Twice-Exceptional Students of Mathematics in England: What Do the Teachers Know?

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Abstract

Although they have the potential to excel, twice-exceptional (2e) students of mathematics do not usually have this opportunity as their special educational abilities, and special needs are often ‘misdiagnosed’ or ‘missed’ diagnosed in schools due to the teachers’ lack of knowledge. The study explored this issue using an electronic survey for primary school teachers in four local authorities in England. It was planned as a pilot study to gather insights from a small number of schools aiming to identify areas for further study and larger-scale research. When comparing responses from teachers with gifted-related training and those who had not, the study found some knowledge of specific types of 2e students among both groups of teachers, but no significant difference between them. This raised concerns about the effectiveness of the training, as well as identifying areas that need further and more systematic research.

Keywords: twice-exceptionality, gifted education, special education, mathematical ability, educational policy

Twice-Exceptional Students of Mathematics in England: What Do the Teachers Know?

There has been a growing interest within the international literature in students who are twice-exceptional (2e) and their education. Students are considered 2e when they simultaneously have a strength associated with a high cognitive ability, such as high mathematical ability, and a weakness associated with a disability or disorder, which might be a physical, sensory or learning disability, or a developmental, emotional or behavioral disorder. Although these students have the potential to excel in particular fields, including science, technology, engineering and mathematics (STEM), and make a significant contribution to society, they often do not have the opportunity to overcome their weaknesses and reach their full potential; this could be attributed to a lack of knowledge about this particular population among educational professionals as well as a lack of specific educational provision for them (Foley-Nicpon, Assouline, & Colangelo, 2013; Lee & Olenchak, 2015).

Most previous research on 2e students is generic, not subject-specific, and often involves weaknesses associated with a specific learning difficulty (SLD) (e.g., a learning disability in reading, writing or calculation), a developmental disorder such as attention deficit hyperactivity disorder (ADHD) or autism spectrum disorder (ASD), or emotional difficulties (ED) linked with depression or anxiety (Foley-Nicpon, Assouline, & Colangelo, 2013). There is little research related to twice-exceptionality, particularly in mathematics, and research here has mainly focused on cases of gifted with ASD (e.g., Chiang & Lin, 2007). Even though mathematics is an area in which underachievement (Stoeger & Ziegler, 2005) and subject anxiety (Ashcraft & Krause, 2007; Maloney, Schaeffer, & Beilock 2013) often co-occur, the possibility that these might be the result of twice-exceptionality has been overlooked. This study aimed to explore teachers' knowledge of 2e students of mathematics (particularly those with co-existing ED, SLD, ADHD, or ASD) and their experience of and confidence with identifying such students in English primary schools.

Currently, in England (UK), there is considerable interest in the education of children with special educational needs and/or disabilities (SEND) (Department for Education & Department of Health, 2015; Equality Act, 2010), children from disadvantaged backgrounds who show potential (Villiers Park Educational Trust, 2015), students with complex needs (Department for Education, 2016), and students with mental health issues (Department of Health and Social Care & Department for Education, 2017). However, students with identified weaknesses or limitations and a co-existing high cognitive ability are not considered. The term *complex needs* refers to students with learning and other disabilities falling into the SEND category, but not the twice-exceptional category. Even though the new SEND Code of Practice recognizes that “problematic” behaviors (e.g., persistent disruptiveness or withdrawal) and low attainment might not always equate to special educational needs, it links these behaviors only to other weaknesses (e.g., learning difficulties) or unfortunate events (e.g., bullying, family problems). It does not recognize that children with high cognitive strengths often display similar “problematic” behaviors or that children with “difficulties” may also have cognitive strengths. There is also continued interest in the education of students who are highly able across subject areas (Office for Standards in Education, 2015), but this interest has not been supported by specific policy and/or gifted-education specialists since the abandonment of the Gifted and Talented (G&T) Initiative in 2010 (Dimitriadis, 2016). Some schools still have a G&T Coordinator, but this is on the decline (Dimitriadis & Georgeson, 2018). Special Educational Needs Coordinators (SENCOs) are now the key specialists in schools with responsibility for managing provision for special populations. Overall, education policy appears to recognize learners who have either SEND (a clear weakness or a combination of weaknesses) or high abilities, but not learners who may have both SEND and high abilities at the same time.

Additionally, no research has been conducted in the U.K. so far to ascertain the levels of knowledge of education professionals, with or without a specialty in gifted or special education, regarding students who are 2e, and their confidence in recognizing them. A survey from the United States has shown that gifted-education specialists were significantly more knowledgeable about twice-exceptionality than other educational professionals, including certified school psychologists and special education teachers (Foley-Nicpon et al., 2013). This study, inspired by Foley-Nicpon et al.’s study, aimed to explore the same topic to find out whether and what kind of relationship exists between gifted-related training and teachers' knowledge of 2e students, and what this might mean within the current educational context in England. The study was a small-scale exploratory study and part of a pilot research study aiming to find out how primary schools in England recognize and address the needs of children who have the ability or potential to excel in mathematics despite underachievement or additional needs, and what educational provision might be available to them. The findings regarding whether and what kind of provision is offered by schools for children who are highly able in mathematics in general have been presented in Dimitriadis and Georgeson (2018).

Theoretical Perspectives

Mathematical Giftedness and its Complex Nature

To describe the characteristics of mathematically gifted students, literature from the field of mathematics (e.g., Deal & Wismer, 2010; Koshy, Ernest, & Casey, 2009; Sheffield, 1999, 2003) often draws on the work of Krutetskii (1976) to suggest that mathematically gifted students have a unique mathematical ability enabling them to recognize mathematical relationships, patterns, bonds, and practical dependencies, use creative and flexible thinking, and helping them to excel in technology and innovation.

Sheffield (1999) proposed the term *mathematical promise* as a function of ability, experience/opportunity, motivation and belief, adding a future-oriented dimension (“promise”) and the aspect of affect (“motivation and belief”) to highlight the complex nature of mathematical giftedness and the challenges in recognizing this kind of promise without specialized knowledge. Teachers who lack secure knowledge about the nature of mathematical giftedness might find it challenging to recognize truly gifted mathematicians. They might not recognize characteristics, which are less easily measured by tests, such as capacities associated with mathematical creativity (Renzulli, 1999; Sheffield, 2003). They might also fail to identify mathematical giftedness when it is disguised due to certain fears, including fear of having to do extra work (Koshy, 2001), being unpopular in a typical classroom (Freeman, 1998) or being labelled as "geek" or "nerd" (Sheffield, 2003), or when it is masked by a co-existing learning disorder or other disability (Karolyi et al., 2003). The latter is the focus of the current study and is discussed in detail in the following section.

Literature on giftedness from the field of psychology (e.g., Feldhusen, 2005; Gagne, 2011; Gardner, 1999; Renzulli, 2012; Tannenbaum, 1983) also suggests that giftedness, in any field of human activity, is complex and that a natural ability (e.g., intellectual, creative, social, physical) is not necessarily developed and demonstrated as a particular type of giftedness unless there are appropriate supportive experiences or opportunities.

According to Gardner’s (1983, 1999) theory of *multiple intelligences (MI)*, mathematical giftedness can be thought of as a bio-psychological potential associated with a distinct intelligence, a *logical-mathematical intelligence*; this allows those who have it to process information in unusual or unique ways to solve problems or create things of value in STEM fields. Initially, Gardner (1983) linked this intelligence with a specific center in the brain (namely left parietal lobe) and certain functions of the nervous system determining the extent to which specific intellectual operations were executed. With advancements in research into brain functioning, Gardner (1999, 2006) later suggested that it would make more sense to refer to several brain areas and to emphasize that some are more critical for mathematical processes than others and that each intelligence may work either independently or in concert with other intelligences for complex intellectual activities (e.g., logical-mathematical and linguistic intelligences working together to solve a complex word problem).

Further brain studies (Houde & Tzourio-Mazoyer, 2003; Just & Varma, 2007) have confirmed the existence of distinct areas in the brain and shed more light on brain functioning. Houde and Tzourio-Mazoyer's study suggested that areas in the frontotemporal lobes are more prominent in logical deduction and areas in the parietofrontal lobes in numerical calculation. Just and Varma’s study suggested individual differences in how these regions collaborate with each other to respond to a novel cognitive challenge, and that the levels of giftedness displayed by individuals are determined by these regions’ capacity to collaborate.

Gardner's MI theory has raised questions and received criticism about its scientific validity (Sternberg, 1996; Waterhouse, 2006), and its practical implementation in education (Plucker & Callahan, 2014). However, like the abovementioned brain studies, more recent reviews of neuroscience evidence (e.g., Shearer, 2020) do support the relevance of connections between MI theory, neural cognitive functions and architectures, and academic skills, especially "via the logical-mathematical and linguistic intelligences" (Shearer, 2020, p. 60).

In the context of our study, the ideas outlined above suggest that mathematical giftedness is a result of a complex interaction between functions and may be demonstrated in different ways, or not at all, depending on the presence or absence of higher-order cognitive and stimulating opportunities. Consequently, this would suggest that education professionals should be aware and have an understanding of the multiple, often complex, ways in which mathematical giftedness can present itself.

Although there is no universally accepted method for how best to identify and develop mathematical giftedness, gifted theory (e.g., Gagne, 2011; Gardner, 2006; Renzulli, 2012) and high-ability studies from the field of mathematics education, such as the longitudinal Study of Mathematically Precocious Youth (SMPY) (Kell, Lubinski, & Benbow, 2013; Lubinski & Benbow, 2006) agree about what is needed for this ability to be recognized and the importance of early identification and suitable interventions; both are urgently needed for individuals to reach their full potential and find a rewarding role in society. Identification should be based on multiple sources of information, including “above-level” assessment opportunities (e.g., mathematical and verbal reasoning measures from the higher level of mathematics syllabus) (Kell et al., 2013; Lubinski & Benbow, 2006), intelligence quotient (IQ) tests and assessment practices that take into account psychological and neurological data along with observations of students' behavior and their ways of working (Gardner, 1992; 2006; Karolyi et al., 2003). Without specifically mentioning 2e students, these recommendations touch upon an essential aspect of identification of twice-exceptionality, namely knowledge of these students' individual neuropsychological, intellectual, and learning profiles.

Twice-exceptionality and the Problems of "Misdiagnosis" and "Missed" Diagnosis

In the international literature, interest in 2e students and their educational needs is increasing (Assouline, Foley Nicpon, & Huber, 2006; David, 2017; Wang & Neihart, 2015; Webb et al., 2016). To date, what is known from this literature is that 2e students are a special and distinctive population who simultaneously have a high cognitive ability – e.g., a logical-mathematical intelligence (Gardner, 1999) – associated with an academic (e.g., mathematical) giftedness and a weakness associated with a disability such as SLD (gifted/SLD), ADHD (gifted/ADHD), ASD (gifted/ASD) or ED (gifted/ED). Though the 2e population is not limited to these categories, this study focuses on these four types of twice-exceptionality because these have been studied the most. Most of the existing research has focused on gifted/ADHD (e.g., Lee & Olenchak, 2015; Leroux & Levitt-Perlman, 2000; Moon et al., 2001; Neihart, 2003) or gifted/SLD in mathematics or reading (Assouline, Foley Nicpon, & Whiteman, 2010; Brody & Mills, 1997; Crawford & Snart, 1994; Lovett & Lewandowski, 2006) followed by gifted/ASD (Assouline, Foley Nicpon, & Doobay, 2009; Chiang & Lin, 2007; Lovecky, 2004), and a small amount of research into gifted/ED and gifted-with-behavior-problems (Alloway & Elsworth, 2012; Cross, 1997; Morrison, 2001). As Foley-Nicpon et al. (2013) highlight, the latter is, however, mainly linked to the area of gifted education and problems associated with the social-emotional development of gifted students.

What we have learned from research to date is that, to identify any type of twice-exceptionality, secure knowledge and understanding of both the ability and disability/disorder are needed (Webb et al., 2016) or strong collaboration between professionals specializing in these two areas (Assouline & Whiteman, 2011; Foley-Nicpon et al., 2013). Without such knowledge and understanding, teachers and other educational professionals may be unable to differentiate “pathological” from gifted behaviors leading to “misdiagnoses” or “missed” diagnoses (Webb et al., 2016).

Misdiagnosis usually occurs when behaviors demonstrated by students with high intellectual and creative ability are misunderstood due to a lack of knowledge, and consequently confused with characteristics and associated behaviors of students diagnosed with a psychological condition or disorder (e.g., ASD or ADHD) (Assouline et al., 2009; Neihart, 1999; Webb et al., 2016). Chiang and Lin’s (2007) research found that even among students with high-functioning autism, there were some with co-existing mathematical giftedness, but this giftedness was not recognized when attention was focused on their observed behavior related to autism only. Untrained professionals are more likely to focus on characteristics associated with ASD rather than mathematical giftedness. The same may also happen in the case of a gifted mathematician with a co-existing ADHD. Characteristics of mathematical (or other academic) giftedness that may be confused with ADHD could include difficulties to (a) maintain attention due to an active imagination and an inclination to daydream, (b) complete required tasks due to varied interests, and (c) pay attention during less attractive activities (Baum & Olenchak, 2002; Cramond, 1994). It is not uncommon for students with very high intellectual ability and creativity – both aspects of mathematical promise (Sheffield, 2003) – to display disengagement, inattention, or disruptive behavior when they attend an under challenging class; this behaviour can then be misinterpreted as ADHD and teachers and parents induced to label these students as underachievers; lazy, difficult students; or students with mental problems and disorders (Assouline et al., 2006). When this happens, intervention support cannot address the real need, as it focuses on the symptom, not the cause – by offering, for example, further boring and under challenging work to an exceptional mathematician, instead of challenge and extension.

Missed diagnosis of either a strength or weakness within twice-exceptionality often occurs because some strengths (e.g., mathematical intelligence) and weaknesses (e.g., psychological or learning disability involving language-based or auditory processing disorders) mask each other, resulting in average classroom performance. Average performance does not usually cause concern, but in the case of a twice-exceptional mathematician, where mathematical intelligence (Gardner, 1999) and therefore the potential for mathematical excellence exists (Kell et al., 2013; Makel et al., 2016), “average” represents unfulfilled potential (Assouline & Whiteman, 2011). Missed diagnosis of either weakness or potential and failure to address each may lead to increased emotional problems involving anxiety and stress (Wang & Neihart, 2015). When combined with perfectionism, such as the 'self-oriented perfectionism' that reflects gifted students' tendency to set out high and unreachable personal achievement standards (Guignard, Jacquet, & Lubart, 2012), it might cause not only disengagement from learning and underachievement but also unhealthy conditions, including severe psychological problems and illnesses – even suicide when the levels of depression are too high (Adkins & Parker, 2006; Hamilton & Schweitzer, 2000).

The twice-exceptionality literature recommends that schools have in place an educational program for 2e students aimed at identifying and addressing both their area(s) of strength and their area(s) of weakness (Assouline et al., 2006). For such a program to be successful, knowledge of 2e students and their complex needs is required, as well as collaboration between specialists from gifted and special education (Assouline & Whiteman, 2011; Foley-Nicpon et al., 2013).

The current study explored primary-school teachers' knowledge, their experience, and their confidence in recognizing different types of 2e students of mathematics (those with ADHD, ASD, SLD, and ED). It examined responses from teachers with and without additional training in gifted education, teaching able/gifted mathematicians, or teaching higher mathematics. In addition, teachers' knowledge, experience, and confidence were compared between those who had received training around giftedness and those who had not.

Methods

Participants and Procedures

The sample derived from a pool of primary schools (age 5-11) within four local authorities in close proximity to the university in which the research began. This provided a convenient sample in anticipation of possible follow-up in-depth studies. In June 2015, all 622 primary schools of the four authorities were contacted by utilizing the university's school database. The purpose was to collect information through an electronic survey from education professionals with teaching responsibilities about their classroom practices to support able mathematicians, their views regarding the effectiveness of their methods, their perceived needs, and their knowledge, experiences, and confidence regarding students who are 2e in mathematics.

The survey was addressed to the headteachers (term used for "headmasters" or "principals" in other countries), who were asked to complete the questionnaire and then to forward the electronic link, along with the Participant Information Sheet, to all teachers in the school. We expected this questionnaire to attract the interest of the teachers with responsibility for managing provision for special populations — one or two in each of the participating schools, e.g., a SENCO and a G&T coordinator when possible — or a mathematics coordinator (the one who leads the teaching of mathematics at school). The number of schools that we contacted was large for a pilot study, but we wanted to ensure that our target of having responses from 30 schools, and therefore 50-60 teachers, could be achieved within a minimal time.

Twenty-nine responses were returned from 28 mainstream schools, including academies and maintained schools, such as community, church, voluntary aided, and independent schools, representing diversity in size, type, and demographics. Twenty-one responses were from the classroom-teachers and eight from headteachers who were actively teaching, representing 29 professionals with teaching responsibilities (referred to as TEACHERS) from 28 schools in total. The number of responding schools (28) was close to our expectations (30) but not the number of teachers (29 instead of 50-60) from those schools. In a period of time in which there was no specific policy and statutory requirement for the education of highly able or gifted students, with or without SEND, we expected to have around 5% response rate from the schools we approached, half of the response rate that was obtained by a larger-scale survey in England (Koshy, Pinheiro-Torres, & Portman-Smith, 2012) investigating school provisions for gifted children within the period in which the G&T initiative was in place. Teachers' responses from each school were lower than our expectations, as we received no more than one per school (apart from one case).

About half of the respondents were ordinary classroom teachers (15 out of 29). Of the remaining 14 teachers, 13 taught special classes for able mathematicians (top math sets or pull-out groups) and one taught across all classes. Seventeen teachers had an additional role: 12 were subject coordinators (10 of whom were mathematics coordinators), three ran mathematics-related clubs, and two supported school planning and assessment.

Survey Instrument

The survey included a Classroom-teacher Questionnaire with 38 questions. The questions were mainly closed questions (e.g., multiple-choice and Likert-type questions) and some open ones. The latter added a qualitative element to the research essential for researching educational issues (Miles, Huberman, & Saldaña, 2014). All the questions exploring levels of knowledge and experience (see Table 1, Table 2 and Table 4), were 4-point Likert-type scales (0–3) ranging from 'not' to 'very', similar to those used by Foley-Nicpon et al. (2013) in the US for the same purpose.

The questionnaire had been piloted twice before it was distributed. Ten practicing teachers (both head- and classroom teachers) working in schools from the lead researcher's university partnership scheme piloted the questionnaire. After each pilot, minor revisions were made to improve the clarity of the questions or correct technical issues (e.g., layout and order of the questions).

Analysis

Open questions were analyzed thematically and categorized under common themes. The closed questions were analyzed using descriptive and inferential statistics. The former helped us identify patterns among the data, whereas the latter helped us compare data from those who had received training versus professionals who had not received any training in working with gifted children, using non-parametric Mann-Whitney tests. Non-parametric tests are suitable for small samples and ordinal data that are not normally distributed. The Mann-Whitney, in particular, is a test of spread, which can look at other aspects of the range that might be important for the study (Hart, 2001).

All data were anonymized. Ethical approval had been obtained from the university's ethics committee, and participants confirmed their informed consent before they completed the questionnaire.

Results

Teachers' Training Background Regarding Teaching Able/Gifted Mathematicians

Through multiple choice and open questions, teachers were asked to provide information about their training background regarding teaching able or gifted mathematicians. Twenty-one teachers stated that they had some training, including training in gifted education (n = 7), education of able or gifted mathematicians (n = 10), and training in higher mathematics (n = 4). However, analysis of teachers' responses to follow-up questions asking for details about their training, showed that nine of the 17 responses mentioning either gifted education in general or gifted mathematicians in particular, did not actually concern training but rather involvement in teaching groups of able children (e.g., "Run a math club / Math sets", TEACHER 14, Key Stage 2 mathematics coordinator). These responses were not considered evidence of specialized training. No other training that might be relevant to gifted or 2e mathematicians was mentioned by the teachers in the open questions. Thus, only eight of the 17 responses provided evidence of training in gifted education in general or in mathematics in particular, and even these were limited mainly to short training courses provided by the local authorities or staff development meetings led by G&T Coordinators.

Based upon teachers' training background in gifted education, two groups were created: "teachers with some training" ($n = 8$) and "teachers with no training" ($n = 21$).

Teachers' Knowledge of Twice-exceptional Students in Mathematics

Teachers were asked to respond using a 4-point Likert-type scale (0–3) about their knowledge of 2e students in mathematics ranging from "not at all" to "very" knowledgeable. The descriptive analysis of their responses (presented in Table 1) showed that teachers, both with and without training, displayed lower levels of knowledge regarding the term "twice-exceptional" and more familiarity regarding specific types of 2e students, such as gifted/ASD and gifted/ADHD. Notably, there was no score at the top level of the scale ("Very") among responses from teachers with training. Non-parametric Mann-Whitney tests showed that there was no difference between teachers with some training in gifted education compared with those with no training in terms of their self-reported knowledge regarding gifted/2e; $U(67.00)$, $p = .977$, $z = .012$, gifted/ADHD; $U(48.50)$, $p = .262$, $z = .243$, gifted/ASD; $U(56.00)$, $p = .511$, $z = .150$, gifted/SLD students $U(60.00)$, $p = .669$, $z = .101$ or gifted/ED; $U(56.00)$, $p = .511$, $z = .148$.

Table 1. Knowledge about twice-exceptional students in mathematics

	Teachers with some training (n = 8)						
Answer Options	No (%)	Slight (%)	Moderate (%)	Very (%)	Mean	Median	SD
Twice-exceptional students	37.5	25.0	37.5	0.0	**1.00**	**1**	0.86
Gifted students with ADHD	0.0	37.5	62.5	0.0	**1.63**	**2**	0.27
Gifted students with Autism Spectrum Disorder (ASD)	0.0	25.0	75.0	0.0	**1.75**	**2**	0.21
Gifted students with learning disabilities in particular areas (e.g. maths, reading)	12.5	25.0	62.5	0.0	**1.50**	**2**	0.57
Gifted students with emotional difficulties (depression, anxiety)	37.5	12.5	50.0	0.0	**1.13**	**1.5**	0.98

	Teachers with no training (n = 21)						
Answer Options	No (%)	Slight (%)	Moderate (%)	Very (%)	Mean	Median	SD
Twice-exceptional students	41.2	23.5	29.4	5.9	**1.00**	**1**	1.00
Gifted students with ADHD	29.4	29.4	35.3	5.9	**1.24**	**1**	0.94
Gifted students with Autism Spectrum Disorder (ASD)	5.9	52.9	17.6	23.5	**1.59**	**1**	0.88
Gifted students with learning disabilities in particular areas (e.g. maths, reading)	17.6	35.3	41.2	5.9	**1.35**	**1**	0.74

Gifted students with emotional difficulties (depression, anxiety)	17.6	29.4	41.2	11.8	**1.47**	**2**	0.89

Teachers' Experience of Working with Twice-exceptional Students in Mathematics

Teachers were asked to respond using a 4-point Likert-type scale (0–3, ranging from "not at all" to "extensive") to indicate their experience of working with 2e students in mathematics, in general, and with specific types in particular. A descriptive analysis of their responses is presented in Table 2.

There were no differences between the teachers who had received training and those without training in terms of their experience in working with 2e children; *U*(58.00), *p* = .588, *z* = .123, gifted/ADHD; *U*(59.00), *p* = .628, *z* = .110, gifted/ASD; *U*(61.50), *p* = .711, *z* = .080, gifted/SLD; *U*(60.50), *p* = .669 , *z* = .092, or gifted/ED; *U*(65.50), *p* = .887, *z* = .030. The lowest scores among both groups of teachers appeared again for the overall category (2e students). The largest variances within each group were associated with experience with students who are gifted/ADHD and gifted/ED.

Table 2. Experience of working with twice-exceptional students in mathematics

	Teachers with some training (*n* = 8)						
Answer Options	No (%)	Some (%)	Moderate (%)	Extensive (%)	Mean	Median	SD
Twice-exceptional students	50.0	25.0	25.0	0.0	**0.75**	**0.5**	0.79
Gifted students with ADHD	25.0	0.0	62.5	12.5	**1.63**	**2**	1.13
Gifted students with Autism Spectrum Disorder (ASD)	37.5	25.0	37.5	0.0	**1.00**	**1**	0.86
Gifted students with learning disabilities in particular areas (e.g. maths, reading)	25.0	25.0	37.5	12.5	**1.38**	**1.5**	1.13
Gifted students with emotional difficulties (depression, anxiety)	25.0	25.0	37.5	12.5	**1.38**	**1.5**	1.13
	Teachers with no training (*n* = 21)						
Answer Options	No (%)	Some (%)	Moderate (%)	Extensive (%)	Mean	Median	SD

Twice-exceptional students	35.3	35.3	23.5	5.9	**1.00**	**1**	0.88
Gifted students with ADHD	23.5	29.4	29.4	17.6	**1.41**	**1**	1.13
Gifted students with Autism Spectrum Disorder (ASD)	29.4	29.4	35.3	5.9	**1.18**	**1**	0.90
Gifted students with learning disabilities in particular areas (e.g. maths, reading)	29.4	29.4	35.3	5.9	**1.18**	**1**	0.90
Gifted students with emotional difficulties (depression, anxiety)	17.6	41.2	17.6	23.5	**1.47**	**1**	1.14

Teachers' Confidence in Identifying Twice-exceptional Students in Mathematics

Teachers were asked to indicate their confidence in their ability to identify twice-exceptionality and its specific types on another 4-point Likert-type scale (0–3, ranging from "not at all" to "very" confident).

Teachers with training were not more confident than those without training with regards to their self-reported ability to identify specific types of twice-exceptionality: 2e students; $U(65.00)$, $p = .887$, $z = .037$, gifted/ADHD; $U(66.00)$, $p = .932$, $z = .025$, gifted/ASD; $U(41.50)$, $p = .172$, $z = .296$, gifted/SLD; $U(58.00)$, $p = .588$, $z = .125$, or gifted/ED; $U(44.50)$, $p = .175$, $z = .292$. Furthermore, the descriptive statistics (Table 3) showed that teachers with no training displayed higher levels of confidence than teachers with training in identifying specific types of 2e students, such as gifted/ASD, gifted/SLD and gifted/ED.

Table 3. Confidence in identifying twice-exceptional students in mathematics

	Teachers with some training (n = 8)						
Answer Options	No (%)	Slight (%)	Moderate (%)	Very (%)	Mean	Median	SD
Twice-exceptional students	37.5	12.5	50.0	0.0	**1.13**	**1.5**	0.98
Gifted students with ADHD	0.0	37.5	62.5	0.0	**1.63**	**2**	0.27
Gifted students with Autism Spectrum Disorder (ASD)	25.0	37.5	37.5	0.0	**1.13**	**1**	0.70
Gifted students with learning disabilities in particular areas (e.g. maths, reading)	0.0	50.0	50.0	0.0	**1.50**	**1.5**	0.29

Gifted students with emotional difficulties (depression, anxiety)	0.0	62.5	37.5	0.0	**1.38**	**1**	0.27
	Teachers with no training (n = 21)						
Answer Options	No (%)	Slight (%)	Moderate (%)	Very (%)	Mean	Median	SD
Twice-exceptional students	29.4	29.4	29.4	11.8	**1.24**	**1**	1.07
Gifted students with ADHD	17.6	23.5	47.1	11.8	**1.53**	**2**	0.89
Gifted students with Autism Spectrum Disorder (ASD)	5.9	29.4	47.1	11.8	**1.59**	**2**	0.76
Gifted students with learning disabilities in particular areas (e.g. maths, reading)	17.6	17.6	47.1	17.6	**1.65**	**2**	0.99
Gifted students with emotional difficulties (depression, anxiety)	11.8	17.6	47.1	23.5	**1.82**	**2**	0.90

Teachers' Experience with Underachieving Students who have Mathematical Potential

Before they answered the specific questions about twice-exceptional students (the scales presented above) and before any mention of twice-exceptionality was made, teachers were asked to indicate any experiences with students achieving below their expectations, despite having mathematical strength, and to give details of any support provided for them. The purpose was to discover any possible links (direct or indirect) with experience of twice-exceptionality.

Out of 29 teachers, 18 – from whom eight either had some training in gifted education (1), in teaching mathematically able children (2) or both (5) – indicated that they had met at least one student who was achieving below their expectations in mathematics and whom they felt might have some potential. Of those teachers, 15 stated that those students had extra support with 13 explaining this support in an open statement. Their responses were categorized and are presented in Table 4.

Around half of the responses involved one-to-one help, followed by work in a small group and work with either the classroom teacher (CT) and/or a teaching assistant (TA). There was only one case of a student working with a G&T specialist and one with a mathematics specialist, but no mention of any involvement of a special needs education specialist (SENCO) or a possible identification of a co-existing SEND. The outcomes of the support were generally positive, with 10 of the children showing improved attainment, one improved skills, and one improved confidence and motivation to engage in more difficult tasks.

Table 4. Type of support for mathematically able underachievers

Categorised Answers	Response Rate
Extra 1:1 help	6
Working in small group	5
Working with a TA	4
Working with the CT and a TA	2
Working with a learning mentor	2
Working with a G&T specialist	1
Working with a maths specialist	1
Extra support with reading	1

n = 29

Discussion

This was a pilot study with primary teachers regarding the education of students who have the potential to excel in mathematics but show difficulties in other areas of their development, known as 2e students. It examined teachers' knowledge, experience, and confidence within the current educational context with an aim to identify areas that need attention and further research. The findings are now discussed in relation to teachers' training and issues related to policy and practice.

Issues Related to Teachers' Training

The study found that teachers with and without training in teaching able or gifted mathematicians have some familiarity with specific types of twice-exceptionality (e.g., gifted/ASD and gifted/ADHD), though not always with the name itself (twice-exceptionality). The levels of knowledge and confidence between teachers with training and those without did not differ greatly. In some cases, confidence appeared higher amongst those with no training.

Due to the nature of the data collection instrument (i.e., self-reported measure using rating scales), we will not attempt generalizations regarding the impact of training. Participants' personal bias and subjectivity might have influenced their responses (McCroskey, 1997). Research (Glucksberg & McCloskey, 1981) also suggests that people's decisions about their knowledge or ignorance and responses to questions about levels of confidence are complicated, and this aspect of the findings requires additional research. Self-perception about knowledge and self-efficacy varies amongst people and can sometimes be counterintuitive to their knowledge. However, our findings from the use of rating scales, which were similar to Foley-Nicpon et al.'s (2013) study in the United States, do allow us to see that there is a different relationship between teacher's knowledge and training in gifted education.

Unlike Foley-Nicpon et al.'s study, which found a positive correlation between gifted-education training and knowledge of twice-exceptionality, this study found no difference between trained and non-trained teachers. This suggests that training in gifted education had no impact, and therefore, might have been inadequate regarding 2e students. Although direct comparison of the results between our study and Foley-Nicpon et al.'s study cannot be made due to the differences in the sample size and methods of analysis, this difference in the impact of gifted-education training on teachers' knowledge between the two studies might reflect the differences in policy and availability of training opportunities between the two countries.

In the United States, since 2004, SEND legislation – such as the Individuals with Disabilities Education Act (IDEA) in 2004 (see Turnbull, Huerta, & Stowe, 2009) – has included gifted students with disabilities and their education. Additionally, universities offer courses in gifted education at undergraduate and postgraduate levels (Johnsen, VanTassel-Baska, & Robinson, 2008), focusing on knowledge of diversity and complex needs within the gifted population, with links to twice-exceptionality. This could explain why, in the United States, gifted education specialists have higher levels of knowledge about 2e students compared with both special education specialists and educational psychologists.

In England, training regarding gifted education was offered for practicing teachers in the form of short training courses through the local authorities as part of the G&T program. The G&T program was abandoned at the end of 2010, and the National Strategies Team, which was responsible for the training, was disbanded one year later. Since the abandonment of the G&T program, references to gifted individuals and gifted educational programs, as well as any relevant training and support for schools, were abandoned as well (Dimitriadis, 2016). Schools are no longer required to have G&T specialists. Any reference to special educational needs or complex needs concerns only particular weaknesses (learning and other disabilities) or a combination of them (complex needs) (Department for Education & Department of Health, 2015), but not 2e students. Although not all the teachers in our study provided full details about their gifted-related training, most of them appeared to have the kind of training offered by the G&T program through the local authorities, which was available for a certain period only. The above-described situation could explain why this study found no difference between teachers with gifted education-related training and teachers with no training regarding their knowledge about 2e students.

The literature suggests that because 2e students need pedagogical approaches that will address both their strengths and their weaknesses, they need educational professionals trained in both gifted and special needs education (Assouline et al., 2006; Foley-Nicpon et al., 2013). Lack of specialized knowledge relates to missed diagnoses or misdiagnoses of either the cognitive ability or disability in 2e individuals within and outside schools (Assouline et al., 2006; Assouline et al., 2009; Assouline & Whiteman, 2011; Neihart, 1999; Webb et al., 2016). Considering the findings described above in the context of the literature, we could argue that there is currently a gap in teachers' training concerning the education of students with high and exceptional academic potential, with or without SEND. To fill this gap, teachers need to have specific training about these special student populations, and this training should be more than occasional inset days at schools as in the past, but systematic training provided by universities as part of initial teacher training, followed by ongoing in-service training.

Issues Related to Policy and Practice

A significant number of teachers (18 out of 29) stated that they had students achieving below their expectations in their classrooms, despite having mathematical strength. This is in line with other studies highlighting the existence of gifted underachievers in schools (e.g., Stoeger & Ziegler, 2005). However, the fact that in our sample only two of those students were reported to have received support from teachers with a subject or gifted-education expertise is not in line with the relevant literature (Sheffield, 1999). Additionally, the lack of evidence of any collaboration between specialists of both gifted and special needs education (e.g., G&T coordinators and SENCOs) in identifying and supporting specific weaknesses or strengths of the students suspected as being gifted underachievers, as suggested by the literature (Assouline, et al., 2006; Foley-Nicpon et al., 2013), indicates a possible problem in the schools' practice regarding recognizing and supporting the needs of students who may be 2e in mathematics. However, due to the small sample, this suggestion is tentative, calling for further in-depth research.

Recent developments in education policy (e.g., Department for Education & Department of Health, 2015) position SENCOs as strategic leaders for all students with special educational needs in schools. This expectation is not supported by the findings of this study, suggesting the need to research and clarify the SENCO's strategic role in relation to students with exceptionalities (i.e., exceptional ability and twice-exceptionality) if we also expect them to oversee the identification of and provision for this special population.

The lack of evidence of SENCOs supporting, with or without the collaboration of other specialists, any of the students identified as underachievers with unfulfilled potential in mathematics or, as reported in Dimitriadis and Georgeson (2018), in organizing and overseeing the provision for students who are exceptionally able, could be considered a logical consequence of the absence of a statutory requirement or any specific policy regarding the education of these special student populations. Schools tend to follow what is required by the central educational policy; they are influenced by political changes and reforms and consequently new rules, standards, and regulations (Ambrose et al., 2010; Gallagher, 2015).

The twice-exceptionality literature advocates the existence of legislation specific to the needs of twice-exceptional learners (Roberts, Pereira, & Dusteen, 2015). The current policy in England does not encourage consideration of giftedness with or without co-existing SEND. Changes, therefore, should begin with redefining at a national level what we consider special educational needs and what types of students might comprise a special population group. A question that requires an answer is therefore: "Do we consider students who are academically gifted or 2e to have special educational needs?" In Europe, some countries view gifted and talented pupils as learners with special educational needs akin to those with learning difficulties or disabilities (Eurydice, 2006). In the United States, some (Coleman, Gallagher, & Job, 2012; Gallagher, 2015) have compared gifted students with SEND students and gifted education with special education, arguing that gifted education is a "civil rights" issue for the gifted students, just as special education is for the students with SEND; a comprehensive educational policy, and therefore educational systems, should recognize the specific needs of gifted children, guaranteeing justice and suitable learning opportunities for them (Department for Education and Skills, 2003; UNICEF, 1989).

Recognizing the particular needs associated with both the exceptional learning ability and disability as special educational needs may be a step forward to realizing and recognizing the complexity of twice-exceptionality, where both kinds of special educational needs co-exist. This, according to this study, is still an issue in the current educational context in England, both in policy and practice.

Limitations

A significant limitation of the study was that SENCOs did not respond to the questionnaire, despite the fact that it was open to all teachers and concerned a special student population. We were unable, therefore, to find out what they know about gifted and 2e mathematicians. Future research should try to secure their participation.

Other important limitations of the study were the small sample and the reliance on self-reported data from Likert scales, which do not allow causal inferences and generalizations. A higher response rate and a longitudinal design would reduce bias that is often linked to self-reported measures and could increase our ability to attempt more conclusive statements. However, the effectiveness of a research study should be determined with reference to the purpose of the study. This particular study was a pilot study that did not aim to draw causal conclusions or generalizations but rather to set the ground for further and more extensive research. As such, teachers' responses, to both closed and open questions, from 28 primary schools provided useful insights into their perceived levels of knowledge, experience, and confidence regarding recognizing students who are 2e, and the current provision in schools for those achieving below teachers' expectations in mathematics. These insights, along with our critical reflections on the methods used for the data collection and participant recruitment, can form the foundation for larger-scale systematic research into an area that is new in England, as explained below.

To overcome the abovementioned limitations, future research should be more extensive and include representation of all different professionals involved in the education of gifted and 2e mathematicians in primary schools. It should be longitudinal and go beyond the use of self-reported measures by including empirical evidence from school practice, through direct contact with the teachers and observations of their practice. It would also be beneficial to explore the educational experiences and perceptions of the 2e students themselves and those of their parents.

Conclusion

This small-scale study aimed to gather information from school teachers to identify areas that need attention and further research on a larger scale. The areas of teacher training, policy, and expert support in recognizing and supporting students who are 2e in mathematics were found to need attention and development. There is a need to redefine, based on research and theory, what we consider special educational needs and clarify the role and responsibilities of SEND specialists regarding students with exceptionalities (i.e., exceptional ability and twice-exceptionality). Without precise definitions and specialists with knowledge of twice-exceptionality, we risk ignoring or misdiagnosing some 'bright' minds in mathematics, missing out on their future contribution, or losing the opportunity to prevent serious consequences due to unaddressed psychological or emotional problems.

The study recommends further and more systematic research. This research should be driven by questions about what constitutes special educational needs, complex needs, gifted underachievers, and possible relationships with twice-exceptionality in general and in mathematics in particular. It should also explore the prevalence of 2e students in English primary schools to acquire a better picture of the magnitude of the problem.

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