Society 2.0: What are the challenges and consequences for science?

Universities: challenges to the last guild in a new information age

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Abstract

The coming of the internet has dramatically changed life in the last two decades. Here I explore the possible consequences for and role of science and universities in this new 'Society 2.0' by going back in time and considering science as a craft (or collection of crafts) and by extension universities as guilds.

Based on this analogy I distinguish between the craft of science and the required basis of knowledge. I identify science as a craft and conclude that its main product, research, is relatively insensitive to the worldwide availability of information. Education at the bachelor level, however, relies on information transfer and is therefore more susceptible to competition. In Society 2.0 universities should aim to maintain the positive aspects of guilds, such as quality control and international transfer of students and skills and try to create a strong competitive position by putting emphasis on skills. Finally, based on the nature of the science craft and its dependence on knowledge I argue for a renewed focus on increasing actual transferal of knowledge, i.e. by memorization.

Introduction

One of the most important changes to life in the last two decades has been the advent of the internet. News, trade, international travel, communication and, in the widest sense of the word, business have all been transformed. News travels via wires and people in ever increasing scale-free networks (Figure 1). Social networks facilitate revolutions as well as looting and riots, while millions of people go online and take time to watch a baby boy bite his brother's finger or a panda sneeze. Perhaps even more profound, however, is that it is now possible to access information on nearly anything from virtually everywhere in the word. It is no longer necessary to be in the major cities to find a big university library. With open/free journals, free encyclopedias, the Gutenberg project and Google Books, any place with internet becomes a huge library, with additional collected experiences to boot. Want a recipe for a salad dressing? Go online to access the hive mind. Want to know the background to and current opinions on Ecclesiastes? Open a new tab. Interested in the collected works of Charles Darwin? Go to the Gutenberg project or check a torrent with e-books on biology. The amount of available information is truly staggering and will only increase. Perhaps the final destination for knowledge and information can be foretold by Google's mission statement: *"To organize the world's information and make it universally accessible and useful"*.

So how will these changes affect the sciences in general and universities in particular? Will people perhaps in the future get their education from the web? Since universities are traditionally known as places where you go to learn and where you leave a Learned Gentleman, is there likely to be a move away from university education? At this time, with rising student debt and tuition fees any alternative might prove attractive.

Here I explore the possible consequences for and role of science and universities in this new 'Society 2.0' by going back in time and considering science as a craft (or collection of crafts) and by extension the tradition of universities as guilds.

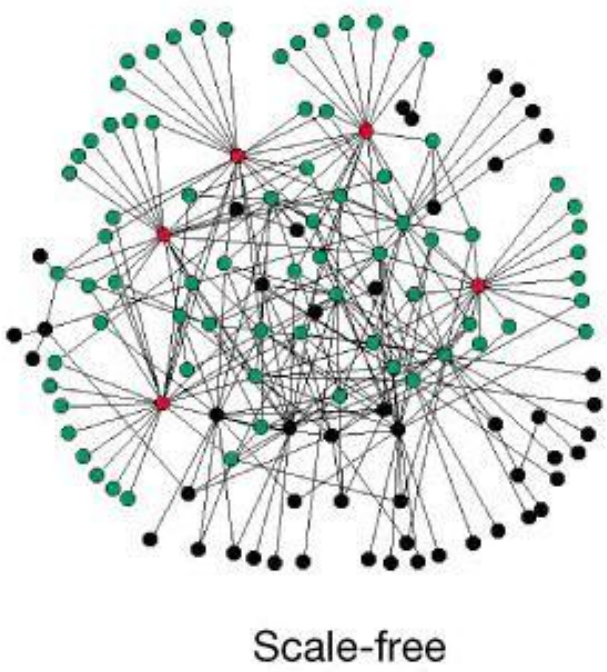

Figure 1: An illustration of a scale-free network (taken from Albert *et al*., Nature, 2000). Scale-free or near scale-free networks occur in various social networks and can lead to high connectivity and distribution of information.

Universities as the last major Guilds

The idea of a university as a guild may to modern eyes seem odd, but some of today's major universities arose out of scholastic guilds (figure 2), with Paris and Oxford being prime examples. Indeed to this day science education strongly reflects these roots. In ancient guilds there would be the apprentice, the craftsman and the journeyman who in modern universities have their counterpart in the bachelor, master and PhD-student. Only after producing a PhD-thesis or masterpiece is one a fully qualified scientist or master.

Fig. 2: A depiction of a medieval university,
the pulpit indicative of their origins as scholastic guilds.

Through their history, guilds have functioned as both labour unions and corporations. As in labour unions, the members of a guild would pay a ‘yilde’ or ‘gild’ into the coffers of the guild, hence the name (think also of Dutch guilders). Like a corporation, however, the guild would act on behalf of its members to protect market share and profit margins, mainly by barring competitors but also by working to keep trade secrets. It is especially these latter aspects that have led some historians to argue that guilds were bad for innovation and society as a whole.

Another quintessential task of a guild would be to set standards for its own members and the goods produced. Thus buying from a guild member was a guarantee of sorts with the added benefit of being able to complain to a larger body if the goods sold were found lacking. Furthermore guilds functioned as networks along which knowledge could be shared, similar to the large monastic organizations. Guilds might communicate over large distances and journeymen, especially in Germany, would spend years on long travels to study under other masters thus facilitating and raising skill and knowledge levels across the board. It has been argued that matching students with masters and finding appropriate placements has been one of the major beneficial function of guilds.

Of the guild aims and purposes mentioned above I would argue that, overall, the self-regulating ones are still present in the universities of today, whereas the union and corporation aspects have mostly disappeared. Universities still, for instance, set standards for behaviour, level of education and research. They function, as the guilds of old, as

networks of knowledge and learning and have kept this function even in the modern information age. MSc- and PhD- students perhaps more than ever travel across the globe to study under certain masters, all within the university framework.

The decline of guilds

The decline of guilds is a complex topic and has been linked to various factors such as the industrial revolution, early capitalism and cottage industry, modernization and modern nation states with patent publishing. The development of industrial production methods driven by low skilled laborers in factories could put strong pressure on the related crafts and guild, as could the cottage industry in the countryside, outside of guild auspices, who could produce, for instance, spun woolens. Whatever the precise historical processes, the slow replacement of guild-based craftsmen with entrepreneurialism, capitalism and a state-backed patent system has had perhaps least effect on the scholarly guilds, i.e. the universities. This is understandable since universities did not rely on trade secrets and their domination in the marketplace of education has been state-backed. It did not hurt universities to have the main sources of knowledge at their sole disposal, a situation which even now continues with access to many important and high profile libraries requiring expensive subscriptions. Still, as noted, this last advantage is disappearing the question here is whether, with knowledge and learning readily available, there will be a renewed struggle for students, not least since tuition fees are rising sharply and aggregate student debt are already historically high. Will the new information highways have the impact that factories and industrial production had on the other major guilds?

The craft of science

To understand the challenges created by the wide availability of information and the likelihood of alternative educational competitors we need to understand the craft of science as it is taught and practiced at universities. Indeed, to draw a useful comparison between science and other crafts it needs to be clear what is being produced. While a blacksmith may produce, for instance, armor, nails or helmets, each of which at some point in time had their own guild, what is it that a modern university produces?

University staff is expected firstly to teach, and secondly to do research and publish it, preferably in Nature or Science. Not surprisingly then, what a modern university produces is research. What is taught are the prerequisites of doing this research as well as the means to understand and finally to actually carry it out.

The initial phase of education focuses on the prerequisites by providing knowledge; on the part of the natural world relevant to the field, on mathematics and on statistics as well as, usually, a short history of the field and some philosophy of science. This more or less covers a bachelor degree after which research in a field is intelligible and can be judged.

The MSc and especially the PhD phases of education fulfill an entirely different role. Their focus is on teaching the actual craft of science, how to do research, first how to work on it and later to create it. Thus, at these levels the knowledge foundation is taken and students are starting to learn how to build.

Using what is taught by universities as a guideline, the scientist's craft is to use knowledge to create knowledge. This is true whether knowledge is created by theorization, experimentation or observation or all of the above. While learning is central to this craft, it also transcends it. Therefore the dissemination of knowledge and its world-wide availability does not seem likely to directly affect how and where the best research is performed.

Learning, skill and the deep web

The distinction between the learning acquired in the bachelor phase and the teaching of the craft in the master and PhD phases of education points towards a difference between learning, knowledge and skill. Throughout this essay 'information', 'learning' and 'knowledge' have been used rather interchangeably. In a way this is logical, since access to information allows one to achieve learning and knowledge. In our review of the craft of science as taught at universities we saw that learning is distinct from the actual craft. It parallels how knowledge of different alloys, metals and pliers does not make one a master blacksmith - simply knowing facts does not make one a good scientist.

I would argue that achieving mastery in a field using only literary sources is, barring exceptional geniuses in theoretical fields like number theory, impossible. The craft of science requires not just learning facts and figures, but also experience and a

process of synthesis and creativity. This may be experience in catching mice in a live-trap, experience in treating and extracting DNA, recognizing specific behaviour, or any other practical skill of which any given scientific field has hundreds. Currently such knowledge, the skill-sets of learning, is not online and despite Google's mission it seems unlikely ever to be. This is unlikely not only because a lot of this information is 'expert-knowledge' which can be hard to even put into words, but also because this information resembles the so-called 'deep web'. It turns out that despite their best efforts search engines only cover a few percent of the total information on the internet. The majority of information is 'hidden' and cannot be found simply through your favorite engine. This other information may, for instance, be hidden in a database on a site only accessible via direct query, similar to how most universities only have master theses available to members via the internet.

To illustrate the problem of transferring experiential knowledge another analogy here might be of the master carpenter. Imagine some people take it upon themselves to describe how to work wood, how to saw, cut, chip and all the intricate techniques that made and make the carpenter's craft. In order to provide the best work, however, a subtle judgment of the wood, of its feel and its structure, is necessary. To be able to produce quality items a carpenter needs to be able to judge dimensions, possible flexibility, effects of humidity and possibly innumerable other factors yet unthought-of . The fact that the situation is this complex for carpentry, indicates that trying to create an online manual to do good science is likely to be impossible.

Education to keep knowledge in the mind

Finally, as noted above, learning is central to the craft of science since it uses knowledge to create it. Recently it has been found that using search engines changes the nature of the human brain, making it depend on the engines for knowledge. In the same way that advanced calculators have changed and decreased the perceived value of mental arithmetic, search engines decrease the perceived value of memorization. However, if science is the creation of knowledge using knowledge then scientists with less knowledge will produce lesser science. At the very least there will be an increase in specialists and ever fewer people with the wide knowledge required to synthesize and gain broad insights. I would argue that to successfully educate new scientists in the age of search

engines and look-it-up education, universities should re-emphasize memorization and actual, active, knowledge. After all, if science is to be more than a collection of papers and information in a database this 'more' will have to be in the mind. To contain this 'more' the mind will have to own knowledge rather than simply accessing it.

Discussion and conclusions

In conclusion, the essential structure of the craft of science is likely to remain intact in society 2.0. At master and PhD level education the actual involvement in the scientific process is a near necessity and hence is unlikely to be profoundly affected by the more general accessibility of information. At this level there is a move away from information towards synthesis, creativity and the creation of new knowledge.

At the bachelor level on the other hand, the transfer of information is central and the wide availability of it may allow other institutions without previous academic history to set up schools. Indeed who is to say Google or Microsoft will not use their collected knowledge to start such programs. Even in this case, however, in many disciplines knowledge is simply better and more readily transmitted in practical, actual meetings in a university or a laboratory. This is clear when you consider the differences between different fields - philosophy, mathematics, history and sociology may be disciplines with fewer applied aspects with prerequisite knowledge that is mostly theoretical. In most life sciences, on the other hand, this situation is slightly different. In a discipline like biology learning the internal structure of organisms is, traditionally at least, directly linked to how to dissect them.

Making cell cultures or microscope slices allows the direct studying of structure but also provides insight in the difference between idealized sketches and drawings and the often messy reality. Similarly knowing your plant species is directly linked to experiencing their environment, the soil, location, surrounding plants and this helps in understanding both the history and the actual content of ecological theory.

In other words, applied sciences may be more resistant to competition and easy learning especially because of the applied elements of their fields. Natural sciences, it transpires, are still best learned by studying nature.