies and dissection awakens is students (Konner 1987), and the respect they develop through seeing professional conduct role-modelled in staff both in the laboratories as well as at the annual memorial services held for donors (Cole 2002). This is the hidden curriculum that anatomy teaching with and without cadaveric specimens enacts (see Table 1 for a summary); not all is tangible but much of it makes sense in terms of patient care and developing ‘soft skills’ necessary for the profession.

While we recognise that by polarising cadaveric anatomy with imaging modalities in anatomy education we have omitted the spectrum of teaching modalities widely utilised in anatomy education, we hope that it will have some value in developing a sense of some of the hidden curriculum issues that taking a deeper look at educational practice can reveal, as well as the wider implications these may have for the patient at the end of every student’s learning journey; institutional change and educational interventions impact directly on the patient, who has little say in the educational journey of their healthcare providers. We thus caution educators and institutions to pause and reflect on what kind of healthcare professional they aim to nurture before blindly incorporating more unevidenced change into their practice or developing increasing reliance on imaging technologies and technological innovations to replace traditional practice (in this case, physical cadaveric teaching) (Waldby 2000), without fully appreciating the long-term impact on society.

Table 1 Hidden curriculum messages using cadaveric dissection and imaging

|  |  |
| --- | --- |
| **Examples of hidden elements in the debate between cadaveric dissection versus imaging in anatomy education (modified from Gunderman and Wilson, 2005)** | |
| **Utilising Cadaveric Specimens in Anatomy** | **Utilising Imaging in Anatomy** |
| Encounters are tangible, physical and may evoke emotion | Encounters are distant, cold, emotionless, and abstract |
| Multiple senses are evoked in all interactions | Only vision is sufficient in interactions |
| Encounters with patients may be ‘messy’ | Encounters with patients are clean and ordered |
| The encounter is active, requires engagement with multiple modalities | The viewer is god-like and all-seeing, not necessarily needing to see or touch the patient |
| Active exploration is needed to make a diagnosis | Passive participation (and an image) can reveal a diagnosis |
| A face links the body with humanity and their previous life | Encounters can be faceless, and occur below the skin |
| Evokes a sense of professionalism and a code of conduct around death and dying | Encounters may be distant with no opportunity for professionalism and discussions around death and dying |
| Encounters role model confidentiality | Faceless encounters with all patient details removed, so no need for further confidentiality development |
| Instill a sense of wonder in the human body, the foundation of practice | Little wonder at the body, technology is supreme |

**5 Can the hidden curriculum be used as a mechanism by which to teach?**

Healthcare students have described several instances of professional misconduct and dehumanizing treatment but they often feel trapped in these situations and feel pressured to be a team player, fearing repercussions of professionalism monitoring. Thus, students keep silent and aim to fit in, despite intuitively knowing the behaviours they have experienced are unprofessional. Within months, they can become assimilated to these hidden cultures and are at risk of propagating these bad practices in future (Laio et al 2014). By addressing the hidden curriculum, it may be possible to not only change hidden bad practice and rectify poor organisational culture but even harness the knowledge of the unknown to teach. Within the anatomy education literature, there are examples of faculty reporting their deliberate use of the hidden curriculum as teaching tool (Aka et al 2018). The idea of the deliberate exploitation provides a distorted lens through which both the hidden curriculum and education can be viewed. The context of the Aka et al study was using anatomical body painting to ‘teach students by stealth’ required professional skills, such as how to ask someone to undress or for informed consent for a physical examination. This use of the hidden curriculum to achieve explicit learning outcomes without formal teaching demonstrates the hidden curriculum in a peculiar and uncomfortable reframing. Unpicking this framing, one first considers the hidden curriculum by definition, it is both hidden and conveyed tacitly, and there have been studies have remedially suggested initial uncovering the hidden curriculum and subsequent embedding learned insights into the formal curriculum, to date, no one has recast tacit learning as being intentional. Recasting raises a numerous questions but we will consider a few here. How can a learning outcome that is formally un-stated and intentionally invisible to students be evaluated or assessed? Indeed, how would students know if they are meeting these hidden learning outcomes? How would faculty know when their students had met these learning outcomes? Are strategies of intentionally invisible teaching ethical?

What does all of this duplicity mean for the use of digital resources within biomedical fields? The obvious take-home message is that teaching by subterfuge is not an appropriate educational strategy, mostly because it cannot be guaranteed that learning will be achieved, as well as potentially crossing ethical boundaries.

**6 Conclusions**

In the ever-evolving digital landscape within modern-day medical education, addressing the hidden curriculum is no simple feat; by its very definition, the hidden curriculum is difficult to recognise and perhaps even harder to tackle - nor is it always ideal or meaningful to address every emerging revelation. Despite clear evidence of the emergence of ‘hidden curriculum fatigue’ within medical education research, there remain areas that require deeper investigation with regards to the phenomenon. Use of imaging without due consideration to the underlying messages that make their way across to students and perpetuate pre-existing poor practice from educators and institutions does need reviewing. Where the hidden curriculum still has the ability to reinforce negative institutional and workforce culture and practice (and be deliberately exploited), it must be examined and considered modifications made. A wider interprofessional and international view is required to tackle flawed educational interventions that emerge over time; this needs to be coupled with a cultural shift involving responsible and reflective implementation of educational interventions, always bearing in mind that what is taught to healthcare students today becomes evident in clinical practice within the space of a few years. Healthcare programmes need to develop clear and unified policies when mapping out educational interventions to ensure that they are meaningful for students, in line with regulatory body recommendations and have minimal negative impact on patient safety in the long run. These include digital interventions, such as imaging, and the indiscriminate use of unregulated digital resources embedded into the healthcare education. Armed with greater information, educators need institutional, pedagogical and practical support to develop a reflective approach to and deeper awareness of the implications of utilising unreliable and unregulated resources, on the impact this may have on students’ learning and on the safety of the patient. Patient care is, after all, the ultimate test of implemented pedagogical interventions, and all meaningful reform must place the patient at its very centre.

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**Figure 1: Potential sources of the Hidden Curriculum associated with the use of digital resources in biomedical teaching.**

