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SOCIAL THREADS OF SCIENCE: UNRAVELING THE IMPACT OF NETWORKS ON CAREER CHOICES IN SCOTTISH STUDENTS

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Abstract: Scotland's socio-economic progress is intricately entwined with the cultivation of a profound scientific understanding and technological expertise across its population, as emphasized by the Scottish Executive's policy priorities (Scottish Executive, 2001a). The recognition of science, engineering, and technology (SET) as drivers of societal change underscores their central role in shaping the trajectory of a nation. The Scottish Executive further acknowledges that public awareness of scientific issues is foundational for a thriving democracy, while proficiency in SET stands as a linchpin for economic success.
However, a stark reality is revealed in 'The Public Attitudes to Science and Engineering; Scottish Comparison Report' (Scottish Executive, 2001b), exposing that 65% of Scots lack formal qualifications in any science subject. This revelation, indicative of a significant gap in scientific education, prompted Scotland to articulate the "Science Strategy for Scotland" in 2001. This strategic document sets forth two pivotal aims:
To ensure exceptionally high levels of achievement among individuals specializing in science.
To equip all learners with the capacity to navigate scientific issues as informed citizens and decision-makers.
This study endeavors to delve into the intricacies of Scotland's science education landscape, exploring the challenges elucidated in the 'Scottish Comparison Report.' By examining the prevalent attitudes toward science and engineering, the research aspires to offer nuanced insights that can inform targeted interventions aimed at mitigating the existing gap in formal qualifications. Additionally, it seeks to contribute substantively to the overarching objectives of the Science Strategy for Scotland, delving into avenues to elevate achievement levels in science specializations and enhance scientific literacy among the broader learner community.
This exploration assumes paramount significance not only for the educational fabric of Scotland but also for the broader societal and economic landscape. Aligning with the strategic goals outlined by the Scottish Executive, the study aims to be a catalyst for informed policy decisions and transformative interventions, fostering a more scientifically literate and technologically adept Scottish populace.
Keywords: Science Education, Scientific Literacy, Technology Skills, Educational Disparities, Policy Priorities

INTRODUCTION

Many of the Scottish Executive's major policy priorities depend upon the development of a high level of scientific understanding and of technological creativity and skill in the population (Scottish Executive, 2001a). They recognise that science, engineering and technology (SET) increasingly drive change within society; that public awareness of scientific issues is vital for a healthy democracy; and that skills and capability in SET are key ingredients of successful economies. But unfortunately, 'The Public Attitudes to Science and Engineering;

Scottish Comparison Report' (Scottish Executive, 2001b) showed that 65% of Scots have no formal qualification in any science subject. As a consequence, Scotland's strategy document entitled "Science Strategy for Scotland" (2001) explicitly identified two key aims:

- To secure very high levels of achievement by those specialising in science and
- To ensure that all learners acquire the capacity to cope as citizens and decision makers when dealing with scientific issues.

In addition to this concern regarding the need for science and scientists, it had been argued that pupils' perception, experience and performance in subjects may be crucial to their selection of those subjects for their leaving certificate (Millar, Farrell, and Kellaghan, 1998). In science education this is a crucial element, as there is plenty of international evidence to suggest that, in particular countries, pupils are opting out of science when given an opportunity to do so (see for example, Department of Education Science and Training, 2003; Roberts, 2002). Many reasons have been put forward to account for why pupils opt out of science.

Some researchers identified a link between educational achievement and family process variables (Bowen and Bowen, 1998). This supported Smith's (1981) view of a link between educational expectations of a child and his/her parents' educational goals for their offspring. It also supports the view of Small and McLean (2002) regarding parental influence on pupils' career choice.

Over thirty years ago, Shoffner and Klemer (1973) suggested that parent's personal habits and attitudes influenced pupil achievement behaviour. Less than ten years ago it was posited that pupils adopted parent's values, norms and perceptions, if they experienced strong parent-child relationship ties (Schneider and Stevenson, 1999). As a consequence, some researchers (Schneider and Stevenson, 1999; Israel et al., 2001) argued that social capital, which includes the theme of family, is an important contributor in shaping pupils' future plans as it influences educational aspiration. Even though many who have attempted to put ideas about social capital to use have concerns about defining the concept, social capital allows us to think about processes and problems influencing institutional and social outcomes in innovative ways (McGonigal et al., 2007).

Bourdieu was associated with identifying the value of social capital (Baron, Field and Schuller, 2000) while Putnam (2000) and Coleman (1990) through empirical analysis generated interest for the following themes: families and youth behaviour; schooling and education; community life; work and organisations; democracy and governance; collective action; public health and environment; crime and violence; and economic development. Bourdieu, Putnam and Coleman view social capital as intrinsically relational, with attendant emotional and perceptual consequences (McGonigal et al., 2007).

So even though the measurement of social capital defies simple quantification and it faces several criticisms, for example some suggest it is gender blind and ethnocentric (Reynolds, 2004), it supports analysis of pupils' views with respect to science careers, in terms of the social capital provided by families and friends. In addition, given the view that pupils are also social actors who shape and influence their own environment (Morrow, 1999), and hence generate their own social capital networks, its important that we consider peer network influences. Coleman's reciprocity expectations and group enforcement of norms suggests that family and friends expectations may significantly influence pupils' views (McGonigal et al., 2007).

This article provides an insight into the relational and attendant emotional and perceptual consequences of family and friends (social network) influences on pupils' interest in science careers.

METHODOLOGY

Sampling

This project involved 546 pupils aged 14 - 15 years. The pupils attended one of 5 volunteer schools in one Scottish city. In this city all 5 schools are reputed to generate middle-high pupil academic performance. This focus on middle-high performance schools was not intentional, but a consequence of convenient sampling, as these schools agreed to participate.

In Scotland, the local authorities are gatekeepers to access to schools. Hence the local authority was sent information about the project and ethics clearance was sought to conduct the research in the schools. Once this was obtained, Head Teachers at every city school were contacted and invited to participate in the project. The school received a letter that outlined the project aims; described data collection, data storage and data reporting. Those that agreed to participate were asked to involve all pupils in one year level. Schools could decide when to administer the questionnaire, but most ensured that during the course of one day all pupils at the specified year level completed the questionnaire.

Tables of results for all sections of the questionnaire and for the five schools were sent to each of the participating schools. However to maintain the anonymity of the other schools, each school was only given the code that represented their school.

Clearly one of the limitations of this approach and sample is its bias toward the more able pupil. In the city there are other schools with lower academic performance track records. However they did not volunteer to participate. As this was a pilot project, it is hoped that future research will involve the schools with lower academic performance track records.

Instrumentation

The data was collected through a paper-based questionnaire administered in school and transferred to an online form by a research assistant. This allowed for a large number of pupils to be included in the sample with minimum disruption to pupil activity in school and it allowed for ease of data manipulation when the electronic data was exported to SPSS. The data collected included the pupil's age, their maternal (parent/guardian) occupation, their paternal (parent/guardian) occupation, their cultural background, the number of siblings in their family.

As signalled earlier, the robust network of relationships (Bourdieu, 1997) or the social networks (Putnam, 2000) draw attention to the influential role of family and friends on pupils. Therefore the questionnaire explored pupils' perception of their relationship with their family and friends through; a few open ended questions, some with closed response options and a majority of statements with Likert type option responses.

For example, closed response questions included: "Whom do you talk to about science?" Their options were 'family', 'friends', 'family and friends' or 'no-one'. Sadly nearly half of the boys (48.4%) and girls (45.6%) ticked 'no-one'.

Open ended questions included: 'Assume you are grown up and working as a scientist. You are free to do research that you find important and interesting. Write some sentences about what you would like to do as a researcher and why. I would like to……..because…….'

Examples of the Likert type statements are littered throughout this article. In essence the pupils were faced with four options for most statements.

Random sampling was used to ensure that data input was reliable. The questionnaires were coded to ensure that pupils and schools were rendered anonymous.

Interpreting the findings

In the next section findings from the project are presented in the form of tables and in narrative. In the narrative, the percentage figures refer to 'rounded up' values. In the tables the figures present percentages to one decimal point.

In addition, in the narrative, Likert responses that are in the affirmative have been collated and Likert responses that are in the negative have been collated for the reported statement. For example, in some cases those that 'disagreed' and 'strongly disagreed' are summed up and reported to illustrate that particular perspective. Correspondingly, in some instances the 'agreed' or 'strongly agreed' responses are also collated in the narrative. In the same way, those who ticked 'important' or 'very important' are collectively reported in the narrative. We have deliberately chosen not to use parametric tests, as in our use of the Likert statements it would be difficult to argue that the interval between agree and strongly agree is the same as the interval between agree and disagree.

In contrast, and in order to provide the reader with an opportunity to explore the degree and position of consensus, the tables provide percentage figures relevant for each of the (usually) four Likert response options. The tables of results are also presented to allow the reader to consider gender influences. Therefore instead of simply presenting percentage figures for the overall cohort, the tables and the narrative report on figures from a gender perspective. Furthermore the percentage refers to the proportion within each gender group.

Therefore, for example, in Table 1, the figure of 28.2% refers to the proportion of boys from the boys only rather than the entire sample of boys and girls. The reason for presenting this data in this way stemmed from the fact that the numbers of boys and girls varied from school to school. For example in school five there were 60 girls and 40 boys who completed the survey. Overall 271 girls and 250 boys submitted a questionnaire. Consequently had we reported on the percentage of boys or girls having calculated it as proportion of the whole sample, the difference in numbers of boys or girls responding to a given statement or question may have unintentionally embroidered the data.

In Scotland the ages and stages element was removed, so at present pupils can make decisions about their subject choices at different ages and stages depending on the school. Some pupils make them in January of their S2 year (their second year of secondary) and complete their standard grade in S3, others make choices in S3 and complete in S4. Such choice can in effect close down options for further science study and careers. The timing of our survey with the particular sample is close enough to the point where these decisions were made in these schools for the elicited responses to be considered a fair reflection of the attitudes at the point in time when the decisions were made.

Table 1. Pupils' views on science and technology.

Gender	Degree of agreement	Science and technology cause environmental problems (%)	Science and technology benefits are greater than the	Science and technology make our lives healthier,	Science and technology can solve nearly all

			harmful effects it could have (%)	easier and more comfortable (%)	problems (%)
Male	Strongly agree	28.2	17.2	29.3	12.3
	Agree	48.5	49.2	50.4	37.4
	Disagree	19.5	25.6	14.9	36.3
	Strongly disagree	3.7	8.0	5.4	14.0
Female	Strongly agree	18.7	3.9	16.0	3.3
	Agree	55.0	48.4	60.4	43.9
	Disagree	21.8	40.7	19.0	42.0
	Strongly disagree	4.6	7.0	4.5	10.8

RESULTS

In this section we provide tables and narrative to illustrate:

- Pupils' views about science and scientists,
- Their interest in science,
- Their family and friends' views of science, - Their views on the factors that will influence their career choices,
- Their perception about family and friends' views regarding science careers, and
- Their interest in pursuing a science career.

It is worth noting that findings suggest that pupils' views about scientists and science are finely balanced, in terms of the numbers for and against a particular view. For example 49% of the boys believe that science can solve nearly all problems, while 51% do not support this statement.

Pupils' views about scientists and science are also finely balanced, in terms of the value and purpose of science. For example, as the table below shows, it would appear that significant numbers think that science and technology cause environmental problems, (77% of the boys and 74% of the girls) yet, significant numbers (nearly 80% of the boys and 76% of the girls) think science and technology make our lives healthier, easier and more comfortable.

On the whole the pupils have equally mixed views about scientists. Table 2 shows that 50% of the boys and 52% of the girls believe that scientists do listen to the views of everyday people. Nearly 60% of the boys and 70% of the girls do not believe that scientists know what's best for us.

Overall the pupils had promising views about school science. As Table 3, below shows, nearly 82% of the boys and 80% of the girls thought that science was useful in real life and was not only needed for schoolwork.

Interestingly, even though the majority (58% of the boys and 66% of the girls) thought that science subjects were difficult to understand just over half of the sample (52% of the boys and 54% of the girls) did not believe that science subjects are only for very clever people.

Overall the pupils held hopeful views about science occupations. For example, the Table 4 shows that a significant majority (78% of the boys and 74% of the girls) believe that scientists earn a lot of money and the majority (65% of the boys and 62% of the girls) do not think that scientists' jobs are boring.

In light of the mixed views about the image, potential and value of science, and the positive views about science careers, as well as their interest in science (Table 5), it is worth considering whether pupils believe their friends and family to be interested in science. The table below suggests that 58% of the boys and 45% of the girls perceive their parents to be interested in science, but only 25% of the boys and 26% of the girls talk about science issues at home. In addition, only 43% of the boys and 35% of the girls think their friends are interested in science.

It is worth noting that though the pupils do not believe their parents or friends to be interested in science, when it comes to homework significant numbers ask their parents for assistance. For example, 67% of the boys and 80% of the girls ask their parents for help with homework (Table 6).

The questionnaire also sought pupils' views with respect to the importance of particular factors when it came to influencing their thoughts about career options. What was particularly noticeable was the influence of family. The pupils were asked to tick a box (representing the Likert statements, very important, important, not important, not important at all) to signal the importance of various statements to them. Statements included the following: 'when it comes to choosing your future occu- pation or job.' Nearly 83% of the boys and 86% of the girls said that having lots of time for family was important or very important to them when it came to choosing their future occupation or job. Similarly high percentages, (71% of the boys and 76% of the girls) said that parental pride in their career choice was important or very important to them (Table 7).

Table 8 shows how important pupils consider other factors, such as working as part of a team, making a contribution to society, becoming famous, being a boss/managing people, or earning lots of money.

Although over all both boys (92%) and girls (92%) signal earning lots of money as very important or important considerations, the difference between the genders can be seen in the fact that 63% of the boys and 42% of the girls consider this to be very important. Indeed, for the boys, earning lots of money was the significant driver when it came to factors they considered important when choosing a career.

The findings suggest that Scottish society has a promising future, as 74% of the boys and 72% of the girls think that opting for a career that makes a contribution to society is important. However, the data regarding pursuing a career in order to become the boss or manager is depressing given ongoing concern regarding the glass ceiling that women encounter in many professions and given the decades of concern regarding girls opting out of science due to a lack of female role models. While 61% of the boys consider this an important consideration when selecting a career, less than half of the girls (47%) consider this an important element.

When it comes to pupils' perceptions regarding pursuing a science career, though significant numbers of girls (71%) believe their friends think they should go to University, only 11% believe that their friends think that science careers are the best. Likewise, though 52% of the boys believe that their friends think they should go to University, only 14% believe that their friends think that science careers are the best.

A comparison between the findings presented in Table 9 and those in Table 10 would also appear to suggest that pupils' perception of parents' views with respect to science and science careers are more influential than pupils' perceptions of peer views.

Unfortunately, even though Roberts (2002) signals a need for Scottish youth to pursue science careers, less than half the sample, 44 % of the boys and 34% of the girls are considering a career that involves science. Perhaps this has something to do with the fact that despite significant numbers of the pupils (83% of the boys and 90% of the girls) believing that their parents think they should go to University, only 26% of the boys and 17% of the girls believe that their parents want them to follow a career in science.

Table 10. Pupils' perceptions of parents' views on career and university prospects.

Gender	Degree of agreement	My parents think I should go to University (%)	My parents want me to follow a career in science (%)	My parents think science careers are the best (%)	I am considering a career that involves science (%)
	Strongly agree	39.1 43.8	8.0	6.8	15.2 29.4
	Agree	10.7	18.1	17.8	34.6
Male	Disagree		51.5	55.5	
	Strongly disagree	6.4	22.4	19.9	20.8
	Strongly agree	39.4	3.0	4.9	8.8
	Agree	50.4	13.6	17.7	24.6
Female	Disagree	9.1	64.9	63.0	43.5
	Strongly disagree	1.1	18.5	14.3	23.1

Conclusion

Given that Bourdieu, Coleman and Putnam all suggest that relational behaviours have emotional and perceptual consequences; these pupils' views provide an interesting window into the complex influence of parent attitudes and beliefs on pupil engagement and practice. For as Coleman (1994: 300) suggests, 'social capital is the set of resources that inhere in family relations and in community social organisation and that are useful for the cognitive or social development of a child or young person.'

Coleman identifies the importance of family and community norms, sanctions, expectations and obligations, and suggests that the stronger the sense of identification between, in our case science education and parents, the more likely the investment in that field to promote academic action and future achievement in science education. Even though the pupils' perceptions of scientists and science were evenly balanced in terms of positive and negative elements, and the majority of pupils were considering attending a University, it was note worthy that significant numbers were not considering careers that involve science. The findings suggest that pupils' perceptions of parents' views and attitudes to science have a significant influence on pupils' decision to pursue a science career. Indeed, despite the fact that the pupils identified high income as an important consideration for career choice and most also signalled that science careers were well paid; the majority will not be pursuing

a career in science. This would suggest that a financial incentive is not sufficient for them to pursue a career in science.

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