International Journal of Learning, Teaching and Educational Research
Vol. 12, No. 1, pp. 35-52, June 2015

The use of Technology to Support the Innovative Teaching of Mathematics to Students with SEBD: A Debate Related to the use of Technology in the Classroom to Promote Inclusion

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Abstract. This paper explores in detail the innovative uses of technology that link to a connectionist approach together with a reference to classroom experience. This paper ties the debates related to the use of technology in the classroom into broader issues relating to inclusivity. It also recognises the individual difference of students within the classroom framed around a recognition of social and emotional differences. This is thought about and understood as a pedagogical challenge and one in which technology facilitates shifts (or the opportunity to shift) in the approach to teaching utilised. It is argued this will be beneficial for all, and potentially crucial for some, and a convincing case is presented.

Keywords: Mathematics; Teaching, Learning, Technology, SEBD.

1.0 Introduction

1.1 The Context

The potential of computer technology to assist students in engaging in the learning of Mathematics is commonly acknowledged as a fact (Zbiek, Heid, Blume & Dick, 2007), however educational research and reports (Dynarski et al., 2007; National Center for Education Statistics, 2009; National Mathematics Advisory Panel, 2008) indicate that merely introducing technology into the classroom environment does not necessary imply a significant improvement in the learning and teaching of Mathematics. Technology is just a medium and the pedagogy used still remains a key feature in offering the students an engaging and meaningful educational experience. Technology can offer a range of pedagogical tools that can help students engage in learning. Hence, it can aid the teacher to offer students in the classroom a better and more engaging educational experience.

This paper will focus on how the incorporation of technology in the

Mathematics classroom can be used in the development of innovative teaching, such as Inquiry-Based Learning (IBL), which in turn will offer all the students in the classroom, particularly those with Social Emotional Behavioural Difficulties (SEBD) in mainstream schooling, a better and more significant educational experience. To argue in support of this statement, I will first discuss how technology can be used to bring about a change in pedagogy, which can better meet the needs and the learning characteristics of students with SEBD. I will move on to give an example of such a pedagogical change leading to innovative teaching, namely IBL. I will also discuss how IBL, integrated in the Mathematics classroom, with the help of technology, can have a positive effect on students with SEBD.I will draw upon a project I conducted two years ago related to this topic (see Camenzuli, 2012; Camenzuli & Buhagiar, 2014).

1.2 Overview of need

The presence of Students with SEBD creates particular difficulties for schools since they challenge the mainstream school systems (Ofsted, 2004). Hence, they are generally misunderstood at school, consequently the least likely to receive effective and timely support (Baker 2005; Kalambouka et. al. 2007; Ofsted, 2007). 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). This type of learning environment alienates students with SEBD even more than others, as they find it especially hard to take a passive role in the learning process (Munby, 1995). Schooling that, as von Glaserfeld (1989) argues, has traditionally positioned students as passive recipients of knowledge, places students with SEBD at a disadvantage and they will become increasingly disengaged from the learning process. Thus, these students need to be actively involved in learning (see Groom and Rose, 2005).

Students with SEBD have less tolerance for frustration, and thus, it is more likely that students with SEBD will get distracted or exhibit undesirable behaviours if the educational experience presented to them is not of a good quality. The end result is that these students risk being excluded from schooling for simply exhibiting the behaviours that define their special educational needs (Jull, 2008). It is fair to say that although students, who do not have SEBD, are less likely to exhibit undesirable behaviours when presented with an irrelevant or inadequate learning experience, they will also benefit from the use of a more active pedagogy being used in class.

Hence, the point here is that the improvement in standards of the students' learning experience on offer will be beneficial for everybody, but particularly effective with students with SEBD given their critical inclination to deviant behaviours when poor educational standards are presented to them. Moreover, technology is relevant since it's utilization can be used to drive the standard of teaching forward. Furthermore, it can be used to aid innovative teaching in the classroom and can offer a range of pedagogical tools that can help students engage in learning and become less distracted and disengaged from learning. The introduction of technology in the classroom must not be a mere cosmetic change for the sake of looking modern and up to date with modern times. My argument is that the introduction of technology is most effective when it also includes a pedagogical and paradigm shift in teaching and learning towards a more active and meaningful learning experience.

1.3 Defining the main terms

An important aspect of every piece of writing is to decide which understanding I will be attaching to the main terms that will be used throughout. Thus, I will now briefly give my own working definition of the main terms that will be used in this paper.

In the introduction, I have already referred to some difficulties students with SEBD pose to the educational system. I will be adopting Cefai's (2010) definition of SEBD since it captures the complexity of these difficulties, describing SEBD as a:

> 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)

When it comes to the teaching and learning of Mathematics, Askew et al. (1997), Enest (1991) and Swan (2006) describe three main approaches. These are: the transmission approach, the discovery approach and the connectionist approach. Table 1.1, which is reproduced from Swain and Swan (2005; cited in Primas, 2011) summarises the main features of these three approaches. A careful reading of this table reveals that, for each approach, views on the nature of Mathematics are intimately linked to how the teaching and learning of the subject are perceived.

Table 1.1: Three approaches to the teaching and learning of Mathematics (Swain and Swan 2005; cited in Primas, 2011)

Views of the subject	**Transmission Approach**	**Discovery Approach**	**Connectionist Approach**
	A given body of knowledge and standard procedures. A set of universal truths and rules which need to be conveyed to students.	A creative subject in which the teacher takes a passive, facilitating role, expecting students to create their own concepts and methods.	An interconnected body of ideas which the teacher and the students create together through discussion.
Views of learning	An individual activity based on watching, listening and imitating until fluency is attained.	An individual activity based on practical exploration and reflection.	An interpersonal activity in which students are challenged and arrive at understanding

			through discussion.
Views of teaching	Structuring a linear curriculum for the students; giving verbal explanations and checking that these have been understood through practice questions; correcting misunderstandings when students fail to 'grasp' what is taught.	Assessing when a student is ready to learn; providing a stimulating environment to facilitate exploration; avoiding misunderstandings by the careful sequencing of experiences.	A non-linear dialogue between teacher and students in which meaning and connections are explored verbally. Misunderstandings are made explicit and worked on.

Hence foward, innovative teaching methods in Mathematics should move away from the transmission approach towards the connectionist approach. In fact, the European Union (EU), through the project named Promoting Inquiry in Mathematics and Science Edcuation Across Europe (PRIMAS, 2010) (see http://www.primas-project.eu) is promoting this exact pedagogical change in the EU:

> PRIMAS aims to effect change across Europe in the teaching and learning of mathematics and science by supporting teachers to develop inquiry-based learning pedagogies so that in turn, pupils gain first-hand experience of scientific inquiry. Our objective is that a greater number of pupils will have a more positive disposition towards the further study of these subjects and the desire to be employed in related fields.

Notwithstanding this campaign by the EU, an analysis of national contexts conducted on behalf of the EU-funded PRIMAS project revealed the low level of application of IBL oriented pedagogy in all the 12 participating countries[1] (PRIMAS, 2010). Instead, this analysis shows the continued dominance of the transmission teaching approach in most of these countries. This in spite of PRIMAS (2010) reporting that, in recent years, in all the countries taking part in their project there have been policy changes favouring the adoption of IBL-friendly pedagogies. This reality reveals that it takes more than policy changes to actually change teacher practices. However, the introduction of technology in the classroom can serve as catalyst to bring about this change in pedagogy as proposed by the EU. Technology can be vital in helping the teacher implement innovative ways of teaching moving away from the traditional transmission approach of teaching.

[1] Countries which took part in the PRIMAS project are Germany, Switzerland, Netherland, England, Spain, Slovakia, Hungary, Cyprus, Malta, Denmark, Romania and Norway.

Finally, I will be adopting a very vast definition of technology including any physical technological components such as projectors and laptops and any forms of digital media such as social networks, educational games and educational software packages.

2.0 Technology in Mathematics Education

2.1 A paradigm shift in pedagogy

Linking principles of learning to the teaching of Mathemtics using technology is of utmost importance. Technology can be used to promote a shift to a better and more meaningful pedagogy in the Mathematcs classroom. Hasselbring (2001), in fact, made a very important point by arguing that the integration of technology should also be accompanied by important learning principles such as connectedness with prior knowledge, developmental of understanding rather than only memorisation and include active learning. All this links with a connectionist approach in teaching Mathematics. This is beneficial to all students learning Mathematics, especially students with SEBD as will be documented later. It is important that technology integration in the calssroom supports students' abilities to actively engage in and make sense of Mathematics (Allsopp et al., 2010). Similarly, Hofstetter (2001), addressed this issue by arguing that the readily available technological tools make the activation of prior knowledge and incorporation of revlevant connections more possible. Hence, here Hofstetter (2001) emphasises the importance of linking the integration of technology with cognitive learning principles. Quite simply the arguments of both Hasselbring (2001) and Hofstetter (2001) are that technology should be used to push foward innovative ways of teaching.

Thus, the change here is not between having a technology free classroom to one in which technology exists. The change must be a pedagogical one, essentially about replacing 'surface learning' with 'deep learning' with the help of technology. According to Marton and Säljö (1976), in contrast to a surface approach to learning which is dependent on attempts to remember course material whilst treating it as unrelated; a deep approach to learning encompasses an active search for meaning, underlying principles, structures that link different concepts or ideas together, and widely related techniques. The student agency implied in the pursuit for deep learning clearly calls for some form of inquiry on students' part as they engage in activities that mimic mathematicians' efforts to develop mathematical knowledge (see Van Schalkwijk et al., 2000). Simply integrating technology in the classroom will not bring about 'deep learning'.

2.2 Trends of the use of technology in Mathematics Education: An overview

Technology's integration in the classroom can be shown to have a positive impact on student learning in Mathematics (Craig et al., 2009). In 1999, Schacter, reviewed over 700 empirical studies in which students had exposure to the use of technology in the classroom and showed an overall positive gains in achievment. Nevertheless, the research on using technology to imporve Mathemtaical understanding demonstrates mixed results. Dynarski et al. (2007) reviewing various software products designed for Mathematics learning found no significant test score differences between the groups of students using the system as part of their classroom instruction and the groups of student in a standard classroom. Harris et al. (2008) and Mayo (2009) in two different studies suggested that use of technology in the Mathematics classroom increased achievement (as measured by standardized testing). Kebritchi's (2008) study supported the potential of technology in the Mathematics classroom although establishing positive results for students achievment, no positive effects were recorded with regards to student motivation. Ke and Grabowski (2007) investigations on a particular mathemtatics educational computer package showed that students using this package outperformed their peers in achievement gains. Students with low socioeconomic backgrounds registered the greatest improvement.

Simply integrating technology in the classroom setting does not automatically increase students' achievement or motivation in the subject. Young et al. (2012) suggests that careful research needs to conducted on the use of technology and technology should be designed to allow the use of contempory learning theories.

3.0 A pedagogy that caters for all: How can technology help?

Disruptive behaviour can obstruct learning more than inattentivness since it effects the whole classroom, disrupts the teacher and wastes lesson time. An international study amongst twenty-three countries, reported that one of the major factors which hampers teachers' effectiveness was misbehaviour in school, with an average thirteen percent of teacher time spent on maintaining order and correcting misbehaviour in the classroom (OECD, 2009).

Students are known to misbehave in school or to skip school altogether, not because they dislike school, but because they do not appreciate the way in which they are being taught (White, 1982). Thus, it is essential to have a pedagogy that caters for all types of students (Davies, 2005). In spite of this key role played by pedagogical issues, there is a tendency to focus support to students with SEBD on issues of behaviour management rather than to enhance pedagogical methods in class.

Major importance needs to be given on the ways in which teachers deliver the curriculum if students with SEBD are to benefit from their educational experiences (Moody et al., 2000). Indeed, the rooted policies, practices and provisions in the chosen pedagogy either support or hinder the learning of these students (Visser, 2005). For instance, it is essential that students with SEBD get immediate and regular feedback (Hughes & Cooper, 2007), which can easily be done by the integration of technology. In addition, technology also gives the teacher the opportunity to be flexible according to student's needs and to build upon their prior knowledge rather than to follow blindly a rigid curriculum. From personal experience, technology can be used to adapt and differentiate material according to the students' ability. Thus technology can help the teacher set indvidualised learning tasks and carry out indivisualised training in the classroom. Hence, technology removes barriers to making progress in the classroom. This can be an advantage for students with SEBD who are known to engage more with a flexible academic programme (see Crowley, 1993; Habel et al., 1999).

Rather little research has been conducted so far regarding instructional, curricular, or classroom settings that is aimed at enhancing the learning and academic performance of students with SEBD (DuPaul & Stoner, 2004). Still, the array of pedagogical approaches that are used by teachers to support students with Attention Deficit Hyperactivity Disorder (ADHD) (see DuPaul & Stoner, 2004; Purdie et al., 2002; Zentall, 1995) can easily be applied to students with SEBD. These so called 'educational' approaches are designed to exploit, rather than inhibit, some of the characteristics that are associated with ADHD or any other form of SEBD (Hughes & Cooper, 2007).

One of the suggested strategies involves students writing answers to teachers' questions on cards and holding these up for inspection by the teacher (see Zentall, 1995). The strategy's embedded provision of visual motor-tasks increases the active participation of students with SEBD. This reduces the often-problematic waiting intervals between the accomplishment of the tasks and the receiving of teacher feedback. This strategy – which helps to improve both performance and behaviour of students with SEBD (Hughes & Cooper, 2007) – can be easily integrated using technology in the classroom. Instead of using cards, students can use their laptops or tablet to share their answers and get immediate feedback.

Students with SEBD tend to be talkative at unsuitable times. This behaviour can be very annoying for teachers. An increase in participation by students can be a solution for this problem (Zentall, 1995). With the use of technological applications, students can increase their participation and communication with the teacher and peers thus reducing the need for talking out of turn and disrupting the flow of the lesson. Hence, technology can help teachers offer students a better educational experience (Allsopp, McHatton, Farmer, 2010).

It is essential that students with SEBD are given an active role during lessons (see Camenzuli, 2012; Camenzuli & Buhagiar, 2014). For, as Munby (1995) warns, these students often experience alienation when they are required to take a passive role in the learning process. On the contrary, students with SEBD react well to an active style of learning. Thus, this type of learning appears to: (i) increases students' attention levels while doing tasks, thereby reducing disruptive and impulsive behaviours (Hughes & Cooper, 2007); and (ii) encourages student agency which is a key feature of a constructivist approach on which innovative learning styles, which will be discussed later, are grounded. Technology can help the teacher give students an active role during the lesson since students can be involved for large periods of time in investigations which they conduct themselves with the help of computer packages. An example of this instance will be discussed in section 5.1

4.0 Technology and innovative teaching

4.1 The context

The Maltese National Curriculum Framework (NCF) (Ministry of Education & Employment (MEE), 2012) emphasises that:

> Teaching is most effective when learners are provided with opportunities to make sense of new knowledge in a context which allows them to interact with the teacher and other learners to discuss and negotiate their understanding. In this view, a teacher-dominant pedagogy, which relegates learners to a passive role, emphasizes memorisation and limits interactions between learners, is not recommended. (MEE, 2012, p. 39)

Thus local policies are pushing for innovative constructivist pedagogies such as Inquiry-Based Learning. Rather than the transmissive approach to education (see section 1.3), this pedagogy is increasingly being pushed forward globally as a way of ensuring that students acquire 'deep learning' as opposed to 'shallow learning' (see Marton & Säljö, 1976). Technology can be a key element in this change since it can be used to aid the implementation of such an innovative way of teaching and can be an ideal partner for the teacher. Thus, technology can be vital in the move away from a transmissive way of teaching Mathematics to a constructivist one which results in 'deep learning' such as IBL.

4.2 Innovative teaching

Technology should push forward innovative ways of teaching in the Mathematics classroom. But what do we understand by innovative teaching and how can this be implemented with the help of technology? Here, I will first discuss what innovative teaching in Mathematics involves, drawing upon IBL. Later on I will give an example of how technology can be used to implement innovative teaching in the Mathematics classroom.

Innovative teaching approaches in Mathematics should on one hand fundamentally move teaching away from the 'transmission' pedagogy that is characterised by teachers imparting 'their' knowledge to students (Gattegno, 1971) who are viewed in turn as passive recipients ready to be filled with 'that' knowledge. The handing down of 'knowledge objects' from the expert to the novice is the main attribute of this teaching approach (Burton, 2002). Here the knowledge is itemised into discrete skills, concepts and techniques that are delivered in a hierarchical manner, starting from the simpler tasks and gradually moving on to the more complex ones to facilitate its transmission.

However on the other hand, innovative teaching should draw upon contemporary work in cognitive and constructivist psychology which has shown that knowledge, far from being an external map that can be transposed directly into a student's head, results from the organic process of reorganizing and restructuring undertaken by the student as he or she learns (Gipps, 1994). Students are now seen as agents, active constructors of meaning and knowledge who share responsibility for learning with their teacher, but no longer perceived as passive receivers of knowledge (Murphy, 1996). Knowledge from a social constructivist perspective is a product of dialogue and negotiation between and among teachers and students (Jaworski, 2002). The latter perspective holds that "we learn from being part of and interacting within a social environment, and that individual construction of knowledge is derivative of its social construction" (Jaworski, 2002, p. 73). In both instances,

> … understanding involves creating links in the mind and that 'making sense' of something depends on these links. Isolated pieces of information do not have links to existing mental frameworks and so are not easily retained in the mind. The identification and creation of links to existing frameworks depends on the active participation of the learner and on the familiarity of the context of the material to be learned. Understanding, in this view, is the process of construction and reconstruction of knowledge by the learner. What is known and understood will, of course, change with new experience and as new ideas and skills are presented to help make sense of it. (Harlen & James, 1997, p. 368)

This definition of understanding signifies a move away from what Black (1998) calls an 'atomised approach to learning' that promotes learning by rote, of small pieces of information without the understanding that links them together, and of fixed rules and procedures. The new direction in learning that is being planned is towards a more collaborative course in which students work together on interconnnected and challenging tasks (see PRIMAS, 2010) that inspires their thinking and create opportunities for critical reflection and understanding (see Jaworski, 1994). The change, therefore, is essentially about replacing 'surface learning' with 'deep learning'. The student agency implied in the pursuit for deep learning clearly calls for some form of inquiry on students' part as they engage in activities that emulate mathematicians' efforts to develop mathematical knowledge (see Van Schalkwijk et al., 2000).

4.2.2 Exploring Inquiry-Based Learning

Inquiry-based learning which is an example of innovative teaching in Mathematics is intimately connected to constructivist approaches in education that have shown how students' learning experiences are deeper and more significant if they are dynamically involved in instances where they investigate rich situations and if they share responsibility of monitoring their own learning (PRIMAS, 2011).

Inquiry can be described as a process, which can be commenced by either the teacher or the students, in which students investigate central, essential questions under the guidance of their teacher (Alvarado & Herr, 2003). Given that the teacher must follow a predetermined syllabus at school and certain curriculum attainment levels should be reached, the teacher has to keep students on track during this process of inquiry so that students do not deviate away from the material to be covered (Alvarado & Herr, 2003). According to Li et al. (2010), scientific inquiry prompts students to ask stimulating questions, plan and conduct investigations, use suitable techniques to collect data, think critically about evidence and possible explanations and share their arguments, rather than forcing students to follow a prescribed routine. Along similar lines, the Rocard Report (see Rocard, 2007) represents IBL as the planned process of identifying difficulties, reviewing experiments, differentiating alternatives, planning investigations, researching conjectures, searching for information, constructing models, debating with peers, and forming coherent arguments. Thus, with these characteristics attached to inquiry-based learning, it is no surprise to understand why the PRIMAS project (see PRIMAS, 2011), to which I referred in section 1.2, has described IBL with reference to Mathematics as a way of teaching and learning in which students are supposed to work in ways that are similar to what mathematicians actually do.

The IBL approach, apart from requiring students to be active in their learning, carries important implications for the teacher in line of constructivist learning theories. According to Ronis (2008), the teacher's role in IBL – which is, at times, also referred to as problem-based learning – is that of a facilitator rather than a leader. The teacher facilitates the learning process by directing students and shaping the learning environment (Li et al., 2010). As part of this facilitation, for instance, the teacher refocuses students on their tasks through the use of guiding questions (Alvarado & Herr, 2008). Apart from challenging students through effective, probing questions, a teacher who is committed to an IBL approach is expected to make constructive use of students' prior knowledge by managing small group and whole class discussions that offer space for alternative viewpoints and help students to make connections between their ideas (PRIMAS, 2011).

5.0 Integration of technology to deliver IBL to students with SEBD: an example

How can technology help to promote inquiry and hence innovative teaching in the Mathematics classroom and how will this in turn help students with SEBD experience a better educational journey? Here I will draw upon a project (see Camenzuli, 2012; Camenzuli & Buhagiar, 2014) that I carried out to answer this question.

The data, which was essentially qualitative, was collected over 15 consecutive weeks. Several data collection methods were used to explore the implementation process in great depth and detail (see Feagin, Orum & Sjoberg, 1991). I used a journal in order to guarantee a detailed record of the lesson proceedings. This journal also provided the space and time for data interpretation and critical reflection on the unfolding events inside my classroom (see McNiff and Whitehead, 2008; Mertler, 2009). I 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 (see Mertler, 2009). To enhance further the effective articulation of students' views, I interviewed and digitally recorded my students at two different stages of the study – 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). Focus group sessions with the students were also conducted discussing different processes of IBL.

The project 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. This 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 (see Head, 2005) is not meant to lower students' goals and expectations. Instead, the aim of the core programme is 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 these 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).

The main aim of this project was to explore how students' with SEBD react when taught through a constructivist pedagogy such as IBL. Here, technology played an integral part of this project since it helped me implement inquiry-based lesson. Technology was helping me, the teacher, make a pedagogical shift towards a more active and meaningful one as advocated by Hasselbring (2001) and Hofstetter (2001). A pedagogy in which students made use of prior knowledge and one in which 'deep learning' was facilitated. Students used computers to carry out investigations that otherwise would not have been feasible due to time constraints. Adequate software packages were used in order to design experiments to reach the desired learning goals (see section 5.1).

Basically, by preferring connectionist approaches to both transmission and discovery approaches (see table 1.1), I used classroom practices that based on mathematical inquiry as a way of engaging learners with mathematical ideas and to deepen their understanding of and connections between mathematical concepts. Consequently, I did not only expect students to solve problems, but also to understand what they are doing, to explain their methods and to follow the explanations of others. The idea is for students to view Mathematics as a significant endeavor, to develop a range of strategies for mathematical work and to employ these in a flexible and eventually efficient manner. This understanding helped me to develop lessons that value students' prior knowledge of mathematics and engage them in a wide variety of processes that facilitate deep learning.

I will briefly discuss here my main findings from this project. Firstly, students started to view learning as an activity in which they were active agents and as an enjoyable experience. Compared with their previous traditional learning experiences, students had a positive reaction to this active way of learning. Research evidence shows that the IBL-induced shift away from traditional teaching also introduced a strong element of enjoyment into their Mathematics lessons.

The research evidence also indicated a notable improvement in students' behaviour during the 'core programme' Mathematics lessons. Both the students and the teacher appear to have credited this improvement mainly to a less rigid classroom environment combined to a more active and collaborative learning approach. The noted improvement in students' behaviour during the 'core programme' Mathematics lessons was accompanied by a genuine motivation on the students' part to learn mathematics.

Also, 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-related processes. The resulting positive effect that IBL was having on students' motivation to learn did not go unnoticed and it opened the door in turn for students' learning that was reflected in higher achievement.

Evidence from this project also suggests that IBL supports students' learning of Mathematics and leads to better achievement. The students, on their part, regularly referred to this 'new way of doing mathematics' as 'an opportunity for learning'. Many of the students in class expressed the wish to have more IBL lessons and their desire for similar lessons was not only based on 'enjoyment', but also on a sincere belief that they were beginning to understand things and learn Mathematics.

5.1 A concrete example

In the following section, I will be giving an example of how technology can be used to help in the implementation of innovative ways of teaching such as IBL in the Mathematics classroom. This particular example deals with the teaching of the Tangent ratio in Trigonometry. Similar methods can be used for other topics such as angles, Pythagoras' theorem, circle theorems and various other topics in the Mathematics curriculum.

The objectives of this particular lesson was to understand the Tangent ratio, apply it, support student's creativity and belief in their own abilities and model a humane picture of Mathematics in pupils' mind and humanistic educating via demonstrating an experimenting technique using technology to 'discover' the trigonometric ratio. Key IBL pedagogical skills used during this lesson was: promoting student co-operation, autonomous learning, securing basic knowledge and experiencing subject boundaries and interdisciplinary approaches. The following figure illustrates the IBL method used.

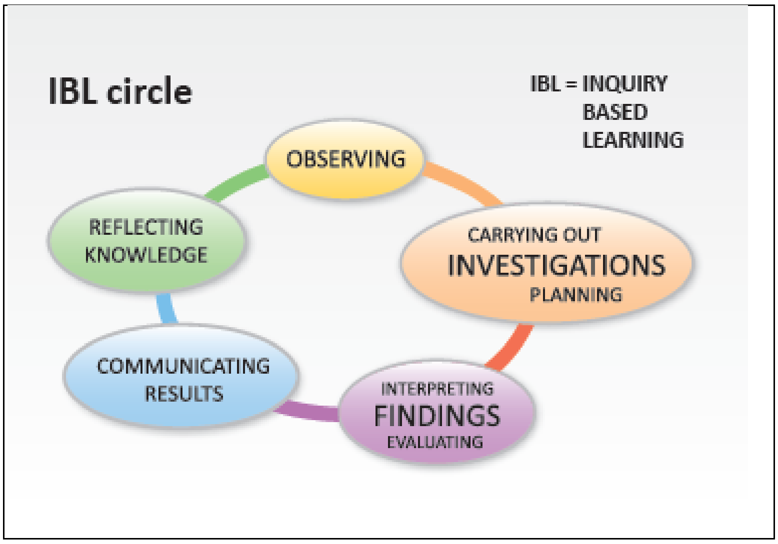

Figure 4.1: The IBL Circle

Using a computer package such as Cabri-géomètre the following file (figure 4.2) was prepared for students on their computers. The students were split into groups, each group having access to a computer. Without technology this would have consumed too much time and its feasibility would have been questioned. However, with the integration of technology students could be exposed to many examples of right-angled triangles and they could investigate the relationships based on various examples. Hence, here technology is helping in overcoming obstacles related to lack of time. In fact, teachers mentioned problems related to time constraints as a reason for not using innovative teaching methods in the classroom and reverting back to a transmission approach (Rocard, 2007). Also, technology can help the teacher in his/her preparation. For example, here the teacher does not have to prepare different sets of right angles for the students to measure.

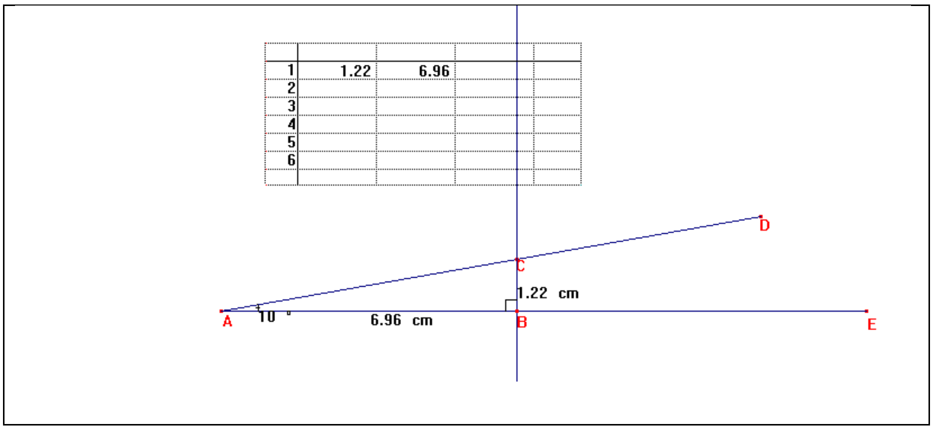

Figure 4.2: Teaching Trigonometry

Very simply, students are asked to drag point D so that angle BÂC was 10°. Using the software, the students are then queried to measure side BC (Opposite) and AB (Adjacent). Afterwards, they are requested to keep the same angle and move B along AE to another four different positions and note the lengths of BC and AB. Every time they are asked to record sides BC and AB using the software. The boys are asked to find a relationship between BC and AB. What happens when they add them? Subtract them? Multiply them? Divide? The different groups are invited to communicate their findings. What can they conclude? Does this only work for 10° angles? Why? How can they prove it?

Here students are engaged in 'deep learning' through inquiry with the help of technology.

6.0 Conclusion

Technology can play a unique role in facilitating a paradigm shift away from a classroom pedagogy that is grounded on a transmission approach to one that engages students in cognitively demanding tasks (Bransford, Brown & Cooking, 2000; Culp, Honey & Mandinach, 2003; Jonassen, Howland, Moore & Marra, 2003). Technology can be used as a catalyst for pegagocial change which is greatly needed in the light that a dominance of a transmission approach still remains in some EU countries (see Primas, 2010).

However, even though research has shown that technology can be used in ways to support students' efforts to engage in cognitevely demanding tasks, technology has not been widely adopted for this purpose in most classrooms (Becker, 2001; Wenglinsky, 2005). Unfortunately, as argued by Young et al.'s (2012), technology has become a mere 20-minute activity during the lesson rather than an integral part of the curriculum. If technology is being used just for the sake of appearing modern and justifying the thousands of Euros spent in introducing technology in the class, then its use will not bring about the positive change in education we all desire.

Educators have to look at technology as an ideal partner which will help them bring about the required pedagogical enhancements in education. For example, technology can be used to drive the change from using a transmissice pedagogy in class to the use of innovative teaching strategies grounded on a constructivists approach. The use of innovative teaching in the Mathematics classroom can be regarded as an 'educational approach' (see Du Paul & Stoner, 2004) that will help all students in the classroom have a better educational experience, but will have an even deeper impact with students with SEBD. This is because students with SEBD will exhibit deviant behaviours more easily when presented with an inadequate learning experience given that they are less resilient to it. Technology offers on important opportunity for the implantation of such 'educational approaches' and can be an integral tool in the development of innovative teaching methods in class as shown in the example given.

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