Homo Nodus: Preparing For The Next Stage Of The Internet Of Things In Medical Education

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Citation

K Masters. *Homo Nodus: Preparing For The Next Stage Of The Internet Of Things In Medical Education*. The Internet Journal of Medical Education. 2015 Volume 5 Number 1.

DOI: 10.5580/IJME.32411

Abstract

The Internet of Things (IoT) is upon us. The exact impact of the IoT on medical education is, as yet, unknown, but we do know that it promises great potential to be harnessed. In order to prepare for this phenomenon and its possible impact, medical educators need to have some understanding of it, and of the fundamental manner in which it will affect a learner who has essentially become a node (homo nodus) in a vast knowledge and experience network. This will require fundamental changes to teaching and assessment.

BACKGROUND

The computer network as a collection of connected and communicating physical objects has had a significant impact on the power of computing. As networks grew to become the Internet (an Inter-connection of Networks), so this power increased also.

In computing terms, these objects connected to the network are known as nodes. It is important to note that a node is not merely something that is connected to a network (for a computer is also "connected" to a simple power-source); a node is something that is connected to and communicates with other nodes, sending and receiving information even when apparently not "in use." (For example, if you are reading this document on a computer connected to a network, the computer is currently communicating with a file server even though you may not consciously be sending or receiving data).

Whatever the connections between nodes, however, until very recently, these nodes have had two important characteristics:

- They are obviously "computers" or computer-related: either desk-tops or laptops, or even tablets, but including other items such as printers;
- They are objects.

RECENT CHANGES

The miniaturisation of computing components and increase in computing power, roughly following Moore's Law [1] has had the obvious expected result of computers' becoming smaller and more powerful. With this miniaturisation, however, two important changes of the characteristics listed above have occurred.

Change 1: Non-computers into computers

The first, the conceptual significance of which seems to have been missed by many, has already occurred: the change of the mobile phone to the smart phone.

I am not arguing that the development of the smart phone has not been noticed – of course, it has been noticed, and the smartphone has had a massive impact across the world. What appears to have gone unnoticed is that the smart phone is not a phone, and this phenomenon is so unnoticed that we still call this device a phone. We still call it a phone, because the evolution occurred so gradually that it was merely a phone that slowly acquired more features.

But the smart phone is not a phone; it is a hand-held computer, and the "phone" component is merely an application ("app") that runs on the computer. And that app is not necessarily the most important app on the computer. To refer to this computer as a "phone" at all makes as much sense as referring to it as a camera, or a calendar, or a map book, or a prescription reminder, or any other of the hundreds of thousands of apps that may be running on it. The smart phone has gone the same way that the Word

Processor of the 1970s and 80s evolved into a desktop computer with the Word Processor being merely one of a plethora of programmes running on it. We would not refer to our desktop computer as a Word Processor, yet we still call this hand-held computer a phone.

The conceptual importance of this is that a device that was not a computer, and is still not thought of as a computer, but a *phone*, is a *computer, and that computer is a functioning node connected to the Internet.*

That said, what constitutes the computer connected to the Internet is merely the computing components housed within the thing that looks like a phone. The significance of this is that, just as these computing components can turn a phone into a node on the network, so they can turn any object or thing (such as a refrigerator, a shoe, a watch, or a jacket) into a computing node on the network. It is this change, the change of things not obviously "computers" into nodes of the Internet that changes the first characteristic given in the background above. And it is this networking of so many "things" that gives rise to the term the "Internet of Things" (IoT).

With current estimates indicating that at least half of the mobile programmers and developers are working on IoT apps [2], the IoT is set to take off dramatically within the next few years.

Change 2: From people to nodes: homo nodus

There is a second change that is currently underway, and set to increase just as dramatically: changing a person from an individual to a functioning node on a network.

The objects that can be changed from non-computing devices (a shoe, a watch, a jacket) are usually referred to as "wearable computers" or "wearables." The source of this term is obvious and needs no elaboration. The significance of these wearables, however, is that they communicate with other wearables on the Internet, including, naturally, other wearables worn by the same person. In the network, then, the prime function of the person wearing these wearables is as a super-node for the nodes he or she is wearing. The individual person, then, has become an Internet node, or *homo nodus*: a human object, not only connected to the Internet, but continuously communicating with all other nodes on the Internet, even when apparently not "in use" (i.e. sleeping).

(As an aside, we should note that this paper currently refers to wearables only. We are only a few years away from large numbers of directly-embedded nodes, an event that will serve to further entrench *homo nodus* as a functioning entity).

THE IMPACT ON MEDICAL EDUCATION

The impact on medical education is, as yet, unknown, but there can be little doubt that it will be profound. For many years, we have been watching the potential and now the impact of mobile, especially wearable, devices [3-5]. Using this impact as a pattern, we can safely speculate as to the areas in medical education that will need to be addressed.

The distinction between the self and others' information

No matter how much medical education encourages team work in the form of wonderful teaching methods like Problem-Based Learning (PBL) and Team-Based Learning (TBL), there is an underlying discordance that all astute teachers are aware of, but, for reasons of bureaucratic and administrative expediency, have to ignore: medical students learn in teams or groups because it is crucial for them to be able to function professionally in teams or groups, but then we assess them as individuals. We spend great effort teaching them the skills to work in teams, and then we never (or hardly) assess these skills. Instead, students mostly sit silently and individually, taking examinations. Assessment is perceived to drive education or, at the very least, strongly influence it [6, 7], but our failure to assess in teams undermines everything we have taught them in teams.

Worse, many teachers still use broadcast methods of education, and fret about policies regarding students' use of mobile devices in the class, unaware (or simply ignoring the fact) that those students can access information on the subject of the lecture far faster than can be spewed forth. Some staff are unfortunate enough to be aware of the situation, but are paid, rated by and work in an environment that is confined to measuring lectures as education, and so, against their better judgement, these teachers have to continue in this method.

Similarly, the wealth of constantly changing information has led medical educators to realise that we need to teach students where to find information, how to filter and sift through reams of it, and yet, we hardly assess those skills: instead, we assess students' ability to memorise points and facts, usually given to them in the form of bulleted PowerPoint slides. By implication, students perceive this as the "important" stuff that they have to learn.

Our aims in this type of assessment are noble: we wish to reduce the process of cheating – i.e. gathering information from others (in professional circles, known as collaboration or teamwork). We wish to know just how much the student knows by him- or herself, we wish to reduce the need for students to look up the information (in professional circles, known as keeping current with today's research). Finally, we wish the student to have a sense of absolutes and unchanging certainty of information (also known as rigidity, tunnel-vision, and even prejudice).

But homo nodus is not designed for that, and, if we teach and assess medical students in the old way, we run the risk of losing the vast potential of an ocean of knowledge and collaboration. Worse, we run the risk that the students come to expect these methods as being good methods of education, and so internalise these processes as good education. As a result, when a faculty member does attempt to break out of the mould, students protest, wanting the bulleted summaries in PowerPoint slides, believing that learning these is real education.

ACTIONS TO BE TAKEN

I am not arguing that every medical student is a "digital native" and is automatically at home with computers, but all people are becoming nodes on the network, whether they like it or not, and we have the opportunity to take advantage of the benefits this offers.

So, where do the methods of teaching and assessments for *homo nodus* lie? It is difficult to know for certain, but glimmers of possibilities are in properly-coordinated team-based processes and assessments, courses run on Connectivist principles as described by Stephen Downes [8, 9] (not necessarily as MOOCs, but possibly so), networked simulations and virtual reality collaboration. Whichever methods we use, we need to begin with a conceptual shift away from teaching and assessing the individual, and teach people who are functioning nodes on a vast network of knowledge and experience, teach them how to properly access and use that knowledge and experience, and then assess them within that context.

In all of these methods, there will be a varying degree of technological involvement. One thing is certain, however, to ignore *homo nodus*, and to teach and assess in the old way of aiming only at the individual will be a great disservice to education in general and to medical education in particular.

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