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A STUDY OF THE FACTORS AFFECTING PERCEPTION OF SCIENCE, ENGINEERING AND TECHNOLOGY (SET) IN YOUNG PEOPLE

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Abstract — *This paper intends to present results from a study of young people's perceptions of science, engineering and technology (SET) and the influence of outreach activities. The poor uptake of SET subjects has long been considered a problem in Britain and many outreach initiatives exist to encourage an improvement in this area. At the University of Glasgow we are carrying out a long-term study of young people's perceptions of SET and the role of outreach initiatives in promoting it.*

The initial results of the study illustrate quite dramatically, that there are marked differences between pupil's enjoyment of SET subjects and their perceptions of these subjects for future careers. These differences are particularly stark in the case of girls where, even at age 10 or 11, the percentage considering a career in SET already lags behind boys by a large margin. Our research also suggests that it is not sufficient to offer exciting SET outreach activities and that a much deeper understanding of perceptions of SET subjects is required. It is the intention of our long-term project to address this issue and to make recommendations for those involved in the development of SET education.

Index Terms ¾ Education, SET, outreach, young people, gender.

INTRODUCTION

The role of science, engineering and technology as a driver of society's development and economic growth is an important one. This role however is sadly not reflected in current employment trends in the UK. An example of this being the decline of manufacturing jobs in the UK, which shows a drop of 39% from 1978 to 2000 [6]. Sir Gareth Roberts' recent review of SET [9] highlights the contribution that it makes to the economy and society more generally. He does however express concern at the decline of provision in the UK in recent years.

"The Review has identified a number of serious problems in the supply of people with the requisite high quality skills...there have been significant falls in the numbers taking physics, mathematics, chemistry and engineering qualifications. These downward trends, combined with deficiences in transferable skills among graduates, could undermine the Government's attempts to improve the UK's productivity and competitiveness."

The diverse range of generic and specialist skills and knowledge which SET undergraduate students gain are becoming increasingly attractive to non-SET employers with 54% of SET graduates entering non-manufactucturing or construction sectors [2]. In exploring the relationship between young people's perceptions of SET and their career choices, a number of factors have been considered.
1. How perceptions are formed.
2. External influences on perceptions.
3. Ability to change perceptions.

To date the study has collected perceptions data from a broad selection of stakeholder groups in order to give a overview of the position of SET and it is hoped that trends and relationships can be identified and highlighted over the coming years. The stakeholder groups chosen to inform this study are:
- Primary 7 pupils (10-12 years old).
- Secondary pupils (13-14 years old).
- Parents of secondary pupils.
- Undergraduate student facilitators.

The parents chosen for consultation within the scope of the study were of second year pupils at a secondary school who were just about to make their subject choices at Standard Grade level. The research to date has employed both qualitative and quantitative methodologies in order to explore and develop findings as the the analysis of data progresses. To this end, data have been collected using survey questionnaires which have combined open and closed questions so that effective triangulation and elaboration of responses can be achieved. This has been supported by the use of semi-structured interviews and will be further supported with stakeholder focus groups as the study progresses.

YOUNG PEOPLE'S PERCEPTIONS

The phenomenalistic assertion that our perceptions are formed by our interactions with and experience of our environment gives cause for consideration of the world view of scientists, engineers and technologists. The commonly

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held vision of the 'nerdy' scientist or eccentric inventor, who works in isolation of the outside world is an enduringly negative one [1]. The media often portrays scientists, engineers and technologists in a stereotypical and anti-social manner which does little to promote them as role models or the subject as a potential career. Much conflict has taken place over recent years as to how SET is portrayed in the media and therefore perceived by the public in general.

Dr Tom Wilkie, former science editor of the Independent newspaper takes the media to task on this issue in Hargreaves' report on the media's relationship with the science community [3].

"British press coverage conveys a strange impression of the isolation of science. Scientists appear as figures in possession of great power, but remote from the public at large."

In order to evaluate young people's general perceptions of SET at the crucial period of secondary school when subject choices are being made, a sample of 68 second year pupils who had just made their subject choices were surveyed. The sample consisted of 33 male and 35 female pupils.

Since subject choice can be related to career preference, respondents were asked what kind of job they would like when they left school. Table I indicates the imbalance between sexes in terms of career choice.

TABLE I

What kind of job would you like when you leave school?

	Male	Female
SET related	48%	6%
Non SET related	45%	83%
Don't know	7%	11%

When pupils were asked to list three SET related jobs, the most popular three choices were:
1. Car mechanic (54%)
2. Computer engineer/programmer (28%)
3. Electrician (22%)

This finding indicates a lack of awareness of SET careers at a professional level and was compounded by the fact that 53% of respondents claimed not to know anyone who was involved in SET as a career. The choice of computer engineer/programmer was often linked directly with boys' enthusiasm for computer games.

Pupils also displayed a marked preference for non-SET subjects when asked their favourite subjects at school. When they were asked for their favourite three subjects, the top five subject choices were:

1. Physical education (47%)
2. Music (41%)
3. Art & Design (34%)
4. Drama (22%)
5. Computing (19%)

The prevalence of non-SET vocational subjects as pupils' preferences is demonstrated here, with the link between the fifth choice, computing and play through computer games as discussed earlier, also evident.

PARENTS'/GUARDIANS' PERCEPTIONS

The role of parents in the subjects chosen by young people is an important one. Therefore, in order to gain an insight into the influence of parents and guardians on subject choice and future career choices a questionnaire was administered in which results were obtained from 28 respondents. Table II clearly indicates that a large majority of respondents regarded engineering as a worthwhile profession.

TABLE II

Would you regard engineering as a worthwhile profession for your child/children?

Yes	No	Don't know
79%	4%	17%

When asked if they hoped their child/children would enter university upon leaving school, 83% of respondents answered 'yes'. The high number of respondents who highlighted career flexibility (Table III) as the most important consideration in selecting subject options, whilst at the same time giving control of subject options to their children (Table IV), demonstrates parents/guardians concerns for their children's happiness whilst keeping their options open in terms of future careers. This could be said to coincide with today's more flexible and less geographically dependent attitude to work. In particular it contrasts with the historical nature of engineering employment associated with the first half of last century in the UK where career paths were often less flexible and dictated by large localised manufacturing industries and workforces.

TABLE III

What do you feel is the most important consideration in selecting subject options?

Career flexibility	Specific career	Ability
63%	8%	29%

TABLE IV

Who should play the largest part in selecting your child/children's options?

Parent/guardian	Child	School	Don't know
8%	83%	4%	4%

SET OUTREACH INITIATIVES

Whilst SET outreach initiatives offer young people exciting and diverse opportunities to interact and learn through a range of activities, their influence on future career choice appears minimal. Woolnough [11] classifies SET activities in two categories:

1. **Pupil research activities** – students are personally involved in problem solving.

2. **Stimulus activities** – stimulation of learning through the promotion of products and processes by a third party.

The contextualised nature of many SET outreach initiatives, whether research or stimulus based gives young people the opportunity to engage in problem solving in a constructivist manner. Learning is encouraged through co-operation with other learners, with tasks set in real world contexts engendering the development of skills, attitudes and knowledge in an integrated manner. Research activities in particular give added value in terms of social interaction between learners as an accompaniment to individual learning. Matthews [7] in particular has highlighted the role of SET and science in particular in promoting young people's social and emotional development.

THE YOUNG TECHNOLOGISTS' CHALLENGE

A case study was carried out which looked in detail at 10 to 12 year olds' perceptions of a particular research based initiative, The Young Technologists' Challenge. In total, a sample of 120 children (62 male and 58 female) who had completed the activity in two primary schools responded to questionnaires over two years. In addition to this, observational data has been collected as the pupils have progressed through the challenge.

The aim of the challenge is to help schools implement outcomes for the Technology component of the Scottish national guidelines for Environmental Studies 5-14. The challenge itself involves the construction of a themed tabletop display utilising a standardised selection of components such as pulleys, gears, LEDs and solar cells.

After completion of the initiative, pupils were asked to complete a questionnaire which investigated their perceptions of the initiative as well as their perceptions of science, engineering and technology more generally. The questionnaire was supported by semi-structured interviews with undergraduate students who acted as facilitators for pupils during the challenge.

In order to gain an insight into the pupils' understanding of the roles of scientists, engineers and technologists, they were asked what scientists, engineers and technologists actually do. A surprising 24% of pupils were able to explicitly differenciate between the research and discovery role of scientists and application role of engineers/technologists. This was evenly split between male and female pupils.

Examples of pupil statements were:
"Scientists try to figure out stuff, technologists try to work out stuff and build it and engineers try to build things together."

"Engineers build things like planes, ships and cars. Scientists research things like medical cures and dinosaurs. Technologists are like inventors."

"Scientists research things and find out about things. Engineers fix things. Technologists build things to do with technology."

At variance with the earlier discussion on stereotypical negative images of scientists, many pupil statements identified perceptions of scientists, engineers and technologists as positive role models, often citing their relationship with improving the environment and making '…the world a better place.' When asked whether they enjoyed science, engineering and technology, pupils responses were largely positive (Table V).

TABLE V

Do you enjoy science, engineering and technology?

	Year 1	Year 2
Yes	66%	72%
No	15%	4%
Don't know	19%	23%

As a supplement to whether they enjoyed SET, respondents were asked why they enjoyed science, engineering and technology. Responses fell predominantly into five categories (note: pupils may have cited more than one category).
1. problem solving/challenge (29%)
2. learning/knowledge acquisition (38%)
3. building/practical work (50%)
4. fun/excitement/creative (53%)
5. groupwork (9%)

Examples of pupil statements were:
"I enjoy science and technology because it is fun, you learn lots of things and it's good education."

"I enjoy it because I like a bit of a problem if something goes wrong. Also because it involves teamwork."

"I enjoy it because it's exciting and you get to learn how to construct and put things together."

A large majority of pupils responded positively to the activity over the two years. Any disparity between the responses for the two years can, to an extent be attributed to the success of the chosen theme for the challenge in each year (Tables VI & VII).

TABLE VI

Did you enjoy the Young Technologists' Challenge?

	Year 1	Year 2
Yes	77%	89%
No	12%	2%
Don't know	11%	9%

TABLE VII

Would you like to do something like this again?

	Year 1	Year 2
Yes	60%	66%
No	16%	13%
Don't know	23%	21%

When positive pupil perceptions of the initiative is related to potential career however, a clear breakdown in the ability of the initiative to translate to career choice becomes apparent (Table VIII).

TABLE VIII

What kind of job would you like when you leave school?

	Year 1	Year 2
SET related	25%	32%
Non SET related	70%	66%
Don't know	5%	2%

Interestingly, the survey showed that pupils' use of the Internet has increased over the two year period from 88% using it sometimes or often in year 1, rising to 98% in year 2. This proved to be strongly linked to SET related career choices for male pupils, where 83% listed ICT related careers as their preference although just 2% of female pupils expressed an interest in ICT as a career.

When asked why they had chosen particular careers most respondents cited their enjoyment of the subject area. Where financial reward was highlighted, this was never associated with SET related careers, but was associated with careers such as lawyer and doctor on a number of occasions.

GENDER ISSUES

The survey findings from the case study have also highlighted the gender imbalance of young people's perceptions of SET in concurrence with other studies [2,8,10,11]. Analysis of the questionnaire by gender indicates a marked difference in percpetions of the initiative along gender lines, with female pupils reacting, paradoxically, more positively than male pupils (Tables IX & X).

TABLE IX

Did you enjoy the Young Technologists' Challenge?

	Male	Female
Yes	77%	86%
No	11.5%	5%
Don't know	11.5%	9%

TABLE X

Would you like to do something like this again?

	Male	Female
Yes	56%	69%
No	13%	17%
Don't know	31%	14%

Whilst female pupils appear to have enjoyed the experience of participation in the initiative more than their male counterparts, this is not however borne out in future career aspirations (Table XI).

TABLE XI

What kind of job would you like when you leave school?

	Male	Female
SET related	37%	17%
Non SET related	56%	81%
Don't know	7%	2%

Interviews with two undergraduate student facilitators who supported pupil activities during the Young Technologists' Challenge explored their observations and findings throughout the challenge. In one particular school the challenge was regarded as a 'status topic' with pupils aware of the challenge in primaries 5 and 6, although not actually allowed to participate until primary 7. This created a

highly motivated approach to the challenge from pupils of both sexes. It was also viewed by staff as offering excellent benefits to pupils in terms of social interaction and self-esteem.

Gender issues were again raised when pupils were observed during the activities, with many girls tending to show more of an interest in the aesthetic elements of the project than the boys, who tended to show more interest in the engineering and technology elements of the activity. This is supported to an extent in the survey, where 28% of female pupils listed aesthetic design careers as a preference. Male pupils were also observed to show a vocational interest in SET activities such as the construction of robot kits outwith the scope of the initiative which wasn't generally in evidence amongst the female pupils.

The facilitators noted that whilst primary staff consistently highlighted a lack of confidence in their ability to teach the science and technology component of their courses as evidenced in the Scottish context by the work of Harlen and Holroyd [4,5], the initiative provided an excellent platform for staff development and confidence building.

DISCUSSION

Whilst stakeholder perceptions of SET are in general positive, there is a disparity between these perceptions and actual uptake of SET at higher educational level and/or as a career. The inability of positive perceptions of SET to impact on career choice is problematic, particularly amongst girls.

There would appear to be a strong differentiation between the positive perceptions of practical problem solving activities engendered by SET outreach initiatives and the perceived academic rigour of SET subjects. This can be seen in pupils' preferred subjects where SET subjects fair badly when compared with non-SET subjects. The study also identifies a need for greater awareness of SET careers at a professional level and the rewards available through this kind of career choice.

The role of external influences such as the media in exacerbating stereotypical images of SET is problematic and is something which this research intends to explore further as it progresses. In general however, the study found that young people regarded scientists, engineers and technologists as positive role models which contradicts the view which is largely held within the SET community.

In terms of awareness, outreach activities play a strong and positive educational role, even if there is no obvious spin-off in terms of SET related career choice. To this end the collation and co-ordination of SET outreach initiatives through the Setpoint network[4] whose aim is *"…to offer every student, in every primary and secondary school, an opportunity to take part in a quality STEM (Science,* *Technology, Engineering and Mathematics) activity,"* should serve to promote greater awareness of the multifarious initiatives on offer at regional and national level.

Many SET initiatives provide valuable platforms for meaningful experiential learning to take place, in a manner and setting which is unavailable, particularly in the primary education sector. As well as promoting SET awareness, they engender social interaction and can facilitate the raising of young peoples' self-esteem, as has been evidenced in this study. To this end the value of SET and outreach initiative moves beyond the scope of changing perceptions.

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