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UK SCHOOL STUDENTS' ATTITUDES TOWARDS SCIENCE AND POTENTIAL SCIENCE-BASED CAREERS

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Abstract: This is a review of literature pertaining to UK secondary school students, their uptake of science at higher levels and their consideration of careers as scientists. As with all countries, the continued uptake of sufficient numbers of science at all levels is in the UK's interest. Unfortunately too many UK secondary students see science as uncreative, and difficult. They do not recognise its study as important for developing transferrable skills such as technical competence, numeracy, analytical and problem-solving. Many factors are highly influential in shaping students' attitudes towards science and possible science career choice. External factors include parental and family attitudes to science, the enthusiasm of teachers and teaching quality, availability of work experience and direct contact with those working in a particular industry. Internal reasons such as gender, perceived usefulness and relevance to future career aspirations, ease or difficulty and enjoyment play a role. Also considered in this review, is the impartiality in relation to careers advice received by students.

Key words: science careers, attitudes to science, secondary school, impartial advice

Introduction

'*STEM careers and the opportunities they generate are important drivers of social mobility in our society'* [1].

A review in 2002 [2] commissioned by the UK Government highlighted the importance of science expertise as key to sustaining both the UK economy and its international competitiveness. It is reported that 'a shortage of graduates is likely to become increasingly serious since the UK economy-with its large financial services sector, strong science base and increasing focus on high-tech and high value-added manufacturing business-is likely to need more mathematical and physical science graduates, not fewer.' The report's author, Sir Gareth Roberts, also emphasised the increase in demand in the economy for graduates and postgraduates in strongly numerical subjects (such as science and mathematics) to work in research and development, the financial services sector and ICT. This is reiterated 8 years later in the 2010 STEM Careers Review [1] which highlighted the importance of STEM (science, technology, engineering and mathematics) for the UK's future prosperity, emphasizing that the country's future economic success will be driven by the supply of people with STEM skills and training. Significantly, a report by the Confederation of British Industry (CBI) stated that almost 6 out of 10 employers expected difficulty recruiting people with STEM skills between 2010 and 2013 [3].

As a result of the combination of the shortage of graduates, and the more attractive career opportunities in financial services, employers struggle to attract new talent into scientific research and development roles. Regrettably reports have shown that students perceive science as an uncreative discipline, leading to divisions in which students categorize themselves as either an 'artist' or a 'scientist' [4]. Action must therefore be taken to prevent science from being stereotyped as 'uncreative'. After all, scientific research and development is based on both innovation and ingenuity in order to create new products, services and processes. If this 'uncreative' perception can be reversed

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it may be lead to an increased supply of science graduates with the appropriate skills into research and development.

Research has also highlighted the importance of STEM qualifications for developing transferrable skills including; technical competence, numeracy, analytical and problem-solving skills, communication and teamwork skills and intellectual rigour [3]. These transferrable skills are highly valued and well respected by employers in all industries. Consequently those with STEM qualifications have better job prospects and a wider choice of rewarding careers. It is important for students, parents, teachers and careers advisors to understand that STEM qualifications are often valued for these transferrable skills.

Science is important in transforming young people's life chances; both increasing their range of career options and their employability. Good quality careers guidance is therefore vital, particularly for those who are not connected to others with STEM qualifications.

In order to encourage the uptake of science by students it is necessary to address the importance of studying science [5]:

- many of the skills that are acquired through studying science are in high demand by employers in many areas of work;
- in order to address the increasing number of important global issues which involve science and its consequences;
- everyone needs to (and has the right to) have an understanding of the technological and scientific processes that surround us in everyday life;
- and there is a continuous need for highly educated scientific and technological manpower to be supplied to the economy.

Students' attitudes towards science

Recent research in the UK has shown that, despite the majority of students aged 10 to 11 enjoy science and view science in a positive light, less than 17% of these children aspire to a career in science [6]. Primary school children show a natural enthusiasm for science and exploring the world around them but after the transition to secondary school the positive attitude declines significantly. Those left uninspired and unenthused by science rapidly lose interest and it can be seen that, even at the age of 14, students have become disengaged from science [4].

A report commissioned by the UK's National Foundation for Educational Research (NFER) [7] indicated that, among a sample of 1011 students aged 14, science was the least likely subject to be classified as 'easy'. This perception of science as being a difficult subject is widely viewed; however research has shown that the effect of this perception varies with age [8]. Primary school students are motivated by the challenge of science, in contrast to secondary school children who are often deterred and alienated from the subject by its difficulty. For girls, the difficulty of science can have a negative effect on their self-efficacy. However, in a study of 16-year-old students in England, Osborne and Collins noted that as girls' self-confidence grew with higher achievement, their interest in science also increased [9].

During the transfer from primary to secondary school, other subjects such as English do not mirror the pattern of declining attitudes that is seen in science. It is evident that students who enjoy primary school science expect secondary school science to be 'even more exciting', but often find themselves disappointed [10].There is a known disparity between primary and secondary science teaching with some secondary school teachers dismissing what has been taught at primary school on the assumption that it is 'oversimplified' or 'wrong'. Others assume that pupils have very little science knowledge. Many children are alienated by this 'fresh start', in particular high achievers who are keen to learn new

material and concepts [*ibid*]. Some students are unable to see a connection with what they learn in science lessons (which are often seen as dry and boring) and 'real-world' science [4].

From the age of 14, the attitudes held towards science are generally carried forward into adult life [*ibid*]. This suggests that the 11 to 14 age group (when perceptions of science are particularly vulnerable to change) is an important time to inspire pupils with science and the range of careers that to which it can lead. Research has shown that while many children believe that 'anyone can do science', their views do not lead them to choose to study science [11]. A similar report found that despite young people around the world viewing science as 'important for society', there was an overall negative response to the statement 'I would like to be a scientist' [12]. This clear disparity between enjoying 'doing' science and 'being' a scientist is a theme of popular research. Reports have shown that this disjoint has arisen mainly from the highly gendered views of young people and socio-economic differences. A Royal Society report noted that 'some branches of science are seen as male only domains' [13].

It is widely viewed that students are unaware of the full range of careers that science has to offer. In the report commissioned by the NFER on the career awareness of 14 year-old students, it became apparent that they had misapprehensions and lacked a full understanding about such careers. Cause for concern is that many students were unaware that chosen subject options post 14 years, could limit the range of careers they could do in the future. It should be emphasized to students that choosing to study science does not restrict them to a career in science; in fact it widens the opportunities available. The survey highlighted that young people are already thinking about careers and consider it very important to make the right choices, particularly when they chose their options [7]. It is interesting to note that Munro and Elsom [5] showed that students were not attracted to the idea of choosing sciences post 16 as a method of ensuring flexibility of career and course choice and that this strategy of studying science to keep options open was not promoted by teachers.

The transferrable skills developed whilst studying science, and hence the range of options available to people with science qualifications, seem to be concepts that are not widely recognised by both students and parents. Choices that students make at 14 years, at a time when their motivation in science is disappearing, and then post 16, can crucially affect their future opportunities. By opting-out of studying for certain science qualifications many young people have found themselves to be cut off from a whole range of careers. It is therefore important to inform young people of the benefits of studying science from an early age to prevent students from unconsciously passing decision points and finding out too late that they need science qualifications to gain entry to particular career areas.

Factors influencing young people's attitudes

A young person's attitude to science is shaped by a combination of external factors and experiences. This is noted by Sir Gareth Roberts in his 2002 report 'Set for Success' [2]. *'The views of parents, teachers, careers advisors and society in general towards study and careers in science and engineering can play a significant role in shaping pupil's choices as to whether to study these subjects at higher levels. Regrettably and incorrectly, pupils often view the study of science as narrowing their options, rather than broadening them. A contributing factor is that careers advisors often have little or no background in the sciences, and that science teachers are often unwilling to advise pupils on future career options*'

The following have been identified as factors that are highly influential in the decision making of young people:

(a) Parental and family attitudes to science are known to play an important role in shaping children's science aspirations. A strong correlation is shown between positive parental attitudes and children's high aspirations. Despite a family's social structural location (ethnicity) being an important influence on these aspirations, it is generally regarded that the attitude of the family to science and their encouragement and fostering of science in everyday life is a more important influence [14]. This is reiterated by Pollard *et al* [15] who found that *'parental influences appear often to be more important than teachers or other influences'*. Further research by Milward *et al*

(2006) [16] also confirmed these findings: *'parental advice was the most frequently sought and useful of sources for making job, careers and course decisions than advice obtained by teachers and friends.'* There is evidence to suggest that young people's perceptions of opportunities are regularly based on both the perceptions and experiences of family and friends [5]. Hodkinson and Sparkes [17] concluded that those young people who had a strong idea about their future career had been influenced by close relatives and friends who worked in their particular area of career choice.

(b) Teachers and teaching quality can be very influential in shaping a student's attitude towards a subject and their future choices. The importance of the role of the teacher is highlighted in a study by Maychell *et al* (1988) [18]: it was discovered that those who remained in education were more likely to have discussed their post-16 options with a teacher than those who left aged 16. Roberts [2] highlighted; *'teacher's subject knowledge and teaching style are vital factors, but it is often their enthusiasm that captures pupil's interest and motivates them to study a subject'*. It is apparent, however, that the power of the teacher to exert influence over a pupil's subject choice does not always extend as far as career choice. Despite students seeking advice from teachers and valuing their opinions, the report by Munro and Elsom [5] commented *'science teachers did not see themselves as a source of information or advice about careers in science'*. Research [19] has shown that teachers do not feel well informed about science careers, are unsure of where to look for information and have few opportunities to update their own careers awareness through courses or placements. A lack of direct contact between science teachers and careers advisors/teachers only adds to this problem.

Munro and Elsom [5] emphasized that the decision to continue studying science was highly dependent on the pupils' experience in the classroom. It was also noted that the delivery of sufficient information and guidance on careers by teachers during lesson time was hindered by timetable constraints. In this study it is reported that teachers felt unable to enthuse students about science as a result of *'time constraints imposed by a dull and content-driven National Curriculum'* and *'continual time pressure squeezing out extra-curricular activities and wider-ranging discussion about current science issues'*.

(c) It is widely regarded that work experience and direct contact with those working in a particular industry are valuable methods to provide clarity to students about career pathways. In spite of its importance, evidence suggests that students find it very difficult to gain work placements due to the reluctance of employers to offer experience on the grounds of insurance and health and safety issues [5]. A shortage of opportunities has resulted in students having little real awareness of the range and variety of job roles that exist within industry areas and thus resorting to generalisations and received wisdom to inform their choices [20]. Research [19] has shown that when students have the chance to contact people who work in scientific jobs, they find it very valuable as it allows them the opportunity to ask questions and find out what they do: *'People, their lives and the work they do are the richest and most respected resource for learning about careers. Whilst a proportion of young people are attracted to science and technology for itself, many are interested first in the people'*. This highlights effectively the importance of role models in the creation and shaping of children's aspirations.

(d) Careers professionals are often criticised for not presenting the full range of science-related options to young people [1]. This usually arises because, despite having received the relevant careers training, professionals do not have a scientific background themselves, and therefore lack the specialist knowledge related to science careers that is sought after by so many students. Munro [5] reports that only one in ten careers advisors had a science degree. Research [19] showed that students felt that much of their 'careers advice' focused on subject choices relating to their educational progression and that there was little opportunity to learn about the range of employment in science.

There exists a vicious cycle in which students are unaware about certain science careers, therefore they do not ask questions about them to careers advisors, and thus advisors do not feel the need to gain an understanding of these careers. In order to address this cycle, careers advisors need to be informed about the full range of careers available in order to relay, with confidence, their knowledge to students. In Munro's report [5], one career advisor said *'working in a target-driven environment, there is little time to do any research. The other issue is we know about jobs and careers we are always asked about. It is not time efficient to study careers we are never asked about by pupils'*. A lack of up-to-date

knowledge also builds up among careers professionals due to the rapid pace at which developments in science are moving, and the ever-changing details of qualifications, courses and science-related careers [1].

(e) Socio-economic status is widely accepted as being closely linked to the aspirations of students. Across different social groups there is an uneven distribution of science participation- in particular within the physical sciences- with those most poorly represented being women and those from working class and/or ethnic minority backgrounds [21]. There is evidence to suggest that those who are more interested in science tend to be from higher socio-economic backgrounds [7]. Furthermore, the socio-economic status of parents - including previous experience of higher education and of employment and their ability to provide financial support for their offspring - has a direct influence on the career aspirations of children [22].

Since socio-economic factors have such a profound effect on the futures and aspirations of children, it is important for careers advisors and professionals to develop the necessary skills to impart knowledge and help to children to enable them to pursue any career pathway they may wish to follow without being restricted by socio economic status and cultural constraints.

It is clear that young people's attitudes towards science are shaped by a complex combination of the external factors along with other internal reasons such as gender fit, perceived usefulness and relevance to future career aspirations, ease or difficulty and enjoyment. Young people are a highly heterogeneous group and thus the extent of the influence of each factor will vary enormously.

Impartiality and careers advice

'Impartiality is a fundamental tenet of careers guidance. At its heart, impartiality means providing information with the interests of the student as the sole consideration' [1].

In the 2010 STEM Careers Review it was highlighted that there is a pressing need for the clarification of the term 'impartiality' with respect to careers guidance. It is widely regarded that careers advice should be impartial to allow students to make their own decisions about their futures. However, clarification of the definition is needed due to the common misconception that impartiality refers to all subjects and qualifications having equal worth, which is untrue [1]. It has been shown (*ibid*), yet not widely known, that subjects such as science and mathematics have greater value in the labour market than others. A universal interpretation of 'impartiality' is therefore required to provide careers advisors and other professionals with the confidence to impart reliable information that takes into account both the student's best interests and knowledge of the labour market. Impartiality must not prevent advice being given that subjects such as science and mathematics can have greater value.

Unfortunately, as well as the issue of impartiality, other factors also exist that are preventing science from being promoted to students. The growing importance of 'league tables' for ranking the UK's schools has reinforced schools' need to achieve high grades. As science is among the most severely graded subjects, it is not in the interest of the school or college to advise a student to study several sciences when they are likely to achieve a higher grader in an alternative subject. Reports [19] have suggested that, in light of league tables, institutions have failed to inform students on the general skills that are gained by studying science, as well as failing to explain that by studying non-science subjects, students are at risk of closing down certain career options. Somewhat surprisingly, it has also been reported that even schools with a specialist status in science do not acknowledge any responsibility to promote careers in science [*ibid*].

The status of science as being difficult is a major factor in discouraging students from choosing to study it. Statistical evidence has suggested that, on average, subjects such as physics, chemistry and biology were a whole grader than drama, sociology or media studies at 16 years of age. This is so despite bodies such as the UK's Qualifications and Curriculum Development Authority and the previous government of Tony Blair's ensuring that all subjects are graded uniformly [23]. This perceived difficultly of science forms a strong temptation for students to give it up at the earliest possible stage and reinforces the need for careers professionals to inform students of the greater value of science in their future careers.

UK Government strategy and school-based careers education

'Careers guidance makes a difference. It's in the engine room of social mobility; a vital part of the machinery of social justice. Good advice doesn't just transform lives. It transforms our society by challenging the pre-conceived ideas about what each of us seeks. And what all of us can achieve.' [24].

The Education Act of 1997 stated that all schools have a statuary duty to provide a planned careers education programme in the curriculum for all pupils in years 9-11. This requirement was extended to all young people from the age of 11 in 2004. Although there was no prescribed programme for careers education to follow, a non-statuary framework was published to inform schools about the planning, management and delivery of careers education [19].

In 1999 the Connexions Service was introduced in England with the purpose of working alongside schools to deliver a careers service and guidance on issues such as health, finance relationships, education and personal development to young people.

However, criticisms of the service led to publications such as the 2005 14-19 Education and Skills White Paper and the 'Youth Matters' Green Paper which highlighted the need for improved sources of career information, advice and guidance [22].

The Connexions Service has been criticised for the inadequate provision of advice to a substantial proportion of young people due to its broad remit and resource constraints. The focus of the service on young people not in education, employment or training (NEETs) has also been at the core of the criticism with a report [25] highlighting that 'its focus on the minority of vulnerable young people is distracting it from offering proper careers advice and guidance to the majority of young people'. The same report recommended that the Government remove careers responsibility from the service and reallocate the estimated £20 million of funding to schools and colleges to give them the power to seek careers services from a variety of alternative providers. More recently, in his speech in Belfast, John Hayes (UK Minister of State for Further Education, Skills and Lifelong Learning) reiterated previous criticism when saying 'the quality of careers advice for young people has not been consistently high. The universal aim of the Connexions Service has meant in practice, a dilution of its capacity to provide 'high quality, expert, impartial careers guidance'24.

The previous Labour Government showed an increasing interest in promoting the uptake of STEM (Science, Technology, Engineering and Maths) subjects by young people. The Science and Innovation Investment Framework 2004-2014: Next Steps paper identified a policy priority to 'improve young people's and their parent's awareness of the benefits of studying science and the career opportunities available'. In 2006 a National STEM Director was appointed, followed by the appointment of a National STEM Careers Co-ordinator the following year. These coincided with the Government's commitment to 'launch a national campaign to promote STEM careers and work in close partnership with educationalists, universities, employers and practitioners to develop the best possible information package available to students'[19]. A £140 million STEM programme was initiated, with STEM Careers Awareness forming Action Programme 8: Improving the quality of advice and guidance for students (and their teachers and parents) about STEM careers, to inform subject choice [1]. This campaign to raise awareness in STEM subjects was fuelled by the increasing demand for skilled and educated young people in these subjects to help build the UK economy.

The recent Coalition Government that took office in May 2010 has further pushed the need for awareness in STEM subjects to increase. Their aim to rebalance the economy towards the private sector in an attempt to re-establish economic growth is highly dependent on a strong supply of graduates and postgraduates in STEM subjects [1].

The current Government has recognised that the progress of young people to further learning and employment post-16 is determined by the quality of their schooling and the level of attainment pre-16. Also recognised is the need for schools to support their students in making the right choices [26]. In response to this, the current Coalition Government has announced changes to the delivery of careers guidance to young people in their 2011 Education Bill. The aim is to give schools greater freedom and flexibility in determining the most appropriate careers guidance for students. The legislation is

supported by the Government's belief that schools should be trusted to do what is right for their children. The main features of the legislation are:

- a new duty on schools to secure access to impartial and independent careers guidance for students aged 14 to 16;
- schools will have the autonomy to implement careers education provision which is tailored to the needs of their students and will have to secure access to independent, impartial advice in the form of careers organisations funded by the Government or other expert careers guidance providers;
- and the Government will repeal the statutory requirement for schools to provide a programme of careers education which was implemented in the Education Act of 2007 [26].

The changes above are likely to be implemented in September 2012. In addition, a new, single, all-age national careers service will be established by April 2012 [27]. John Hayes highlighted his proposals for an overhaul of the national careers service stating *'a single, unified careers service would provide major benefits in terms of transparency and accessibility. And a single service with its own unique identity would have more credibility for people within it as well as uses than the more fragmented arrangements that are currently in place'* [24].

The all-age approach is thought to have several advantages including: more cost effectiveness; better able to link careers guidance with public policy; and a more coherent and streamlined with the removal of rigid age-related barriers. However critics have suggested that placing the buying power for careers guidance in the hands of heads of schools and colleges is likely to lead to implications for quality and consistency with unevenness of practise across the country. These problems were experienced in New Zealand after a system change in the mid 1990's [1].

As part of the overhaul of the national careers service, several recommendations have been made to the Government by Careers Profession Task Force. The Task Force, established to help transform the careers workforce in England, has recommended several improvements to the recruitment, retention and development of careers professionals. Among these are; the need for the implementation of clear professional standards during the training process of careers professionals, and the need to attract well qualified people from all backgrounds into the profession [1]. The Task Force has described it as a 'professionalization of careers professionals'. These recommendations are necessary since the profession has previously been described as fragmented as well as lacking clear professional standards, qualifications and a representative professional body [25]. Consequently employers and teachers have, for many years, held little respect for some careers professionals. Thus, combined with the low salary, there is currently little incentive to encourage those with well-respected qualifications to enter the profession. It is the aim of the Task Force and the Government to change what has become the status-quo.

It should be noted that Professional bodies including Society of Biology, Royal Society of Chemistry, Institute of Physics and science charities do provide careers information to school students and others. Future Morph [26] is a UK project to raise Post 16 students' awareness of the career opportunities available, and the skills and knowledge to be gained from studying science and mathematics. 'has been set up to show that studying science, technology, engineering or maths beyond the age of 16 isn't just a one track road to becoming a scientist or engineer – the you gain are valuable in almost any career and will make you very employable.'

Conclusion

UK school students generally enjoy their studies of science from a young age but increasingly get turned off as science gets more demanding compared with their other subjects. At the same time these students have too little appreciation of the wide range of potential careers that require science qualifications. This lack of awareness stems from too many science teachers not promoting the career possibilities or a lack of sufficient understanding of what higher qualifications in the sciences can lead to by careers specialists. The label of being 'difficult' subjects coupled with an ignorance of potential

employment that uses science is turning too many away from areas that are needed for the UK's economic growth.

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