FIVE YEARS OF FAIR SCIENCE

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ABSTRACT *Participation of secondary school students in science fairs in the Waikato region over the period 1990-1995 decreased, while that of intermediate school age students increased at a faster rate. This trend occurred against a background of the preparation and presentation of a fair exhibit being increasingly used as a component of formal science education, rather than an out-of-school and voluntary activity. In general, exhibits on a biological theme are favoured by girls, exhibits related to physical science by boys, with none being particularly drawn to exhibits related to technology. The presentation of group exhibits is more pronounced among girls, especially in the biological sciences.*

The choice of exhibits is apparently student-directed but there is evidence that the organisational culture of some schools not only fosters participation but encourages participation in particular subject areas. When the exhibits are grouped into output classes used by the Foundation for Research in Science and Technology's Public Good Science Fund, it is clear that the priority areas for research policy makers are not those that students find of interest. Possibly related to this is the near inverse relationship between the overall relative popularity of life sciences, physical sciences, and technology exhibits and the relative proportions of employment in those areas.

The role of science fairs in both formal and informal science education may have implications for the appeal and attractiveness of science, both as a school subject and as an employment destination.

INTRODUCTION

Science fairs have been in existence in New Zealand for about thirty years, and over that period a hierarchy of fairs has developed. From local school fairs, exhibits are chosen to represent schools at regional fairs, from which only a couple are chosen to represent the region at the national fair. The 'best' national exhibitors have the opportunity to present their exhibit as guest exhibitors at science fairs overseas. The criteria for judging science fairs are shown in Table 1, and represent a combination of technical competence in the design and construction of the exhibit itself and a knowledge of the science involved. The criteria of 'scientific thought and understanding' and 'thoroughness of effort' come close to the problem solving process (Glaser, 1992) wherein:

> students are led through a problem-solving process and at appropriate points are required to state the problem in their own words, formulate questions, analyse information, generate new ideas, test hypotheses, and evaluate possible courses of action.

except that for science fairs it is envisaged that students will be self-motivated rather than 'led'. Nevertheless, the students are envisaged as "thinking in the context of generally familiar knowledge".

Regional fairs are open to all to attend and provide a vignette on the type of investigative and display skills which schools find appropriate, since the science teachers - and, in some instances, external judges from the scientific community - make the selection of exhibits. Judges use the criteria shown in Table 1. This paper describes and attempts an interpretation of trends in participation at the Waikato Science Fair over the past five years. The data were obtained from the fair programmes, which list all the exhibits for each year.

OVERALL PARTICIPATION TRENDS

The number of exhibits presented at intermediate (forms 1-2), junior secondary (forms 3-4) and senior secondary (forms 5-7) school levels are shown in Fig. 1A. Over the period there has been a marked increase in participation by intermediate school students while there are less marked but overall decreases in participation by secondary school students. The gender balance (Fig. 1B) shows a lessening involvement by both junior and senior secondary male students over the survey period.

Exhibits are categorised as to whether they are concerned with technology, physical science, or biological science (Fig. 2A). The selection of category is made by the student (or teacher) and thus represents their view of the appropriate context of their exhibit. In a few cases, exhibits are reallocated into other categories by judges. The most obvious features of this plot is the low interest shown in technology. It must be emphasised that this may be an indication of student perceptions of what constitutes technology, since generally these exhibits tend to be devices, or applications of science rather than representing any notion of technology as a discipline of thought (Gardner, 1992). Nevertheless, for those who seek to introduce the subject technology into schools there is a clearly expressed 'marketing' problem ahead. Noteworthy too is an increase in the proportion of biological exhibits over the period, although - as is discussed further later - this may be a consequence of the trend in gender balance. A very pronounced trend in all age-groups is the preference for experimental rather than display exhibits, even allowing for the fact that most of the technology exhibits are actually displays (Fig. 2B). A possible cause of this trend is the increasing use of science fair exhibit preparation as part of normal science classes, presumably as part of or instead of laboratory work.

The topics presented as exhibits were classified according to the Public Good Science Fund (PGSF) categories. For intermediate participants the category "environment, exploration and assessment of the Earth" dominates, but declines over the survey period, perhaps at the expense of increases in the "social development" and "primary production" categories. For secondary school participants there is a rather more even spread of topics, but there does seem again an increase over the time period in "social development" and "primary production", in this case at the expense of "materials, engineering, and telecommunications", a category largely dominated by exhibits related to

TABLE 1: Judging criteria for science fairs

Scientific thought and understanding	The exhibit must demonstrate clear scientific thought; the application of appropriate scientific methods; an application of the need for accuracy in observation, measurement, data collection and reporting; and an understanding of the underlying or related scientific principles embraced within the subject.
Technical skill	The project must have been assembled with skill and dexterity; any equipment and models need to have been well constructed; living plants and animals must have been well cared for; working parts should be reliable; and the whole presentation should have been well planned and neatly finished.
Originality	In the selection of a topic or statement of the problem the following aspects are judged: uniqueness of approach; resourcefulness in obtaining, handling and interpreting data; the ingenious and inventive use of equipment and materials; the use of creative displays or illustrative objects; the degree of insight offered by the conclusions; and any novel applications of the principle, process or product being studies.
Thoroughness and effort	The effort and work which has gone into a Science Fair project is considered, as reflected in the scope of the topic, the scale of the investigation, the detail obtained, the significance of the results, the degree of duplication of experiments, the construction of the project and its illustrative items, and the thoroughness of the written material and other displays.
Presentation	The exhibit should have been well designed and carefully prepared to be: attractive; visually interesting; informative on all aspects of the investigation; well illustrated with photographs, models, specimens or samples and should have wide public appeal.

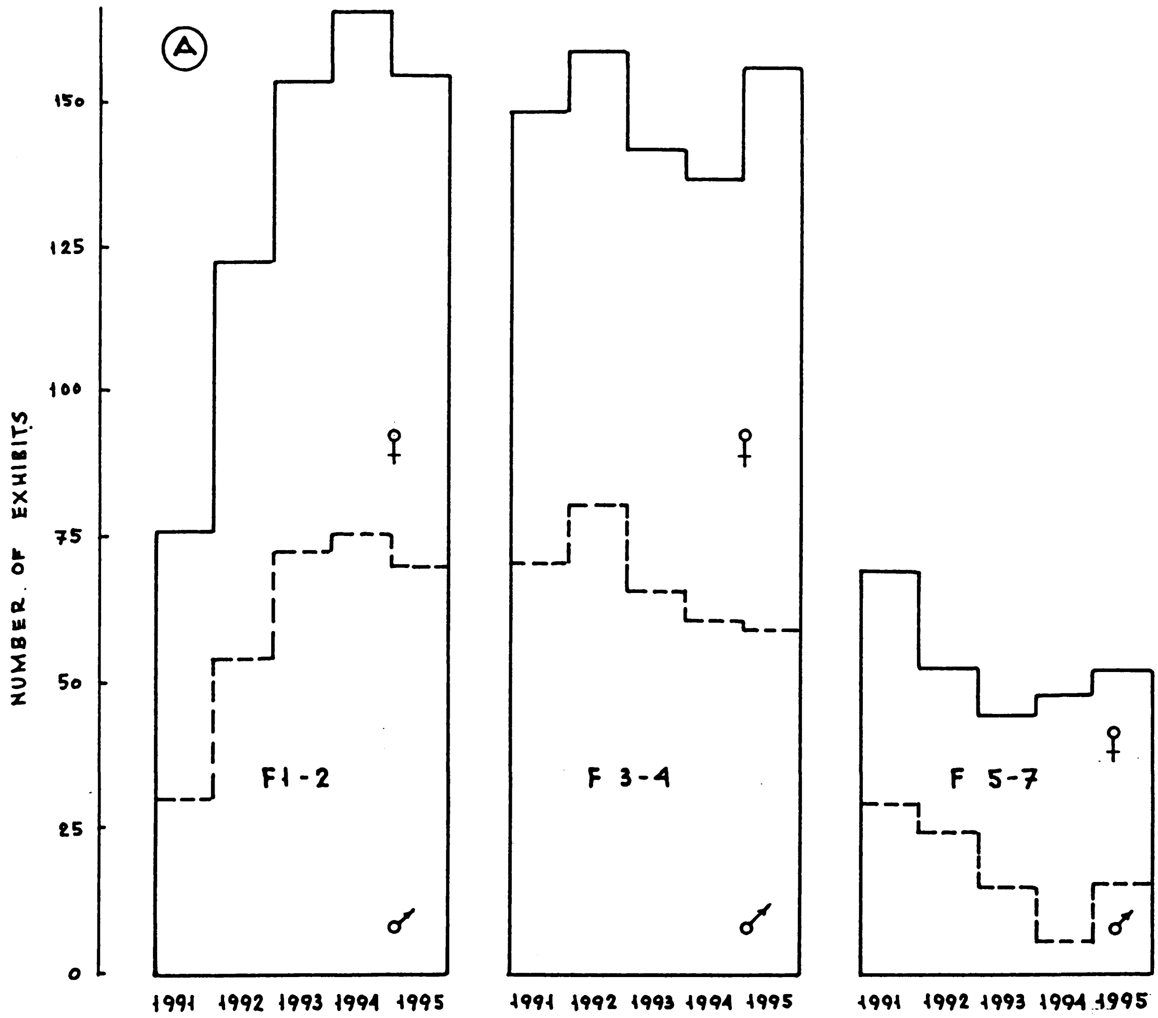

Figure 1A Number of exhibits at Waikato science fairs 1991-1995 in intermediate (F1-2), junior secondary (F3-4) and senior secondary (F5-7) categories

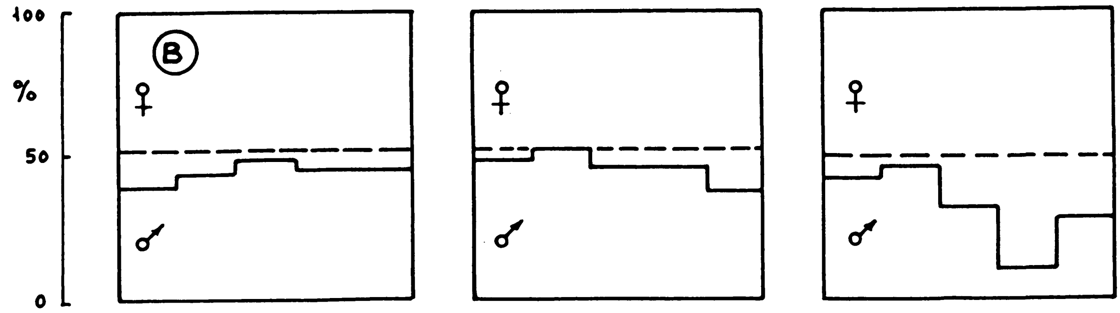

Figure 1B Gender balance for the exhibitor categories in A

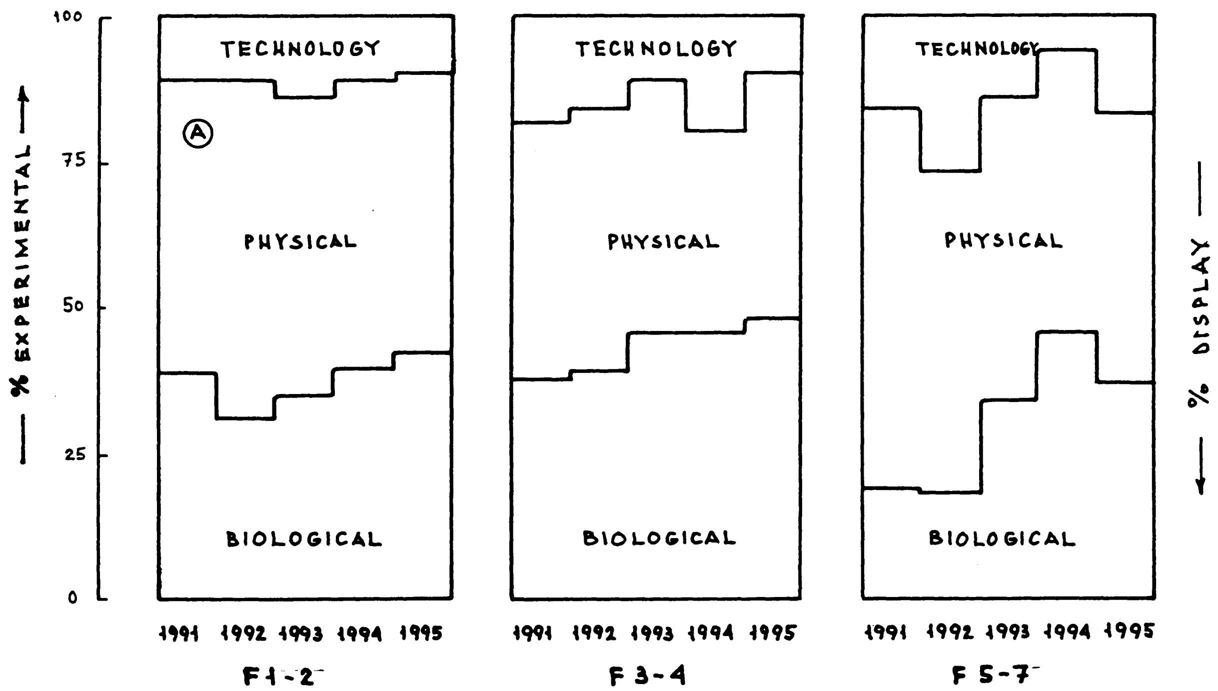

Figure 2A Classification of exhibits into types: biological, physical, and technology. The inference is that technology is applied science or 'devices'

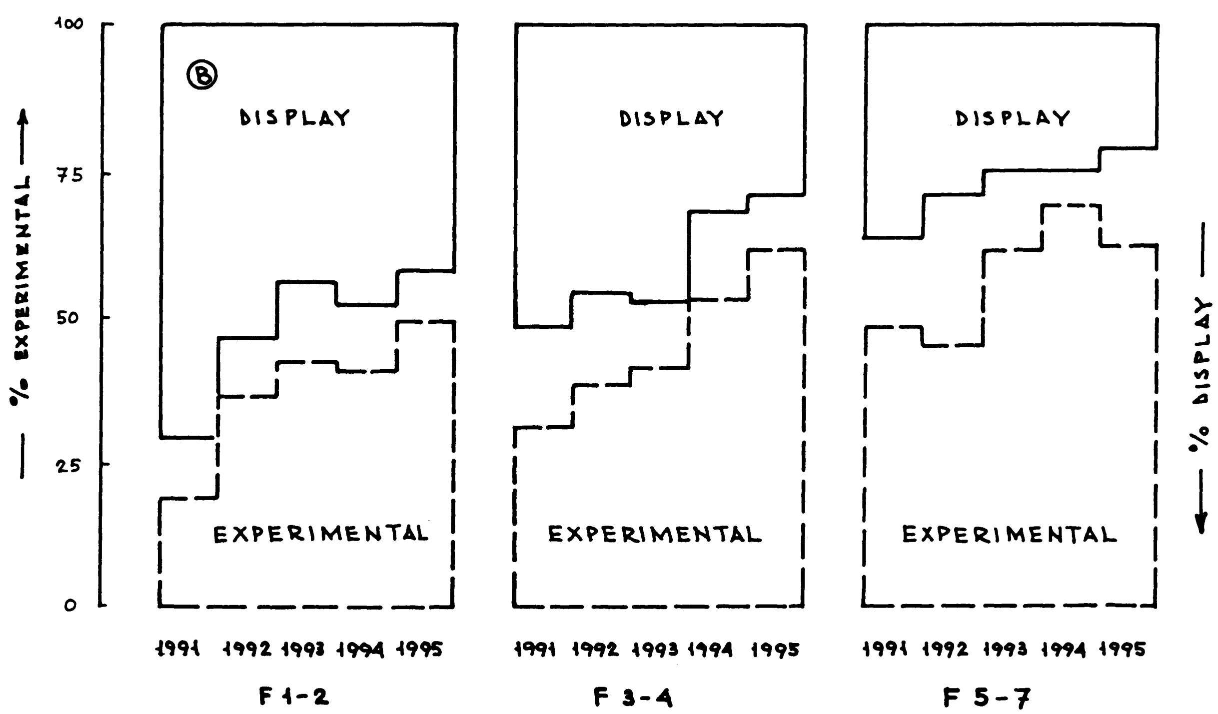

Figure 2B Classification of exhibits into display (solid line) or experimental (broken line). The balance of the plot represents technology. These two diagrams encompass the overall classification in each age category, viz: biological experimental, biological display, physical experimental, physical display, technology.

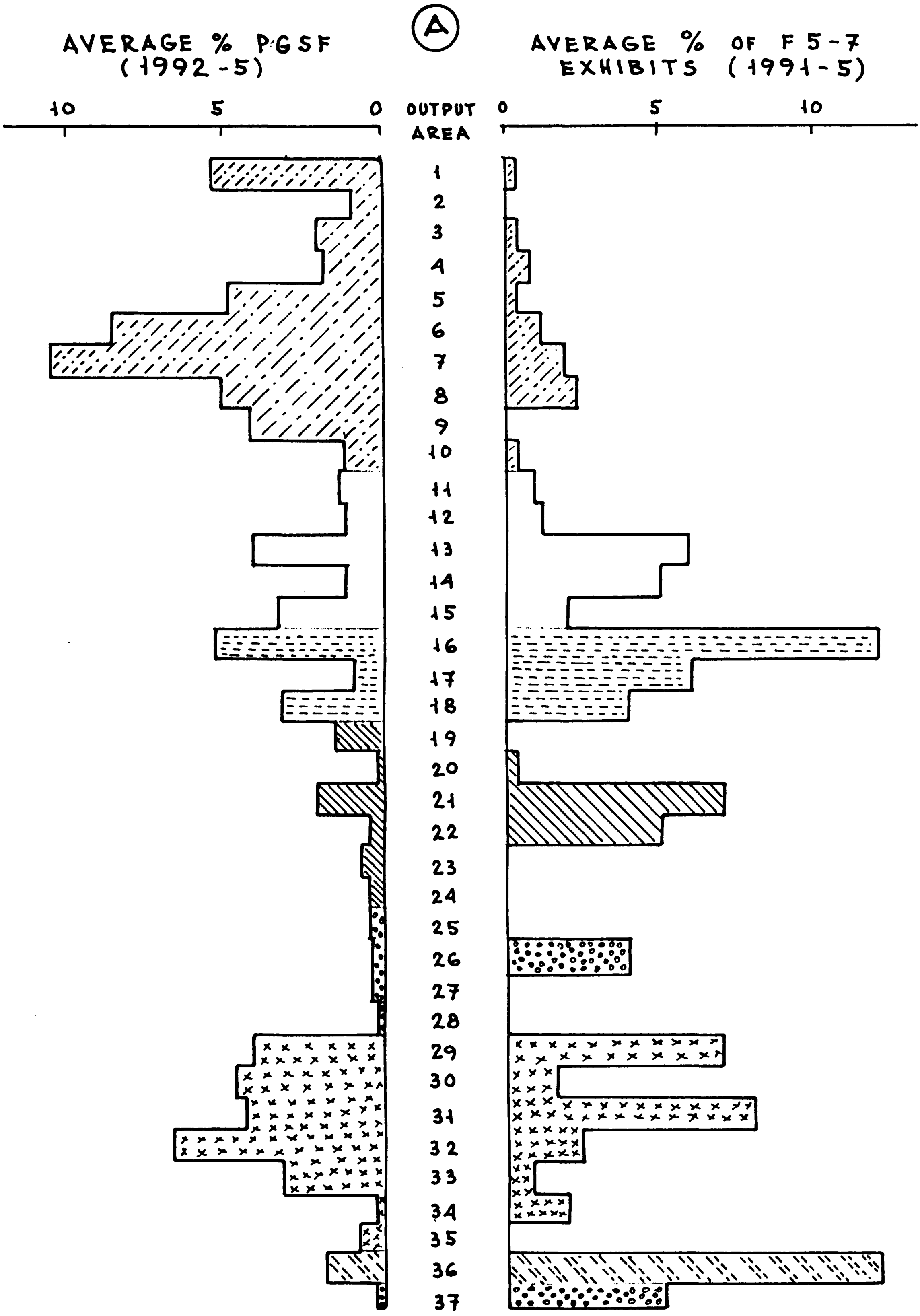

Figure 3A Comparison of average of proportions Form 1-7 exhibits (over the period 1991-5) classified according to PGSF output areas and groups' average funding for the period 1992-5.

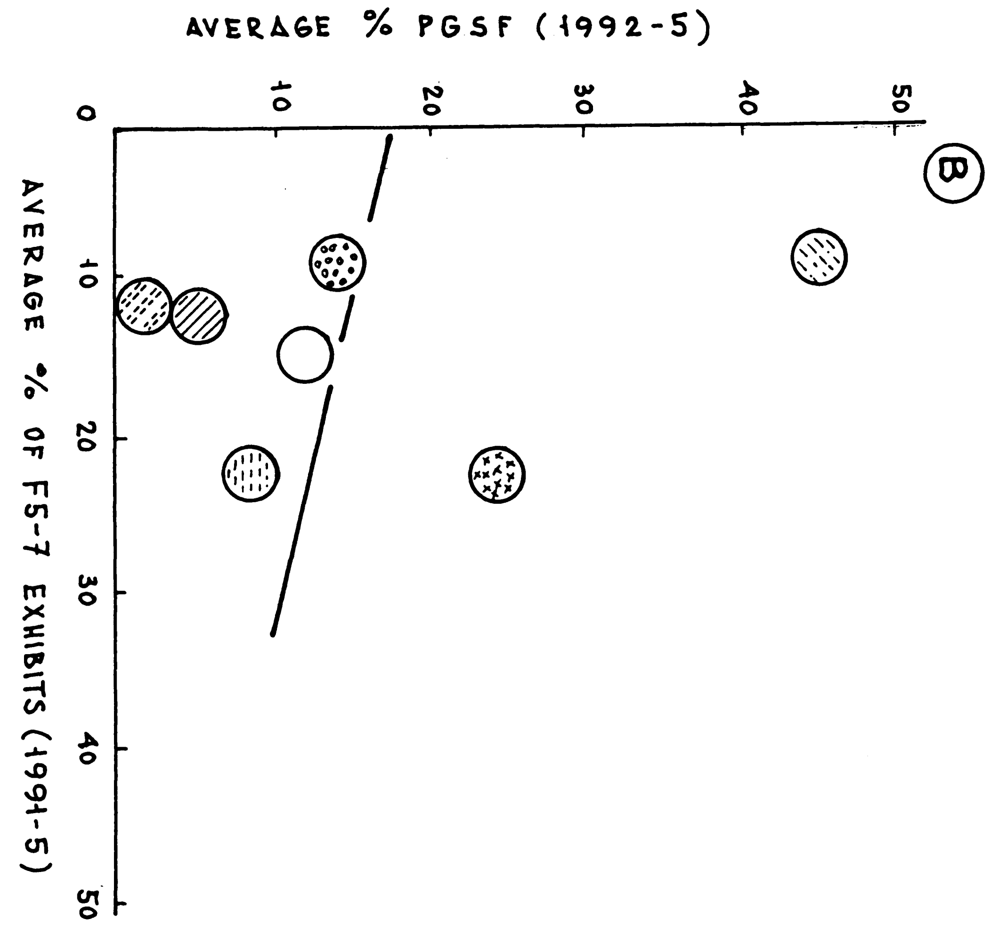

Figure 3B A weak linear regression between extent of PGSF funding and interest in those areas by form 5-7 exhibitors. (Interest is taken as the proportion of exhibits dealing with those groups.)

	OUTPUT AREA - GROUP	AREAS
	PRIMARY PRODUCTION	1 - 10
	PRIMARY PRODUCTS AND PROCESSING (INCLUDING FOOD)	11 - 15
	MATERIALS, ENGINEERING, TELECOMMUNICATION	16 - 18
	INFRASTRUCTURE AND SERVICES (INCL. ENERGY)	19 - 24
	SOCIAL DEVELOPMENT AND STRUCTURE; HEALTH +	25 - 28, 37
	ENVIRONMENT, EXPLORATION AND ASSESSMENT OF EARTH.	29 - 35
	FUNDAMENTAL KNOWLEDGE *	36

computers. An interest in science topics related to health is not unexpected in adolescents, but the increase in social aspects of science generally in interest over the five-year period is less easy to explain. While this could be seen as a desirable combination of scientific knowledge with sociological understanding (Bloch, 1990), the trend is a little disturbing if Solomon (1988) is correct in the belief that opinions on science-technology-society topics are formed at an early age and further 'experiments' - for example on cosmetics, smoking and diet - probably serve only to reinforce these attitudes.

When the average proportions of exhibits of the senior secondary school pupils corresponding to the various output classes of the PGSF are compared with the funding allocated to these areas of research, it is clear that the areas of science that tomorrow's scientists find interesting to investigate are not those accorded priority by todays' funding agency (Fig. 3A). Indeed the plot suggests there may even be an inverse relationship especially for groups of 'output areas' (Fig. 3B). One explanation of this is that the suggestions of topics made to potential exhibitions by peers or teachers are not those at the forefront of science but the "generally familiar knowledge" previously referred to (Glaser, 1992).

GENDER TRENDS AND SCHOOL INFLUENCES

For boys at the intermediate and junior secondary level there is a change from a dominance of physical display exhibits to those with a greater emphasis on experiments, particularly of physical science. A small number of exhibits makes trends in the senior secondary school level more difficult to evaluate, but there was a tendency towards technology, perhaps at the expense of physical experimental exhibits. At all-male schools there appeared to be sporadic attempts to promote physical experimental and technology exhibits. Because this is not a consistent trend it is tempting to consider that this influence is teacher-driven.

Similar influences were at work in all-female schools. It seems that at intermediate schools there is a female preference for biology, which consistently asserts itself. All-female schools have sought to change this, particularly in the senior secondary school, but over time the familiar pattern seems to re-emerge. This encouragement of physical science over biological science is a strategy born of the often quoted low interest of girls in physical science from about age 13. However, the participation in intermediate schools suggests that the preference for biology whether derived by innate differences of learning style or by different experience of the world is actually established two years earlier than that. Technology is consistently a non-favoured choice of girls' exhibits (see also Pearce and Barker, 1995), even in all-female schools where its promotion might be expected as part of the overall promotion of participation in science (e.g. Stanworth, 1983). While this might suggest that the lesser interest in the allegedly 'masculine' physical science and technology is related to the inherent character of the subject, this ignores some powerful sociological and psychological forces that shape self-image. Campbell (1991) notes that even for students enrolled in technically oriented courses, parents did not encourage their teenage daughters to take advantage of opportunities that could lead to the gaining of scholarships in science-technology related areas. This behaviour was shown by Caucasian American parents, but not Asian-American parents, suggesting that attitudes to

TABLE 2 Participation of students in science fairs by type of school

Type	Participation (% of school)	No. of schools
intermediate	3.8	8
secondary		
- co-ed, state	1.3	10
- co-ed, private	1.7	2
- all male, state	0.5	1
- all male, private	1.5	2
- all female, state	3.0	1
- all female, private	4.5	1

TABLE 3 Mean percentages of individual exhibitors over the 1991-5 period, by exhibit class and age

	Intermediate	**Secondary**	
		Junior	Senior
	(F1 - 2)	(F3 - 4)	(F5 - 7)
female			
biological exp.	45	47	46
biological display	51	46	27
physical exp.	60	51	72
physical display	37	48	72
technology	61	54	75
male			
biological exp.	76	63	47
biological display	62	68	80
physical exp.	71	47	68
physical display	61	54	35
technology	51	37	61

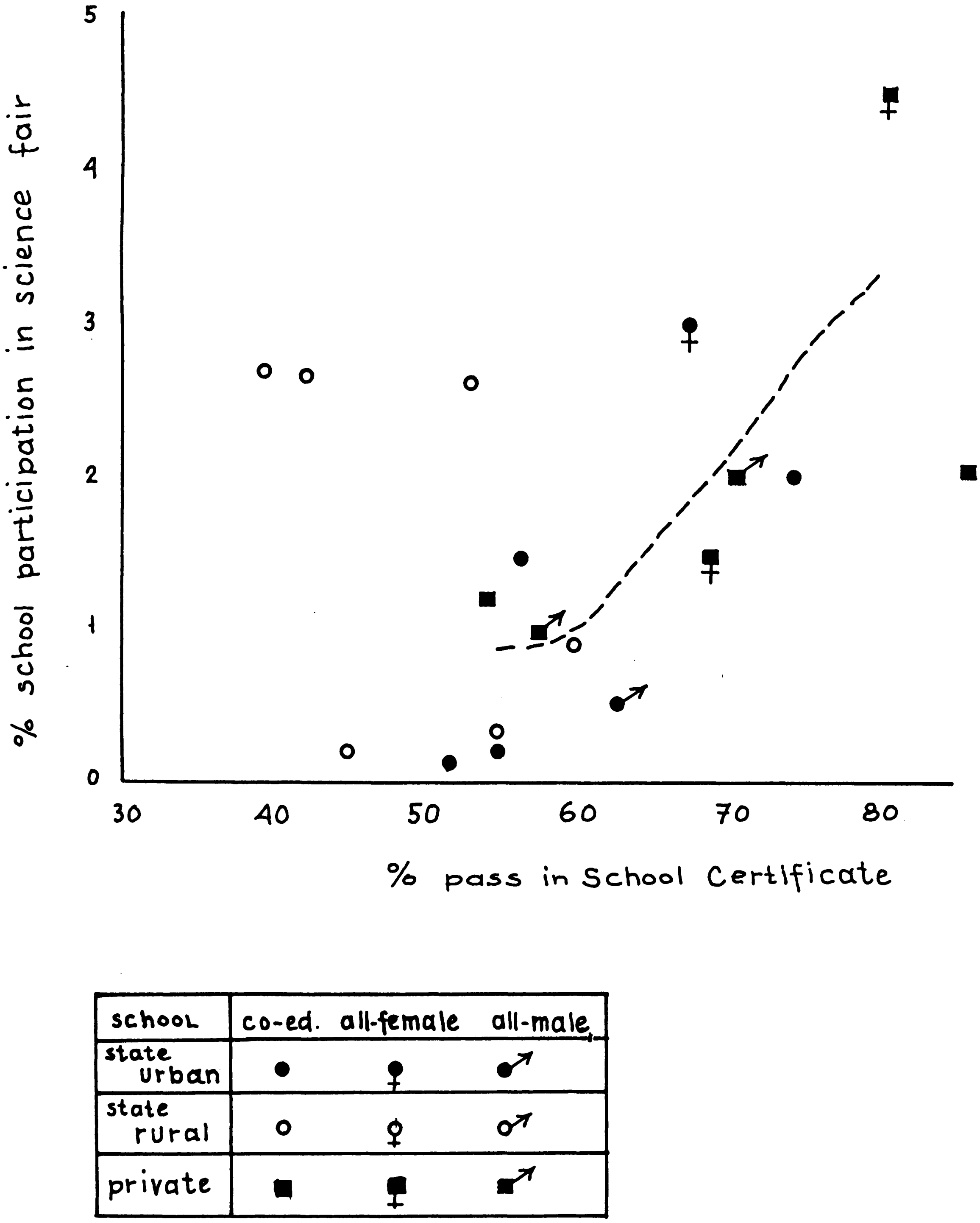

Figure 4 Extent of school participation in science fairs 1990-1995 and academic performance as measured by the percentage of School Certificate passes in 1993 (Broken line is mean participation for successive 10% increments in passes, as moving averages).

science/gender relationships could be culturally driven. The cultural stereotyping from home may be reinforced by the culture "in" schools that the students themselves maintain, and this may be more than a match for the culture "of" the school (the cultural system the school seeks to maintain.) Thus, the mismatch between preferred science in schools and science-related employment is perhaps not surprising.

The proportion of secondary school students exhibiting at science fairs is highest for all-female schools, significantly higher than for co-educational and all-male schools (Table 2). This attests to a clear influence of schools, either indirectly, by encouraging participation, or directly, by using exhibit preparation as a school-based activity. There is a relationship between science fair participation and academic performance (Fig. 4) particularly for Hamilton city secondary schools. This could be a consequence of the schools' institutional culture, but probably also reflects the socio-economic status of their pupils.

The rules of science fairs permit students to exhibit either as individuals or as groups of up to three people. Mixed-gender groups are extremely rare. Collaboration among boys is common at intermediate and junior secondary levels, but there seems to be a time trend towards decreased collaboration. The small number of males' exhibits in the upper school make any conclusion here doubtful. Collaboration is more widespread for females' exhibits, but there are no clear trends.

When considered by exhibit type (Table 3), biological exhibits by male students tend to be individual, and more likely to be group exhibits for females. By comparison, technology exhibits by males are often group efforts. These differences may be a consequence of the perceptions of the science that male and female genders ought to be involved with, or they may result from out-of-school activities, particularly in the early teenage years (Murphy, 1992).

CONCLUSION

Science fairs were initiated as a student-centred extracurricular activity for students interested in science. The involvement at the intermediate school level seems to continue this tradition; the choice of topic areas by gender seem broadly to concur with stereotypical predictions of the masculinity of physical science compared to biological sciences. At the secondary level, particularly among females and notably in all-female schools there is anecdotal evidence to suggest that there are influences at work to change these stereotypes, but they are not reflected in the results of this survey.

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