The Rise and Falter of the Scientific Triad

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Political leaders regularly emphasise the fundamental role that science plays in our society. Themes often include science's innate ability to boost national prestige through 'Big Science' projects like the Large Hadron Collider or putting a man on the moon, or the more immediately obvious practical applications in improving quality of life through medical and technological advances. More recently politicians have taken to stressing science's new role in society: its potential, through expansion and innovation, to boost an ailing economy out of recession [1]. Indeed, the economies of the traditionally scientifically dominant countries are suffering from the recession more than the scientifically emerging countries. The US, the EU and Japan make up the scientific 'Triad' which has had the greatest volume and productivity in national scientific enterprise for decades. However, the Triad represents the only three regions still in recession as of last year [2].

Boom and Stagnation

Growth in the areas of science, technology, and innovation (STI) in Triad members has been minimal over the last ten years, indicating that the recession cannot be entirely to blame. Since 2000, the increase in journal articles published by scientists in the UK has been 3%; in China the number of articles published over the same period quadrupled [1], although there have been questions raised over the quality assurance of some articles produced in this dramatically expanding body of research. Non-Triad, scientifically emergent, countries such as China and India seem to be taking the rhetoric of their politicians much more seriously than Triad members when it comes to science. The growth of scientific output from China has indeed been the most dramatic of recent years. The People's Republic's Science and Technology budget was set at an enormous 194.4 billion yuan (US$29.6 billion, £18.8 billion), up 12.5 % from 2010 [3]. This growth may seem small compared to the staggering growth of previous years, 20% growth was sustained for several years between 2000 and 2010 [4], but only until contrasted against the cuts to the science budgets being implemented in the US and the UK.

Making money out of scinece: a leg up from recession? Reproduced from [17]

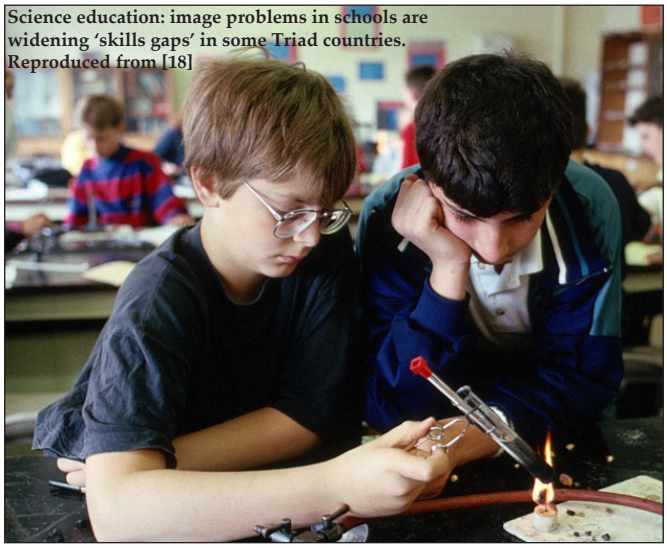
The lack of growth in STI in the Triad is perhaps a cause for worry. There is especially vocal concern over the damage that will be imposed on the US and UK economies through stifling their STI budgets [5],[6]. In Europe, a UNESCO report stated that "without some fundamental changes in the way member states and the EU institutions define their responsibilities in [STI], Europe will not easily achieve its goal of becoming the most competitive and dynamic knowledge-based economy in the world by 2010". One fundamental change stressed in the report was a need for more focus on "excellent institutions of higher learning" [7]. Imploring for more focus on science education is not unique to UNESCO, nor is it limited to higher education [1].

> **"Asia now awards 1 in 4 of all engineering PhDs, which almost outstrips the US and EU combined"**

What is Going Wrong in Science Education?

There is a growing shortage of science graduates in Triad nations [8]. For example, the majority of UK-based STI companies have become forced in recent years to recruit an increasing proportion of their scientific and technical staff abroad [8, 9]. Fortunately, this demand can be readily supplied by non-Triad countries. Asia now awards 1 in 4 of all engineering PhDs, which almost outstrips the US and EU combined [1]. The skills gap that has recently begun to yawn in earnest in Triad nations can be readily filled by the abundance of non-Triad scientists, technicians, and engineers.

However, it is the ambition of politicians such as Michael Gove, the current Secretary of State for Education, to fix the UK educational system to fill this gap from within [1]. But the problems start early on in our system; the proportion of A levels accounted for by physics and chemistry is falling [10]. It is feared that the skills shortage is likely to become increasingly exacerbated by students dropping science subjects the moment they become non-compulsory: "Young people are, at the age of 16, closing off the option of entering a career in science or engineering at a time when the UK is suffering from a shortage of scientists and engineers." [11]. Several decades ago physics outstripped both biology and chemistry in popularity at A level, but now physics attracts fewer than two thirds of the entrants that biology receives [10]. Although biology is surviving reasonably well in uptake at degree level, between 1995 and 2000 chemistry degree entrant numbers fell by 16%, and physics and engineering entrant numbers by 7% [11]. Although different admissions systems to higher education may account for some statistical differences, similar problems are faced by



Science education: image problems in schools are widening 'skills gaps' in some Triad countries. Reproduced from [18]

other Triad countries: over the same period in France the study of physics and chemistry at university level fell by half. The US is suffering a similar shortage of science graduates to the UK [12]. In order to address the STI skills gap in Triad countries, government focus has been on addressing the balance in subject uptake in science post-16.

An Image Problem: Not Glamorous Enough

Decreased uptake of science post-16 in the UK has been attributed to a number of perceptions held by pupils. A key factor identified in a government-commissioned report [10] was that only students with a particular ambition to go into a career which required science A levels took those subjects. Ashley Clarkson, a student at Bede Sixth Form College in Teesside, told the report "You really only go on to study science if you wanted a job which was to do with science": a claim backed up by a similar report by the National Institute for Careers Education and Counselling (NICEC) [13]. This may seem reasonable and harmless: those students who wish to become scientists choose science, those who do not, don't. Unfortunately, the necessary information available to the majority of 16 year olds in the UK on the requirements of scientific careers has been shown to be lacking, such that "students' awareness of scientific careers and the value of transferable skills gained through science would appear to be limited." [10]. Thus it is unlikely that all young people who believe, at age 16 or later, that they may enter a career in STI in the UK will find themselves able to do so.

The poor information offered to young people in schools seems to be at worst misinformation and at best a lack of serviceable careers advice. However, there are more complex social factors which also inhibit young people from aiming for careers in science [14]. The NICEC report mentioned above went on to identify further reasons for lack of aspiration: "Careers in science are not perceived to be glamorous" [13]. Michael Gove will certainly face a challenge in persuading young people of the glamorous allure of goggles and lab coats. Other disincentives listed include perceptions that science is not financially rewarding, and poor images of jobs in science and engineering.

Changing the Global Picture of Science

Thus, if Michael Gove is ever to be successful in his plight to close the skills gap in the UK then a number of deeply ingrained perceptions must be challenged in young people to change the demographic of science students at university level in the UK. The US faces a similar skills gap to that of the UK [15], possibly because it harbours the same cultural prejudices from which the UK suffers. Thus, it seems unlikely that the Triad will retain its global dominancy on science in the coming years. Instead, an increasingly 'multipolar' global science community is emerging [16], as illustrated by the recent prolific scientific and technological contributions of China and India. In the short term, non-Triad nations will be able to fill the skills shortage in Triad nations. Greater collaboration and cooperation in the new multipolar global science arrangement will hopefully be beneficial to all countries set on contributing to science in the long term. ■

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