Mathematics: I Just Know It. Do You? The Gifted Student with Asperger's

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Abstract

Developing effective partnerships between gifted and talented co-ordinators, Asperger's specialist teachers and psychologists can be difficult, given their usual separate focus areas. This study brings together these three areas in an action learning and action research approach in the professional development of teachers of gifted students with Asperger's Syndrome (AS) in a P-12 private college in Queensland. Teachers had expressed confusion about the seemingly opposing aspects of the profiles of these dual exceptional students, and the complexity of addressing their needs in their mathematics classrooms. The findings from the first cycle of the project are reported here. When teachers increase their awareness of the differences of gifted students with AS they become more effective in designing strategies, which are successful in targeting the areas of the students' difficulties, whilst also supporting their strengths.

Introduction and Background

Students' ability to communicate their mathematical thinking is a key element to success in mathematics, especially in Queensland in the senior years at school. Within A.B. Paterson College the "Teaching for Understanding" theoretical framework underpins all curriculum directions. Developed by the Harvard University Project Zero team, the emphasis is on "making your thinking visible", preferably in written form. The rationale is: what students can't explain, they do not understand. Teachers at the college have expressed their frustration and confusion as to why dual-diagnosed gifted students with Asperger's Syndrome (AS) "get the answer", but do not want to explain their mathematical thinking.

Puzzled, also, as to why gifted students with AS appear not to perform to their cognitive ability, teachers have identified difficulties associated with:

- addressing the complex needs of Asperger's students and gifted students, particularly those with a dual diagnosis;
- accessing relevant information to assist them in the development of appropriate strategies; and,

- recognising teaching strategies must be aimed at addressing giftedness and Asperger's.

The "Mathematics: I Just Know It" research project, funded under the "Teachers as Researchers Literacy Numeracy and Special Needs Program - Independent Schools Queensland", came about due to the concerns stated above and those of the school's AS specialist teacher that dual-diagnosed students may be unable to access the same programs available to the gifted students at the college. Neihart (2000) suggests that should it be appropriate that a gifted student with AS be included in gifted programs with schools, that they may not be allowed to do so "because teachers do not know how to make the necessary accommodations".

As members of the Learning Enhancement team, managing gifted students with AS at the college, we have been working collaboratively with the school psychologist since the project's inception in February, 2010. This qualitative study is practice-based, aimed at assisting in building teacher confidence in the value and usefulness of research in practice. The project addresses the following research questions:

1. To what extent do teachers at A.B. Paterson College understand and recognise the strengths and differences of gifted students with AS?

2. How can the gifted students with AS be supported to communicate their mathematical thinking effectively and appropriately?

For the purposes of this study, we have considered Harrison's definition of giftedness:

> A gifted child is one who performs or has the ability to perform at a level significantly above his or her chronologically aged peers and whose unique abilities and characteristics require special provisions and social and emotional support from the family, community and educational context. (Harrison, 1999, p.8)

The literature identifies sets of characteristics for both gifted and AS students. Put together, where the characteristics combine and collide in complex ways (Gallagher & Gallagher, 2002), these dual exceptional students may require interventions and strategies that differ from those used with gifted students or non-gifted Asperger's students (Neihart, 2000). Key characteristics relevant to this study, extracted from Amend, Schuler, Beaver-Gaven and Beights's (2009) checklist, are shown in Table 1. In addition, combinations of AS characteristics may also be present, such as: rigid adherence to routines, difficulties with peer relationships, lack of empathy with others and difficulties in interpreting non-verbal cues.

It is difficult to find research that combines gifted and AS characteristics together into a coherent framework that can be used within the school context. In addition, according to Vanderlinde and van Braak (2010), teachers often have problems in accessing current best practice findings from research and find themselves at a loss as to how to implement those findings.

Table 1. Gifted and Asperger's Checklist

Gifted Students	Asperger's students
Excellent memory for events and facts about a variety of topics	Superb memory for facts and detailed information related to selected topics of special interest
Dislikes rote memorisation tasks although he/she may do it well	Enjoys thinking about and remembering details, facts and figures
If distracted, is likely to return to a task quickly with or without redirection	If distracted by internal thoughts, redirecting to task at hand may be difficult
Intense focus on topics of interest	Intense focus on primary topic of interest
Extensive advanced vocabulary	Advanced use of words with lack of comprehension for all language used
Communicates understanding of abstract ideas	Thinks and communicates in concrete and literal terms with less abstraction
Questions rules and structure	Adheres strictly to rules and needs structure

(adapted from Amend et al., 2009)

Method: An action learning, action research approach

The aim of this project was to develop appropriate and effective intervention strategies for gifted students with AS within their mathematics classrooms. Five teachers and six students across grades 4 to 7 participated in the study. An Action Learning and Action Research (ALAR) approach has been taken, adopting Zuber-Skerritt's (2003) generic model for ALAR programs, in which we act as facilitators/researchers and the six teachers on the project participate as researchers. In each phase, data were collected from all activities within the action learning process, including an initial teacher survey, student interviews, focus group interviews with the teachers, teacher reflection journals, facilitator/researcher observations during workshops, and individual teacher interviews. The aim of data analysis was to identify themes which might provide insight into the research questions.

Initially the students were interviewed to explore their perceptions of their mathematics learning experience. Teachers were asked to complete a survey to assist in ascertaining current levels of teacher understanding of the needs of the gifted student with AS. Teachers were also asked to share their observations of their own students in the classroom. The findings from the student interviews and the teacher surveys established a starting point for the first of three whole-day workshops. These workshops are the key drivers of the action learning process.

During the first workshop gaps in teacher understanding were addressed by the AS specialist, the gifted and talented co-ordinator and the educational psychologist. During brainstorming sessions teachers developed strategies for their individual students. These strategies were implemented in the classrooms and monitored by the teachers for a period of six weeks. As mentors, we supported and observed the

teachers during the implementation of the strategies. Teachers were asked to maintain a reflective journal throughout the study. At the completion of the six-week period, students were interviewed once again to explore their perceptions of their learning experiences under the new strategies. The second workshop was conducted in June 2010, during which the students' perceptions were discussed and teacher reflections were explored further through a focus-group interview.

Gaps in teacher understanding

All teachers were aware of the socialisation characteristics of AS students. This included their difficulty in making and maintaining friendships, significant difficulty in initiating or engaging others in conversation, and lack of social insight (Amend et al., 2009); however, teachers were uncertain as to how these aspects might relate to academic strategies. All teachers were able to identify their student's specialist interest area; not all areas of interest were appropriate for planning academic tasks. Winter-Messiers (2007) suggests AS students respond well to the inclusion of their special interest area into the design of academic activities.

The teachers recognised their students' demands for structure and freedom from distraction. They were also aware that their students have a preference for routine; and three displayed a visual timetable on their board. Visual timetables have been found to aid in students' self-management (Dettmer, Simpson, Myles, & Ganz, 2000).

There were three distinct gaps in teacher understanding as shown in Table 2. Central coherence is the process of constructing a higher meaning from diverse information (Jacobsen, 2005). With a weakness in central coherence the student may "become preoccupied with the detail, focusing on parts rather than wholes" (Attwood, 2007, p. 241). Paying attention to detail is important to the gifted student with AS. Jacobsen (2005) states that when every detail might seem as important as another, the student may become overwhelmed and not know where to start or end a task.

Table 2. Strengths and gaps in teacher understanding of gifted/AS students

Strengths in Teacher Knowledge & Understanding	Gaps in Teacher Knowledge and Understanding
Identify general characteristics of AS	The AS student's weakness in central coherence and poor executive functioning of the brain - classroom implications
Identify student's difficulty with social interaction, communication	Intervention strategies to support academic tasks
Student's special interest area	Understanding cognitive assessments and classroom implications
Student's preference for routine	

AS students often have poor executive functioning (Attwood, 2007), which results in difficulties in their organisation of ideas and processes. "Attention, organization, and generalization contribute to executive functioning" (Jacobsen, 2005, p. 33). When taking part in investigative processes in mathematics, for example, when the emphasis is on reasoning and communicating ideas, gifted students with AS experience difficulties. It is important that teachers understand the classroom implications of potential weaknesses in central coherence and executive functioning in the gifted student with AS.

To further reinforce the validity of considering these students to be in the gifted range of ability, the teachers were provided with comparative data about the students. This included ability test results and achievement tests. The students' percentile rankings compared to same age peers indicated their current superior ability and achievement. However, this varied with each individual student. Teacher understanding of the student's strengths and weaknesses identified from his/her cognitive assessment may influence the intervention strategies developed to support that student's academic tasks. The Educational Psychologist is able to provide the teacher with the classroom implications of that cognitive profile.

Student profiles

Findings from the student interviews and teacher observations suggest the students have difficulties primarily in communicating their understanding, working in groups, contributing to class discussion, initiating tasks, deciphering what is required if the teacher is not explicit, and in some cases accepting feedback.

Students are observed by teachers to "see the world differently and therefore respond in a creative manner" as expressed by one participant, Mrs J. The teachers suggest that the students have trouble expressing their thinking in written form and "experience difficulties in communicating how they know something" (Mrs Z). One student suggested that he could get better at maths by "studying in his mind. I store facts in my brain and it tries to keep it in storage".

Teachers find that the students have difficulties in seeing what information is important and how to place this in the context of the task at hand. Some students have difficulty in seeing the point of planning prior to commencing a task. Most students reported, and teachers observed, that they dislike working in groups and most prefer working with technology. Students dislike contributing to class discussion and teachers suggest that this may be because they do not know how. Another student was observed by Miss T to:

> know and follow rules; he wants to do the right thing. He is happy if the routine is followed, but reacts to change poorly. It is difficult to get him to start tasks. He gets stuck if a basic problem is not solved, he has the wrong book or pencil, and it becomes hard sometimes to motivate him to complete a task. He appears to have difficulty in understanding other people's points of view. And then he might lash out in frustration at others because he is lacking in the skills to communicate his uncertainty.

Inability to discuss uncertainties with the teacher was observed in some students. One student stated that he prefers the learning environment to be quiet and likes to "feel comfortable to ask for help. If I know something, I like to work by myself. If I don't know something, I like to work in groups...because someone can explain it to me. I like to work with smart and quiet people."

Phase 1: Strategy Development

As stated earlier, gaps in teacher knowledge and understanding, and student profiles informed the first of the teacher workshops. Immediately, it was evident that the student profiles revealed areas of concern. Provision of opportunities for students to share and compare their own intuitive solution methods with other class members, initially in small groups and then to take part in whole-class discussions, is viewed in the literature as important in increasing student mathematics achievement (Davidson, 1985).

A graphical representation of the implementation of Phase 1 of the project is shown in figure 1. Teachers took part in the first professional development workshop in April 2010, through which relevant information was disseminated from the three perspectives as shown. As facilitators we guided the teachers in linking the perspectives. This is key to the development of effective intervention strategies to trial in their classrooms. The teachers were asked to consider Leach and Duffy's (2009) categorisation of strategies: preventative (considered before teaching begins), supportive (used during teaching) and corrective (used to redirect or react to a situation). Corrective strategies have already been put in place by the AS specialist teacher at the college. The aim is to limit the need for corrective strategies through the use of successful preventative and supportive strategies. Therefore the latter are the primary focus of the project.

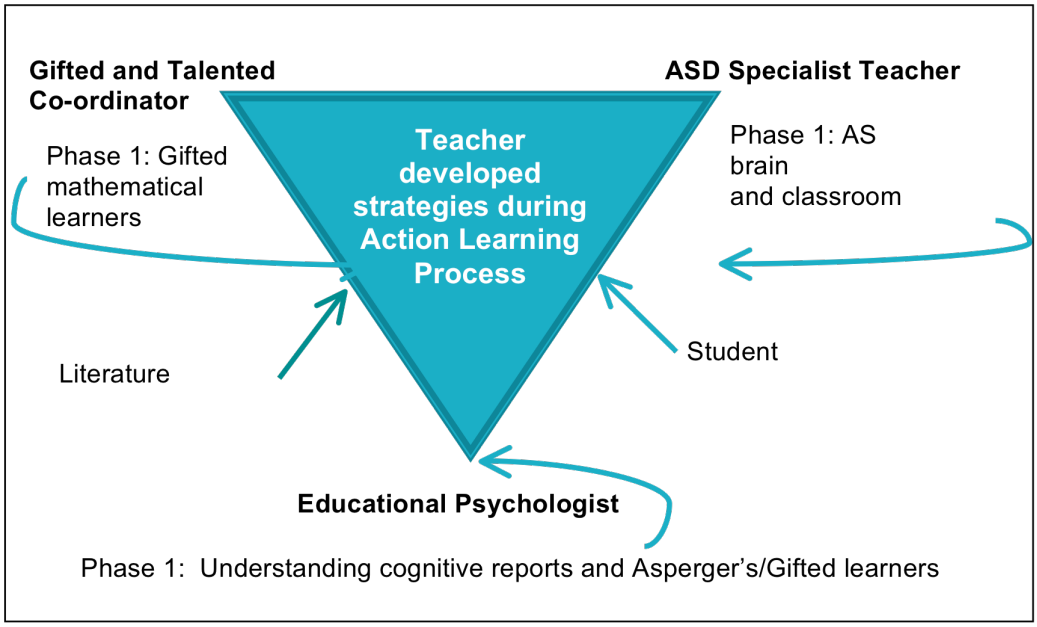

Figure 1. Phase 1 Action Learning Implementation

Table 3 shows examples of some of the strategies developed during phase 1, under Leach and Duffy's (2009) categorisation scheme. Some strategies, which were employed originally as preventative, went on to support the student during phase 1 implementation. Some modifications were made by teachers over the six-week period.

Table 3. Example strategies implemented in Phase 1

Preventative	Supportive	Corrective
Allocate role to student	Flexibility in grouping	Step out/step back in
Colour-coded timetable and "to do" list	Providing a rationale for the need to communicate mathematical thinking	
Establish explicit social and behavioural expectations	Making goal of task and time frames explicit	

Discussion

Phase 1 strategies can be seen to address the following themes, which have emerged from the student interviews and teacher observations:

- Working in groups;
- Contributing to class discussion; and,
- Initiating and completing tasks.

Some strategies, developed originally to aid students in initiating and completing tasks, were found to also support them in working in group situations.

Role Allocation

Within one class, the gifted students worked on an independent program. In order to support one of the dual exceptional students in starting a task, Mrs Z set up a management role to be taken by all students within the gifted group. The role rotates and involves the manager questioning the other students about the task they are working on with the use of a script set by Mrs Z. The script includes questions such as: "What question are you up to? How are you going to start? If you are in the middle of it, how are you going to go on?" The manager is responsible for ensuring everyone starts on the task, stays on task and achieves task closure. Initially, the other students modelled the activity to the gifted student with AS.

A younger student has been given the role of Instructions Manager within his class. He is responsible for ensuring that other class members turn to the correct page to begin the task. The allocation of roles to the students has been found to improve their ability to commence tasks. The students were able to build upon the modelling provided by the teacher and the other students. Mrs Z stated:

> [He] has realised he can take a risk and communicate with other kids after giving him the opportunity to take responsibility in the gifted maths group. This has also rubbed off in other areas. For example, during group work, in response to other child's statement, he said, "That's great, but how about we think about this."

By giving the student a script to carry out his management role in maths, Mrs Z is providing him with a coping mechanism to assist him to commence tasks and initiate communication with other students in his group. Hart and Whalon (2008) suggest that scripts can successfully be applied in classroom settings as a means of increasing academic interactions. Mrs Z has observed a significant change in the student's interactions with other class members in a variety of subject areas. She suggests that taking the management responsibility has played a significant part in that change. Emphasis has been made in the literature on the importance of the development of self-management skills and independence (Hume et al., 2009).

Flexible grouping

All students in the study have been found to be averse to working in group situations. Miss T addressed this by focusing in the first instance on sharing with a peer chosen by the teacher:

> At first I chose a peer whom I thought would allow the student to share and build his confidence, and then the next person he shared with is more at his own level. He then has to compromise as they both share their strategies [for maths problem solving] and use a bit of both strategies. So slow building up and the next person challenges what he has written. We are still at that person, and I am finding that if it is not a big group, if it is a pair, it works quite well. He became an expert in the first pair share and I allow him the freedom of using A3 paper so that he can design it how he sees it in his head. I found that just a blank piece of paper made a whole heap of difference. Owning the work together is what we are working on now.

Miss T allows another of her students to choose a partner to work with on a task "now or at a later time. He has to do it with a partner. If he doesn't do it today, it is happening tomorrow". She incorporates learning to work in pairs and groups within the academic task.

Colour-coding timetable and "to do" list

In response to a student's statement that he thinks in colours, Mrs Z has changed the class pictorial timetable to an individual colour-coded timetable. She also allocates time to sit with the student to colour code a "to do" list. The student has chosen the colours himself; for example, green for urgent tasks.

Activity schedules and "to do" lists have been reported to also contribute to an increase in a student's level of independence, and Hume et al. (2009) suggest that there is a need for interventions that promote independence. This strategy has now been transferred to most tasks within each subject area. Mrs Z stated:

> He really struggled to start a task no matter what the subject and by using this strategy he now does this for everything including home learning. When he looks at a list he doesn't realise what should be a priority. He just looks at it as one giant list. Teacher direction as to what is the most important thing to do for that week makes him feel more comfortable and supported.

Mrs Z has found discrepancies in the colour-coded timetable and as a result will implement modifications in phase 2 of the project.

Step out/step back in

The 'step out/step back in' strategy was developed by Miss Y to address the increased anxiety levels experienced by her student when faced with challenging maths problems. When he recognises that his anxiety level has increased to 4 (a 1-5 rating scale), he steps out of the challenging problem and chooses another maths problem that he feels comfortable to continue working on. When his anxiety reduces to level 1 or 2 he then steps back into the challenging problem.

Miss Y found the 'step out/step back in' strategy to be very effective in fostering the student's independence and addressing his increased anxiety levels:

> He just changes tasks. He does that himself. It is a choice that he makes independently. It was a very big issue. By doing something related he is not stepping outside the program. It is something that is still constructive and going in the same direction.

Establish explicit social and behavioural expectations

Leach and Duffy (2009) suggest that setting clear behaviour and social expectations for students can enhance learning for AS students. Miss Y has been able to link this strategy with Carol Dweck's (2008) "teaching people to have a growth mindset, which encourages a focus on effort rather than on intelligence or talent". She took it upon herself to link the strategies for AS with the high ability area. She conducted a discussion with the class about self-belief and work ethics. When the students understood the difference between "growth mindset" and fixed intelligence, she guided them in the development of a set of class rules. The rules are displayed in the classroom and the teacher and students make reference to them throughout lessons.

> It's okay to follow different paths to the same destination on learning in general and they must believe that they all have a right to share their ideas in a safe environment. And lastly they must believe in themselves. This was developed for all of them but it was originally developed for the gifted student with AS, but they all benefited (Miss Y).

Making goal of task and time frames explicit

Miss T found one of her students "needed an invitation to pack up". He wanted to finish what he was doing instead of engaging in the next lesson.

> I allowed him time for closure of an activity, explicitly stating the time and what the goals of the activity were....give him an explicit time for

> when the work could be finished...being consistent to follow through so that he could trust me....has really changed the whole dynamic.

Other teachers have found success with clarifying task goals, explicitly stating the time students have left to complete tasks, and providing the students with explicit boundaries when students become overwhelmed with detail. Some teachers have experimented with making the main idea of a task explicit visually and intend to explore this further in phase 2. "Research suggests that the provision of visual structure helps improve the level of organisation and the speed of processing for AS/Gifted students" (Niehart & Poon, 2009, p.24).

Providing a rationale for the need to communicate mathematical thinking

Providing students with a reason for the need to explain their thinking proved to be useful in developing their ability to communicate their understanding. For example, one student was asked to explain his thinking strategy to a lower grade level student. Miss X adopted a novel approach by turning the task into a challenging game. Her student is "very good at number crunching" and just gives her the answer.

> He had the answer there and I said, "I bet you can't go backwards and show me your thinking." He said, "I bet I can. See it's like that." And he just did it. Then he corrected me by telling me that actually that is a slow way of doing it, of course it's quicker to go forwards. He then went on to explain. So it has really worked.

Miss X has identified the need to extend this into phase 2 as the student "likes to get up and share his work". She has found that finding the right words to motivate him is important. When she first asked him to explain his thinking his response was:

> I just know the answer, it just comes out of my brain. And I said, "Well can you just tell me, can you just think about what's turning over in your brain, what are those numbers doing in your brain?" He said, "Oh okay."

Conclusions

In Phase 1 of the "Mathematics: I Just Know It" project we have been able to identify the extent to which teachers at A.B. Paterson College understand and recognise the strengths and differences of gifted students with AS. Gaps in teacher knowledge and understanding have been addressed through the provision of professional development from three perspectives within the Learning Enhancement Department: Asperger's specialist, gifted and talented co-ordinator, and educational psychologist. We suggest that when teachers increase their awareness of the differences of gifted students with AS and the classroom implications, they become more able to design strategies which are effective in targeting the areas of student difficulties whilst also supporting their strengths.

Phase 1 strategies were primarily centred on three areas of concern: the students' difficulties in working in groups, their inability or dislike of contributing to class discussion in terms of their mathematical thinking, and their difficulties in initiating

and completing tasks. All strategies have been found to contribute to each student's increased level of independent functioning within the classroom, particularly the allocation of management roles. Single strategies were found to target multiple areas of concern.

We suggest that it is important to consider the student's voice; in this study this entailed a student survey, which explored students' perceptions of their mathematical learning experiences. An opportunity was provided to the students to express how they think (in pictures, patterns, numbers, colours etc.), how they think mathematically, and how they prefer material to be presented. Teachers' increased understanding of the students' needs appears to have contributed to their ability to develop appropriate strategies aimed at improving each student's ability to explain their mathematical thinking. Research question 2 will be further explored in phase 2 of the study, where an emphasis will be placed on thinking mathematically from both high ability and AS perspectives.

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