

Inclusive Practice: Researching the Relationship between Mathematical Ability and Drawing Ability in Art Students

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Abstract

This paper is a component of ongoing research by a team comprising an art school lecturer, a coordinator of dyslexic students' support, and psychologists interested in exploring correlations between drawing ability and factors such as mathematical ability, personality traits and dyslexia. It extends research by gathering and analysing data collected from art students at Swansea Metropolitan University and the Royal College of Art. The paper introduces a research strategy to explore the hypothesis that drawing ability correlates with mathematical ability, with the ultimate objective of developing inclusive strategies for the teaching of drawing.

Previously we have explored how difficulties with drawing relate to dyslexia (1). Although no direct relationship with dyslexia was found, other interesting results were: poor drawing related to poor visual memory and a reduced ability at copying angles and proportions, suggesting problems in spatial perception and memory. Other researchers (2) have reported that dyslexic children who are poor at maths tend to be less good at remembering the Rey-Osterrieth figure. We also noted that students with lower GCSE maths grades tended to be less good at drawing the Rey-Osterrieth figure. In the present, exploratory study we therefore looked at how ability at maths related to drawing ability.

Introduction

Art and drama schools are well known for having a high proportion of students with dyslexia. There are also recent similar, but as yet unpublished, indications relating to schools of music. It is not clear to what extent that reflects enhanced talents in those students, or whether the choice of art, drama or music is because of problems dyslexic readers encounter with the more traditional academic subjects embedded in the three

Rs. Drawing in particular is a skill that would appear divorced from reading, writing and arithmetic, and yet researchers have argued that mathematical ability may be related to drawing. If that were the case, then otherwise well qualified potential art students may be being excluded from admission to art courses because of a requirement for drawing (and by implication, maths). Here we assess how drawing ability relates to maths in a cohort comprising Foundation Diploma students at Swansea Metropolitan University, and Master's level students from the Royal College of Art.

Method

Students were introduced to the general aims of the research project in an illustrated PowerPoint presentation. The cohort was divided into 6 groups of roughly 20 per group, each group invited in turn to a studio set up with laptop, projector and screen (Figure 1). Each student was given an A4 booklet containing the instructions for the series of drawing exercises adjacent to blank pages in which the students' drawn responses were to be recorded. The booklet also contained a questionnaire eliciting students' attitudes to their perceived drawing abilities (Figure 2), mathematical abilities, previous educational experiences, and other factors, including personality traits, handedness and spelling abilities (Figure 3). The entire testing session lasted approximately 40 minutes.

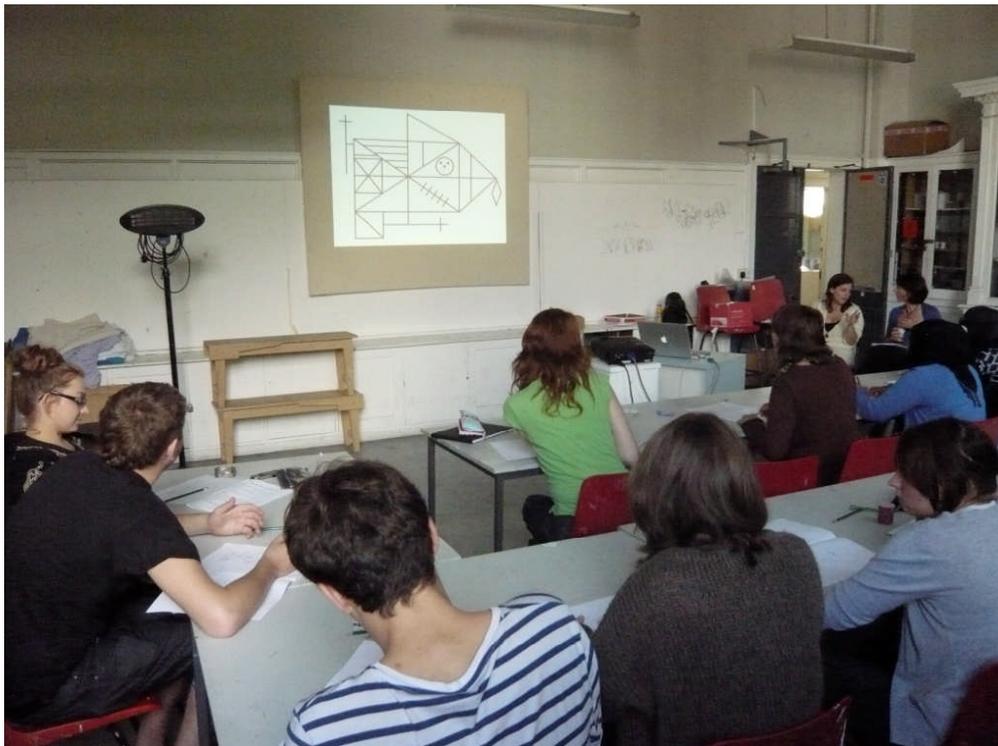


Figure 1a: The Drawing Room. Students are copying the Rey-Osterrieth complex figure. They have not been told that in about 30 minutes they will be asked to draw it again, but this time from memory.

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Figure 1b: The Drawing Room

Firstly, a little on your strengths and weaknesses in various skills related to art and design.

Being as honest as possible, how would you rate your ability at the following skills, *in comparison with other people studying art and design*? If you haven't carried out a skill, simply leave that answer blank.

	Much below average	Below average	About average	Above average	Much above average
Drawing from observation (e.g. life drawing)					
Drawing from imagination					
Use of perspective, shadow and shading					
Confidence in mark making when drawing					
Use of contrast and tone in drawing					
Technical drawing (geometric and engineering drawing)					
Mixing, copying and using colour					
Using colour for aesthetic effect					
Visual composition in two dimensions					
Interpreting technical drawings of 3D objects					
Modelling in 3D (e.g. making sculpture)					
Sensitivity to texture, feel and touch of materials					
Visual composition in three dimensions					
Mentally rotating objects to see them from other positions					
Product design (making objects to solve verbal problems)					
Using hand tools such as chisels, to craft objects					
Using mechanical tools and machines					
Verbal creativity (using words in novel and unusual ways)					
Visual creativity (seeing objects in novel and unusual ways)					
Mechanical creativity (using materials and objects in novel ways)					
Public speaking and communication					
Spelling					
Using word-processors					
Numerical skills (e.g. mental arithmetic)					
Using calculators					

Figure 2: Section of Questionnaire : Perceived Drawing Abilities

We're interested in how art and design students felt about studying maths at school.

How much do you agree with these statements?

	<i>Strongly disagree</i>	<i>Disagree</i>	<i>Agree</i>	<i>Strongly agree</i>
Maths seemed a waste of time				
Learning maths was enjoyable				
I felt confident when doing maths				
Maths is important in everyday life				
I am good at using computers to do maths				
I cannot understand how anyone could enjoy maths				
I have a mathematical mind				
Maths does not scare me at all				
I concentrated hard when studying maths				
I get a sense of satisfaction from solving maths problems				
Maths seemed a useful, worthwhile subject				
I always feel nervous when I look at a maths problem				
The challenge of maths appealed to me				
I could not see the point of most maths				
I could never understand all the symbols in algebra				
Geometry always seemed much easier than other aspects of maths				
Arithmetic was something I always had problems with				
I usually enjoyed studying maths at school				

Figure 3: Section of Questionnaire: Attitudes towards Maths

Analysis of Data

As well as data from 105 students in Swansea in September 2010, we also had other data collected in 2007 from students entering Swansea (n=90) and the RCA (n=187). The 2007 surveys did not include the questions on attitudes to mathematics, but there was information on GCSE achievement, and we have included those participants along with the present data, when possible, in order to maximise the sample size of the study.

Drawing Ability

The main outcome measures for assessing drawing ability were the responses of the students on the six questions on drawing ability: Drawing from observation (e.g. life drawing); Drawing from imagination; Use of perspective, shadow and shading; Confidence in mark making when drawing; Use of contrast and tone in drawing; and Technical drawing (geometric and engineering drawing); see figure 2. In our previous study we found that the first five correlated highly with one another, and a composite scale based on them also correlated with actual drawing ability, thereby validating the questionnaire measures. Previously we did not include Technical drawing as it behaved slightly differently from the other measures, but we included it here, and as will be seen, it does indeed behave somewhat differently.

Maths Ability and Attitudes

Mathematics ability was assessed by grade at GCSE maths, which was of course only available for those who had been educated in the UK. Grades were scored as A*=6; A=5; B=4; C=3; D=2; E=1; else =0. In the Swansea 2010 study we also included 18 questions assessing attitudes to maths at school, which were derived from a range of other published measures (3, 4, 5 and 6) – see figure 3. Factor analysis of the 18 items found two correlated scales which can be broadly described as Maths being *Enjoyable*,

and Maths being *Useful*. Higher GCSE grades in maths were strongly linked to finding maths enjoyable ($r=.457$, $n=72$, $p<.001$), although there was no link to thinking that maths was useful ($r=.150$, NS).

Dyscalculia

Students were asked whether they had ever been told that they had, "dyscalculia or other problems with numbers or calculating". One said they had been diagnosed as dyscalculic, 12 had wondered if they might be dyscalculic, and 88 reported that they had "Never" been considered as being dyscalculic. The 13 who may have been or were dyscalculic reported finding maths significantly less enjoyable at school ($p<.001$), although they did not regard it as any less useful ($p=.402$), and neither did they do less well at GCSE maths in particular ($p=.150$), or at GCSEs overall ($p=.889$).

Drawing and Maths

Table 1 shows the relationship between each of the six self-reported measures of drawing ability and the two measures of attitudes to maths education, achievement at maths GCSE, and overall achievement at GCSE. It is noticeable that three of the drawing measures (life, perspective and technical), show correlations with enjoying maths and/or with GCSE maths grade. However only two correlations are significant after using a Bonferroni correction (at a level of $0.5/24 = .00208$). Both of those significant correlations relate to technical drawing, which is better in those with higher grades at maths GCSE and in those who found maths enjoyable at school.

Exploratory multiple regression suggested that it was not possible to determine whether it was finding maths enjoyable or achieving well at maths GCSE which was the primary correlate of technical drawing ability. Figure 4 shows that grade at GCSE maths is higher in those with greater self-rated ability at technical drawing.

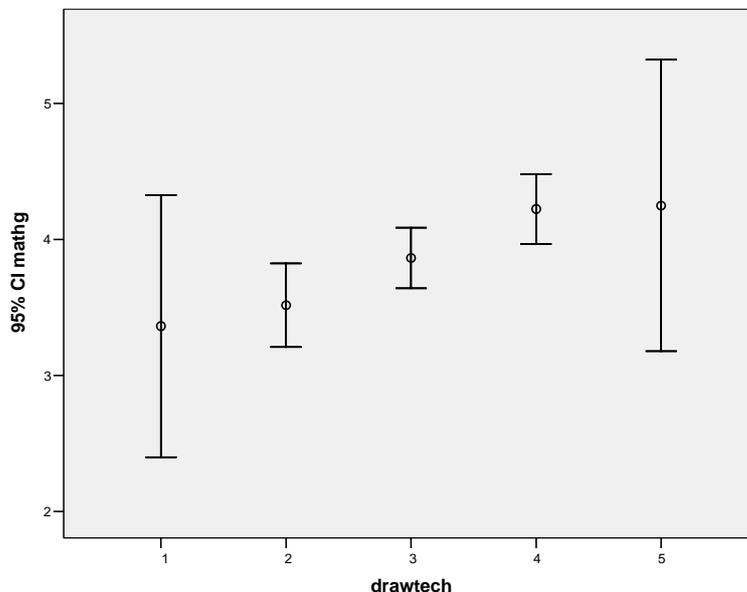


Figure 4: The average grade at GCSE maths (vertical axis) in students who rated their ability at technical drawing from 1 (Much below average), to 5 (Much above average).

Finally it should be emphasised that the correlation with maths achievement is specific, as the correlation with GCSE grades overall is not significant after Bonferroni correction (and neither is it significant in a multiple regression once GCSE maths is included).

Table 1: Correlations significant with $p < .05$ are shown in bold, and those significant after a Bonferroni correction are shown underlined.

	Maths more enjoyable at school (N=83-92)	Maths more useful (N=83-92)	GCSE maths grade (N=207-218)	Average grade at GCSE (N=207-218)
Drawing from observation (e.g. life drawing)	r= .150 NS	r=.151 NS	r=.143 p=.037	r=.196 p=.003
Drawing from imagination	r= .010 NS	r= .094 NS	r= -.081 NS	r= -.057 NS
Use of perspective, shadow and shading	r=.228 p=.029	r=.161 NS	r=.161 p=.018	r=.164 p=.012
Confidence in mark making when drawing	r=.078 NS	r= -.061 NS	r=.123 NS	r=.165 p=.011
Use of contrast and tone in drawing	r=.183 NS	r=.068 NS	r=.120 NS	r=.138 p=.035
Technical drawing (geometric and engineering drawing)	<u>r=.356</u> <u>p<.001</u>	r=.188 NS	<u>r=.257</u> <u>p<.001</u>	r=.159 p=.016

Analysis of actual drawing ability (based on independent ratings of the students' ability to draw an image of a hand holding a pencil, and an image of a model made from children's blocks) revealed significant correlations between this and a) self-rated drawing ability ($r=.461$, $n=102$, $p<.001$) which validates the self-ratings; b) perceptions of how enjoyable the students found maths ($r=.239$, $n=94$, $p=.020$); and c) maths GCSE grade ($r=.316$, $N=79$, $p=.005$). The correlation between actual drawing ability and findings maths useful just failed to reach significance ($r=.196$, $n=94$, $p=.059$).

Discussion

Our study supports the idea that ability at drawing - still a key, central skill in art courses - is related to being good at maths and finding it enjoyable. Art students often wish to be able to draw better, and a possible implication of our results is that those who are weak at drawing may be helped by improving mathematical skills, perhaps in the most obvious area of understanding geometry and spatial relations.

Art students differ in their ability to draw, and ability to draw can impact on many aspects of students' subsequent careers at art school and beyond. Drawing is both an aesthetic activity and also a craft with many technical aspects. Those different aspects are seen in the fact that students differ in their self-ratings of their ability in the six different aspects of drawing that we asked about. The origins of differences in such separate abilities may reflect a host of different learning experiences, but they may also be related to aptitude

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for other academic subjects. Previous research by ourselves and others has suggested that difficulty with mathematical subjects may be reflected in other areas of expertise (and perhaps also co-occur with differences in spatial memory and other relatively low-level cognitive processes). It is therefore interesting, and potentially of practical importance, that difficulty with mathematics at school also seems to relate to difficulty with particular components of drawing ability (and table 1 shows that GCSE maths grades relate to life drawing, the use of perspective and technical drawing, but *not* to drawing from imagination, the making of marks, and the use of contrast and tone). There is a commonality amongst these three aspects of drawing, each emphasising precision and accuracy of representation rather more than the other three which are more concerned with expression and aesthetic impact. Those differences suggest deeper underlying processes in terms of cognition, and that perhaps precise and accurate drawing may require a different *mentalité* to the other components of drawing. In particular it should be emphasised that the correlation with mathematics achievement is not merely to do with academic achievement or intellectual ability overall, since the correlation with overall achievement at GCSE is not significant. Whether that *mentalité* is particularly related to achievement in maths, or instead to a positive attitude towards maths which results in it being enjoyable, is not yet clear, the two measures being quite highly correlated, those liking maths doing better at it (and vice-versa).

Drawing is a complex skill, and it almost certainly requires a range of cognitive processes. Our previous work has suggested that at least two low-level processes – visual memory, and the perception of angles and proportions – are required for good drawing. The current study suggests that those who enjoy maths and are good at it are also better at the more precise components of drawing (and of course perspective, shadows, etc, all have their precise mathematical descriptions, which were much studied in the Renaissance explosion of drawing abilities). Of course that is not to suggest that drawing is merely a mechanical process involved in the representation of the visual world. It is far more than that. But when students have difficulties in drawing, and they also have difficulties in a wider range of mathematical tasks, it suggests that for such students there may be underlying commonalities in the skills. Inevitably it also raises interesting questions about the extent to which difficulty in drawing might be helped by providing support or intervention which concentrates on mathematical and other skills.

We aim to conduct a more in-depth analysis of actual drawing ability in the future, to explore and perhaps verify the findings derived from self-perceived drawing ability.

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