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Using Inquiry-Based Learning to Support the Mathematical Learning of Students with SEBD

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This paper, which draws on action research methodology, explores the use of inquiry-based learning (IBL) in the teaching of mathematics to students with social, emotional and behavioural difficulties (SEBD). The year-long study was conducted in a Form 3 secondary class that grouped 13 male students with SEBD in a Maltese secondary school. After first creating an IBL-friendly classroom environment in the initial months, the actual implementation of IBL pedagogy in class began in the second term and spread over a 15 week period. The data included teacher observations that were recorded in a reflective research journal, two sessions of in-depth interviews with students, student journal writing, samples of students' work and student marks in the school-based half-yearly and annual mathematics examinations. The findings indicate that the use of IBL in the mathematics classroom can benefit students with SEBD in a number of ways. These include infusing a sense of enjoyment during lessons, improved student behaviour and motivation to learn, and facilitating the learning of mathematics which generally translated in higher achievement levels.

Keywords: mathematics, SEBD, inquiry-based learning, pedagogy

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Introduction

Students with social, emotional and behavioural difficulties (SEBD) challenge mainstream school systems and their presence in school creates particular difficulties (Ofsted, 2004). Cefai (2010) captures the intricacy of these difficulties when he defines SEBD as:

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> Loose umbrella term encompassing behaviours and expressions of emotion among students which are experienced by adults and students as disruptive and/or disturbing, and which interfere with the students' learning, social functioning and development and/or that of their peers. (p. 117)

While it is acknowledged that such difficulties arise from "a complex interaction of biological, psychological, sociological and environmental factors" (HMI, 2001, pt. 2.3), students with SEBD tend to dislike traditional lessons that are typically restricted to written work with little interaction and application to real life (Cefai, 2010). Such a learning environment alienates students with SEBD even more than others, as they find it particularly hard to take a passive role in the learning process (Munby, 1995). In view of their critical need to be actively involved in learning (see Groom & Rose, 2005), students with SEBD increasingly disengage themselves from schooling that, as von Glasersfeld (1989) argues, has traditionally positioned students as passive recipients of knowledge. The net result is that the students risk being excluded from schooling for simply exhibiting the behaviours that define their special educational needs (Jull, 2008).

This paper reports on a pedagogical intervention carried out by one of the authors that aimed to create a learning environment that would help students with SEBD break away from their largely non-profitable permanence in school (Camenzuli, 2012). In particular, drawing on action research methodology, the author adopted an inquiry-based learning (IBL) approach with one of his mathematics classes that specifically grouped students exhibiting SEBD. In this study, IBL was interpreted to mean primarily the encouragement of students to engage with mathematics in ways that are similar to how mathematicians and scientists work. In the ensuing student-centred learning culture, students are expected

> …to observe phenomena, ask questions, and look for mathematical and scientific ways of how to answer these questions (carry out experiments, systematically control variables, draw diagrams, calculate, look for patterns and relationships, and make and prove conjectures). Students then go on to interpret and evaluate their solutions and effectively communicate their results through various means (discussions, posters, presentations, etc.). This also means that they should try to generalize the results obtained and the methods used, and connect them in order to progressively develop mathematical concepts and structures. (Maaß & Artigue, 2013, pp. 781-782)

The idea to explore the use of an active learning style, such as IBL, with students with SEBD grew from the understanding first, that it would increase their levels of attention while doing tasks and reduce disruptive and impulsive behaviours (Hughes & Cooper, 2007); and secondly, that instruction based on inquiry, which lies at the heart of IBL, has delivered results in emotional engagement, memory retention and cognitive understanding (Dow, n.d.). Consequently, the focus of the study was to shed light on the extent to which IBL helps to create a classroom environment for students with SEBD that supports their learning of mathematics.

Mathematics, IBL and SEBD

Boaler (2009) expressed concern regarding the "huge gap between what we know works for children and what happens in most [mathematics] classrooms" (p. 1). Moreover, the negative repercussions of this 'gap' appear to be long lasting:

> Far too many students hate maths. As a result adults all over the world fear maths and avoid it at all costs. Mathematics plays a unique role in the learning of most children – it is the subject that can make them feel both helpless and stupid. Maths, more than any other subject, has the power to crush children's confidence, and to deter them from learning important methods and tools for many years to come. But things could be completely different and maths could be a source of great pleasure and confidence for people (Boaler, 2009, p. 1).

Boaler was reacting to the predominant tradition of the teaching of mathematics as a highly individualised endeavour in which students are expected to simply copy, memorise and reproduce methods demonstrated by teachers. Claiming that the resulting 'silent learning' distracts students from the 'wonder of mathematics', Boaler argues in favour of teaching 'real mathematics'. This would involve "problem solving, creating ideas and representations, exploring puzzles, discussing methods and many different ways of working" (Boaler, 2009, p. 2).

Boaler's (2009) invitation is in line with current international efforts to strengthen the learning of mathematics through the adoption of teaching approaches that emphasise inquiry (Maaß & Artigue, 2013). These approaches are characterised by students investigating central, essential questions under the guidance of their teacher without deviating away from the prescribed syllabus and curriculum standards (Alvarado & Herr, 2003). More specifically, instead of continuing to force students to follow a prescribed routine, a focus on inquiry would prompt them to ask interesting questions, plan and conduct investigations, use appropriate techniques to gather data, think critically about evidence and possible explanations, and communicate their arguments (Li, Moorman & Dyjur, 2010; Maaß & Artigue, 2013; Rocard et al., 2007). This doing away with the traditional, narrow form of teaching opens the door for students to learn mathematics as they use it, which reflects in turn how mathematicians actually work (Boaler, 2009). The active learning approach advocated by IBL thus gives students the opportunity to experience an authentic version of the subject and get a taste of high level mathematical work (see Boaler, 2009). Put differently, the creation of an appropriate classroom culture of inquiry has the potential, as Battista (1999) has shown, to pave the way for powerful mathematical learning.

Davies (2005) calls for a pedagogy that caters for all types of students in order to stop school failure from leading, as often happens, to antisocial behaviour as a way of compensating for the acquired low academic status. IBL may well be part of the answer to Davies' call. Although 'generalist' in nature, IBL is especially effective in helping students with lower levels of self-confidence and/or from disadvantaged backgrounds to engage with learning (Rocard et al., 2007). It renders mathematics more interesting and exciting, and consequently leaves a positive impact on students' attitudes and motivation in the subject (Bruder & Prescott, 2013). The potential of IBL to help students love and learn mathematics earmarks this teaching and learning approach as particularly suited for students with SEBD. For these students are in dire need of a pedagogical tool that combats their alienation from schooling and is capable of channelling their active nature to serve learning purposes.

This paper discusses the implementation of IBL pedagogy in one of the mathematics classes taught by the first author, who henceforth will be referred to as 'the teacher' in this paper.

Methodology

The core programme

The study was conducted in a secondary school for boys in Malta that groups students, aged roughly from 11 to 16 years, in mixed ability classes spread over five Forms. The school offers a range of support initiatives for students who encounter specific learning difficulties. One of these initiatives – known as 'core programme' – caters for the three core subjects of the local educational system, namely, Malta's two official languages (i.e., Maltese and English) and mathematics. Although the school advocates inclusive policies, students who are at risk of exclusion from their class and eventually from school are provided with small group out-of-class teaching in these three subjects. This replication of 'special' provision within a mainstream school (Head, 2005) is not meant to lower students' goals and expectations, but to offer students who either have serious learning difficulties in the three core subjects or exhibit SEBD in class, with the same mainstream syllabus in a more student-friendly learning environment. The embedded emphasis on providing such students with a second chance to reach their full potential is guided by the understanding, highlighted by Cooper (2009), that students' learning is closely linked to how they feel about themselves and to how they relate to other students. The programme thus tries to redress, among other things, students' feelings of fear and anxiety, as these can act as a barrier to their engagement with learning (see Cooper, 2009).

Implementing IBL in class

The teacher taught a Form 3 core programme mathematics class made up of 13 students from the school's four Form 3 mainstream classes. Although not all the students in this class had been diagnosed as having a particular form of SEBD, they were still classified under this category at school as they all had difficulties which were interfering with their learning, social functioning and development (Cefai, 2010). The teacher's desire to 'do something fruitful' with them was based on the belief that they misbehave or skive school because they do not appreciate the way in which they are taught (White, 1982). Tempted by the learning potential of using IBL in the teaching of mathematics to students with SEBD, the teacher decided to explore this promising pedagogical initiative by adopting an action research design guided by self-reflective inquiry (Carr & Kemmis, 1986). This choice of methodology reflected a desire to conduct a study that would leave a positive impact on his practices, a desire that effectively precluded the use of a rigorous pre/post-control design that could not capture the complexity of the classroom environment (Maaß & Artigue, 2013). The ensuing research project – which entered the implementation phase after obtaining informed consent from the school administration, parents and students (Lewis, 2005) – spread over the whole scholastic year.

The teacher identified the inquiry-based 'connectionist approach' to teaching as the mathematics learning environment that best supports the implementation of IBL (Swan, 2006). Thus, he set about organising a classroom environment in which mathematics is viewed as an interconnected body of ideas that he and his students create together through discussion; where learning is viewed as an interpersonal activity that challenges students who are expected to arrive at understanding through discussion; and finally where teaching is viewed as a non-linear dialogue between the teacher and the students where the exploration of meanings and connections does not shy away from making explicit and working upon misunderstandings

(Swain & Swan, 2005). By committing himself to inquiry-based teaching, the teacher had decided effectively to move away from traditional teaching to assume a role that is more consonant with IBL, and in the process support his students to work independently (Maaß & Artigue, 2013). Working within these parameters, the teacher planned his lessons, which still followed the normal school mathematics syllabus, to include and emphasise a number of important IBL processes, such as active participation, included "posing questions, making decisions, designing experiments, predicting, exploring alternative methods, discussing, collaborating, checking each other's work, summarising and communicating results" (Maaß & Reitz-Koncebovski, 2013, p. 8). For each process, the 'level of inquiry' (Fradd, Lee, Sutman & Saxton, 2001) was increased gradually as the study progressed to allow students to acclimatise well and feel more comfortable working within an IBL environment.

Gathering the data

The data, which was essentially qualitative, was collected over 15 consecutive weeks, coinciding with the implementation of IBL lessons in class. Prior to that, the teacher focused on preparing his students by stressing, for example, the importance of being respectful towards others, waiting for one's turn to speak, listening attentively to others and working to the best of one's ability (Zentall, 1995).

Several data collection methods were used to explore the implementation process in depth and detail (Feagin, Orum & Sjoberg, 1991). These methods can be grouped under 'out-of-class' and 'in-class' techniques. The 'out-of-class' ones included observing the students outside of the classroom during breaks and other school activities; and discussions with other teachers about these students, particularly those who had taught them in previous years and those who were teaching them other school subjects. The teacher duly recorded this data, with accompanying reflections, in a research journal. The journal was also used as part of the 'in-class' data collection methods. Apart from guaranteeing a detailed record of the lesson proceedings, the journal provided the space and time for data interpretation and critical reflection on the unfolding events inside the classroom (McNiff & Whitehead, 2008; Mertler, 2009). The teacher also regularly checked students' work and kept samples of it as part of the research data.

The students, on their part, were invited to keep a personal journal in which they were asked to provide feedback about their thoughts, perceptions and learning experiences (Mertler, 2009). To enhance further the effective articulation of students' views, which Cooper (1993) considers as a moral obligation in research, the teacher interviewed and digitally recorded his students at two different stages of the study, namely midway and towards the end of the study. Both interviews were semi-structured. Although interview guides had been prepared, prompts and supplementary questions were availed of and the actual sequence of the questioning changed according to students' responses and the flow of the conversation (Cohen, Manion & Morrison, 2007; Gillham, 2005).

The only quantitative data that was collected in the study were the results of all the Form 3 students in the school-based half-yearly and annual mathematics examinations.

Analysing and interpreting the data

The initial analysis and interpretation of the incoming data occurred informally as the study progressed. By engaging in this critical reflection, the teacher could understand, change and improve his classroom practices (McNiff & Whitehead, 2008). This level of analysis, which was meant primarily to improve the IBL experience that was being offered to students in class, offered the first indications of the emerging research themes. The formal data analysis, however, only began after all the data had been collected. This entailed systematically organising all the data and then applying the three phases of the 'thematic analysis' described by Boyatzis (1998), namely recognising an important moment (i.e., seeing), which paved the way for encoding (i.e., seeing this moment as something) and eventually to attaching meaning to the moment (i.e., interpretation).

Findings

The findings of the study are presented in three sub-sections that deal respectively with 'newness and enjoyment', 'behaviour and motivation' and 'learning and achievement'. All student names are pseudonyms.

Newness and enjoyment

As part of preparing the students for the implementation of IBL in class, the teacher sought to create a congenial learning environment based on mutual trust, open communication and willingness to take risks without fear of negative consequences. The IBL processes were then infused in the mathematics lessons without drawing any undue attention on them. The students, however, still realised that they were 'doing things differently' in class. James captured this general feeling among the students in class by saying:

> I liked it because it is something original...something that not everybody does in his mathematics lesson. Other students most probably just sit down in class and see things on the whiteboard. (Second interview)

James' comments reflect awareness that IBL lessons are different from the 'normal' mathematics lessons in which students are passive receivers of knowledge. Instead, learning was viewed by James and the other 12 students as an activity in which students are active agents (Murphy, 1996). The students contrasted positively this new, active way of learning mathematics with their previous traditional experiences:

> We never did these things before...I think the teachers did not let us do them as they wanted to have all the time for themselves. (Roger, second interview)

> For me it was like discovering something new in mathematics. (Sam, second interview)

Clearly, the students were elated to realise that the teacher was not expecting them to 'be like statues' (James, second interview) or to 'copy all the time from the whiteboard and gaze at it' (Roger, second interview). The IBL-induced shift away from traditional teaching also introduced a strong element of enjoyment in their mathematics lessons. On one occasion, for instance, after discussing trigonometry in class, the teacher took the students to the school grounds and invited them to find the heights of a number of structures. In this particular case, the opportunity to apply their mathematical knowledge in a real life context (Boaler, 2009) brought a high level of enjoyment to their learning. This was very clear from the comments they wrote after this activity:

> It was a brilliant activity and I really had fun. (Roger, student journal)

> The activity was great. I really liked it. Let's do this again. (David, student journal)

> Yesterday was the best activity because we went out in the grounds. (Ian, student journal)

The strong link between the IBL pedagogy and enjoyment of mathematics lessons was one of the most evident and consistent findings of the study. Seeing students with SEBD – usually associated with the highest levels of fear, anger, frustration, guilt and blame (Cooper, 2006) – enjoying themselves during lessons was not only viewed by the teacher as a source of inspiration, but also as a fundamental step towards improved students' behaviour and motivation:

> Behaviour was good throughout the lesson and students got immersed in the activities. Through their feedback and comments I can say that they are enjoying this experience and their behaviour reflects this. I am also witnessing their enjoyment first hand during lessons. As a result I am feeling that students are not just coming for the lesson because it is a slot in their time table, but because they are enjoying themselves and they are motivated to learn new things. This gives me great pleasure and in turn motivates me in my preparation. (Research journal)

It is worth remembering that the above comments refer specifically to a group of students who had previously been excluded from their mainstream mathematics classes on a regular basis and who were also at risk of being excluded altogether from school. Although they were generally regarded at school as being either 'difficult' or 'troublesome', their vast majority had a psychologist's report that diagnosed them with some form of SEBD, the most common conditions being attention deficit hyperactive disorder (ADHD) and attention deficit disorder (ADD). The study therefore indicates that IBL pedagogy can provide the means through which students with SEBD can start enjoying mathematics lessons and, possibly as a consequence, reduce the risk of being excluded from schooling.

Behaviour and motivation

One of the reasons the students in this study were enrolled in the school's core programme was because they regularly exhibited behaviour difficulties inside mainstream classrooms. The findings indicate a notable improvement in their behaviour during the core programme mathematics lessons, even if their behaviour might have continued to be erratic once they re-joined their mainstream class. James crystallised this situation when he said:

> Here [i.e., core programme mathematics class] I never fight with the other students or with the teacher...but in the other class [i.e., mainstream] I fight with the other students and sometimes even with teachers. (First interview)

The teacher's ongoing classroom observations and discussions with colleagues corroborated similar comments made by the students. The research journal entries regularly focused on how the implementation of IBL in class was having a positive effect on their behaviour. Both the students and the teacher appear to have attributed this improvement largely to a less rigid classroom environment combined to a more active and collaborative learning approach. The following two excerpts, the first lifted from a student interview and the second from the teacher's research journal, are typical exemplars of this attribution:

> In the other class [i.e., mainstream] I feel bored all the time sitting down. I prefer standing up and working in groups rather than alone. That's why I'm enjoying mathematics now and paying attention. (Matthew, first interview)

> In view of the less rigid boundaries in comparison to the mainstream class and an emphasis on student participation/involvement, the IBL class is having a very positive effect on the behaviour of students with individual educational needs, such as ADHD. In IBL, students are always at the centre of attention and active. This helps students with SEBD since they are not solely expected to sit down and listen. (Research journal)

The suggested link between these students' behaviour and the classroom environment and pedagogical style supports Moody et al.'s (2000) claim that the extent to which students with SEBD benefit from their educational experiences depends on the manner in which teachers deliver the curriculum. In fact, the noted improvement in students' behaviour during the core programme mathematics lessons was accompanied by a genuine motivation on their part to learn mathematics. This newly found motivation was repeatedly stressed by the students throughout the study:

> I feel better and more motivated coming to the core class. (Jean, first interview)

> When we're doing experiments I feel more motivated to learn and to search for the solution. (Simon, student journal)

> We never had the opportunity to learn in this way. Usually the same four students work everything out. Here everyone has the opportunity. This motivates me. (Karl, second interview)

It is interesting to note that while the students linked their improved behaviour in the core programme mathematics class to both environmental and pedagogical changes, they tended to explain their increased motivation more in terms of being exposed to specific IBL processes. This finding concurs with the argument put forward by Long and Fogell (1999) that student motivation is affected by a number of factors, including the quality of the lesson and the teaching style. In fact, the teacher made it a point to choose exploratory activities that were neither too challenging nor too easy for students in an effort to pre-empt disruptive behaviour and capture their attention (Lawson, 2000). The resulting positive effect that IBL was having on students' motivation to learn did not go unnoticed. This is evidenced by the numerous entries in the teacher's research journal that referred specifically to it:

> The students were also very excited and their enthusiasm could be easily seen on their faces; I had never seen this enthusiasm for the mathematics lesson. (Research journal)

> The IBL method is having a positive effect on my students. I can say this by the amount of interest all of my students are showing in the subject. (Research journal)

The noted gains in behaviour and motivation opened the door in turn for students' learning that was reflected in higher achievement. Karl implied this when he said, 'Everybody understands more in the core class' (Second interview).

Learning and achievement

The findings also suggest that IBL supports students' learning of mathematics and leads to improved achievement. The students, on their part, consistently referred to this 'new way of doing mathematics' as 'an opportunity for learning':

> They [i.e., IBL lessons] make me see the subject in a good way and I can get better in the subject and perform better. (Karl, student journal)

> Yesterday's activity was good and I enjoyed it. I wish that we could have similar activities like this one since I learn from such activities. I enjoyed this topic [i.e., trigonometry] and liked it. In the other topics I would like to have a similar enjoyable experience. (Alex, student journal)

Many of the students in class concurred with Alex's desire to have more IBL lessons. What is particularly interesting is that their desire for similar lessons was not only based on 'enjoyment', but also on a genuine belief that they were beginning to understand things and learn mathematics. They felt that they were experiencing 'mathematical power' – a phrase that the National Council of Teachers of Mathematics (NCTM, 1995) of the USA coned to capture the shift in expectations for all students:

> The shift is toward understanding concepts and skills; drawing on mathematical concepts and skills when confronted with both routine and nonroutine problems; communicating effectively about the strategies, reasoning, and results of mathematical investigations; and becoming confident in using mathematics to make sense of real-life situations. (pp. 2-3)

The favourable reaction by the students to IBL lessons on the basis of feeling mathematically empowered, supports Lawson's (2000) argument that students find teaching based on inquiry to be more effective than traditional teaching practices. In particular, their approval of this new type of pedagogy was linked mostly to providing them with the opportunity to learn in their preferred mode. Their comments therefore suggest that IBL builds on Gardner's (1983) 'Theory of Multiple Intelligences' which is based on the premise that different people have different intelligences and learn in different ways. The following excerpts indicate how much the students in the study valued being taught in a manner that matched their learning style:

> It is better with the experiments...better than the other type of lesson. It is better that one involves himself rather than just look at the whiteboard. (David, second interview)

> These lessons are the best type of lessons as children participate and understand better. This year I have improved a lot in mathematics. Before, I could not keep up with the rest of the class. These experiments however made a difference, because I started liking mathematics. (Karl, second interview)

> Mentally I cannot understand, but visually I can cope...pictures make a big difference for me...I wouldn't have understood without them. (Jean, second interview)

Although the students found visuals, such as videos and computer programmes, to be particularly helpful in learning, they attributed their learning to a mixture of learning modes from the wide variety that accompanied the lessons throughout the year. The 'success' of this differentiated teaching scenario presents IBL as an ideal pedagogy for mixed ability classrooms (Tomlinson, 2001), such as the one in this study. Because even if the students had been getting low grades in mathematics, it was recognised at school that their mathematical potential varied greatly. Notwithstanding this, students' and teacher's comments signal an across the board departure from 'surface learning' to 'deep learning' characterised by an active search for meaning, underlying principles, structures that link different concepts or ideas together, and widely applicable techniques (Marton & Säljö, 1976). This is how the teacher expressed his satisfaction towards the end of the study with the noted improvements in students' learning:

> ...I can say that IBL is having a very positive effect on my students. I base this on my classroom observations and from what I see when I correct their work in detail. Most of them give a valid contribution during class discussions and their work, which I check daily, is constantly improving. Something has definitely changed for these students. I can say that these students are now actually doing mathematics. (Research journal)

The data suggests further that these improvements in learning, recognised by both the students and their teacher, led to higher achievement for most of the students in the core programme mathematics class. These gains refer to students' performance in the school-based half-yearly mathematics examination (which preceded the introduction of IBL lessons) and the annual mathematics examination (which came at the end of the study). All students in school, irrespective of whether they take mathematics lessons in a mainstream or a core class, sit for the same examination. While the average mark of the 13 students who were in the core class rose by 13.47% from the half-yearly examination (36.15%) to the annual examination (49.62%), the corresponding increase for the remaining 83 Form 3 students in the four mainstream mathematics classes was 2.28% (i.e., rose from 60.11% in the half-yearly examination to 62.39% in the annual examination). The trend in mathematical achievement gains amongst the participants in the study becomes more apparent when their rankings in these two examinations are compared with the rest of the Form 3 students at their school. Table I shows that 10 out of the 13 students in the core class made ranking gains, which varied from 3 positions (Josef) to 27 positions (Alex), from the half-yearly examination to the annual examination. Matthew, one of the other three students in the core class, maintained his ranking, while Karl (1 position) and Simon (14 positions) both registered losses. Simon, the only student in class to obtain a lower mark in the annual examination than in the half-yearly examination, was passing through a particular rough period at home during the IBL implementation phase of the study, which roughly occurred in between these two summative assessment points.

Table I. Students by mark and school ranking in the half-yearly and annual mathematics examinations

Students in Core Class	Half-Yearly Examination		Annual Examination		Change in Rank (96 Students)
	Mark	Rank	Mark	Rank	
Alex	14%	90th	50%	63rd	+27
Andy	56%	56th	70%	45th	+11
David	58%	54th	66%	50th	+4
Ian	32%	77th	42%	72nd	+5
James	11%	93rd	30%	84th	+9
Jean	30%	81st	50%	63rd	+18
Josef	37%	71st	47%	68th	+3
Karl	70%	33rd	75%	34th	−1
Luke	10%	94th	38%	74th	+20
Matthew	18%	86th	24%	86th	0
Roger	50%	61st	70%	45th	+16
Sam	50%	61st	60%	55th	+6
Simon	34%	74th	23%	88th	−14

Discussion

The findings indicate that students with SEBD stand to benefit in a number of ways from the use of IBL in the mathematics classroom. The noted improvements are related to enjoyment while doing mathematics, acquiring a mode of behaviour that is more consonant with school expectations, a genuine motivation to learn, experiencing mathematical learning beyond the realm of routines and manipulations, and advancement in mathematical achievement in comparison to peers who have not been taught through IBL. These multiple benefits suggest strongly that IBL – a pedagogy that practically aligns the classroom teaching-learning scenario to what Boaler (2009) calls 'real mathematics' – offers these students the opportunity to embrace, widen and deepen their mathematical experiences. In particular, seeing how students' improvement in behaviour and learning occurred concurrently as they experienced IBL lessons, this study supports Head's

(2005) claim that dealing with 'inappropriate' behaviour should not be seen as prerequisite to addressing learning. If anything, the present findings indicate that behaviour which hinders learning can be decreased, if not eliminated, when the emphasis inside the classroom, such as the implementation of IBL in this case, is on promoting a pedagogy that enhances leaning behaviour (Head, 2005).

As this study has shown, the chosen pedagogy can either support or hinder learning (Visser, 2005). The students with SEBD in this study found in IBL a form of teaching that not only matches, but also builds on their characteristics. While the characteristics associated with SEBD are generally seen to hinder learning in traditional teaching, IBL appears to have the potential to exploit for learning these very same characteristics. This was particularly evident with students who could only sit still and listen to teacher talk for very brief periods of time. The constant change and movement during lessons, two important components of the active learning style advocated by IBL, proved fundamental in creating a positive classroom environment for the students (Long & Fogell, 1999). More directly related to learning styles, the participating students commented favourable on how the use of visuals, discussions and what they called 'experiments', facilitated their learning. The need to single out and laud such aspects of the 'new mathematics lessons' signals how absent these normally are during traditional teaching. Possibly without realising, the students were emphasising their right to be taught in a manner that respects the way they learn best (Gardner, 1983).

Establishing the right match between instruction and students' preferred learning modes is at the heart of differentiated teaching, which in essence is about active planning for student differences inside classrooms (Tomlinson, 2001). This applies to all students in all classrooms, as every student is an individual with his or her individual learning needs. Consequently, all classroom settings, including the core class in the present study, need to be considered as essentially heterogeneous. The findings reported here join a chorus of other studies and documents (e.g., Boaler, 1997; Lawson, 2000; Maaß & Reitz-Koncebovski, 2013; Walker, 2007) that have promoted the use of IBL and related pedagogies as an effective alternative to traditional teaching. In relation to the teaching of mathematics, the literature has repeatedly associated such pedagogies with 'helping children learn and love maths' (see Boaler, 2009). One therefore has to ask why many teachers of mathematics continue to opt for traditional pedagogy that in reality only presents a 'mutated version' of the subject in class:

> In many maths classrooms a very narrow subject is taught to children, that is nothing like the maths of the world or the maths that mathematicians use. This narrow subject involves copying methods that teachers demonstrate and reproducing them accurately over and over again. Of course very few people are good at working in such a narrow way, and usually everyone knows which people are good at it and which people are not. But this narrow subject is not mathematics, it is a strange mutated version of the subject that is taught in schools. (Boaler, 2009, p. 2)

A possible explanation for the continued reliance on traditional teaching could be that it permits those students earmarked by teachers as capable of passing mathematics examinations to actually do so. The underlying idea that mathematics is for a limited number of students, certainly not for everyone, eases one's conscience when confronted with consistent evidence that shows how the school mathematics experience makes many students feel both helpless and stupid (Boaler, 2009). What is required instead is a pedagogy like

IBL, that helps all students to reach their full potential in the belief that everyone is capable of learning mathematics (NCTM, 1995). In reality, even those students who do well in mathematics examinations, are victims of traditional teaching, as it only offers them a very narrow representation of the subject rather than 'learning' based on the construction of knowledge (Hmelo-Silver, Duncan & Chinn, 2007). But the other students, especially those with SEBD, are by far greater victims of the effects and consequences of traditional teaching (see Cefai, 2010). In particular, the alienation from schooling of students with SEBD could prove fatal for their learning and achievement in mathematics, a subject that acts in turn as a 'critical filter' or 'gatekeeper' to economic access, full citizenship and higher education (Stinson, 2004). The indications from the present study that IBL creates a positive learning environment and actually facilitates mathematical learning and achievement therefore signal a ray of hope for such students. Not only does IBL appear to ease their normally troubled presence in school, but it also empowers them with the mathematical 'key' that opens the gate to future success (Stinson, 2004). This is consistent with the view of SEBD as a particular cognitive style, rather than as a reflection of an underlying deficit (Hughes & Cooper, 2007).

The challenge ahead

The realisation that IBL can help students with SEBD to have a much better educational experience in mathematics reinforces the argument of those who sustain that SEBD is better seen from a biopsychosocial perspective (DuPaul & Stoner, 2004; Purdie, Hattie & Caroll, 2002; Zentall, 1995). From this perspective, biology is not seen as destiny and pedagogical approaches, which are referred to as 'educational' approaches, are considered as tools that help students with SEBD have a better educational experience. The use of IBL in mathematics classrooms can consequently be regarded as an 'educational' approach that helps students with SEBD learn mathematics.

The 'reframing' of SEBD can play a fundamental role in rendering educational systems fairer. For by helping teachers adopt a more positive attitude towards students with SEBD (Hughes & Cooper, 2007), 'reframing' beckons the opportunity to help students with SEBD achieve their full mathematical potential in an inclusive environment. In such an environment, all students learn side-by-side with age peers irrespective of ability or learning needs (Griffin, 2008). On the contrary, the core programme mathematics class in this study, in spite of the notable successes achieved, was still a form of exclusion from mainstream education.

The next challenge therefore is to replicate the present successes when students with SEBD are in a mainstream class. Apart from addressing the concerns related to inclusion, this replication would make a much stronger case for the educational value of IBL, as there would be less plausible factors to which the noted improvements could be attributed, such as the smaller class size and the possible interactional, pedagogical and achievement ramifications that this might bring (Wößmann & West, 2006). It would surely signal IBL as a successful, liberating form of pedagogy in line with Artigue and Blomhøj's (2013) assertion that one of the original intentions of inquiry-based education has been to promote the values of emancipation and democracy.

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