"If D&T wasn't so easy, I wouldn't be so good at it": Nonverbal Ability and Confidence.

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ABSTRACT

At the heart of this paper is a belief that the English education system enacts systemic discrimination against nonverbally intelligent students by teaching and assessing non-academic subjects via academic means. This paper presents action research that focuses on students with a nonverbal bias, attempting to boost their self-efficacy (Bandura et al., 1999), self-concept (Bong & Clark, 1999), and discusses how these may be hurt by current D&T assessments. The study examines the comparative perception of intelligence levels needed to succeed in school subjects, alongside the types of intelligences assessed within English educational policy.

To boost intelligences specific to design, this research took a two-pronged approach; verbally promoting high-attaining students and presenting their outstanding book work in the spirit of Gardner's Multiple Intelligence theory (Gardner, 2006), and testing for "eductive" problem-solving intelligences (Raven et al., 1994) at the beginning of each class in a 6-week Scheme of Work with Raven's Progressive Matrices (RPM), logged publicly on a leaderboard in the classroom. The results reveal a positive shift in whole-class perceptions of intelligence needed for D&T, and increased confidence levels among students on the leaderboards, alongside decreased confidence levels of those not on the leaderboards. The study acknowledges limitations in the methodology, particularly an overemphasis on RPM, which subjugated other aspects of intelligence in design, and my own inadvertent acculturation into the quantitative testing culture.

The conclusion acknowledges failures in the research, yet emphasises the need for a cultural shift in English state schools to recognise and respect the non-academic intelligences required to succeed in creative fields like D&T. It highlights the inadvertent discrimination against nonverbally intelligent students due to the dominance of academic culture and advocates for a more tailored approach to D&T assessment which better reflects abilities used in real-world design industries.

Keywords: Design and Technology Education, Self-efficacy in Design and Technology Education, Self-concept in Design and Technology Education, Nonverbal Intelligence, Nonverbal ability discrimination.

1. INTRODUCTION

During my teacher training placements, I became aware that highly capable teachers and students in the Design and Technology (D&T) department considered themselves unintelligent due to a lack of literacy, working memory or low attainment in academic subjects such as English, mathematics or sciences – this is despite being highly adept with their analytical problem-solving, draughtsmanship and manufacturing abilities. Furthermore, I was sceptical that the D&T curriculum was an effective way of accessing many of the abilities used in the design industry due to the preoccupation with memory recall and literacy in coursework and exams. These thoughts formed the rationale for this action research, in which I aimed to identify, assess, and celebrate design-specific intelligences to enhance the confidence of students exhibiting these forms of intelligence.

This paper will critically discuss the value and assessment of intelligence types in schools referencing prominent psychologists such as Spearman (Davis et al., 2011) and Gardner (2006). It will then critically discuss self-efficacy and self-concept, referencing esteemed psychologist Bandura (1999). It will then discuss my action research, consisting of a series of nonverbal intelligence tests accompanied by a public leaderboard. Throughout this paper, I will intersperse discussion of English educational policy and reflections on my own experiences in English state coeducational secondary schools as a teacher of D&T.

I propose that the cultural understanding of intelligence in English state schools is predisposed towards verbally biased students, and has led to the denigration of non-academic subjects. I conclude that my intervention positively shifted perceptions of intelligence in my D&T class and boosted the confidence levels of targeted students. However, major limitations include the overemphasis of "eductive intelligence" (Gardner, 2006) with the leaderboard, ethical considerations linked to this, and my inadvertent acculturation into quantitative testing in creative fields.

2. LITERATURE REVIEW

2.1. What do schools consider intelligence?

In my teacher training school placements, I found that many students who excelled in D&T did not consider themselves equally as intelligent as students who achieved similar grades in subjects such as mathematics, the sciences, or English. During an interview, one student commented, "It's not that I thought I wasn't intelligent, I just thought there were people in that room who were more intelligent than me." When questioned further, they replied, "Mainly because I know them in a lot of other subjects. Like there's loads of them in my maths class […] I'm not great at maths." Despite being one of the top-performing students in D&T class, they felt inferior due to their grades in mathematics. This aligns with a key debate within the field of educational psychology; whether individuals have a general intelligence which determines their intellectual capacities across all subjects, or whether there are different types of intelligences which determine different aptitudes for different tasks (Davis et al., 2011). Cultural notions of intelligence can shed light on this.

Modern-day intelligence tests were developed from the work of French psychologist Alfred Binet, who aimed to identify school children with special educational needs in the early 1900s, and English psychologist Charles Spearman, who attempted to develop a measure of general intelligence, or "g" (Davis et al., 2011). The work of these two catalysed a contemporary understanding of intelligence as being a single general measure (Davis et al., 2011). However, in recent decades there have been many challenges to this notion, perhaps the best known is Gardner's theory of Multiple Intelligences (MI), which asserts that the ability to demonstrate one type of intelligence does not guarantee comparable aptitude in a different type of intelligence (Gardner, 2006). Gardner identified eight forms of intelligence which he claimed were autonomous and could be drawn on individually or simultaneously to problem-solve, including "linguistic", "logical-mathematical", "spatial", "musical", "bodily-kinesthetic", "naturalistic", "interpersonal" and "intrapersonal" intelligences (Davis et al., 2011, p485). He argued that only two of these intelligences were being valued and tested for in modern state schools; "linguistic" and "logical-mathematical" – the combination of which he labelled "academic intelligence" (Davis et al., 2011). Indeed, the D&T qualification for the British secondary school (GCSE) consists of 50% coursework with a rigorous amount of written work and 50% memory-recall exam, which is 2-hours long (AQA, 2023). I am troubled that practical work is not highly graded in D&T GCSE assessment, while academic intelligences are. It is reasonable to assume that talented students with non-academic, nonverbal biases may internalise a lack of confidence in the D&T classroom due to this.

However, Gardner has been heavily criticised for failing to establish measures for his eight intelligences, and with the onset of neuroscience, subsequent factor studies have shown no evidence for individual neural processes for these (Waterhouse, 2023). Gardner maintained that his research was based on empirical studies, but did concede that neither psychometric tests, neuroimaging techniques, nor exams yet exist to test aptitude in specific intelligences (Davis et al., 2011). Davis notes that although we have no existing set of tests to measure spatial intelligence, for example, we might conclude that someone is an expert in this if they are a successful sculptor or architect (Davis et al., 2011). Since my subjects were all students, I could not assess their careers. Regardless, my research takes inspiration from the ambitions of the eight intelligences as "intelligence profiles", rather than scientifically falsifiable cognitive measures (Waterhouse, 2023). In search of standardised tests for design abilities, I turned to English educational policy guidelines.

2.2. So how do we test for non-academic intelligences?

Between 2007 and 2010 The Department for Children, Schools and Families (DCSF) released guidelines describing children with "academic abilities" in subjects such as English, science and mathematics as "gifted learners", and children with "applied skills" in subjects such as art and physical education as "talented learners" (Twissell, 2011). These guidelines dictated that gifted learners should be assessed with tests, and talented learners should be assessed through teacher assessment. Twissell argues that this distinction is too simplistic for D&T which does not fit into either category exclusively (Twissell, 2011). Twissell argues that this disparity extends to a lack of D&T-specific assessment, which formed the rationale for his 2011 study assessing whether the Middle Years Information System (MidYIS) and YELLIS Cognitive ability tests (CATs) were appropriate ways to measure "giftedness" in D&T students (Twissell, 2011). The study concluded that new, D&T-specific methods should be used to identify giftedness in D&T students, rather than the existing cognitive tests in place, and suggested measuring student "use of creativity". Twissell never explained how to test for "use of creativity", but he did concede that using the nonverbal subset tests from the CATs exams would be a valid compromise since they draw upon visual-spatial ability (Twissell, 2011). Armed with this information, I approached the SEND hub of my placement school, which presented me with the RPM, a nonverbal test for problem-solving and the processing of visual information (Frost et al, 2018). This widely used nonverbal measure seemed to adhere to the recommendations of both Twissell and Gardner, transcending literacy and academia, accessible to students with English as an additional language (EAL) and to some students with special educational needs and disabilities (SEND) (Frost & Ottem, 2018, p. 265). RPMs focus on a subset of nonverbal intelligence named "eductive" ability (Raven et al., 1994, p. 22), which I will explore below.

2.3. Confidence.

Confidence is described by several psychological constructs, with two of the most prominent being related but distinct; self-efficacy and self-concept (Bong & Clark, 1999). Bandura defined self-efficacy as the confidence one has in their ability to execute certain behaviours to achieve specific outcomes (Bandura et al., 1999). Fouad and Smith created a self-efficacy scale for middle-school students (Fouad et al., 1997), which was adapted further by Panorama Education to create a survey intended to gauge subject-specific self-efficacy (Panorama Education, 2023). I adapted these to compare confidence across twelve core subjects (figure 1).

However, the interests of this paper do not lie solely with students' confidence in their D&T ability, but also with their perception of the value of that ability. To address this, self-concept is useful in discussing the self-perception of students in more general terms (Bong & Clark, 1999). Frost and Ottem (2018) found that "academic self-concept" depends on performance in verbal, nonverbal, and reading skills (p. 265). Given the crucial role of verbal and literacy skills in assessing all subjects, individuals with a nonverbal bias might develop a negative academic self-concept, including in D&T, even if they excel in nonverbal tasks that are essential for design-related abilities. For this reason, I adapted the second survey (figure 2) to compare perceptions of how intelligent a student needs to be to do well in each core subject. By doing this I hoped to gauge whether students with high levels of self-efficacy in D&T might also show low levels of self-concept by ranking D&T as requiring little intelligence.

2.4. Leaderboard and trophies.

During my teaching placements, I observed highly effective behaviourist-inspired extrinsic reward systems (Karpov, 2014) such as public charts with gold stars, "student of the lesson" affirmations or class-quiz league tables. Inspired by these, I created a leaderboard for the RPMs to instil a sense of pride and kept plastic trophies on display for the winners. The ceremony of revealing results each class catalysed excitement and prestige associated with "eductive intelligence". However, Kohn discusses the pitfalls of extrinsic motivators and explores how they might undermine intrinsic motivation and creativity (Kohn, 1999). In my research I found the leaderboard to inspire confidence, however, it seemed to overpower the verbal persuasion I was using in class, ultimately leading to the RPMs subjugating any other form of intelligence praised, as I will discuss below.

Figure 1.

Survey A, taken in lesson 1 and lesson 9, before and after the intervention.

How confident are you that you can do the hardest work that is assigned in your subjects?

Art & Design	Not at all confident	Slightly confident	Somewhat confident	Quite confident	Extremely confident
Design & Technology	Not at all confident	Slightly confident	Somewhat confident	Quite confident	Extremely confident
English	Not at all confident	Slightly confident	Somewhat confident	Quite confident	Extremely confident
Geography	Not at all confident	Slightly confident	Somewhat confident	Quite confident	Extremely confident
History	Not at all confident	Slightly confident	Somewhat confident	Quite confident	Extremely confident
ICT & Computer Science	Not at all confident	Slightly confident	Somewhat confident	Quite confident	Extremely confident
Mathematics	Not at all confident	Slightly confident	Somewhat confident	Quite confident	Extremely confident
Music	Not at all confident	Slightly confident	Somewhat confident	Quite confident	Extremely confident
Modern Foreign Languages	Not at all confident	Slightly confident	Somewhat confident	Quite confident	Extremely confident
Physical Education	Not at all confident	Slightly confident	Somewhat confident	Quite confident	Extremely confident
Religious Education	Not at all confident	Slightly confident	Somewhat confident	Quite confident	Extremely confident
Science	Not at all confident	Slightly confident	Somewhat confident	Quite confident	Extremely confident

Name: .... Class: ....

Figure 2.

Survey B, taken in lesson 1 and lesson 9, before and after the intervention.

How intelligent do you need to be to do well in these core subjects?

Art & Design	Not at all intelligent	Slightly intelligent	Somewhat intelligent	Quite intelligent	Extremely intelligent
Design & Technology	Not at all intelligent	Slightly intelligent	Somewhat intelligent	Quite intelligent	Extremely intelligent
English	Not at all intelligent	Slightly intelligent	Somewhat intelligent	Quite intelligent	Extremely intelligent
Geography	Not at all intelligent	Slightly intelligent	Somewhat intelligent	Quite intelligent	Extremely intelligent
History	Not at all intelligent	Slightly intelligent	Somewhat intelligent	Quite intelligent	Extremely intelligent
ICT & Computer Science	Not at all intelligent	Slightly intelligent	Somewhat intelligent	Quite intelligent	Extremely intelligent
Mathematics	Not at all intelligent	Slightly intelligent	Somewhat intelligent	Quite intelligent	Extremely intelligent
Music	Not at all intelligent	Slightly intelligent	Somewhat intelligent	Quite intelligent	Extremely intelligent
Modern Foreign Languages	Not at all intelligent	Slightly intelligent	Somewhat intelligent	Quite intelligent	Extremely intelligent
Physical Education	Not at all intelligent	Slightly intelligent	Somewhat intelligent	Quite intelligent	Extremely intelligent
Religious Education	Not at all intelligent	Slightly intelligent	Somewhat intelligent	Quite intelligent	Extremely intelligent
Science	Not at all intelligent	Slightly intelligent	Somewhat intelligent	Quite intelligent	Extremely intelligent

Name: .... Class: ....

2.5. Culture wars.

Following my literature review, I realised that my concerns about D&T extended further than I initially thought. Given the impact of cultural context on confidence (Bandura et al., 1999), and the education sector's bias towards academic intelligence (Gardner, 2006), I was persuaded that England needs a significant cultural shift to address this (Fouad et al., 1997). This was beyond my study's scope, so I focused on my Year 8 D&T class, celebrating various intelligences not typically recognised in English state schools. I will now discuss how I attempted this.

3. METHODOLOGY

3.1. Sample and Action Research.

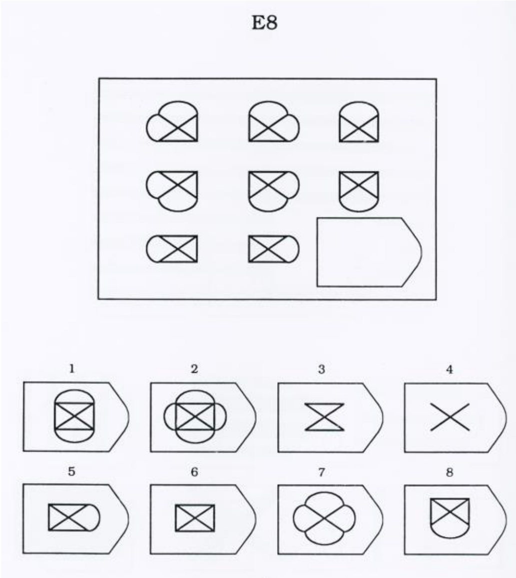
The intervention was conducted with 21 Year 8 students in a mixed-ability D&T class at a rural Norfolk secondary school, with 11 male and 10 female students. 2 were ethnically Black, 17 White British and 2 White European, with 2 EAL, 9 SEND, and 6 Pupil Premium students. To actively address issues and improve teaching, I utilised action research (Cohen et al., 2011), yielding both quantitative and qualitative data through surveys, tests, bookwork, interviews, and triangulating findings with previous grades and discussions with previous D&T teachers. Only the most relevant data gathered is presented in this paper. Since my sample was limited to one year-eight class of 21 students, the results from my research are not generally applicable but rather serve as a case study from which further inquiry could arise.

3.2. RPM and Surveys.

RPM tests (figure 3) were conducted in silence in the first 10 minutes of each class throughout the six-week SoW (table 9). They were completed in books, marked after each class, and scores averaged with 3 to 7 frontrunners entering a public-facing leaderboard. This was revealed at the beginning of the next class, before eliciting answers from the frontrunners. The data was logged and analysed lesson-by-lesson, with triangulation of data allowing for comprehensive analysis of who presented design-specific intelligences, alongside demographic differentiations (Cohen et al., 2011).

Quantitative data was logged from Surveys A and B (figures 1 and 2, tables 1-8) in the first and last classes of the intervention. Following the intervention, I conducted semi-structured interviews with the leaderboard students to gain rich qualitative data about their perceptions of D&T, their confidence, intelligence, and whether the leaderboard had changed these.

Figure 3.
Example question from the RPM test from set E, testing "eductive" nonverbal ability.



3.3. SoW.

The SoW, "Designing Our Tomorrow" (DOT), developed by Nicholl and Hosking (2009), required students to empathise with arthritic, visual impairment sufferers and design for their needs, employing a range of intelligences Gardner would call "interpersonal", "spatial", "bodily-kinesthetic" and others. I adapted this SoW, significantly reducing the amount of literacy required to excel. I made use of Gardner's MIs, identifying and praising students who exhibited them, and included student examples in presentations to enhance learning from peers, consistent with self-efficacy boosting methodology mentioned by Fouad and Smith (1997, p.21).

4. RESULTS

4.1. Perceptions of confidence and intelligence.

As tables 1-4 show, my intervention led to an average increase in respect for D&T, rising from 3.1 to 3.3, but self-efficacy in D&T decreased from 3.33 to 3.15. However, in tables 5-8 we can see that students on the final leaderboard showed respect for D&T rising significantly more, from 3, to 3.71, and their confidence rose from 3.71 to 4.

Table 1.
Table showing whole class averaged student indications of "HOW CONFIDENT ARE YOU THAT YOU CAN DO THE HARDEST WORK THAT IS ASSIGNED IN YOUR SUBJECTS?" in lesson 1 (Survey A).

Subject	Average self-efficacy in the subject - lesson 1
1) P.E.	3.57
2) English	3.43
3) Science	3.38
4) DT	3.33
5) Mathematics	3.29
6) History	3.24
7) ICT	3.19
8) Geography	2.86
9) Art and Design	2.81
10) Music	2.76
11) R.E.	2.67
12) MFL	2.52

Table 2.
Table showing whole class averaged student indications of "HOW CONFIDENT ARE YOU THAT YOU CAN DO THE HARDEST WORK THAT IS ASSIGNED IN YOUR SUBJECTS?" in lesson 9 (Survey A).

Subject	Average self-efficacy in the subject - lesson 9
1) P.E.	3.55
2) History	3.5
3) Science	3.4
4) English	3.3
5) Mathematics	3.25
6) DT	3.15
7) Music	3.1
8) ICT	3
9) Art and Design	2.95
10) Geography	2.8
11) R.E.	2.75
12) MFL	2.65

Table 3.
Table showing whole class averaged student indications of "HOW INTELLIGENT DO YOU NEED TO BE TO DO WELL IN THESE CORE SUBJECTS?" in lesson 1 (Survey B).

Subject	Average intelligence needed for the subject - lesson 1
1) Science	4.33
2) Mathematics	4.29
3) English	3.86
4) ICT	3.57
5) History	3.29
6/7) Art / Geography	3.19
8) MFL	3.14
9) DT	3.1
10) Music	2.9
11) P.E.	2.71
12) R.E.	2.48

Table 4.

Table showing whole class averaged student indications of "HOW INTELLIGENT DO YOU NEED TO BE TO DO WELL IN THESE CORE SUBJECTS?" in lesson 9 (Survey B).

Subject	Average intelligence needed for the subject - lesson 9
1) Science	4.19
2) English	3.76
3) Mathematics	3.71
4) ICT	3.52
5) DT	3.33
6) History	3.31
7) P.E.	3.24
8) Art & Design	3.14
9) MFL	3.05
10) Music	3
11) Geography	2.95
12) R.E.	2.73

Table 5.

Table showing averaged final leaderboard students' indications of "HOW CONFIDENT ARE YOU THAT YOU CAN DO THE HARDEST WORK THAT IS ASSIGNED IN YOUR SUBJECTS?" in lesson 1 (Survey A).

Subject	Average self-efficacy in the subject - lesson 1
1) P.E.	3.86
2,3,4) DT / ICT / Music	3.71
5) History	3.57
6) Art and Design	3.43
7) English	3.29
8) Maths	3.14
9) Science	3
10,11) R.E. / MFL	2.86
12) Geography	2.57

Table 6.

Table showing averaged final leaderboard students' indications of "HOW CONFIDENT ARE YOU THAT YOU CAN DO THE HARDEST WORK THAT IS ASSIGNED IN YOUR SUBJECTS?" in lesson 9 (Survey A).

Subject	Average self-efficacy in the subject - lesson 9
1) History	4.14
2,3,4) Art / DT / Music	4
5,6) P.E. / ICT	3.71
7) Science	3.43
8,9,10) English / Maths / R.E.	3.29
11,12) MFL / Geography	2.43

Table 7.
Table showing averaged final leaderboard students' indications of "HOW INTELLIGENT DO YOU NEED TO BE TO DO WELL IN THESE CORE SUBJECTS?" in lesson 1 (Survey B).

Subject	Average intelligence needed for the subject - lesson 1
1) Mathematics	4.14
2,3) ICT / Science	4
4) Music	3.71
5) English	3.57
6) Art and Design	3.43
7) History	3.29
8,9,10) DT / Geography / MFL	3
11) P.E.	2.86
12) R.E.	2.29

Table 8.
Table showing averaged final leaderboard students' indications of "HOW INTELLIGENT DO YOU NEED TO BE TO DO WELL IN THESE CORE SUBJECTS?" in lesson 9 (Survey B).

Subject	Average intelligence needed for the subject - lesson 9
1,2) Science / ICT	4.14
3) English	4
4) Mathematics	3.86
5,6,7) DT / History / MFL	3.71
8,9) Art and Design / Music	3.57
10) R.E.	3.14
11) P.E.	3
12) Geography	2.57

4.2. RPM.

Table 9.
Table showing the scores per Set of Raven Progressive Matrices (RPM). The students who entered the leaderboard are highlighted in yellow, with the students on the final leaderboard in green. There were 7 leaderboards in total, with no leaderboard in lesson 1 since frontrunners were not yet apparent.

Student	Set A	Set B	Set C	Set D	Set E	Total	Average	Nonverbal Y7 CAT scores
Student 1	12	7	8	0	7	34	6.80	101
Student 2	6	6	3	8	0	23	4.60	74
Student 3	12	12	9	10	6	49	9.80	95
Student 4	12	12	11	10	7	52	10.40	103
Student 5	12	12	11	11	8	54	10.80	109
Student 6	11	0	5	0	0	16	3.20	110
Student 7	11	10	8	6	2	37	7.40	-
Student 8	12	11	8	1	5	37	7.40	77
Student 9	12	12	11	11	8	54	10.80	95
Student 10	12	12	9	8	6	47	9.40	102
Student 11	12	11	10	9	7	49	9.80	104
Student 12	11	10	12	11	8	52	10.40	114
Student 13	0	11	10	9	7	37	7.40	107
Student 14	12	11	9	8	2	42	8.40	84
Student 15	12	12	9	10	7	50	10.00	98
Student 16	12	11	10	9	7	49	9.80	122
Student 17	12	12	4	11	8	47	9.40	103
Student 18	11	12	11	9	7	50	10.00	114
Student 19	12	12	9	9	9	51	10.20	104
Student 20	1	12	11	11	9	44	8.80	108
Student 21	12	11	6	9	6	44	8.80	103

4.3. SEND students.

5 of 9 SEND students were on the final leaderboard. On average, these students' perceptions of D&T intelligence shifted from 3 to 3.8, with their confidence rising from 3.8 to 4. On average, their confidence across all subjects rose from 3.45 to 3.67, with the largest shifts in art, +0.8, history and R.E., +0.6, and seeing a drop in confidence in both language-based subjects, English and MFL, -0.4.

4.4. Interviews.

Following the intervention, I interviewed 8 students who had entered the leaderboards. This was in pairs. They unanimously discussed disbelief at their achievement, with statements such as “If I'm completely honest, I was just like ‘maybe it was just like all the guesses I got correct’”, and “I’m shocked! [...] I hoped I’d be, but I didn't think I would be.” Two students initially thought it was a mistake in my marking. Three discussed how some of their classmates were better in maths and science classes, so they assumed those students would do better across all classes, and discussed their lack of confidence due to a lack of academic ability, working memory, and literacy skills.

All these students appeared to sit a little taller and further forward, holding their trophies and eager to discuss their experiences. They identified very positively with entering the leaderboard, expressing confidence in themselves and each other with statements such as; “We’re very proud”, and “excited”, and “Oh, my God, I actually know this stuff”, and “I was so proud of you when I saw you joined us on the leaderboard”.

The two highest-scoring students in the RPMs, Students 5 and 9, discussed enjoying this D&T unit because there was no physical making. They explained that neither of them had finished making their product in the previous D&T rotation and had little ability in manufacturing. CAT scores indicated “mild verbal biases” for both, predicting lower attainment in D&T.

5. DISCUSSION

The results suggest this intervention raised the status of D&T in my class and boosted the confidence of students on the leaderboard. However, I believe basing the leaderboards solely on RPM was a limitation, as it failed to celebrate other design abilities and perpetuated the idea that the students with the best RPM scores were the best designers. The top two students on the leaderboard self-indicated low manufacturing abilities in the interview, and Raven conceded that there are many kinds of meaning-making activities which the RPM cannot highlight (Raven et al., 1994). By triangulating the RPM results with CAT scores and bookwork, I have concluded that the RPM was not the correct metric with which to form the leaderboard.

Student 16, for example, never entered the leaderboard, but had the highest nonverbal CAT scores in the class and demonstrated excellent bookwork (table 9). Their teacher-assessed work demonstrated more complex problem-solving and draughtsmanship than leaderboard students such as 3, 10, 17, 18 or 19. The survey results suggest that this damaged student 16’s confidence.

It is a similar situation for students 20 and 21, making this a key theoretical and ethical failing of my intervention, consistent with Kohn's discussions of extrinsic motivators as potentially demotivating (Kohn, 1999). However, the leaderboard did significantly boost whole-class engagement, and the confidence of those entering it, and I would assert that the top five in the RPM leaderboards were among the top six students in the D&T class, based on bookwork.

Six of the nine students who entered the leaderboard were SEND students. When interviewed, they unanimously discussed disbelief at entering the leaderboards, describing a lack of academic ability and working memory, demonstrating the severity of bias for verbal/academic assessment and for the impact on their self-concept. Much like Spearman's "g" measure of intelligence (Davis et al., 2011), they expected students who excelled in verbal/academic subjects to excel in the RPM tests too. I posit that this betrays a cultural bias towards verbally intelligent students, with sinister ramifications for what we label as SEND.

6. CONCLUSION

At the heart of this paper was a belief that the English education system enacts systemic discrimination against nonverbally intelligent students by teaching and assessing non-academic subjects via academic means. My aim was to disrupt this culture by celebrating non-academic intelligences in non-academic classes. The leaderboard was a powerful tool, and the shift I logged in SEND student attainment and confidence supported my expectations. However, my reductive focus on testing for "eductive" intelligence failed to celebrate many other forms of intelligence needed to create high-level design and possibly damaged the confidence of students with potential. For these reasons, I would continue to use the leaderboard, but with a far greater focus on teacher-assessed bookwork. Nationally, I would urge for a change in the way we assess D&T; dropping memory-based exams entirely, lessening the emphasis on literacy, and dramatically boosting the assessment of intelligences used in design industries such as problem-solving, draughtsmanship, and the ability to conceptually and physically manipulate in three-dimensional space.

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