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GIFTED AND TALENTED MATHEMATICIANS

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Part of the provision for members of the government funded National Academy for Gifted and Talented Youth (NAGTY) includes two week summer schools hosted by various higher education institutions across the country. In this paper we explore the responses of young people on a mathematics summer school for 11-16 year olds held at Lancaster University and tutored by mathematics educators. Two main areas are considered: the students' attitudes towards being labelled as 'gifted and talented' and their mathematical experiences during the summer school.

INTRODUCTION

The National Academy for Gifted and Talented Youth (NAGTY) was established by the British government in 2002, amongst its aims is the '*driving forward of improvements in gifted and talented education*'. NAGTY is part of an integrated and inclusive approach to gifted education whereby pupils who are identified as 'Gifted and Talented' remain within mainstream education but are provided with additional support and opportunity.

NAGTY's student academy deals with 5% of the student population aged 11-19 years which is approximately 200 000 students; current membership is approximately half this and rising. The ethos underpinning the academy is that whilst many gifted and talented youngsters do go on to achieve highly this is not in practice always the case. Support and opportunity are therefore provided to allow students to develop their talents. (Eyre, 2005). Students are selected to become members of the academy, in other words defined to be the top 5% of the student population, by being recommended according to a variety of potential supporting criteria. Evidence could include results from cognitive ability tests, national tests, UK Mathematics Challenge or world class tests. Non-test evidence could take the form of a recommendation from a teacher or evidence of extra-curricular achievement and potential for example outstanding chess success in a national competition. A range of behaviours have been attributed to able mathematicians see for example Straker (1983).

Two-week residential summer schools are hosted by a number of universities around the country and the provision is inspected by Ofsted. Students apply, with support from their school, to the summer school of their choice. Means tested bursaries are available to enable students from diverse socio-economic backgrounds to participate.

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THE LANCASTER UNIVERSITY MATHEMATICS SUMMER SCHOOL

The course was designed with the intention of giving students the opportunity to use mathematics as a way of perceiving and making sense of the world as exemplified by Cole (1998). 'Using mathematics to make decisions' was the main theme. The mathematical activities offered were accessible, open-ended and challenging. The purpose of the activities was to enrich and extend but not specifically to accelerate. This meant that we did not confine ourselves to National Curriculum content, for example game theory was included which is typically undergraduate course content. The enrichment approach to working with Gifted and Talented pupils in England is well established and an issue upon which generally mathematics educators have a general consensus of opinion (Gardiner, 2003). Enrichment offers access to all learners as it is not reliant upon content coverage (Piggott, 2004).

Approximately one-third of the time students spent working in small groups on a chosen environmental issue. This approach was selected as co-operative group work can enhance pupil learning as well as boosting confidence in mathematics through the use of peer support (Askew & Wiliam, 1995). The groups engaged with the Data Handling cycle (DfEE, 1999): identifying a question, researching data (largely web-based), analysing the data and presenting their findings to the other groups. The rest of the course was spent working on mathematics that encouraged the students to appreciate and develop mathematical perspectives on a range of situations.

The students were exposed to many differing perspectives upon what it means to be a mathematician as sessions were run by mathematicians from industry, business and higher education. A mathematician from the government Fisheries Agency showed how probability modelling is used in monitoring fish stocks. Many of these session leaders talked about what being a mathematician meant to them and the qualities of a mathematician, for example when the students worked on the mathematics of paper folding with a colleague from St. Martin's a dialogue developed about perseverance skills.

Twenty two students from all over England started the summer school, one boy left after a few days. Two students had attended a NAGTY summer school before. The table below summarises who completed the summer school.

Age	*Boys*	*Girls*
11		*1*
12	*1*	
13	*7*	*5*
14	*1*	*2*
15	*2*	*2*
Total	*11*	*10*

The students were always willing to have a go at whatever was offered and they generally showed sensitivity towards one another, offering additional explanations and support. Some students would take the opportunity to go beyond what was on offer, for example in a session on locus, two students worked with a tutor to derive the equation for a parabola while others preferred to construct curves of pursuit.

As might be expected with an age range of 5 years there was a considerable diversity in the mathematical skills of the students. Some were extremely comfortable with algebra and felt they weren't doing mathematics if they weren't writing down an equation. Many were surprised that they could spend a fortnight doing mathematics without a textbook or worksheet. We did have a selection of books for the students including dictionaries and books of recreational mathematics puzzles and problems, however most students were not familiar with such resources.

What does it mean to be gifted and talented?

It became evident during the course that the students had a range of perceptions about what it meant to be 'gifted and talented' so just over half way through the summer school students were invited to work in groups of 3 or 4 to consider the question 'what does it mean to be gifted and talented?'. The students produced posters based on their discussions of the question. It is worth noting that by this stage students felt very comfortable with one another and were keen to share their experiences.

Six posters were produced and *'opportunity'* was common to five. Students perceived that they had additional opportunities such as summer schools and outreach events which their school peers didn't have. Several posters made reference to self-image: *'makes you feel special', 'gives you strength in yourself', 'we have lots of potential'*. Comments about academic ability included '*we are in the top 5% of the country for our age', 'being intelligent', 'smart', 'surpassing academic levels in one or more subjects – gifted', 'better test results'*.

Whilst much of the poster content was positive there were some common concerns '*you get called a boff or swot', 'people call you names because they are jealous'* and *'more is expected from you'*.

In the ensuing discussion the students were unclear about the definitions used for gifted and talented, particularly what it meant to be in 'the top 5%'. The concerns raised on a small number of posters proved to be a common experience: most students had been victims of name calling and other bullying and students spoke of feeling under pressure to do well from teachers, parents and friends. Some students said that they felt they set themselves unrealistically high expectations because of this external pressure.

The government's aim in labelling young people 'gifted and talented' is about helping to ensure that their potential is optimised by offering opportunities and support. The students on the mathematics summer school recognised the

opportunities that were available to them, but none mentioned the additional support. Indeed the raised expectations of teachers and parents may be placing undue pressure on young people. The public labelling of young people also makes them targets for bullying by their peers as they have been identified by the system as 'different'.

Self Assessments

At the end of the summer school students were invited to complete a self assessment giving details of what they thought they had learned during the summer school. They were encouraged to use their diaries and not to simply list what they had done in sessions.

All the students completed a self assessment and made reference to aspects of mathematics that they had particularly enjoyed during the summer school. The table below summarises the areas of mathematics students identified.

Golden ratio	*13*	*Population simulation*	*6*
Fibonacci numbers	*10*	*Conic sections*	*4*
Loci	*10*	*Quadratic equations*	*4*
Paper folding	*9*	*Mazes*	*4*
Game theory	*9*	*Other topics**	*4*

* These included: Pythagoras' theorem, constructions, probability and relationships between shapes.

Fourteen students made explicit reference to mathematical processes including problem-solving, extending the problem, looking for patterns, generalising, explaining and justifying solutions found: *'…if I had got an answer, I would then go on to ask why and what would happen if I changed something'*.

During the summer school students were encouraged to work within different groups and seven students mentioned this in their self assessments *'we were put into different groups…we had to use teamwork … to work effectively'. 'Co-operation has been a key to success on this course…'.*

Whilst the summer school was not explicitly about having fun and enjoying mathematics five students explicitly mentioned *'fun'* in their self assessments and hoped to take their enjoyment back into school *'I would like to show my teachers what I have done … bring some aspects I have learnt … to liven up some lessons while having fun but still learning'. 'After experiencing this way of learning – the **fun** approach, I doubt that I will be able to accept the 'textbook' way of teaching my school has adopted'.*

Three students made reference to developing their personal confidence and personal skills such as communication, presentation, academic and social. Some students identified future aspirations including making more use of ICT in mathematics (three students) and studying mathematics to a higher level (two students).

One of the aims of the summer school was to develop mathematical awareness, by this we mean the ability to use mathematics as a way of perceiving and making sense of the world. More than half of the students made explicit reference to mathematics in other areas in their self assessments. These other areas included science, nature, decision making, environmental issues, business, crime and terrorism.

CONCLUSION

One aim of the summer school was to raise the students' mathematical awareness in a variety of ways. Whilst much of what students noted down in their diaries was content driven their self evaluations indicate some success as more than half the students said that they could see how mathematics was relevant in other areas and nearly all the students identified mathematical thinking/problem-solving skills as areas in which they had developed. Many students indicated that their views about mathematics had changed as a result of the summer school. Perhaps they had the opportunity to 'play' in the garden rather than walk around the outside glimpsing through cracks in the fence!

The students' perceptions of what it means to be 'gifted and talented' reveal a mismatch between the government's stated purpose and their experiences. Whilst students recognise and enjoy access to opportunities they don't necessarily get extra support. The fact that students are likely to be victims of bullying from their peers and subject to pressure for exceptional performance from teachers and parents suggests that support is essential. Those responsible for identifying 'gifted and talented' students need to be acutely aware of the potential consequences and ensure there is adequate provision to deal with them.

To develop this work further we would want to find out to what extent our sample of twenty-one students is typical of the 'gifted and talented' population. Are mathematicians different? We would also like to be able to follow students who have attended a NAGTY mathematics summer school – do they go on to study mathematics at school (and beyond) successfully? Hmm…..

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