The Role of Competitions in a Mathematics Programme

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Abstract

What role do competitions play in a mathematics programme for our students, especially our gifted and talented students? This question is examined from the perspectives of fifteen students (10-13 year olds) identified by their schools as mathematically gifted and talented, their teachers, and their parents. Students participated in variety of different types of mathematics competitions – local, national, and international. There was differential access to the competitions and differing perspectives; students and parents shared similar views about the value of competitions, but there was a difference of opinion among the teachers.

Introduction

Competitions are viewed as an important part of the educational provisions for gifted and talented students (Renzulli, 1994; Riley & Karnes, 2007) and part of the recommended continuum of differentiated opportunities (Ministry of Education, 2000). In a national review conducted in 2004, 66.4% of schools (n=809) reported competitions as one of the school-based provisions for gifted and talented students across all areas of ability (Riley, Bevan-Brown, Bicknell, Carroll-Lind, & Kearney, 2004). The area in which competitions was most commonly utilised was in the domain of physical and sport abilities followed by the intellectual/academic domain.

Competitions can also be used as part of the multiple method identification process. Moreover, they offer students the opportunity to strive for personal achievement and to compare themselves with others. They are a means for “providing an encouraging environment in which gifted students compete, excel, and are honoured for their abilities” (Grassl & Mingus, 1999, p. 291). Karnes and Riley (1996) suggested that competitions also enhance students’ self-directed learning skills and sense of autonomy.

The primary goals of mathematics competitions are to increase motivation, excitement and interest in mathematics, and to provide schools and parents with information about more able students. A competition result provides one measure of a student’s mathematical ability and discriminates ability levels of individuals at the participant’s level. Preparation for a competition in mathematics may demand targeted independent study as many competitions require rapid and accurate answers under pressure. Some competitions in mathematics, such as those organized by local mathematics teachers’ associations, include group problem solving activities where team work and collaboration are important. However, most competitions rely on independent problem solving abilities. Success in mathematics competitions, Ridge and Renzulli (1981) warned, is indicative of a particular type of mathematical talent and tells us little about the slower more logical formal type of mathematical talent.
Motivation from competitions can also be extrinsic, resulting in certificates and awards, selection for other competitions, and recognized prestige. Udvari (2000) in a comprehensive analysis of the literature on competitions, concluded that “learning to deal with competition in a constructive manner is essential for gifted children, especially given the competitive nature of Western culture and the central role of competition in high-level achievement” (p. 215). This view was supported by Riley and Karnes (1998/99) who declared that “the opportunities to tap and showcase kiwi talent far outweigh the negative elements often associated with competitions” (p. 25). The negative outcomes, cited by Davis, Rimm, and Siegle (2011), were stress and feelings of failure from excessive competitiveness. It is important to note that not all competitions are designed well. Rusczyk (2012) provides a caution that if the competition emphasizes speed and memorisation they may encourage students to value such skills, instead of emphasizing the ability to think about and solve challenging problems. Students should also not be faced with problems that extend beyond their ability which could be discouraging. There is little research reporting the effectiveness of competitions in meeting the unique cognitive, social, and emotional needs of gifted and talented students. Campbell, Wagner, and Walberg (2000) acknowledged the need for such empirical research, but warn of the dilemma given the role of sponsorship that exists with many competitions. Research has focused more on Mathematics Olympiad students (see, for example, Campbell Wagner, & Walberg 2000), but not on younger students. Consequently this research-based article focuses on the role of competitions for younger students and is based on multiple perspectives: students’, parents’, and teachers’.

The New Zealand setting

In New Zealand schools, we have a range of local, regional, national, and international opportunities for students to compete against their own and others’ mathematical abilities in individual and team competitions, problem solving events, projects, and assessments. This range of challenges spans primary through to secondary-aged students, meeting the needs of many levels of ability, from developing expertise to exceptional, expert-like skills. In this section of the article, we highlight some details for the mathematical competitions in New Zealand, but encourage readers to visit their websites (included in the resources section at the end of this article).

At the local or regional level, we have competitions such as Canterbury’s Cantamaths, Hawkes Bay’s Mathletics, and Manawatu’s Mathex. These mathematics competitions are designed for primary, intermediate, and junior secondary school students. Typically, these competitions provide opportunities for selected teams of students to answer mathematical questions in a timed environment. These mathematical questions include both computations and practical tasks, such as constructing three-dimensional models. Schools prepare students and sometimes host their own events for deciding which students will represent them. Some of these local events also have independent competitions; for example, Cantamaths offers students in years 6 to 10 independent project challenges, such as creating a computer generated design, publicity motif, mathematical poster, geometrical design, geometrical design, or mathematical model.
The *Otago Problem Challenge* is a maths problem competition for children in years 7 and 8, but may be of interest to mathematically gifted children in year 6. This competition began in 1991 and reached its peak in 2002 when some 728 schools entered more than 42,000 children, of which 3,800 were in year 6. Children individually solve five questions in 30 minutes, but share their answers and strategies in small groups. The problems are aimed at more able children and all participants receive a certificate of participation and awards are given to the top one percent of participants.

Many New Zealand students in years 4 to 13 participate in the *International Competitions and Assessments for Schools* (ICAS, commonly referred to as the Australasian Schools Competitions) conducted by the University of New South Wales. This competition is comprised of a suite of assessments for primary and secondary students to provide diagnostic information about their abilities in core skills in areas such as science, mathematics, and English. It is expected that the assessments help identify students with particular talents.

The *Mathematics Olympiads* are intended for the crème de la crème of mathematically gifted and talented secondary school students and give opportunities for students to attend mathematics camps and to continue, if selected, to compete internationally. These Olympiads are now part of *Science OlympiadNZ*, along with the Olympiads in biology, chemistry, Future Problem Solving, geography, informatics or physics. This organisation tries to ensure that all gifted and talented students in mathematics have the opportunity to participate in an Olympiad or tournament and the secondary school students who compete in these international competitions are among the brightest and most technologically savvy in the country. New Zealand students excel internationally, winning, for example, 2 silver medals, 2 bronze medals and 2 honourable mentions, and maintaining their rank as 29th in the world, in 2011.

Another event for secondary students is the *Senior Mathematics Competition*, hosted by the New Zealand Association of Mathematics Teachers and currently sponsored by Eton Press and Casio. This competition is open to all year 12 and 13 students, with top competitors battling it out in Wellington for cash prizes, gifts, and certificates of recognition.

*Mathematics Achievement Challenge* is designed to extend and enrich students in mathematics at Levels 3 and 4 of the New Zealand Curriculum (Ministry of Education, 2007). The objective is that students complete in-depth mathematical investigations that are challenging and relate to everyday life. The students are encouraged to complete the challenges at school or at home. These challenges do not really fit the category of competitions as such, but are used by teachers to provide enriching, extra challenges for the more able students in mathematics.

**The research sample and methods**

This study examined, from multiple perspectives, and over a two-year period, the education of a group of fifteen Year 6 and Year 8 students who had been identified by their teachers as mathematically gifted and talented. The group consisted of ten Year 6 students (2 girls, 8
boys) who transferred from primary school to a new school for Year 7, and five Year 8 students (2 girls, 3 boys) who moved to secondary schools for Year 9. In the first phase of the research three schools were involved but after the students made a transition in the following year, eight schools were included in the study.

One purpose of the study was to seek understandings about the educational provisions for mathematically gifted and talented students, including competitions. The students’ mathematical experiences, both past and present were examined using evidence from school policy documents; student, teacher, and parent interviews; questionnaires; and classroom observations. The gifted and talented policy documents from each school were examined to see what provisions were documented and if these provisions specifically included competitions. Thirteen teachers from both phases of the study (pre and post transition) were interviewed about the key features of their mathematics programme and if they used competitions as part of the programme. If competitions were included as part of the provisions, they were asked to elaborate. Students were asked to talk about their mathematics programme, including the role of competitions. The parents (one for each child including 13 mothers and two fathers) were given an opportunity to talk in individual interviews (pre and post transition) about any opportunities for their child to take part in mathematics competitions.

What opportunities were the students given?

Six of the eleven schools (two primary, three intermediate, and one secondary) stated in their policies that gifted and talented students should be given opportunities to participate in competitions. This opportunity in practice relied on factors such as school and teacher organization. All of the teachers in the study valued the use of competitions (for certain students) as part of their mathematics programme. The range of competitions included the Otago Problem Challenge, Mathematics Achievement Challenge, the New South Wales Competition (International Competitions and Assessments for Schools), the Australian Mathematics Trust Competitions, National Bank Competition (from 3 March 2011 known as The Junior Mathematics Competition), and team competitions run by local mathematics teachers’ associations.

The Otago Problem Challenge was valued by some of the teachers and students for its emphasis on problem solving skills. The Achievement Challenge was not so favourably received by students, although the two teachers using the competition felt it was useful as a voluntary enriching activity and to encourage independent work. Students from seven of the schools participated in The Australian Mathematics Competition. There was an expectation that the students in each of the special classes (represented in this study) would compete in the Australian competition each year, although one teacher confessed that in that particular year their entry form had been mislaid. Some students missed out because the teacher or school were late with their entries, or they just did not get around to organizing it in that particular year, and in some schools the opportunity was restricted to only those in the designated ‘gifted’ class. This was the case for one student; he was initially not allowed to participate in the Australian Mathematics Competition because he was not in

The gifted class and at the last minute was allowed to participate, only because of his mother’s perseverance.

The students were very aware of what competitions they had or had not been able to participate in. Most of the students were in favour of being able to participate in competitions and had participated in previous years. If their school failed to send in entries or did not participate in competitions that they had previously competed in, the students were not impressed and the parents expressed disappointment. In two cases, the parents intervened because they knew about the competitions (their children had participated in previous years) and they were annoyed when it became apparent their children had not been registered to participate. The parents felt their children enjoyed the competitions (especially the New South Wales competition) as it gave them a chance to compare themselves with not only others in their group at school, but also with a wider set of students. The students who competed in the Australian competition talked about wanting to obtain distinction. The Australian Competition results, according to the intermediate school teacher, were used as a way of monitoring students’ achievement levels and checking that “there was no slippage”.

There was one case of a student being entered in a mathematics competition that varied to the competitions she had usually competed in. Nina (Year 9) was not impressed with this particular competition. She explained:

> We did do this other one which I didn’t like, the questioning was so different, it asked pointless questions which didn’t test your true academic ability in maths, it asked you strange things ... I got distinction, I didn’t like it; I’m not doing it again. They were just pointless questions like how many acute angles can you have in a polygon with 2001 sides, it was harsh, no calculators. First questions were real easy Year 6 and last ones were ridiculous. I prefer ... [when] it actually asks what you know and what you should know rather than random ones. (Nina-Year 9 student)

All of the schools in the study entered teams in their local competitions. The team competitions were very favourably received by students, parents, and teachers. The students talked about the value of “working together”, the preparation, and how when you have been doing it for a few years “you kinda know what to expect”. It was an opportunity to represent the school. In some cases, the schools held internal preliminary competitions, so even the process of being selected was viewed with a sense of challenge and excitement. In two of the primary schools, the principals with interest and expertise in mathematics took responsibility for the training of the teams for this competition. In most cases, there was deliberate coaching and preparation. It was also viewed as an opportunity for the students to work as members of a team; this feature was acknowledged by students, teachers, and parents.

> It’s good because they have to work within a team and quite often they might be gifted mathematicians who just like to focus on their own and not to problem solve in a

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1 The top 5% of students
group. I think it’s good for them as they may not be used to problem solving in a group. (Year 6 teacher)

Why participate: Multiple perspectives

There was a variety of different competitions referred to by the students, teachers, and parents. Most of the students had experienced the local team mathematics competitions and most had participated at some time in individual national and/or international mathematics competitions. These competitions were viewed favourably by the students and parents.

The students appreciated the opportunity to participate in competitions and recognised the differences between the international ones and the team approach in the local competitions. The most common reason for the individual competitions was the chance to prove themselves among their peers, nationally and in Australasia. Two of the students wanted to make sure they maintained their record of obtaining ‘distinction’. Nearly all of the students had represented their schools in local team competitions and were prepared to practise solving problems as a team. They also recognised the differing types of mathematical abilities within the group. For example, they recognised who was the speediest “number cruncher’, who tackled geometric problems the best, and who was the most confident in solving fractional reasoning problems. The students talked about the strategies they employed in working as a team under the pressure of time and the delegation of problems.

The parents liked to use competitions as an additional way of monitoring their children’s learning through participation and results in competitions. The parents strongly supported competitions and when the opportunity was not given, they usually took some form of action such as contacting the school to make inquiries about the competitions. The parents supported their children’s participation in competitions in monetary terms; the costs were not high and some schools subsidized this expense.

Although the students and parents shared similar views about the value of competitions, there was a difference of opinion among the teachers. Although most of the teachers recognized the benefits of competitions, two teachers expressed some reservations. One teacher explained:

Not all of the students thrive on competition, so I have to be very careful about how I use them. Probably 60 to 70% of this class are more extroverts and like competitions. They have to feel safe and comfortable so I don’t use them at the start when they are sorting each other out and they are afraid to make mistakes. Now they are really comfortable with each other so I can use competitions more. (Year 9 teacher, co-educational secondary school)

The schools that enrolled students each year in the competitions used the results as a form of tracking student progress. Interestingly, both teachers in the boys’ schools associated competitions with gender. One teacher commented; “that determination to get it right. I’ve
noticed that with boys, they thrive on competition”. Similarly, another teacher explained that “competition is part of the programme. A lot of this school is about competition; boys like competition….We foster competition”.

One of the teachers from a co-educational secondary school was ambivalent about competitions. He explained:

Personally, I sit on the fence on it, in some ways I think that it’s good because there are some students who thrive on the challenge and like to compare themselves against others in the world and they find that absolutely inspiring whereas there are others that find it a chore….I don’t force them, it’s upsetting; some just don’t enjoy competition at all. (Head of Mathematics Department)

Conclusion and implications

Competitions were recognized as an integral part of the mathematics programme. Some, but not all, competitions were well received by the students. It depended on the particular competition, with the preference for most of the students being an Australian competition and the local mathematics teachers’ associations’ team competitions. The students liked to be compared with other students outside of New Zealand, yet also enjoyed the opportunity to compete as part of a team in their local setting. The students found competitions motivating; students and parents appreciated the comparative component. These positive attributes are supported in the literature and they should form part of the continuum of provisions (Renzulli, 1994). However, issues were raised about access to the competitions and continued opportunities after a student makes a transition in the school system (such as the move from primary to intermediate school, or intermediate to secondary school). There were not always the same opportunities as experienced in the students’ previous schools.

Competitions should be acknowledged in school policy as part of the mathematics programme. Equitable opportunities should be provided for students to participate in mathematics competitions and ideally a promising student should not be denied opportunities because of the cost factor. Schools could invite students to provide feedback on their experiences so that their participation is taken seriously and not viewed as a separate part of the programme. Competitions can serve as a way of bringing students of ‘like minds’ together so that they find friendship, inspiration, and encouragement from working with others. This may be in preparation for the competition, working on problems from previous competitions, or sharing after a competition.

This study affirms the importance of competitions for gifted and talented students and argues that both individual (national and international) and group mathematics competitions are an important component of any programme for the mathematically gifted and talented. As with other provisions, they should not be utilized in isolation or without careful consideration as to who might benefit and should be planned in advance. However, opportunities to participate in competitions must also be seen as an open and equitable process.
Competitions Resources

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<td>International Competitions and Assessments for Schools</td>
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References


