EQUATIONS IN A CONSUMER CULTURE: MATHEMATICAL IMAGES IN ADVERTISING

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Affect energises the learning and use of mathematics; a key influence comes from the images of mathematics available in society. We sought advertisements containing such 'images' (e.g. mathematical expressions, equations or graphs) in 1600 editions of UK newspapers, over two recent three-month periods. We found that 4.7% of editions included a 'mathematical' advert, compared with 1.7% found in the pilot for 1994-2003. This supports the idea that mathematical images are being used more in advertising, paralleling the increase observed anecdotally in films. The incidence varied from 8.2% among the 'quality' papers, to 2.3% in mid-market, to 0.6% among the 'populars', suggesting a correlation with the social class of the readership.

INTRODUCTION

Despite traditionally being considered to be 'invisible', mathematics has recently seemed to be 'everywhere', as a theme in Hollywood movies, as a basis for works of art, and in equations purporting to explain all aspects of human experience (e.g. Goldacre, 2008). We are interested in how the availability of different types of image of mathematics in various cultural outlets have effects on people's attitudes and emotions towards mathematics (Evans *et al.*, 2007; Mendick *et al.*, 2007). This second phase of this ongoing project built on a pilot study, which searched for adverts including a 'mathematical image' in a 'light sample' of 543 newspaper editions (sampled over the years 1994-2003, from three 'quality' titles, one mid-market and two 'populars'). We thus examined a much more representative sample of newspapers than in the pilot, to study differences among different categories of newspaper, which in the UK are related to social class profiles of the readership.

THEORETICAL BASES

Gail FitzSimons (2002) sees the *public images* of mathematics as "created and reflected both in the cognitive and affective domain and concern[ing], *inter alia*, knowledge, values, beliefs, attitudes, and emotions". She argues that

> a very strong influence on the public image of mathematics comes from the experience of formal mathematics education … [and] other influences such as stereotypes reinforced by popular media, or personal expectations conveyed explicitly and implicitly by significant others such as peers and close relatives. (2002, pp. 43-45)

For these reasons, the public images of *mathematics* and the images of *mathematics education* are exceedingly difficult to disentangle.

Our theoretical approach uses discursive perspectives (see Evans, Morgan & Tsatsaroni, 2006), drawing on work on pedagogic discourse in the sociology of

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education (Bernstein, 2000), and on advertising (e.g. Williamson, 1978). Williamson argues that adverts refer outside of themselves and draw meanings from one or more *referent systems*, such as mathematics or other types of high-status knowledge. Bernstein's sociological theory provides the key concept of recontextualisation in understanding the construction of discourse. Pedagogic discourse is created through social processes involving selection, repositioning and refocusing of elements drawn from knowledge producing discourses. These processes entail transformations of these elements and changes in social relations. Therefore, like official pedagogic discourses, media discourses regulate the construction and reconstruction of identities and subjectivities: agencies (and agents) of symbolic control, such as advertising companies, are "concerned with the regulation of social relationships, consciousness, disposition and desire" (Bernstein, 2001, p. 21). In Bernstein's theory the pedagogic discourse assumes priority over 'unofficial' (or non-state, e.g., media) institutions and their discourses in the cultural field. However, a poststructuralist reflection on Bernstein's notion of discourse (Delamont & Atkinson, 2007) recommends greater consideration of the interconnections – and the boundaries – between the wider cultural field and the field of education.

Bernstein's brief analysis of media discourses provides insights relevant to advertising as well. First, *cultural productions*, whether oral communications in the classroom, textbooks, syllabuses, advertisements or films, are the means by which power relations translate into discourse and discourse into power – through classification and framing. Both concepts utilise the idea of boundary pointing to the importance of describing changes in its strength in the processes of recontextualisation through which (pedagogic) discourse is constructed, and enacted. Second, contrary to pedagogic discourses that form more durable pedagogical relations, media and other cultural representations contain a range of discourses that are segmentally organised, and aim to maintain, develop or change an audience niche (Bernstein, 2000, Ch. 11). Due to their segmental organisation, we cannot expect a strong, or even indirect, control over the context, social relations and motivations of the receivers/consumers of media discourses. Bernstein calls such cultural forms *quasi-pedagogic discourses*, thus indicating that they entail some form of pedagogic (i.e. social) regulation, irrespective of the ways in which messages are acquired.

Thus the problem of the kind of mathematical pedagogic identity created in formal schooling – clearly important to mathematics education researchers – would benefit from detailed empirical work on changes in the field of cultural (re)production.

RESEARCH QUESTIONS

We start from the idea that cultural representations, in particular advertisements, may play a major role in reinforcing (or challenging) long-term public images of mathematics, thereby reproducing or disturbing dominant social and educational discourses. In particular, our hypothesis is that the modes of communication created

by the organization of advertising texts may work to distribute differentially forms of consciousness, identity and desire. Thus, the following set of research questions:

RQ1 To what extent – and in what ways – do advertisements use mathematics as a resource to construct their messages?

RQ2 What kind of images of mathematics, people doing mathematics, and/or teachers of mathematics can be identified in our sample of advertisements?

RQ3 How are readers / consumers affected by advertisements depicting mathematics / mathematicians? That is, how are they constructed by discourse as able to learn, or as knowledgeable or not, in mathematics? And how may this vary according to social position (e.g. class, gender, age group, general vs. specialised reader)?

METHODOLOGY

UK national newspapers are divided into 'quality', 'mid-market', and 'popular' papers, on the basis of their traditional styles of presentation and level of reporting and commentary – and their consequent attraction of readers from different social classes. We sampled four of the five 'quality' papers in the UK (*Daily Telegraph, Financial Times, The Guardian, The Times*), two mid-market papers (*Daily Express, Daily Mail*), and three 'populars' (*Daily Mirror, Daily Star, The Sun*). We selected two three month periods, Sept. – Nov. 2006, and Jan. – March 2008 for all papers (normally including the Sunday editions), except for *The Guardian / Observer*, where we also examined an intermediate period (July – Sept. 2007).

As indicators of a 'mathematical image', the following key words were used: mathematics, maths, mathematicians, geometry, geometrician, algebra, science/scientist, calculations, sums, equation/s, number/s, calculation/s (or related terms); and the name or picture of a prominent mathematician (such as Einstein, Stephen Hawking). Or a mathematical expression, equation, formula, or graph.

RESULTS

Here we examine each of the Research Questions in turn.

RQ1 To what extent – and in what ways – do advertisements use (images of) mathematics as a resource to construct their messages?

For each of the nine papers, we examined between 150 and 185 editions, with the exception of *The Guardian / Observer* (see above); see Table 1. The overall 'success rate' (the number of adverts found, divided by the number of editions) at 4.7%, is about three times as high as in the Phase 1 pilot (1.7%), when we examined over 500 editions from six newspapers (Evans *et al*., 2007). Part of this increase may be due to the more representative corpus we examined in Phase 2, but we consider that the increase also reflects the greater use of adverts containing mathematical images in the period 2006 to the present, compared with the earlier period, 1994-2003. We have argued, in considering media and culture more generally, that there has developed, over recent years a greater sensitivity to the meaning of mathematics as an indicator

of scientificity and reliability, and a greater interest in representations of mathematics, and of people doing mathematics, also evident for instance in film production (Evans *et al.*, 2007). Nevertheless, there is a fair amount of variation over the two time periods of Phase 2, with the success rate apparently decreasing from autumn 2006 to winter (Jan.-Mar.) 2008. Some newspapers (three) have seen their success rates rise between the two periods, and others (five) have fallen.

When we group the titles into the three types of newspaper, there is the expected difference in success rates. This is shown in Table 1.

Publication type	No. of editions	No. of adverts	'Success rate'	'Success rate' %
Quality	790	65	0.082	8.2%
Mid-market	344	8	0.023	2.3%
Popular	475	3	0.006	0.6%
Total	1609	76	0.047	4.7%

Table 1. **'**Success rates' (incidence of 'mathematical adverts') by newspaper type.

To address the question of how advertisements use mathematics as a resource to construct their messages, we go on to RQ2.

RQ2 What kind of images of mathematics, people doing mathematics, and/or teachers of mathematics can be identified in our sample of advertisements?

We classified each of the adverts, according the main image of mathematics used in it. Since a number of the 76 adverts found in our sampling were 'repeats' (in different newspapers), now we have only 56 distinct adverts, not 76 instances; see Table 2.

Type of mathematics	No. of adverts	%
Use of key words	8	14.3
Name/picture of mathematician	0	0
Numbers, figures	4	7.1
Squares, powers etc	8	14.3
Charts, graphs	17	30.4
Simple equations	13	23.2
More complex equations	3	5.4
Other	3	5.4
Total	56	100

Table 2. Type of mathematics used in the set of distinct advertisements (n = 56).

Here we see that simple uses of keywords, such as 'mathematical', and slogans like 'Do the maths' accounted for almost 15% of the types of mathematics used. Adverts reporting simple numbers (e.g. "9 ½ / 10 for student satisfaction. No other university scored higher.") or measurements accounted for half that number, though this category did include one advert for a bank, where a face was constructed rather appealingly from numerals (RB34, Quality, Jan.'08). Adverts using simple equations (including formulas and mathematical expressions) accounted for a second 25%. Adverts using charts and graphs accounted for 30%: only 4 of 17 of these presented real data, while the rest used fabricated data, often 'playfully', in their message; moreover, almost all could also be considered as simple, with the exception of one advert for an asset management firm which arguably uses a parabola in a thought-provoking way (RB49, Quality, Mar.'08). Thus, even considering the adverts using squares and powers (almost 15%, and more complex equations and other uses (5.4% each) as more challenging for the reader, around ¾ of the adverts use very simple mathematics indeed. We discuss the adverts using equations in more detail below.

Given the strong social class stratification in UK newspapers, we consider differences in the types of mathematics used for different types of newspapers; see Table 2a.

Newspaper type			Mid-mkt/Pop.	Quality	Total
Type of math used	Use of key words	Count (%)	2 (25.0%)	6 (12.5%)	8 (14.3%)
	Numbers, figures	Count (%)	1 (12.5%)	3 (6.3%)	4 (7.1%)
	Squares, powers	Count (%)	0	8 (16.7%)	8 (14.3%)
	Charts, graphs	Count (%)	1 (12.5%)	16 (33.3%)	17 (30.4%)
	Simple equations	Count (%)	3 (37.5%)	10 (20.8%)	13 (23.2%)
	Complex equation	Count (%)	1 (12.5%)	2 (4.2%)	3 (5.4%)
	Other	Count (%)	0	3 (6.3%)	3 (5.4%)
Total		Count (%)	8 (100.0%)	48 (100.0%)	56 (100.0%)

Table 2a. Crosstabulation of type of mathematics used by type of newspaper.

Because of the small numbers of 'mathematical' adverts found in the mid-market and popular papers, we consider the two types together. We note that 38% (3 of 8) of the adverts in mid-markets / populars use simple keywords or figures, compared with only 19% of qualities. There is a similar difference between the two groups in the use of *simple* equations. On the other hand, there is a greater use of charts in the 'qualities' (33% to 12.5%) and in the use of squares, powers, etc. (17% to none).

Thus adverts in the quality papers use a wider range of types of mathematics, and more demanding mathematics (charts & graphs, more complex equations).

At this point, we examine the 16 uses of 'equations', accounting for more than 25% of the adverts found. Most of these might more accurately be called 'formulae', since

they involve a 'mathematical' expression (the 'left-hand side') set equal to what the reader needs / needs to do, in order to obtain what is indicated on the 'right-hand side'. Sometimes the elements that are added are icons – e.g. Christmas gifts in a Woolworths advert (RB42, Popular, Nov.'06); sometimes they are words, or a mixture of words and figures – e.g. "40min + £199 = YOUR PERFECT MORTGAGE" (RB35, Quality, Nov. '06). 13 of the adverts fall roughly into this category, including 2 of the 3 'more complex' equations. There are at most two 'equations' which are even plausibly correct in mathematical terms: one simple equation which sums the prices of pieces of furniture that you could buy with a £5000 prize draw voucher from a shop (RB40, Quality, Mar.'08), and one more complex, which contains a formula for velocity ("Give him the Lift Off Rocket and who knows what he'll grow up to be", RB2, Mid-market, Nov.06). See also our analyses of the equations used in adverts from the pilot study (Evans et al., 2007).

RQ3 How are readers / consumers affected by advertisements depicting mathematics / mathematicians? That is, how are they constructed by discourse as able to learn, or as knowledgeable or not, in mathematics? And how may this vary according to social position (e.g. class, gender, age group, general vs. specialised reader)?

Newspaper	**% Male readers**	**% ABC1 readers**	**'Success rate' %**
The Times	58.2	89.0	7.3%
The Guardian	55.7	91.7	5.8%
Financial Times	74.1	94.1	13.1%
Daily Telegraph	55.7	86.0	5.9%
Daily Express	51.3	60.8	2.3%
Daily Mail	47.8	65.4	2.3%
Daily Star	70.5	32.0	0.6%
Daily Mirror	52.8	41.9	1.3%
The Sun	56.8	36.8	0.0%
Total			

Table 3: 'Success rates' for newspapers, by gender and social class of readership. *Source*: Readership data from the National Readership Survey Oct.-Nov. 2007

To address this question, various types of evidence are being produced by the present project: readings of the 'semiotics' of advertisement(s) as text, aiming to draw out the discourses that underpin them (cf. Evans *et al*., 2007); and interviews with 'typical' readers, asking for 'reactions' to particular adverts in terms of 'how it makes you feel'. Here we can begin with RQ3 by noting any relationship between the demographic characteristics of the readership of the newspapers studied and the incidence of adverts' containing 'mathematical images' during our time periods.

Table 3 shows a clear stratification of the nine newspapers into three familiar groups – 'qualities', mid-market and 'populars' – according to the percentage of ABC or 'middle-class' readers. And there is a clear correlation between category of newspaper and 'success rate' (which can be seen even more simply in Table 1 above). At first, there does not appear to be a strong relationship between gender of readership and 'success rate': the two newspapers with the highest proportion of male readers are the *FT* and the *Star*, and they have very different 'success rates', but when we look more closely (or check the scatterplot of success rate and % male readers), we see that the *Star* can be considered an 'outlier'.

Now, the correlation coefficient of success rate and % ABC1 readers is 0.862 ($p \leq .001$, highly significant) and the correlation of success rate and % male readers is 0.493, $p \leq .089$, not quite borderline significance). But the partial correlation of success rate and % male readers, controlling for % ABC1 readers, is 0.850 ($p \leq .008$, again highly significant).

Thus we can conclude that both the % of ABC1 readers and the % of male readers of a newspaper make a statistically significant contribution to 'predicting' the incidence of adverts containing mathematical images in newspapers.

CONCLUSIONS

In this phase of the research, we found a much higher incidence of mathematical images in advertisements during 2006-08 (a 4.7% 'success rate'), than in the pilot phase (1.7%, using very light sampling during 1994-2003). There was a much higher success rate in 'quality' newspapers, compared with mid-market or 'popular' ones, showing a strong correlation with the percentage of ABC1 (middle class) readers, and also with the percentage of male readers (controlling for social class of readership). Nevertheless, the images of mathematics offered by the advertisements were for the most part simplistic, and hence impoverished, for all – and the range of images offered was more restricted in the popular and mid-market papers, as compared with the quality papers. Thus, we might agree with other researchers that mathematics suffers from 'low visibility' – but to different degrees across different social groups.

Our evaluation of the level of mathematical demand made on the reader by these adverts raises questions about the value of using such means as resources in the mathematics classroom. Nonetheless, some of the adverts might be useful in two ways: first, in discussing the effectiveness of the adverts as adverts – and that of the mathematical images, including how they are or are not 'properly mathematical'; and second, in discussing how they might influence students' feelings about mathematics. More generally, however, both policy makers and researchers may have an interest in considering the extent to which cultural representations work to cancel out initiatives designed to improve the level of mathematical knowledge in the general population.

Relatedly, we note the emergence of a trend – supported by our evidence – whereby mathematics equations or formulae are recruited as global communication

technologies of subjectivity, shaping desire especially for those strata of the middle classes that are the most promising clients in the global consumers' market. This emerging strategy might undercut the use of maths as a critical discourse for citizens.

Our overall approach uses mixed methods (see Evans *et al*., 2007), but the analysis here has been mostly quantitative. Nevertheless, we hope to have shown how much can be done with such an analysis, especially in the light of our concerns with social difference and social justice (Evans & Tsatsaroni, 2008). We see further research as important on several levels. First, we are extending our work (in Phase 3 of the project) by (i) 'audience research' interviews with 'typical' readers, to study reactions to selected adverts; and (ii) interviews with agency workers, on the creative process. Second, other fields of media activity can be investigated for their images of mathematics (see e.g. Mendick *et al*., 2007). Third, there is scope for cross- cultural studies, using an approach like that described here.

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