# A study of Northern Ireland Key Stage 2 pupils' perceptions of using the BBC Micro:bit in STEM education.

Ву

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### Abstract

This research investigated the perceptions held by Key Stage 2 (KS2) pupils, across two Northern Ireland (NI) primary schools, towards the use of the BBC Micro:bit that has been recently dispatched to United Kingdom (UK) primary schools. The study involved the researchers creating and implementing a teaching resource that included a range of different activities for the pupils to complete using the BBC Micro:bit. Upon completion of these activities, feedback was sought and obtained from the pupils via a questionnaire. The study is important as it is one of only a few pieces of research surrounding the BBC Micro:bit and to the authors' knowledge, it is the only research to date conducted in NI that focusses on pupils' perceptions involving the use of BBC Micro:bit. The data was obtained by means of a questionnaire and involved the participation of 70 KS2 pupils. In NI, KS2 refers to the final three years of primary education (P5, P6 and P7). Two schools were involved in this study, with school A contributing 41 of the pupils surveyed and school B providing 29 pupils. Pupils took part in activities over the course of four morning sessions, two mornings per school, from 9:30 to 12pm. The participants completed the questionnaire at the end of the second morning. It is important to note that two classes from school A participated in the study, which resulted in each class taking part in activities for only one day.

What was most apparent in this study was the very positive response of the pupils towards using the BBC Micro:bit. Nearly all of the pupils who took part in this study responded that they found using the BBC Micro:bit easy, enjoyable and useful in relation to both programming and problem solving. A minority of the pupils also commented on how the BBC Micro:bit provided an opportunity to work as a team in order to overcome problems during the programming stage, promoting the important skills of team work and problem solving. Nearly all pupils expressed a keen interest in programming and indicated that they learnt a lot in such a short time. Furthermore, pupils expressed great enthusiasm towards using the BBC Micro:bit and expressed a desire to use it more often, both inside and outside of the school.

Based on these key findings and taking account of the strengths and limitations of this research, ideas for further research are presented alongside advice for teachers who may be considering the use of the BBC Micro:bit within their own lessons.

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## **Chapter One - Introduction**

"Teaching computer science should no longer be viewed as teaching a trade or providing training for coders. In many ways, it's becoming similar to needing to learn your native language in school. Teachers push pupils to analyse and construct poems, write short stories, or read theatre plays. They don't do this with the primary goal of creating the next generation of writers or poets" (Schmidt, A. 2016, p.5)

Information Communication Technology (ICT) is becoming one of the most important subjects for primary schools across the world, playing a key role in educational, economic and social changes. There is therefore a need to develop teaching resources capable of meeting the demands of ICT education by means of both nurturing ICT literacy and skills, both in schools and as part of lifelong learning (Vanderline et al, 2015; Kozma, 2008).

The current Northern Ireland Curriculum (NIC) for Key Stage 2 (KS2) aims to develop the skills of the individual in regards to the cross-curricular skills of Using ICT (UICT) in order to improve pupils' thinking skills, as well as providing them with opportunities to become independent, self-motivated and flexible learners (CCEA 2007). As of 2017, the NIC does not directly reference coding or programming, however, teachers do have the option to teach it providing it is relevant to the NIC. That having been said, the teaching of coding happens very rarely in NI at either KS2 or KS3/KS4, which suggests that there may well be a lack of coding skills among teachers (Perry 2015).

Key Stage	Foundation	KS1	KS2	KS3	KS4
	(P1 / P2)	(P3 / P4)	(P5 / P6 / P7)	(Year 8 / 9 / 10)	(Year 11 / 12 GCSE)
Ages of pupils	4-6 years old	6-8 years old	8-11 years old	11-14 years old	14-16 years old
Type of school	Primary	Primary	Primary	Post-Primary	Post-Primary

Table 1 - Key Stages in Northern Ireland schools.

Perry (2015) however also observes that many primary schools in NI are running 'Programming Clubs', usually operating during lunchtime or after school. The clubs provide pupils with the chance to develop their programming skills by undertaking a range of activities from game creation to website design. Extra-curricular programming activities can provide a fun and interactive way for teachers and children to develop their programming and problem solving skills (Code Club, 2016). James et al (2014) further argue that such programming activities allow pupils to gain an understanding of both its relevance and importance to their everyday lives. These school based clubs incorporate a wide range of programming activities ranging from block editors such as Scratch, to more advanced forms of programming such as Python. Using a block editor such as Scratch, at the beginning is useful for providing the basic skills required when it comes to programming. The Block

Editor provides pupils with an introduction to structured programming via drag and drop coding blocks that snap together (BBC Micro:bit, 2015). This helps raise pupils' awareness surrounding the various programming terms, providing them with the foundation to develop their programing skills; this in turn facilitates the transition from working with block editors such as Scratch to the effective use of other coding languages such as Python (James et al, 2014).

Although Scratch / block editors are normally colourful, engaging and relatively easy to use, the pupils only ever achieve on screen results as opposed to, for example, programming a robot. This might be considered to limit creative opportunities for pupils to develop creative thinking in regards to what is actually possible through programming. Kazakoff (2014) suggests that children require early experience in programming in order to facilitate meaningful discussion on matters that bear relevance to what is happening in the world around them. Kazakoff further contends that the use of tangible items e.g. robots, may enable abstract ideas beyond their current cognitive abilities to become more concrete. Pupils should feel motivated and excited to create programs and by encouraging them to create their own unique programs, this can help develop their interest in Science, Technology, Engineering and Maths (STEM) related subjects, including computer science (Schmidt, 2016).

As suggested previously, the use of an on screen editor is useful in developing knowledge about basic programming skills. However, the use of robotics has also the potential to make programming relevant to the pupils' lives, allowing them to experience the many potential uses for programming. This contention is supported by Kazakoff (2014, p555) who maintains that, *"new technologies, in particular robotics, make different kinds of learning opportunities possible, including new ways for peer social interactions, and many opportunities for creativity, social, and cognitive development"*.

The BBC Micro:bit is a new and innovative educational tool which has been developed as an aid to assist teachers in the teaching of computer science and programming. It is a pocket sized programmable computer, which has been developed by the BBC for the purpose of providing a computing platform for school pupils which enables them to fully appreciate the potential of programming as an educational tool.

The BBC Micro:bit consists of a range of different technical features, such as, LEDs, push buttons, an accelerometer and a compass (See Appendix 1). To program the BBC Micro:bit, the BBC has provided a range of different methods, ranging from Block Editors aimed towards beginners e.g. Scratch, to more advanced forms of programming such as Python (BBC Micro:bit, 2015). This range of software allows the teacher to set different levels of challenges in relation to the pupils' ability levels.

As stated previously, in NI there are currently no syllabi for computer science from the Council for the Curriculum, Examinations and Assessment (CCEA), to computer science / programming. There is evidence to suggest that teachers are not being adequately trained in the area of computer programming and that this may result in difficulties arising in terms of teaching programming to pupils (Perry, 2015). Beggs (2000) and Balanskat et al (2006) argue that a lack of teacher confidence may lead to anxious feelings about using ICT in the classroom and thus lead to teachers not using it at all in fear of taking away from the pupils' academic development.

In their recent evaluation of the area of learning within the NIC titled the 'World Around Us' Perry and Irwin (2015) suggested STEM education was underdeveloped in just over 54% of the primary schools inspected by the Education Training Inspectorate Northern Ireland (ETINI). Schools highlighted a range of different issues whilst suggesting a lack of training and teacher confidence was the main reason for the lack of STEM education programmes. It has also been reported that the future success of the NI economy will be dependent on increasing numbers of skilled computer programmers becoming available (Sentinus, 2015). That being the case it is imperative that teachers should be empowered to integrate the teaching of computer programming within the overall spectrum of STEM education.

This study will examine how the BBC Micro:bit can be used as a tool for developing pupils' problem solving skills as part of a pedagogical approach to STEM education. The focus of this research will examine KS2 pupils' perceptions of using the BBC Micro:bit and whether they view it as an enjoyable, challenging and educationally beneficial learning tool as part of STEM education.

In order to achieve this, the research will focus on a range of different processes. Firstly, a review of current literature will be carried out for the purpose of providing an insight into the current literature concerning the topic of NI KS2 pupils' perceptions of using the BBC Micro:bit as part of STEM education. Chapter two, will refer to the various issues relating to the participants of the research, the procedures that will take place, the research methods used for the investigation, ethical considerations and finally, the data analysis. After Chapter two, the results of the investigation will be analysed and presented within Chapter three. Chapter four will highlight the various strengths and limitations of the research as well as providing recommendations for further research that could be conducted on this particular aspect of STEM education within primary schools.

### **Chapter Two - Literature Review**

#### 2.0 Overview

This section of the study will critically review literature pertaining to the topic of using programming in problem solving as part of STEM education within NI primary schools.

#### 2.1 STEM Education

STEM education may be viewed as an approach in which STEM subjects are integrated through a pedagogical method that uses design-based, problem-solving, discovery, and exploratory learning strategies (Fioriello, 2010; cited in Roberts, 2013). It can also be considered through the lens of a collective curriculum wherein the content can become integrated or fused as one subject, strengthening students' understanding of complex concepts (Morrison & Bartlett, 2009; cited in Roberts, 2013).

Bybee (2013) argues that the acronym 'STEM' is widely used and applied within many different areas of both everyday life and school education, resulting in it becoming increasingly difficult to understand. Bybee further contends that when focusing solely on education, the term STEM is often misinterpreted, resulting in the subjects being taught in isolation.

Although Bybee criticises how the STEM acronym is used, he does defend the principle of STEM education, the importance of each subject and of their relevance to one another. However, Pitt (2009, p.41) offers a more definitive and critical overview of STEM education when claiming that, *"STEM as an educational concept is problematic, there is little consensus as to what it is, or how it can be taught in schools".* He further contends that there is no clear approach when it comes to teaching STEM, with many viewing it as made up of discrete subjects, whilst others feel that by having an activity that involves any STEM subject as being a STEM activity.

Benuzzi and Grace (2015) highlights the importance of cross-curricular teaching when it comes to STEM education, emphasising that the acronym itself highlights how STEM requires cross-curricular thinking, connections and teaching. Despite their arguments for the cross-curricular teaching of STEM, reports carried out by the Department of Education NI (DENI) and the Department for Employment and Learning NI (DELNI) (2009) and Perry and Irwin (2015) suggests that a lack of teacher confidence / training may be one reason for the disconnected teaching of STEM subjects.

This is a problem that needs to be addressed considering that cross curricular learning can provide pupils with opportunities to take responsibility for their own learning, as well as providing them with a more in-depth understanding of what they are learning (Kerry, 2015).

#### 2.2 STEM Education in Northern Ireland

In NI, STEM education is referenced within the foundation stage, with children between the ages of four to six being introduced to various elements of Science, Technology and Maths. At school, pupils have opportunities to build upon their previously acquired STEM skills through using Mathematics and ICT, as well as engaging in thinking and problem solving activities. The teaching of these skills to pupils takes place during the foundation stage within the Numeracy and 'World Around Us' areas of learning. Within these areas of learning pupils are provided with opportunities to explore and develop age appropriate answers to some of the big questions in relation to the world around them (CCEA, 2007). The skills obtained are intended to be further developed in post-primary schools where pupils study Mathematics until the age of 16 whilst having the choice to study Science and Technology and Design (DE and DEL 2009). (DE and DEL 2009; Roberts, 2013; DEL 2015; CCEA 2007) argue that by studying STEM based subjects, pupils will not only be provided with knowledge of the subjects they are studying, but also develop investigative and problem solving skills and an understanding of how they may be implemented in the real world, although evidence for this is sparse. It is interesting to note that none of the above authors refer to STEM education as an integrated approach, referring to the subjects in isolation.

The report of STEM Review (2009), commissioned by DENI and the DELNI, expresses concerns in relation to STEM education in NI. As a society we rely increasingly on aspects of STEM based knowledge and understanding to help us understand the rapid rate of technological change which we see around us today (DENI and DELNI, 2009; Roberts, 2013). However, the report by DENI and DELNI further argues that young people in NI are increasingly disengaged from STEM, resulting in a decreased uptake at both higher and further education, which, in turn, influences the growth of the future economy.

DENI and DELNI (2009) suggest three areas of concern for STEM education in NI. Firstly, how the lack of planning at primary and post-primary impacts upon pupils' progression. Secondly, the relevant Continual Professional Development (CPD) undertaken by teachers is very limited in its scope. Thirdly, the quality of careers guidance is questionable, with a limited amount of time allocated to providing careers guidance in the majority of schools limited (DENI and DELNI, 2009).

The Report of the STEM Review (2009) produced a 'vision' for the future of STEM education in NI, with the stated aspiration of *"Empowering future generations through Science, Technology, Engineering and Mathematics to grow a dynamic, innovative economy"* (DENI and DELNI, 2009, p. 11). From this, 20 recommendations on how this vision might be realised were outlined and subsequently summarised under four key areas:

- 1. Business must take the lead in promotion of STEM.
- 2. We must alleviate Key constraints in the STEM artery.
- 3. There needs to be increased flexibility in the provision of STEM education.
- 4. Government must better co-ordinate its support for STEM.

These recommendations mainly focus on the benefits that an effective STEM education policy might bring to the economy and comments on how educational success involving STEM may be improved. Suggestions such as further STEM education training for teachers, improvement to planning at KS2/KS3, STEM scholarships and cross-departmental structures at government level were made.

It is well documented within the various reports previously mentioned relating to STEM education that primary education is a crucial time as children begin to develop a sense of wonder and enthusiasm for science and technology. However, the report indicated that many primary pupils are developing negative attitudes towards science and technology, with many practical and investigative approaches used by teachers being viewed as underdeveloped.

"The indications are that many primary teachers may lack the knowledge, skills and confidence to deliver a science and technology programme which develops progressively the children's skills and knowledge" DELNI (2009, p.48).

#### 2.3 Teacher confidence

The DENI and DELNI (2009) contends that as a matter of urgency, support offered to primary school teachers to ensure they develop the confidence and enthusiasm needed to successfully deliver effective STEM education programmes. This would appear to support the views, as indicated previously, expressed by Perry and Irwin (2015) in relation to teacher training, teacher confidence and teachers' ability to teach computer programming in primary schools.

Hammond (2000) argues that better qualified teachers may make a difference to pupils' learning and achievement within the classroom. Hammond also argues that the improvement of teachers' knowledge and skills often leads to improvements in pupils learning and achievement.

Lessing and Witt (2007) suggested that teachers who they consulted in their research indicated that CPD courses could be an excellent means of providing teachers with the necessary confidence and competence in what they teach, with nearly all teachers agreeing that CPD programmes improved their confidence, knowledge and skills. *"CPD refers to any activities aimed at enhancing the knowledge and skills of teachers by means of orientation, training and support"* (Coetzer, 2001, p.78). It is also likely to affect attitudes and approaches, contributing to the improvement of the quality of learning and teaching (Lessing and Witt, 2007).

CPD courses can also help improve confidence amongst teachers who are uncertain about implementing certain elements of STEM education into their teaching (DENI and DELNI 2009; DENI 2010). Although DENI and DELNI (2009) suggest a need for more CPD courses and training for teachers in order to improve STEM education, research has shown that a lower number of primary teachers are taking CPD courses. Around 37% of teachers took part in STEM training and 24% opted for further CPD. It is highlighted that the cause of this problem is due to cuts to DENI funding (Perry and Irwin, 2015).

#### 2.4 Programming in Northern Ireland Primary Schools

Computer programming could be described as a process, which involves the development and implementation of various sets of instructions, enabling a computer to perform a certain task, solve problems and/or provide human interactivity (Balanskat and Engelhardt, 2014; Kazakoff and Bers, 2014).

The revised curriculum for NI has been in place since September 2007 with the aim to "empower young people to develop their potential and to make informed and responsible choices and decisions throughout their lives" (CCEA, 2007, p.4). Balanskat and Engelhardt (2014) contend that the underlying concepts of programming will be valuable to the individual regardless of whether or not they make a career out of it. Papert (1980) further supports this view by claiming that a deep understanding of programming, in particular within the areas of analysis and debugging, will result in significant educational benefits in many domains of discourse, including those unrelated to computers and information technology.

Although computer programming is not referenced directly within the NIC at KS2, the crosscurricular element of UICT provides teachers and schools with opportunities and the flexibility to teach programming if they wish (Perry, 2015). As illustrated previously, various issues such as teacher confidence, CPD, funding and resources may result in teachers not being fully informed of the potential that teaching programming can have for their pupils. Fluck et al. (2016) and O'Kane (2016) maintain that the removal of barriers to learning programming concepts will not only benefit pupils as individuals, but eventually have benefits for the economy. For example, this may occur through the development of computer scientists who will sustain a competitive edge in a world driven by technology. In addition, economic, social and cultural changes require an educated, innovative society, which continually investigates problems for the purpose of realising solutions that improve the human condition, this is as opposed to having change imposed on them through technological changes (Webb et al. 2015). These core elements of the economy, society and culture also apply to the NIC where it is maintained that the provision of learning opportunities for young people should be encouraged to develop as individuals, contributors to society and contributors to the economy and environment (CCEA, 2007). Perry's (2015) research on coding in schools within NI contends that the teaching of programming at primary or pre-GCSE rarely happens with many schools moving towards the informal teaching of programming. This informal teaching is mainly offered as an extracurricular activity, operating during lunchtime, after school and during the holidays, which may result in only a minority of pupils attending.

Kozma (2008) contends that the use of computers within schools often has a significant role in the educational, economic and social changes that happen daily in an ever-advancing society. As a society, there is an ever-growing demand for effective STEM education that will help society us understand the challenges that we may face in our everyday lives and to manage the rapid rate of technological change which we see around us (DENI and DELNI 2009; Fluck et al. 2016; Webb et al. 2015). It is also maintained that as technology advances, pupils and teachers must develop skills and attitudes towards STEM/ICT so that they can develop the expertise necessary to thrive within the 21<sup>st</sup> century (Anderson, 2008; Kozma, 2008 Fluck et al. 2016; Webb et al. 2015).

Contrary to the past, when children would explore and create artefacts from the materials around them, Flannery and Bers (2013) contend that materials have dramatically changed due the evolution of computers. Changes in simple activities such as games and storytelling have moved from needing physical resources to their incorporation within digital technology. Furthermore, Flannery and Bers maintain that advances in human-computer interaction allows young children to engage in digital creation through programming child friendly robots.

"Working with age-appropriate programming tools and curricula, children can creatively problem solve and explore powerful interdisciplinary skills and knowledge" Flannery and Bers (2013, p.81).

In order for children to grow up digitally literate they need to understand basic computer functions, in particular programming, which will help them in their understanding of basic technological concepts that are needed to operate 21<sup>st</sup> century products (Kazakoff and Bers, 2014). Programming, with the addition of age-appropriate materials, will allow children to learn and apply core-computational thinking concepts such as analysis, decomposition and iterative design (Kazakoff and Bers, 2014; Lee et al. 2011). The study of computer programming has been found to influence a wide

range of cognitive skills in early childhood, including computational thinking, meta-cognition, and transferable skills in the areas of problem presentation, problem solving and debugging (Papert, 1980; O'Kane, 2016; Kazakoff and Bers, 2014; Webb et al. 2015; Fluck et al. 2016).

#### 2.5 Educational Philosophy

This section will focus on the views of various authors' educational theories in an attempt to draw conclusions on how best to deliver a programming course.

Papert (1980) maintains that children's creativity should not be stifled, instead an environment should be created where the perception that ideas need to be either true or false is less dominant. Furthermore, Papert suggests that educators often provide pupils with 'correct' theories before they have the chance to invent their own. Papert's views on cognitive development is in line with that expressed by Piaget.

Piaget's cognitive development theory focuses on the development of the child rather than their ability to learn concepts, proposing discrete stages of development, marked by qualitative differences (McLeod, 2015). Papert (1980) is in agreement with Piaget, proposing that children construct their own learning by means of exploring the world around them. According to Piaget and Inhelder (1958), learning should be centred around the pupil with the focus on active discovery learning. Furthermore, assimilation and accommodation require an active learner, not a passive one, because problem-solving skills cannot be taught, they must be discovered.

Papert's (1980) interpretation of Piaget's cognitive development theory within ICT, advises an interactive approach whereupon the learners can become constructive architects of their own learning. Flannery and Bers (2013) further support this by maintaining that the process of creation and problem solving will enable children to actively explore and develop cognitive skills and domain-specific content in developmentally appropriate ways. Kazakoff and Bers (2014) further argue that hands on experiences enable children to become the producers of content and not simply the consumers of technology created by others. Knowledge should not be poured, so to speak, into the child's mind nor passively absorbed; instead, the child must construct the knowledge for him or herself (Piaget, 1970).

At the time of Papert's research into 'constructivist programming' computers were not widely used within education. However, Papert (1980) could see the potential of computers, maintaining that when programmed they could be anything and appeal to anyone. Papert used the Creative Hybrid Environment for Robotic Programming (CHERP) language whilst carrying out his research (Kazakoff and Bers, 2014). CHERP is a hybrid programming language which allowed children to transition back

and forth between screen based (graphical) and tangible (block based) programming interfaces (Bers and Horn, 2010). This hybrid approach provided the individual with the opportunity to work with various styles of programmable actions, thus allowing them to iteratively analyse and adapt their work according to their discoveries (Horn et al. 2012; Flannery and Bers 2013). Following Papert's research, many developers have created developmentally appropriate programming environments for children (Kazakoff and Bers, 2014). For example, Scratch, an object based programming language that allows children to build their own stories, games and animations (Brennan and Resnick, 2012; Glezou, 2014).

Kazakoff and Bers (2014) agree with Papert's view of a 'constructivist programming' environment where children are engaged in thinking about their own thinking, thus resulting in abstract ideas becoming more concrete. However, they also suggest a different pedagogical approach in order to achieve this. Kazakoff and Bers contend that developmentally appropriate technological tools provide opportunities to scaffold learning that, through interactions from parents, teachers and peers, may enhance learning, drawing on Vygotsky's theory of the Zone of Proximal Development (ZPD).

Vygotsky's ZPD theory focuses less on stages and age, but more on the process of the continuous development of an individual (McLeod, 2015). Vygotsky (1978) refers to ZPD as the space between what a child can achieve on his/her own, versus what they can achieve with assistance. Additionally, Bruner's theory on scaffolding adds to this, stating that *"Scaffolding refers to the steps taken to reduce the degrees of freedom in carrying out some tasks so that the child can concentrate on the difficult skill he/she is in the process of acquiring"* (Bruner, 1978, p.19).

Flannery and Bers (2013) maintain that children who are at different stages and sub stages of cognitive development would benefit from learning goals, activities and scaffolding, which have been designed specifically for their distinctive cognitive characteristics. Furthermore, Flannery and Bers propose that when interacting with younger children, a slower pace and expanded focus on the introductory activities allow more time for children to explore the various features of programming. This would enable the child to work towards solving short challenges, benefiting from teacher interaction who, through scaffold learning, may progress the child towards the concrete operational stage (Kazakoff and Bers, 2014; Flannery and Bers, 2013; Lee et al. 2011).

The review of the literature provides evidence to suggest that there are some barriers in relation to the implementation of STEM education by means of programming in NI primary schools. Teacher confidence, CPD, funding and resources are some of the issues highlighted in reports carried out by Perry and Irwin (2015); DENI and DELNI (2009) and DENI (2010). Despite the issues, arguments for

programming have been made with Fluck et al. (2016) as well as O'Kane (2016) maintaining that the removal of barriers to learning and the introduction to programming concepts will not only benefit pupils as individuals, but also society at large.

Papert (1980); Kazakof and Bers (2014); Flannery and Bers (2013) as well as Lee et al. (2011); Brennan and Resnick (2012), provide a good insight into what already has been trialled and proven to work. The reoccurring themes seem to focus on scaffolding and problem solving and the suggestion that through support from the teacher and the presentation of small, problem solving based activities, the child will progress towards the concrete operational stage where they no longer need assistance from the teacher.

As for issues surrounding teacher confidence, O'Kane (2016) maintains that through carefully planned training and support, teachers will develop the confidence to introduce programming into their classrooms, especially within the areas of literacy and numeracy. Although issues surrounding CPD exists, including funding and teachers' willingness to attend (Perry and Irwin, 2015), the availability of online CPD courses and on-site training offers teachers and schools the ability to overcome barriers in relation to funding and motivation (Cordingley and Temperley, 2005).

## **Chapter Three - Research Methodology**

#### 3.0 Overview

The purpose chapter three is to outline the research process to be carried out in order to obtain KS2 pupils' perceptions of using the BBC Micro:bit in STEM education. The process included the creation of a resource that was greatly influenced from the information gathered through the review of literature surrounding educational theorists, leading to the creation of a resource that pupils would use in conjunction with the BBC Micro:bit. As well as this, the method for data collection is also discussed as well as ethical considerations relating to this research. Finally, an analysis of the data is provided along with consideration given to the issues surrounding the quality of data obtained.

#### 3.1 Introduction

Cohen et al. (2011) and Peters and White (1969) both argue that educational research should be viewed as being both empirical and self-correcting and result in us being provided with new knowledge about the topic being investigated. Elliott (1991) described educational research as a study of a situation with a view to improving the quality within that particular area. Stringer (1996) further adds that, research potentially has both practical and theoretical outcomes, leading to an increase in knowledge that enhances both the effectiveness and efficiency within the area being studied.

Pring (2000) argues that educational research fails due to the incapacity of the educational system to make decisions based on research, further contending that although some research may be viewed as being impartial, valid and reliable, there is much that fails to impress or to have an impact upon policy and/or practice.

Not all researchers agree on a particular research method or conclusion (Arthur, 2012). However, Wellington (2015), Miles and Huberman (1984) contend that methods can and should be mixed. They further add that qualitative data provides richness and colour to research, whilst quantitative data provides structure, with a mixture of the two being described as the 'perfect blend'.

This research will adopt a mixed-method approach involving both qualitative and quantitative approaches, conducted within a school-based environment. This research will also be conducted on a small scale due to time limitations.

#### 3.2 Aim of the study

The aim of this research is to investigate NI KS2 pupils' perceptions of using the BBC Micro:bit in STEM education. A research question guides and centres your research and should be clear and

focused (Schonberg, 2014). This is supported by Andrews (2003) who further adds that answers to research questions should be achievable in relation to the resources and the time frame allocated to the research project. Opie (2004) suggests that research procedures must be appropriate to the research questions being asked and the answers being sought, while Johnson and Onwuegbuzie (2004, p.18) further support this by stating that, *"Research methods should follow research questions in a way that offers the best chance to obtain useful answers"*.

With this in mind, a learning resource for pupils (Appendices 2 & 3) was created in order to not only help facilitate in the completion of this research project, but to focus the pupils so they could adequately complete the questionnaire for the purpose of obtaining the data required to address the research question.

The overarching question guiding this research focuses on how the BBC Micro:bit can be used as a tool for developing pupils' problem solving skills as part of a pedagogical approach to STEM education. From this question, a number of sub-questions were developed that would help further guide and add quality to this research. The following sub-questions were asked of the pupils:

- When programming the BBC Micro:bit, how enjoyable was it?
- When programming the BBC Micro:bit, how difficult was it?
- How useful is the BBC Micro:bit in providing opportunities for problem solving?
- How relevant is the BBC Micro:bit to STEM subjects?

#### 3.3 Research Design

Three schools took part in this research programme which used the BBC Micro:bit; a pilot was carried out with year 8 (KS3) pupils who attended an all-girl's grammar school located in West Belfast. One primary school located in West Belfast and the other located on the outskirts of County Derry provided the pupils who participated in all aspects of the research. The programme was delivered to primary six pupils over the course of two morning sessions, which ran from 9am – 12pm.

School	Year/Primary Group	Type of School	Age range of pupils attending
			school
School A	Primary 6 (KS2)	Co-Educational Primary School	4-11
School B	Primary 6 (KS2)	Co-Educational Primary School	4-11
School C	Year 8 (KS3)	All Girls Grammar School	11-19

Table 2 - Type of schools taking part in the study.

The research design has been greatly influenced by the overarching aim of the research question. The main aim was to try and ascertain the perceptions of those who participated in the research, focusing on how the BBC Micro:bit can be used as a tool for developing pupils' problem solving skills as part of a pedagogical approach to STEM education. This greatly influenced the research design as the pupils within each school had varying abilities when it came to programming skills. As a result, a set of control problem solving activities were developed that gradually increased in difficulty, building upon the skills previously obtained.

The views of the pupils were sought after completion of the activities on Day 2. The pupils were supplied with a questionnaire that aimed to obtain their perceptions regarding the activities they completed in relation to problem solving with the BBC Micro:bit. As Shaw et al. (2011) argues, the researcher has to be particularly careful not to influence the pupils' views regarding the program they are undertaking.

When creating the resource, consideration of many key educational authors' theories including Dewey and Vygotsky were carefully examined in order to provide guidance on how the resource should be developed and structured. Views of different educational theorists such as Kolb (1984) and Papert (1980) were also sought, providing an insight into experiential learning and effective teaching methods in relation to programming.

The Lewinian learning model consists of two aspects, firstly, the 'here-and-now', where personal experience is the focal point for learning, giving subjective personal meaning to abstract concepts. Second is the 'feedback process' which provides the basis for a continuous process of goal-directed action and evaluation of the consequences of actions in order to improve and build upon what has been achieved previously (Kolb, 1984).

Dewey's model of learning, similar to the Lewinian model, focuses on the developmental nature of learning and how learning transforms the impulses, feelings and desires of concrete experience into higher-order purposeful action (Kolb, 1984). Dewey's philosophy aimed to address the approach of modern education, where the delivery of knowledge was the focus and not the experiences of the students (Neil, 2005).

"What he has learned in the way of knowledge and skill in one situation becomes an instrument of understanding and dealing effectively with the situations which follow. The process goes on as long as life and learning continue" (Dewey, 1938, p. 35, 44).

Vygotsky and his theory of scaffolding as mentioned in the literature review "refers to the steps taken to reduce the degrees of freedom in carrying out some tasks so that the child can concentrate on the difficult skill he/she is in the process of acquiring" (Bruner, 1978, p.19). With the above theories in mind, a resource was created which centred on the idea of scaffolding and experiential

learning. At the beginning, simple, well-instructed tasks were presented to the pupils, with each task building upon the previously acquired skills whilst introducing new tasks with less instruction. As a result, it was hoped that pupils would construct the knowledge for themselves, becoming active discovery learners instead of learning passively (Piaget, 1970; Piaget and Inhelder, 1958).

As described in the literature review, Kazakoff and Bers (2014) agree with Papert's (1980) view on 'constructivist programming' and how through scaffolding, abstract ideas may become more concrete. Papert's CHERP model, that includes visual and tangible resources for teaching programming provides pupils with the opportunity to utilise hands on experiences, enabling children to become the producers of content, analysing and adapting their work according to their discoveries (Horn et al. 2012; Flannery and Bers 2013; Kazakoff and Bers, 2014). With this in mind, the resource for this research project was created, providing the pupils with visual instructions whilst encouraging creative exploration of the programming software through use of the BBC Micro:bit and various problem solving tasks, incorporating scaffolding and experiential learning as the model for achieving the learning goals.

#### 3.4 Qualitative and Quantitative Research

Qualitative research, as defined by LeCompte and Preissle (1994) is a collection of approaches to inquiry, all of which rely on data including verbal, visual, tactile and auditory. Diem (1994) would further add that qualitative research aims more at thoroughly describing a situation or providing explanation, allowing for a thorough, in-depth understanding of a situation. LeCompte and Preissle further maintain that qualitative research is based on and grounded in the descriptions of observations and experiences made by the research subject.

When carrying out qualitative research, the relationship between the researcher and the participant is often less formal than in quantitative research, with participants having the opportunity to respond more elaborately and in greater detail (Mack et al. 2005). Furthermore, Mack et al. (2005) maintains that through qualitative methods, the researcher can obtain data that is rich in detail, helping in the interpretation and understanding of a complex situation. Borman et al. (1986) further contends that qualitative research methods can often be used for solving problems of inquiry in various disciplines. By contrast, Borman et al. (1986) and Lee (1999) further argue that qualitative research is often criticised by suggesting that the relationship developed between the researcher and the participant often leads to a bias in the interpretation and presentation of the data.

Diem (1994) describes quantitative research as gathering data with the focus of measurement and counting, attempting to categorise and summarise using numbers and labels. Balnaves and Caputi (2001) would define quantitative data as evidence that is observable and testable, leading to results

that avoid being biased. Balnaves and Caputi further maintain that for quantitative data to remain unbiased, quantitative methods require detachment of the observer, especially in experimental methods. Blaxter et al. (2001) maintains that the results gathered from quantitative research can be readily analysed and interpreted by the user in order to generate a valid, non-biased conclusion.

#### 3.5 Mixed Methods Approach

Mixed methods research entails a combination of qualitative and quantitative approaches with the objective to generate a more accurate and adequate understanding of the area being researched (Arthur et al. 2012). Johnston and Onwuegbuzie (2004) define mixed method research as the type of research that involves a researcher or a team of researchers who combine elements of qualitative and quantitative methods for the purpose of obtaining validated, in-depth data. Additionally, Denzin (2008) maintains that due to the disadvantages inherent within both qualitative and quantitative methods, the combination of the two can be viewed as a more faithful and reliable option. The use of a mixed methods approach is a "powerful way of demonstrating concurrent validity, particularly in qualitative research" Cohen et al (2011, p. 112). Furthermore, Cohen et al. (2011) suggests that the use of a mixed methods approach adds to the validity of the data gathered, leading to the presentation of less bias and more accurate conclusions.

Arthur et al. (2012) claims that the idea of mixed methods research can be said to have developed from the notion of 'Triangulation', which is the combination of two or more research methods, enhancing the strength and validity of research findings. It is necessary to rely on multiple sources of data through a combination of both qualitative and quantitative methods, reducing the possibility of fragmentation and loss of specifics in concrete conclusions (Adam, 2014).

#### 3.6 Data Collection Method

A range of different data collection methods could have been adopted, ranging from, questionnaires and interviews to observations based on the activities completed. The use of observations requires the researcher to record and present results that are accurate, unbiased and richly detailed (Lodico et al. 2010). Goetz and LeCompte (1984) further maintain that observations must remain unbiased and within a neutral setting, with careful attention being paid to the researchers' presence and influence in relation to what is occurring within that setting. With that being said, it was agreed that observations would not be a suitable method for capturing data as the researchers in this instance would have an active role in delivering the resource to the pupils. Supported by Borman et al. (1986), this may have resulted in a poor standard of observational notes and/or poor quality of teaching to the pupils, limiting their experience with the BBC Micro:bit.

The use of interviews as a method of obtaining the pupils' perceptions was also considered. Seidman (2006) refers to interviews as not being about getting answers to questions, but becoming interested in understanding the lived experience of other people and the meaning they make of that experience. There are many different types of interviews, from structured, semi-structured and unstructured, allowing the researcher to tailor the interview to suit the participant. The interviewing process allows the participant to express meaning to his or her own words (Brenner, 2006; Mack et al. 2005), providing the researcher with the opportunity to ask for clarification of answers or ask additional questions on unexpected issues that arise (Lodico et al. 2010).

Interviews can also be conducted in small groups, often referred to as focus groups. Focus groups rely on interaction within the group where a number of specified topics are discussed (Cohen et al. 2011; Webb and Doman 2008). Webb and Doman (2008) contend that it is possible for the researcher to unintentionally control the dynamics of the group, preventing certain views from being expressed. As well as this, quieter members of the group may feel reluctant to talk and participate in the focus group, allowing talkative members to dominate (Lodico et al. 2010).

Due to the particular nature of the researchers' involvement in the practical activities, it was decided that interviews were not suitable in relation to obtaining the pupils' perceptions. Borman et al. (1986) maintains that when a relationship is developed between the participant and the researcher, it may lead to bias when interpreting the quantitative data obtained through interviews. Borman et al. further adds that the participant may answer questions untruthfully, manipulating their own opinions to please the researcher who they have developed the relationship with.

Upon reviewing the literature listed within this research methodology section surrounding qualitative and quantitative research as well the mixed methods approach, a decision was reached

that questionnaires would be chosen as the method for data collection. A questionnaire as defined by Hutton (1990) is a method of data collection through the presentation of pre-formulated questions in a pre-determined sequence. Cohen et al. (2011) would agree, however they further add that questionnaires are often used to gather data at a particular point in time with the intention of describing the nature of existing conditions, or identifying standards against which existing conditions can be compared, or to determine the relationships that exist between specific events. Furthermore, Denscombe (2003) refers to questionnaires as being an approach used to capture as wide and as inclusive samples of data as possible.

Nykiel (2007) maintains that questionnaires are perhaps the most widely used research technique, obtaining both factual information and opinions. Zohrabi (2013) agrees, claiming that questionnaires are undoubtedly one of the primary sources of obtaining data in any research. As a widely used and useful tool for collecting different types of data, questionnaires remove the presence of the researcher, often leading to non-biased data that is relatively straightforward to analyse Cohen et al. (2011).

Contrary to the literature that suggests questionnaires are a useful method for data collection, some authors contend that there are issues to consider when choosing questionnaires as a method for data collection. Gibson and Hurry (2014) suggest that issues surrounding the structure of the questionnaire, in both the questions chosen and how they are phrased may reflect the way in which the researcher views the issue being investigated. Gibson and Hurry also maintain that the reliability of questionnaires may be an issue with some returning incomplete and the inability to deem whether or not an answer is genuine. It is important that when designing a questionnaire, it is valid, reliable and unambiguous, ensuring it can be easily understood (Richards and Schmidt, 2002).

Munn and Drever (1990) comment on a range of different advantages surrounding the use of questionnaires in small-scale research such as, anonymity, time and standardised questions. Munn and Drever also comment on the limitations surrounding the use of questionnaires, with information collected tending to describe rather than explain as well as information becoming superficial if the questionnaire is inadequately designed. Dowling and Brown (2010) add that questionnaires are not useful when looking to obtain the participants ideas, with Denscombe (2003) agreeing, stating that through the use of open ended questions, participants may be unwilling to expand on their beliefs for one reason or another. However, Cohen et al. (2011) maintain that through the adequate structuring of a questionnaire, being made to look easy, attractive and interesting, participants will be more likely to view it as less than a form filling exercise, leading to the collection of more reliable data.

The main instruments in the mixed methods approach consist of both close-ended and open-ended questionnaires (Zohrabi, 2013). "These different ways of gathering information can supplement each other and hence boost the validity and dependability of the data" (Zohrabi, 2013, p. 254). The inflexibility of close-ended or fixed questions is that it allows for a meaningful comparison of data (Mack, 2005). However, Gibson and Hurry (2014) Contend that, pre-set response categories determines the way in which the participant can answer the question, leading to answers that the participants would not think of if they had to create answers themselves.

Gillham (2000) maintains that open-ended questions can lead to a greater level of discovery. Although Alderson and Scott (1996) acknowledge the usefulness of qualitative data, they contend that open-ended questions make it more difficult to compare and analyse. Therefore, Zohrabi (2013) suggests that it is better that questionnaires include both close-ended and open-ended questions to complement each other. Cohen et al. (2011) stresses that questions posed should not be leading, reducing the possibility of bias or untruthful answers.

For this research, a questionnaire was created consisting of both open and close-ended questions. The questionnaires, printed double-sided on an A4 page, were distributed amongst the Primary six pupils after they had taken part in the BBC Micro:bit activities. Adequate time was provided for the pupils to complete the questionnaire and once finished; the researcher collected, analysed and compiled the data into a more manageable format.

#### 3.7 Ethical Issues

Due to the nature of this study, with the researchers taking a leading role in delivering the resource activities to the pupils, ethical consent had to be obtained from the principal, parents, teachers and the KS2 pupils taking part in the research.

The British Educational Research Association (BERA) maintain that, in order to enable educational research, all aspects of the research process must be considered and reach an ethically acceptable position so that actions are justified and considered (BERA, 2011). Cohen et al. (2011) further add that participants taking part in the study must have the right to freedom and self-determination, with the researcher providing the opportunity for the participant to withdraw from the research at any given time.

In accordance with the Data Protection Act (DPA) of 1998, researchers must protect the confidentiality of personal data. This includes the removal of all personal identifiers, such as name and addresses from both physical and computer held records (DPA, 1998). Burgess (1989) also highlights the importance of confidentiality and anonymity whilst carrying out educational research. He argues that confidentiality and anonymity are often confused, with confidentiality leading to the

development of good relationships and therefore the obtaining of more honest and open opinions. Anonymity offers individuals privacy in the research process, with the identification of the participant or school being omitted from the research documentation.

In this research, all participants were provided with a letter of consent that contained information regarding confidentiality and an outline of the study. As this research project is focused on the pupils' perceptions, it was important to obtain consent from both the participant and their parent or guardian. Nicholson (1986) maintains that the gathering of parental consent must be sought when carrying out research with any child. Marrow and Richards (1996) further add that when carrying out educational research, consent from adult gatekeepers such as, parents, teachers and principals, must be sought in order to prevent jeopardising the research project. Researchers should also provide all participants with a sufficient amount of information surrounding the purposes of the research and the nature of their involvement so they may make a decision that is informed (Denscombe, 2003).

Informed consent was obtained before the research had taken place. Consent from the principal, parents, teachers and pupils of both schools was obtained through the provision of a written letter (Appendices 7 to 10). These letters outlined the nature of the study and the activities the pupils will be taking part in, with issues surrounding confidentiality and self-determination being addressed. A similar letter (Appendix 9), devised for the parents of the pupils taking part in the study was also provided and then collected the day before the activities took place. The information contained here again highlighted the purpose of the research, the involvement of the child in the study and the opportunity to provide consent or withdrawal from the research project. Finally, a letter to the pupils (Appendix 10) was presented at the beginning of the activities on day one. This explained the purpose of the research project, and again offered the opportunity for the participant to withdraw from the research project. The researcher must seek the consent of all participants before taking part in any research, with the participants being made fully aware of the implications of the research, as well as having a free choice as to whether or not to take part (Sheely et al. 2005).

The methods employed during this research will help in developing a professional relationship with all participants, ensuring a mutual respect is established. It is intended that the methods chosen are fit for purpose, age appropriate and do not cause any stress and are enjoyable.

#### **3.8 BBC Micro:bit Resource Pilot**

A pilot study is a way of testing your research methodologies on a smaller scale in order to reduce the number of unanticipated problems through the provision of feedback, thus allowing the

researcher to redesign parts of their study to overcome difficulties that the pilot study reveals (Woken, 2013).

Following the creation of the teaching resource, it was decided that a pilot would be beneficial in order to generate some feedback on how the pupils responded to the resource and whether or not changes need to be made.

The Head of Department (HoD) for Technology and Design at an all-girl grammar school located in West Belfast (School C) was contacted in relation to delivering the BBC Micro:bit teaching resource to one year 8 (KS3) class. The HoD agreed and a meeting was arranged to discuss how the resource should be delivered as well as the areas in which the researchers needed to receive feedback on. The HoD delivered the resource and provided the researchers with feedback on the following:

- How well the pupils understood the resource.
- The presentation / layout of the resource.
- How enjoyable / challenging the pupils found the tasks and any changes that they had suggested.

Initially the resource was created similar to a step-by-step guide, gradually reducing the instructions as the pupils progressed through the resource. After the resource had been piloted, we arranged to meet with the HoD to discuss how the lesson went. Feedback from the HoD indicated that the pupils were overwhelmed with the amount of written information and found it difficult to follow the instructions. It was suggested by the HoD that with less writing and by allowing the pupils to have more freedom with what they can create would be more beneficial in improving the pupils' understanding of the BBC Micro:bit.

Following on from the previous points, the HoD also recommended the use of visual elements in the resource. As she previously suggested that the writing was somewhat overwhelming and difficult for the pupils to follow, the addition of visual cues would eliminate the need for writing, making the resource and instructions easier to follow.

The HoD finally added that the pupils thoroughly enjoyed the activities and wanted to use the BBC Micro:bit more often. The resource was challenging to understand, however with the simplification of instructions; the tasks would become more understandable and achievable. She added that although the resource was somewhat difficult to understand due to the amount of information being provided, the pupils, due mainly to their own efforts, did not take long before they had appeared to develop an understanding of how to program the BBC Micro:bit.

Following the feedback received from the HoD, adjustments were made to the resource in preparation for the visit to School A and B. It is important to note that the resource was piloted over a 1-hour period with year 8s. The updated resource was delivered to School A and School B over the course of two morning sessions lasting around 3-hours. The points for improvement have been summarised below:

- Decrease the amount of written instruction.
- Increase visual cues such as screen shots to help in guiding the participants through the tasks.
- Encourage independent exploration of the software as a way of developing knowledge and understanding as to the programming of the BBC Micro:bit.

#### 3.9 Context of Study

The method for the gathering of evidence within this report involved the pupils and staff of two primary schools within Northern Ireland. Before carrying out this research, meetings with the principals were arranged to discuss the nature of the study and all parties involved signed consent letters. It was suggested by the researchers and agreed by each principal that it would be best not to overwhelm the pupils with information as they had little or no experience in using the BBC Micro:bit or taking part in programming activities. As a result, it was agreed that all activities would take place during the first half of the day, from 9:30am to 12:00pm with a 15-minute break at 10:30am.

#### 3.9.1 School A

School A is a maintained primary school located within West Belfast, NI. In a recent inspection carried out by the Education and Training Inspectorate for Northern Ireland (ETINI), it was found that the use of ICT within the school was underdeveloped, with recommendations being made with relation to the improvement of ICT in supporting teaching and learning (ETINI, 2016). This study was carried out with two primary six classes, providing the researchers with feedback from 41 pupils, of whom 20 were female and 21 were male. Due to a request made by the principal, the research project was carried out with two different classes on two separate days, resulting in each class only participating in the day one activities. This resulted in the inability to observe the development made by the pupils on Day 2, as each class had only participated in Day 1 activities. It also had implications in relation to the resource being delivered to the pupils at school B, as the Day 2 activities had yet to be completed, resulting in the researchers being unable to observe any underlying issues (if any) in relation to the Day 2 resource. It is important to note that the incompletion of Day 2 activities would have no effect on the opinions obtained through the questionnaire, as the development of skills was not being analysed.

#### 3.9.2 School B

School B is a maintained primary school located on the outskirts of County Derry, NI. In a recent inspection carried out by the ETINI, it was found that the pupils demonstrated a confidence in using ICT, in both an innovative and appropriate manner (ETINI, 2013). This study was carried out on a smaller scale in comparison to School A, with a composite primary 5/6 class involving 29 pupils taking part in activities; this class was made up of 12 females and 17 males. It should be noted that the participants in school B remained the same over the course of the two days, with pupils taking part in day one and day two activities.

#### 3.10 Conduct of Study

After receiving feedback from the HoD, suitable adjustments were made to the BBC Micro:bit resource (Appendices 2 & 3). A total of 70 pupils from two different primary schools took part in the research project. Over four morning sessions (9:30am - 12:00pm), two mornings per school, the pupils took part in activities that included writing and compiling various programs for the BBC Micro:bit, with the pupils at school A completing day one activities only, however the pupils at school B completed both day one and day two activities.

At the beginning of the activities, a short five minute presentation (Appendix 5) was given to provide the pupils with relevant information in relation to the BBC Micro:bit. The pupils were then sorted into groups of three, with each group receiving a resource booklet and a BBC Micro:bit. Each pupil was allocated a role to ensure every member of the group had the chance to experience programming the BBC Micro:bit.

The activities began with the creation of some simple code, gradually progressing to tasks that were more difficult. The researchers provided some assistance to the pupils during the activities; however, this assistance was gradually removed as the pupils progressed, encouraging the use of group work to solve problems. This relates to Vygotsky's ZPD and Bruner's Scaffolding theory, where hints or cues are provided by the educator as a way of helping the pupil achieve a specific goal (Copple and Bredekamp, 2009).

The first set of activities lasted an hour, the pupils then had a 15-minute break after which they took part in other activities that lasted a further 30-minutes. At the end of the activities, the pupils were asked to complete a questionnaire (Appendix 6); this took approximately 20-minutes for the pupils to complete, the aim of which was to obtain their views and opinions on the BBC Micro:bit. The questionnaire focused on how enjoyable, challenging and valuable they found it. As well as this, their perceptions of the possible relationship between the BBC Micro:bit and the various STEM subject's was also obtained.

## **Chapter Four - Data Collection**

#### 4.0 Overview

The main aim of this research was to discover the perceptions of KS2 pupils in relation to the BBC Micro:bit. A mix methods approach was adopted, with a questionnaire being distributed to 70 KS2 pupils, containing both multiple choice questions and open-ended questions. The questionnaire was completed by the pupils on a double-sided A4 page and consisted of eight questions, four open ended and four multiple-choice questions. The pupils were provided with clear instructions on how to complete the questionnaire and were informed that there was no right or wrong answers.

#### 4.1 Analysis of Results

The data analysed has been presented in bar chart format. This format allows for the data captured to be graphically displayed, creating an interface that is quick to analyse and easy understand (Davino and Fabbris, 2013).

As noted in the methodology, four key sub questions were developed as a means for guiding and adding depth to the overall research question. The sub questions are as follows:

- When programming the BBC Micro:bit, how enjoyable was it?
- When programming the BBC Micro:bit, how difficult was it?
- How useful was the BBC Micro:bit in providing opportunities for problem solving?
- How relevant is the BBC Micro:bit to STEM subjects?

The above themes guided the creation of the questionnaire and led to the development of a range of different qualitative and quantitative questions. The analysis of the data generated by the questionnaires is shown in the next section.

#### 4.2 Quantitative Data

Within this section, the quantitative data obtained through the questionnaire has been analysed and presented.

#### 4.2.1 Question 1: How Difficult was the BBC Micro:bit use?

The purpose of this question was to discover how difficult or challenging the pupils found using the BBC Micro:bit. This relates to both the activities as well as the use of the device itself.



Figure 1 - How difficult was the BBC Micro:bit to use? (School A)

At school A, a total of 41 pupils, comprised of 21 males and 20 females were surveyed. When asked how difficult they found the BBC Micro:bit to use, the majority of pupils, both male and female, found the tasks and use of the BBC Micro:bit easy. Of the total 41 pupils, 61% (25 out of 41) found the BBC Micro:bit to be easy or very easy to use, around 22% (9 out of 41) found it to be difficult or very difficult and the remaining 17% (7 out of 41) answered the question as 'don't know'.



Figure 2 - How difficult was the BBC Micro:bit to use? (School B)

At school B, a total of 29 pupils, 17 males and 12 females were surveyed. Similar to school A, the majority of pupils at school B, both male and female answered the question as finding the BBC Micro:bit easy or very easy to use. From the 29 pupils surveyed, 69% (20 out of 29) found the BBC Micro:bit easy or very easy to use, 17% (5 out of 29) finding the BBC Micro:bit difficult to use and the remaining 13% (4 out of 29) answering the question as 'don't know'.

The data indicates that the majority of pupils found that the BBC Micro:bit was simple to use. With around 64% (45 out of 70) of pupils surveyed claiming the BBC Micro:bit to be easy or very easy to use, the data coincides with the information contained on the BBC Micro:bit website where it claims that the device provides a *"super easy, non-intimidating user experience"* (BBC Micro:bit, 2015).

#### 4.2.2 Question 2: How Enjoyable was the BBC Micro:bit to use?

The purpose of this question was to discover whether the pupils enjoyed their experience of using the BBC Micro:bit.





It is evident that from the 41 pupils who took part in the research project at school A, nearly all of pupils, both male and female, found using the BBC Micro:bit Enjoyable. Around 92% (38 out of 41) of the pupils surveyed claimed that the BBC Micro:bit was either enjoyable or very enjoyable to use. There was however a small number of pupils, around 5% (2 out of 41) who found using the BBC Micro:bit very boring.



Figure 4 - How enjoyable was the BBC Micro:bit to use? (School B)

Similar to school A, the results show that most of the pupils, both male and female, found using the BBC Micro:bit enjoyable or very enjoyable, with 90% (26 out of 29) of the pupils surveyed suggesting this. Again a very few (1 pupil) found using the BBC Micro:bit boring, while the remaining 7% (2 out of 29) answering the question as 'don't know'.

When analysing the total number of pupils surveyed, a small minority (4% or 3 out of 70) found the tasks to be boring or very boring. This could be due to many different factors, from working in groups, using ICT or simply the nature of the tasks themselves. Selwyn et al. (2010) argues that it is not ICT per se that pupils find boring but rather the use it is being put to, leading to the pupils having a negative view towards the use of ICT in schools.

It is encouraging for the researchers and the BBC Micro:bit nearly all of pupils (64 out of 70) found enjoyment from using the device. As suggested previously by Kazakoff and Bers (2014) the use of both practical and hands-on activities will enable children to become the producers of content, providing them with learning experiences that are both valuable and enjoyable. The head of BBC Learning, Sinead Rocks, further adds that the BBC Micro:bit is not only a device to teach programming, however it is being used as a way of developing other skills such as teamwork, attention to detail and problem solving (Rocks, 2016).
# 4.2.3 Question 3: How Useful was the BBC Micro:bit when solving problems?

The purpose of this question was to discover whether or not the pupils felt the BBC Micro:bit was

useful in helping them solve problems, in relation to both programming and real world scenarios.



Figure 5 - How useful was the BBC Micro:bit when solving problems? (School A)

From the 41 pupils who took part in the research project at school A, it is evident that nearly all of the pupils (90% or 37 out of 41), both male and female, found that the BBC Micro:bit was useful to them when solving problems. Only one pupil claimed that using the BBC Micro:bit was not useful in problem solving, and the remaining 7% (3 out of 41), answered the question as 'don't know'.



Figure 6 - How useful was the BBC Micro:bit when solving problems? (School B)

Similar to school A, out of the 29 pupils surveyed at school B, most of the pupils (90% or 26 out of 29) found the BBC Micro:bit to be either useful or very useful in helping them to solve problems. The remaining 3 pupils were unsure whether the BBC Micro:bit was useful to them in solving problems, answering the question as 'don't know'. No pupils at school B answered the question as not useful or useless.

In total 90% or 63 out of 70 pupils surveyed found the BBC Micro:bit as being useful or very useful in the solving of problems. Only 1 pupil out of the 70 surveyed claimed that the BBC Micro:bit did not aid in developing their problem solving skills. This data would suggest that practical work is an activity that helps pupils develop their problem solving skills or to discover information for themselves and develop independent thinking skills Delargy (2001). Again this concurs with Rocks (2016), were it is suggested that the BBC Micro:bit is not only a tool for developing programming skills, but also a new initiative in developing problem solving skills.

# 4.2.4 Question 5: Did the BBC Micro:bit link with STEM Subjects?

The purpose of this question was to discover whether or not the pupils were able to make links between the BBC Micro:bit and STEM subjects. This was a close-ended question, asking the pupils to answer yes or no as to whether they felt that the BBC Micro:bit related to the various STEM subjects.



Figure 7 - Did the BBC Micro:bit link with STEM subjects? (School A)

From the 41 pupils surveyed at school A, the most of the pupils found the BBC Micro:bit had links with Technology, Engineering and Maths. However, the results indicated that less pupils found a link with Science, with only 21 saying Yes and 20 saying No.



Figure 8 - Did the BBC Micro:bit link with STEM subjects? (School B)

Similar to school A, links with Technology and Maths were clear and this is evident in the results from the 29 pupils surveyed in school B. There is a notable difference in the number of pupils making links with Science and Engineering, with a significant minority seeing no links with these subjects.

Table 3 summarises all of the data gathered surrounding the link between the BBC Micro:bit and STEM subjects.

Subject	Yes		No	
	No. of Pupils	%	No. of Pupils	%
Science	33 out of 70	47%	37 out of 70	53%
Technology	68 out of 70	97%	2 out of 70	3%
Engineering	35 out of 70	50%	35 out of 70	50%
Maths	52 out of 70	74%	18 out of 70	26%

Table 3 - Statistics for links with STEM subjects (Total)

The pupils commented on how the BBC Micro:bit linked with technology, viewing the device as a physical piece of new technology. They then added that they could make links with maths, with most of the tasks completed involving the use of numeracy skills including logic (+/-/>/</=).

As for Science and Engineering, these were the subjects that produced the lowest result. Whilst conducting the research it was evident that a number of pupils were unsure as to what Engineering was or entailed. This may be due to the age (KS2) at which the tasks were delivered. It is somewhat understandable that the pupils did not see a clear link with Science as the tasks presented were not

tailored around the KS2 science curriculum. This is an area that could be further developed in future research projects involving the use of the BBC Micro:bit, were the STEM curriculum is more involved in the activities completed by the pupils.

# 4.3 Qualitative Data

Within this section, an analysis of qualitative data is presented.

# 4.3.1 Question 4: Why do you think the BBC Micro:bit helped in solving problems?

This question aimed to gather an insight into the perceptions the pupils had surrounding the use of the BBC Micro:bit in relation to problem solving. From the quantitative data gathered, it was clear to see that the majority of pupils from school A and B found the BBC Micro:bit useful in helping them to problem solve.

Most of the answers to this question suggested that the use of teamwork helped in solving problems when writing a program for the device, with many of the answers containing the words *"team work"* or *"group work"*. One pupil stated that, *"I worked as a team and we used the booklet to help us program the Micro:bit"*. Another pupil further added that when *"we had a problem we were able to work as a team to fix it"*.

The pupils' comments suggested that the opportunity for them to develop their programming skills also enabled them to enhance their problem solving skills. One pupil argued that, *"I think the BBC Micro:bit helps solving problems because it helped us to learn how to code…. using the block editor programming software"*. This reinforces the idea that the BBC Micro:bit develops other skills as well as programming (Rocks, 2016).

A group of pupils in School B further suggested that the BBC Micro:bit could be used by the school council in a situation where *"some people had a disagreement it could help you vote and solve the problem"*, the pupils suggested using the BBC Micro:bit to vote on non-uniform days, school dinners and more ICT lessons. In addition to this the pupils considered some real world problems, suggesting that the BBC Micro:bit could be used to save the school money and that *"instead of buying new things like a stopwatch, we can just re-program the Micro:bit to do what we need"*. This demonstrates how well the pupils were able to contextualise their learning, making links as to how the BBC Micro:bit can have a positive influence on their learning and solve problems.

# 4.3.2 Question 6: Did you learn anything new from today's BBC Micro:bit challenge?

This question aimed to gather the pupils' perceptions on what the pupils had learned from the activities they completed. From analysing the answers provided by the pupils, most of pupils commented on how they learnt new programming skills as well how to program the BBC Micro:bit. A

pupil from school A stated that "I learned lots of new things like how to use the BBC Micro:bit and how to program it", while another pupil from school B further added, "It helped me learn how computers work".

Aside from learning new programming concepts, some pupils commented on how the BBC Micro:bit challenge changed their perceptions on the STEM subjects involved with a pupil from school A claiming that, *"I learned that Technology and Maths can be fun"* with another pupil adding that *"today I learned that you can do anything with technology"*. This display of enthusiasm as well as the promotion of imagination and creativity in learning has the potential to enable pupils to develop both their thinking and problem solving skills. Following on from this point, some pupils expressed how the skills they have obtained during the activities might be useful in the future. A pupil from school A stated that *"the BBC Micro:bit learnt us how to code and when we are older we might need it for computers"*.

### 4.3.3 Question 7: Would you like to use the BBC Micro:bit more often?

This question aimed to gather the pupils' perceptions as to whether the pupils would like to use the BBC Micro:bit more often. The reoccurring theme that appeared when analysing the answers to this questions was the term *"Fun"* and *"Enjoyable"*. The majority of replies consisted of these words with pupils answering with statements such as, *"yes, I want to use it again because it was fun and enjoyable"*. Statements similar to this add value to the concept of practical activities and programming within the classroom. Huang et al. (2007) maintain that through increased enjoyment in learning, pupils' behaviours towards subjects perceived to be difficult would change dramatically, with motivation and willingness to participate improving. This point also relates to the comments made by a pupil when answering question 7, when it was stated that through using the BBC Micro:bit, he/she discovered that *"Technology and Maths can be fun"*.

Nearly all of the pupils commented on how they would like to use the BBC Micro:bit again because they enjoyed the challenge it offered, *"I would like to use it more often because it is so fun but also challenging"*. In agreement with Huang's views on enjoyment improving participation in learning, a pupil from school A stated that they would like to use the BBC Micro:bit again because *"it was enjoyable but challenging"*. Another pupil further added that *"it was fun but hard to do it, so I would like to use it more often to learn more about programming and the Micro:bit"*. These comments suggest that although some of the pupils found the BBC Micro:bit challenging, many of them would like to continue using it to improve their skills due to the device being enjoyable to use.

Enjoyment was not the only factor encouraging pupils to want to use the BBC Micro:bit again, with a small number of pupils suggesting they would like to use the device in order to teach others. One

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pupil stated that "yes, I would like to use it again so I can teach my brother and cousins how to use it", while another added "I could show my friends how to use it and I could play and create different faces and objects and it would be fun". This willingness to further their own knowledge and understanding as well as others can have major benefits for not only the pupil but also the environment in which they are learning. The views of the pupils reflects the views of Tien et al. (2002), who's research into peer led learning and teaching discovered that it could have a positive impact on the individuals (both teacher and learner) achievement, attitudes and persistence, leading to an improvement in the ability to explain concepts and better understand different perspectives on approaches to solving problems.

The imagination and creativity of the pupils is something that the BBC Micro:bit can help develop and improve. BBC Micro:bit (2015) claims that *"The Micro:bit is an educational and creative tool to inspire a new generation of young people"*. This statement was validated whilst carrying out this research with nearly all of the pupils finding the creative element of the device appealing, with one pupil in particular answering that, *"It helped me use my imagination instead of sitting on the iPad and watching TV"*.

### 4.3.4 Question 8: If you could change anything about this challenge, what would it be?

This question was included in the questionnaire to gain obtain the pupils' perceptions on the resource and to see what changes (if any) the pupils would make to the activities they completed. A number of answers indicated that they would make no changes to the activities they completed, while others suggested changes to the device itself.

When using the programming software, many pupils discovered the music features that allowed you to create music using various digital tones. This resulted in some pupils suggesting changes that included the incorporation of music into the tasks. Comments such as *"I would like to create music and have the Micro:bit play it" and "I would like to make the Micro:bit play music and the LEDs dance"* were made by two pupils, with a small number of others simply writing the word *'Music'* as their answer. Another hardware change the pupils suggested was in relation to the LEDs. A minority of pupils from School A and B had answers such as, *"I would like to change the colour of the LEDs"* and *"I would change the colours of the LEDs so I could make cooler logos and better badges"*.

Some of the changes suggested by pupils, such as changing the colour of the LEDs, may not be possible to implement by the educator using the device as a teaching resource. However, if the BBC Micro:bit has been incorporated into an appropriate scheme where the pupils are learning new concepts each week, perhaps the use of more advanced features such as music, may be more achievable and appropriate to implement.

# **Chapter Five – Conclusion**

# 5.0 Overview

This research investigated the perceptions held by KS2 pupils, across two NI primary schools, surrounding the use of the BBC Micro:bit for the purpose of enhancing the pupils' experiences of STEM education. Both qualitative and quantitative data was captured via a questionnaire, allowing for various conclusions to be made surrounding the pupils' perceptions on the use of the BBC Micro:bit.

The findings from this research will be discussed under the following headings:

- The key findings of the study.
- The strengths of the study.
- The limitations of the study.
- Recommendations for further research.
- Conclusion.

# 5.1 Key Findings

The findings in this chapter are based on the data obtained through use of the questionnaire that aimed to address the research questions. The questions contained within the questionnaire focused on obtaining the perceptions of the pupils who used the BBC Micro:bit.

# 5.1.1 Quantitative Data – Key Findings

From the qualitative data presented and analysed within the previous section, the results can be easily interpreted due to the way in which they have been presented (Cohen et al. 2011). The data obtained shows that nearly all of the pupils who took part in the study emphasised how easy the BBC Micro:bit was to use with only a small number finding it to be difficult. These findings appear to support the idea that the BBC Micro:bit is a device that provides a *"super easy, non-intimidating user experience"* (BBC Micro:bit, 2015). The next question focused on obtaining the pupils' perceptions and discovering whether the pupils found the BBC Micro:bit to be enjoyable to use. Most of the pupils surveyed claimed that the BBC Micro:bit was enjoyable to use, with only a small number claiming it to be 'boring'. Nearly all of the pupils surveyed perceived the BBC Micro:bit to be useful when problem solving, making links as to how the BBC Micro:bit could potentially be used to address real life problems. The pupils also made links to STEM subjects, with nearly all of the pupils making links to Technology and Maths, and a small minority making links to Science and Engineering. Shown below is a list of the key points summarised from each quantitative question which relates to the pupils' perceptions on the use of the BBC Micro:bit:

- The BBC Micro:bit was easy to use.
- The BBC Micro:bit was enjoyable to use.
- The BBC Micro:bit was very useful when problem solving.
- The BBC Micro:bit was useful in making connections with STEM related subject knowledge.

### 5.1.2 Qualitative Data – Key Findings

The qualitative data captured aimed to obtain a more in-depth view on the perceptions held in relation to the device. When asked to expand on the topic of problem solving, most of the pupils emphasised how working with their peers helped them to overcome problems, with most of the pupils' answers containing the terms 'team-work' or 'group work'. Most of the pupils also commented on how the development of their programming skills made it easier for them to solve problems in relation to the code they were writing. Most of the pupils were also able to make links to issues that affect their own lives, discovering how programming could potentially interact with their everyday lives. Suggestions that the school council could use the device to record votes was made as well as the BBC Micro:bit being used by the school to save money, with the device being reprogrammed to create different devices, such as a stopwatch, so the school would not need to purchase said device.

The pupils who took part in the study had no prior experience with programming, meaning that feedback gathered from the question surrounding 'new learning' was interesting. Nearly all of the pupils' answers referenced the term 'programming' with answers such as *"today I learnt how to program"*. It is understood that this style of answer is quite vague and provides little clarity as to the knowledge the pupils actually acquired during the activities. Most of the pupils expressed their development and understanding of topics as it improved through completion of the activities.

Following on from the previous points, nearly all of the pupils commented on how they would like to use the BBC Micro:bit more often due to the enjoyment they got from it. It is encouraging to see how enjoyable the pupils found using the device and how the thoroughly enjoyed developing their programming skills. Most of the pupils commented on how they would like to use the BBC Micro:bit to teach others, stating that they would like to teach their friends and family how to use it.

The overall response and enthusiasm shown by the pupils towards using the BBC Micro:bit is very encouraging. When enquiring about possible changes, most of the responses related to the programming of the device and how the pupils would welcome the inclusion of more advanced features such as digital music tones. A small number commented on the hardware of the BBC

Micro:bit itself and how they would like to change the colour of the LEDs. Although this is not a current feature of the BBC Micro:bit (as of December 2016), it is encouraging to see the creativity and imagination shown by the pupils in how they would change the device.

# 5.2 Strengths of the study

This study has a number of strengths. It is one of a small number of research projects into the use of the BBC Micro:bit and to the researchers' knowledge it is the only research conducted to date in NI that focuses on the perceptions of pupils using the BBC Micro:bit.

The theme of this research involved children partaking in programming activities and upon completion of these activities, a questionnaire was provided and completed by the pupils for the purpose of obtaining their perceptions of using the BBC Micro:bit. A pilot study of the activities was carried out with a Year 8 (KS3) class, providing feedback on the suggested areas of the program that needed changing. The research itself was carried out between two schools, school A consisted of two classes, providing a sample of 41 pupils taking part in the study, of which 21 were male and 20 female. At school B, only one class was involved in the research, providing a sample of 29 pupils, of which 17 were male and 12 female. In total 70 pupils took part in the research, providing a range of qualitative and quantitative feedback obtained via questionnaires. The questionnaires were completed at the end of the programming activities, with care taken to ensure each pupil fully understood the questionnaire, thus enabling the participants to feel at ease whilst expressing their opinions.

# 5.3 Limitations of the study

It is understood that this study has a number of limitations. Due to time restraints, this research was conducted on a relatively small scale. Although 70 pupils took part in the research and completed questionnaires, the study only took place in two schools. With the study focusing on the perceptions of KS2 pupils in NI, it could be argued that the inclusion of more schools and a larger sample of participants may lend itself to the capturing of data that is more credible in addressing the main research question.

As the researchers had a leading role in delivering the activities to the pupils, the relationship developed between the pupils and the researchers may have influenced the feedback obtained through the questionnaires. This may have resulted in the pupils providing information they felt would please the researchers and therefore not expressing their true opinions.

As the study relied solely on the data gathered by means of questionnaires may also be perceived as a weakness as there was no provision made for triangulation, with interviews and observations not being included as a method for data capture in this study. During the analysis of data, the researchers became aware of questions that may have been useful to include in the questionnaire, as well as different ways in which questions could have been worded. In hindsight, a pilot of the questionnaire would have been useful in determining the appropriateness of the questions, in both the wording and relativeness to the study.

# 5.4 Recommendations for further study

This is, to the researchers' knowledge, the first study into the perceptions of NI KS2 pupils towards using the BBC Micro:bit. Given the recent distribution of BBC Micro:bit devices to schools across the United Kingdom (UK), it was considered important to investigate the pupils' perceptions regarding this device. It is believed that this research adds to the current understanding of how the device has been received by pupils; however, in no way does it claim to provide a definitive conclusion, but rather an important insight into a sample of pupils' perceptions, thus encouraging further study across a wider sample of pupils.

Recommendations for further research in this field could include the involvement of a larger sample of pupils and schools as a way of providing more support for the conclusions. This larger sample would help in validating conclusions made whilst addressing the research question.

It may also be beneficial to contact schools that have already used the BBC Micro:bit and carry out research with these pupils. As the pupils would have already used the BBC Micro:bit for a longer period of time, they may have different perceptions in relation to the device.

Following on from the previous point surrounding data collection methods, the inclusion of more than one would open the possibility of incorporating triangulation into the analysis of data, increasing the validity, strength and interpretative potential of a study whilst decreasing investigator bias (Thurmond, 2001).

If future research is to be a project-based study, all aspects of the activities should be subject to a pilot as the case has been in this particular study. However, it would also be recommended that all data collection methods be piloted as a way of ensuring that questions posed are suitable for the age of the participant, as well as worded correctly so they can be easily understood.

From what has been learned from carrying out this research, further study into the BBC Micro:bit could help in providing a better insight into how this device has been received and implemented by schools, providing insight into how the device has been more effectively used and how improvements could be made. As stated previously, to the researchers' knowledge, this is one of few pieces of research in this field; resulting in a number of different areas waiting to be investigated. Research surrounding the areas of teachers' perceptions, the perceptions of a larger sample of

pupils (including those who have used the device for a longer period of time) and the use of the BBC Micro:bit in developing problem solving skills, are just a small number of suggestions for further research.

# 5.5 Conclusion

The overall aim of this study was to investigate the perceptions of NI KS2 pupils towards the BBC Micro:bit as used within STEM education. The data obtained, analysed and presented throughout this research document provides a clear outlook on the perceptions of the pupils who have experienced using the BBC Micro:bit and should provide encouragement for any educator considering implementing programming into their lessons through using the BBC Micro:bit.

In order for pupils to develop their problem solving skills through programming, an approach including the use of tangible resources alongside activities that require critical thinking is crucial. With no direct reference to coding or programming within the NIC, it is recognised that this will involve new challenges for teachers who wish to implement programming into their teaching yet have limited experiences. However, it is believed that based on the evidence presented within this study, programming has the potential to contribute to the development of a range of skills including teamwork and problem solving, generating a sense of enthusiasm towards learning. This will provide enrichment to the learning environment, whilst also providing pupils with the opportunity to engage in authentic problem solving activities that are not only applicable to their everyday lives, but also to their understanding of STEM education.

From the research it was found that most of the pupils displayed clear signs of enjoyment through using the BBC Micro:bit, with its ease of use providing a pleasurable user experience when learning how to program.

The researchers' experience in delivering the activities to pupils and reviewing the data obtained has been very encouraging to us, both in our role as researchers and teachers. The findings of this research document provides a thorough insight into the positive perceptions held by the pupil participants regarding the use of the BBC Micro:bit, with the data suggesting group work to be a key element in not only developing programming skills but also problem solving skills. The results from this research also asserts that pupils believe that the BBC Micro:bit is an enjoyable, easy to use device that is beneficial when learning how to code, with various other skills being developed in tandem. This concurs with the comments made by the head of BBC learning, Sinead Rocks, who believes that the device is not only a fun and enjoyable way to develop programming skills, but also problem solving skills (Rocks, 2016).

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Rocks (2016) argues that "we happily give children paint brushes when they're young, with no experience – it should be the same with technology", further adding that the BBC Micro:bit is about young people learning how to express themselves digitally. With an ever advancing technological society, and the future success of the NI economy becoming increasingly dependent on the number of skilled computer programmers (Sentinus, 2015), the BBC Micro:bit could arguably be an effective educational tool in not only promoting computer programming, but also help in developing the interest towards the various STEM subjects.

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# Appendix 1 – BBC Micro:bit Technical Details



#### Bluetooth

#### What is a Bluetooth Low Energy Antenna?

You will see this labelled BLE ANNTENA on the back of your BBC micro:bit. It is for a messaging service, built for the Internet of Things so that devices can talk to each other. The BBC micro:bit is a peripheral device which can talk to a central device like a smart phone or tablet that has Bluetooth Low Energy (BLE). The BBC micro:bit can send signals and receive signals from a central device so another BLE device can control the BBC micro:bit or the micro:bit can control another BLE device.

#### What is Bluetooth Low Energy?

Bluetooth wireless technology was developed as an alternative to data cables and allowed wireless communication between devices such as PCs, smartphones and tablets. Bluetooth® Smart or Bluetooth Low Energy is a power-friendly version of Bluetooth wireless technology.

#### What is the Internet of Things?

The Internet of Things (IoT) was first talked about more than 15 years ago, when it was speculated that objects and people would be able to connect wirelessly over the internet. Objects can be detected and controlled remotely, allowing greater integration between the physical and computer based world. It will let you to remotely control your alarm system, thermostat or lights in your home. It has many applications in different fields including manufacturing, health and fitness, consumer electronics and the home.

#### **Technical Information**

The BBC micro:bit has been designed to be a bare-board micro controller for use by children aged 11-12. It is an open development system and we have enabled debugging so that advanced users can interrogate the device.

The device has been through extensive safety and compliance testing to the following standards:

#### Safety

IEC 60950-1:2005 (Second Edition) + Am 1:2009 + Am 2:2013

#### EMC

EN 55032: 2012

EN 55024: 2010

14 33022.2010

EN 301 489-1 V1.9.2 (2011-09) EN 301 489-17 V2.2.1 (2012-09)

#### **Radio Spectrum**

ETSI EN 300 328 V1.9.1 (2015-02)

EN 62479:2010

#### Chemical

Restriction of Hazardous Substances (RoHS) 2011/65/EU Annex II article 4(1)

EN71-3:2013 + A1:2014 - Migration of certain elements.

Analysis of the 163 substances of very high concern (SVHC) on the Candidate List for authorization, concerning Regulation (EC) No. 1907/2006 as published on the European Chemicals Agency (ECHA) website.



The BBC micro:bit device features Bluetooth Low Energy radio. The radio on the device operates in the following frequencies:

Frequency Range: 2402MHz to 2480MHz

Bluetooth Version: V4.0 Bluetooth Low Energy

#### **Declaration of Conformity**

The document can be downloaded by clicking here for the Declaration of Conformity

Terms of use | Privacy policy | Partners | House rules © Copyright 2015 BBC micro:bit

Sourced from, BBC Micro:bit (2015) https://www.microbit.co.uk/device



Sourced from, BBC Micro:bit (2015) https://www.microbit.co.uk/device

BBC

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micro:bit

# Appendix 2 – Pupil Resource Day 1 (final)

# BBC Micro:bit Challenge Pupil task booklet

31

Day 1

A study of Northern Ireland Key Stage 2 pupils' perceptions of using the BBC Micro:bit in STEM education.

# Day 1

# Learning Intentions;

- 1. To demonstrate an understanding of the purpose of the BBC Micro:bit.
- 2. To demonstrate an understand of 'drag and drop' programming as applied to the BBC Mirco:bit.
- 3. To demonstrate an understanding of how to create drag and drop programs and download them on to the BBC Micro:bit.
- 4. To demonstrate creativity and problem solving skills through the use of the BBC Micro:bit.



# **Smiley Faces and Micro Badges**

## Learning Intentions:

Pupils will develop the ability to;

- Demonstrate an understanding of programming skills by using drag and drop programming to create simple code.
- 2. Demonstrate an understanding of how to download code on to the BBC Micro:bit
- 3. Write/create code in order to show different patterns of LEDs on the BBC Micro:bit



# **Smiley Face**





# Here you will find all the code you need! Try to create the

pattern above. Remember to test your program!!

Programmer - Can you create a smiley face when

**button A** is pressed? *Remember to test your* program!!

Scientist - Can you create a sad face when the **button B** is pressed? *Remember to test your* program!!

Engineer - Can you turn the LEDs off when both

button **A and B** is pressed? *Remember to test your program!!* 

# When finished, **download** to program onto the BBC Micro:bit and test!

A study of Northern Ireland Key Stage 2 pupils' perceptions of using the BBC Micro:bit in STEM education.

# Micro badge

Now your group must come up with a group name and a badge to represent yourselves.

Group name; \_





(This is the grid of LEDs on your BBC Micro:bit. Shade in the lights to make your badge)

When you have a group name, use the programming tools that you have learned to;

- 1. Show your team badge when you press button A
- 2. Scroll your team name across the screen when you press **button B**



A study of Northern Ireland Key Stage 2 pupils' perceptions of using the BBC Micro:bit in STEM education.

# **Spirit level**

### Learning intentions;

Pupils will develop the ability to;

- 1. Demonstrate an understanding of the function of a spirit level and demonstrate how the BBC Micro:bit can be programmed to replicate it.
- 2. Program the BBC Micro:bit in order to make appropriate use of the duplicate tool in creating code.

![](_page_63_Picture_7.jpeg)

Does anyone in your group know what a spirit level is? If you do, can you explain to your group what it is and what it is used for?

For any of you that do not know – a spirit level is a device that is normally used by workers to see if a surface is level (level means that it isn't slanting to one side). It has liquid inside it with an air bubble and when the air bubble sits in the middle, this means that the surface is level.

![](_page_63_Picture_10.jpeg)

![](_page_63_Picture_11.jpeg)

Step 1 is to create a variable called bubble. Go to the Variables tab and create this block.

Now go to the Game tab and attach the create sprite at x: 2 y: 2 to the bubble block.

Go to the Loops tab and insert the while do block so your code looks like this.

![](_page_63_Picture_15.jpeg)

while

do

true

Now **test your game** by clicking on run – you should see the LED in the middle lighting up – this is the bubble.

Now we have the bubble – **we want the bubble to move** when we tilt the board so that it acts like a spirit level.

![](_page_64_Picture_4.jpeg)

Put this in here and **test your code** by **using the mouse to tilt** your BBC Micro:bit **on the computer screen**.

The **bubble should move to the right**. Now we want to code the bubble to move to the **left** and **up** and **down** when we tilt the board.

To do this, **duplicate the 'if' block** <u>three</u> times and attach them below each other.

![](_page_64_Picture_8.jpeg)

Make the changes circled in red and test your code to see that it works – when you have the code working on screen, download it to your BBC Micro:bit.

set	bubble v to C create sprite at x: 2 y: 2					
whil	e ( true 🕶					
do	If (acceleration (mg) x ▼ ≥ ▼ ↓ 0					
	change x y of bubble y by 1					
	pause (ms) 100					
	If (acceleration (mg) x ▼ ≤ ▼, 0					
	do change x v of bubble v by (-1)					
	pause (ms) 100					
	<pre> if ( acceleration (mg) y ▼ &gt; ▼ ↓ 0 </pre>					
	do change y of bubble by b1					
	pause (ms) 🖡 100					
	If ( acceleration (mg) v v ≤ v 0					
	do change y of bubble by -1					
	pause (ms) 🔰 100					

Can any of the members of your group hold the BBC Micro:bit so that the bubble/ LED stays in the middle?

# YES / NO

What else could this spirit level be used for inside or outside of school?

Can your group create code so that the bubble appears when buttons A + B are pressed?

# Appendix 3 – Pupil Resource Day 2 (final)

# BBC Micro:bit Challenge Pupil task booklet Day 2

the contract of the contract o

# Day 2

# Learning Objectives;

- 5. To demonstrate an understanding of programming skills by creating programs to solve a problem.
- 6. To demonstrate an understanding of how the BBC Micro:bit can be used to make links between the 'real world' and school situations.
- 7. To demonstrate an understanding of the relevance the BBC Micro:bit may have in our lives and how it helps to develop various skills (programming and problem solving).

![](_page_67_Picture_7.jpeg)

A study of Northern Ireland Key Stage 2 pupils' perceptions of using the BBC Micro:bit in STEM education.

# Name display

As a starter for today to get us thinking again, we will complete a name display task.

Use the Basic tab and t	he Input tab to get all	three team members' names to scroll
across the screen of LEDs.		
		show string 🔰 🎸 Hello! >>
Use these commands for each	team members name and us	se the
block to display each terro		
on button A v pressed do	on button B v pressed do	on shake do

When your group have completed this task, **show it to either your class teacher or one of the mentors**.

A study of Northern Ireland Key Stage 2 pupils' perceptions of using the BBC Micro:bit in STEM education.

# **Mystery task**

### Learning intentions;

- 1. Demonstrate an understanding of how to create unknown program and determine how the program may be used to solve a problem.
- 2. Demonstrate an understanding of how to create a scenario where the program can be applied in order to create a results table.

Use the Variables tab to create two variables called YES and NO.

![](_page_69_Picture_7.jpeg)

To make sure we know the votes have been counted, use the Ba

Basic tab to insert three

more blocks, these will show a tick so we know the vote is counted, a pause for 2seconds (2000ms) and a question mark (?) to show that it is ready for another

![](_page_70_Figure_5.jpeg)

![](_page_70_Picture_6.jpeg)

![](_page_70_Picture_7.jpeg)

To finish off we want to see which one wins and reset the number of votes to zero to start again.

![](_page_71_Figure_0.jpeg)
### finished code should look like this.

1.1	show string ( 44 Vote YES or	NO? **	on b	outton A+B pressed
	· · · · · · · · · · · · · · · · · · ·		ao	show string ( " YES; "
		<u> </u>		show number VES
on t	button A pressed	on button B r pressed		show string ( · · NO; >>
do	change YES by 1	do change NOT by 1		show number
	show leds 0 1 2 3 4	0 1 2 3 4		
				do show string ( 44 YES wins ??
		200000		
				do show string ( " NO wins "
	pause (ms) 2000	pause (ms) 2000		else show string ( " It's a draw "
	show string ( "?"	show string ( "?"		set YES to ( 0

What is this program useful for? State your ideas below and tell them to the teacher or one of the mentors and you may be able to carry out some research.

Create three questions using YES or NO answers. Ask your classmates your questions and get the results.

- 1.
- 2.
- 3.

		RESU	JLTS		
Question 1 Question		tion 2	Question 3		
YES:	NO:	YES:	NO:	YES:	NO:
Winner =		Winner =		Winner =	

Seanpaul Gibson – 40111029 Patrick Bradley – 40104564

### **Appendix 4 – Teacher Resource**

# BBC Micro:bit Challenge Teacher booklet



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# **Curriculum Links**

#### Numeracy

- Create pictures and patterns with 2D shapes.
- Explore movement using programmable devices.
- Copy a simple pattern, for example the badge task.
- Create patterns, for example, when creating code for the BBC Micro:bit.
- Explore ordinal number, for example, first, second, third, last, between, by completing practical activities.
- Follow/give directions from/to a partner for simple movements, for example, *two steps forward, one step backwards.*
- •Understand and use a range of positional words, for example, *in front of, behind, across, beside, between.*
- use co-ordinates to plot and draw shapes in the first quadrant.
- be introduced to a programming
- language and use it to create pictures and patterns and to generate shapes.

#### Literacy

- Participate in modelled, shared, paired and guided reading experiences.
- Read, explore, understand and make use of a wide range of traditional and digital texts.
- Represent their understanding of texts in a range of ways, including visual, oral, dramatic and digital.
- Use a variety of reading skills for different reading purposes.
- Understand the differences between spoken and written language.
- Identify and ask appropriate questions to seek information, views and feelings.

### World Around Us

- Develop their powers of observation, their ability to sort and classify, explore, predict, experiment, compare, plan, carry out and review their work.
- •Looking closely at similarities, differences, patterns and change.
- •Exploring and examining photographs, objects and other items.
- •Skills and concepts should be developed during play and other planned activities/topics and these should be relevant to the children's interests and experiences.
- Movement and Energy:
- How do things move now and in the past?
- •Why do things move?
- •How do things work?
- •Where do things move?
- •What sources of energy are in my world?
- •How and why are they used?

CCEA (2007) The Northern Ireland Curriculum Primary, Northern Ireland: CCEA.

# Whole Curriculum Aims and Objectives Links

Individuals	Contributors to Society	Contributors to the
		Economy and Environment.
Throughout the primary stages	Throughout the primary stages	Throughout the primary stages
teachers should help children to:	teachers should help children to:	teachers should help children to:
Develop a sense of awe and wonder	Be aware of how we rely on each	Develop literacy numeracy and ICT
about the world around them.	other	skills.
Listen to and interact positively		Develop their aptitudes, abilities
with others		and creativity
Develop their motivation to learn		Work independently and as a
and their individual creative		member of a team
potential		<b>•</b> •••• • • • • • • • • • • • • • • • •
		Be willing to take calculated risks
		when appropriate
		Use critical and creative thinking
		to solve problems and make
		decisions

CCEA (2007) The Northern Ireland Curriculum Primary, Northern Ireland: CCEA.

# **BBC Micro:bit Challenge**

This project will take place over 2 morning sessions. The tasks may last for around 2 hours' dependant on the ability of the pupils.

#### Day 1 will consist of:

- An Exploration of the various features in relation to programming the BBC Micro:bit.
- A set of beginner programming tasks that will challenge the pupils, gradually increasing in difficulty as the tasks continue.

#### Day 2 will consist of:

- More in-depth challenges with limited instructions.
- Scenario based problem solving where pupils use the BBC Micro:bit to address a problem and meet a specific need.

# What is the BBC Micro:bit?

The BBC Micro:bit is a new and innovative educational tool which has been developed as an aid to assist teachers in the teaching of computer science and programming. It is a pocket sized programmable computer, which was developed by the BBC for the purpose of providing a computing platform for pupils in a school setting to fully appreciate the potential of programming as an educational tool.

The BBC Micro:bit consists of a range of different technical features, such as, LEDs, push buttons, an accelerometer and a compass (see fig 1).To program the BBC Micro:bit, the BBC has provided a range of different methods, ranging from Block Editors aimed towards beginners e.g. Scratch, to more advanced forms of programming such as Python.



Figure 1 Different features that make up the BBC Micro:bit - Sourced from, BBC Micro:bit (2015) https://www.microbit.co.uk/device

### For more information please visit the BBC Micro:bit website at -

http://microbit.org/

A study of Northern Ireland Key Stage 2 pupils' perceptions of using the BBC Micro:bit in STEM education.

### **Appendix 5 - Presentation**



### How do we program the BBC Micro:bit?

To program the BBC Micro:bit we use an online editor - the BBC Micro:bit we use biock editor - it is similar to scratch.
The block editor is where we use building blocks to create the program

### Connecting the micro:bit to the computer

### Slide 6

The BBC micro:bit comes with a micro USB, this is a lead that connects into the BBC Micro:bit at the top and then the other end connects into the USB port of the computer or laptop.



# Other ways to program the BBC Micro:bit

- The BBC Micro:bit has also got Bluetooth connectivity so that it can be paired with smart devices such as iPads and tablets.
- This means that the BBC Micro:bit can be programmed wireless from these devices using Bluetooth connectivity.



Slide 7

### Example



Slide 8

# What we're going to do

- We will be here for two sessions with you so that you can develop your programming skills in a fun and challenging way and then we hope that you will let us know what you think.
- Day 1 we will be organising ourselves into groups and introducing you to the BBC Micro:bit. In your groups you will then be completing some tasks.
- Day 2 some more challenging tasks in your groups and answering some questions in a questionnaire to help us with our research.

Slide 9

### Appendix 6 – Questionnaire

# **BBC Micro:bit Challenge Feedback**

Tick the correct box = Boy Girl Girl

1. Tick the box which best describes the BBC Micro:bit challenge.

1	2	3	4	5
Very Easy	Easy	Don't know	Difficult	Very Difficult

2. Tick the box which best describes how enjoyable you found the BBC Micro:bit challenge?

1	2	3	4	5
Very Boring	Boring	Don't know	Enjoyable	Very Enjoyable

3. Tick the box which best describes how useful the BBC Micro:bit was when problem solving?

1	2	3	4	5
Useless	Not Useful	Don't know	Useful	Very Useful

4. Why do you think the BBC Micro:bit helped in solving problems?

5. Do you think the tasks linked with the subjects - Science, Technology, Engineering and Maths (STEM)? Place a  $\mathbf{V}$  in the box next to your answer.

Science	YES	NO 🗌
Technology	YES	ΝΟ
Engineering	YES	NO 🗌
Maths	YES	NO 🗌

6. Did you learn anything new from today's BBC Micro:bit Challenge? If yes, what? And if no, why do you think this?

7. Would you like to use the BBC Micro:bit more often? Explain your answer.

8. If you could change anything about this challenge, what would it be?

## Appendix 7 – Ethical Letters: Principal

Dear Principal,

We would like to invite a class of your choice (P6/P7) to participate in research to determine the perceptions of pupils in primary schools towards the use of the BBC Micro:bit. The title of the research is 'A study of Northern Ireland Key Stage 2 pupils' perceptions of using the BBC Micro:bit in STEM education. We are two undergraduate students from St Mary's University College Belfast and the research will be conducted by us. We have been vetted by the appropriate authorities for the purpose of working with children.

The research will involve the pupils who will take part in the practical activities involving the use of BBC Micro:bit. Pupils who do not give their permission to be surveyed will be treated sensitively, with other engaging activities arranged for them to take part in while data is being collected.

Participation of the class will involve them taking part in a questionnaire, along with other pupils, which will take place in a classroom in your school during school hours following agreement from yourself. The questionnaire will take approximately 15 minutes to complete.

The data collection from the questionnaires will take place in a classroom. It will take place during class time or at another time deemed appropriate by teachers and pupils.

We will be the only persons involved in the research and will therefore be the only persons, apart from our University supervisor Dr Kieran McGeown, who will have access to the data gathered from the questionnaires. You can be assured that the pupils', teachers' and school's name(s) will not appear on any documentation or reports stemming from this project. All data will be stored in a safe place at St. Mary's University College, Belfast and destroyed at the end of the project.

We may present the findings of this research project in a research report, in articles, in journals and/or at conferences. However, it will not be possible to identify any school, teacher or child in these presentations.

Participation in this research is voluntary and you may withdraw your permission for your school to participate at any time. Your pupils/parents can also refuse to participate or withdraw from the research at any time. If you give permission for your school to participate in this research, then please indicate this by signing the agreement below. If you have any questions about the research, then please feel free to contact our supervisor at:

Dr Kieran McGeown, St Mary's University College, 191 Falls Road, Belfast BT12 6FE Tel: 02890 268324 Email: <u>k.mcgeown@smucb.ac.uk</u>

This research has been reviewed by our supervisor, Dr K.McGeown of St Mary's University College, Belfast and has been granted approval to proceed.

Yours faithfully

Patrick Bradley	
Sean Paul Gibson	

I, \_\_\_\_\_\_ agree to allowing Patrick Bradley and

\_\_\_\_\_

SeanPaul Gibson to complete the above research project within our school,

\_\_\_\_\_. I fully understand the terms on which this project will be completed.

Signed; \_\_\_\_\_

Date; \_\_\_\_\_

### Appendix 8 – Ethical Letters: Teacher

Dear Teacher,

We would like to invite your class to participate in research to determine the perceptions of pupils in primary schools towards the use of the BBC Micro:bit. The title of the research is 'A study of Northern Ireland Key Stage 2 pupils' perceptions of using the BBC Micro:bit in STEM education.' We are two undergraduate students from St Mary's University College Belfast and the research will be conducted by us. We have been vetted by the appropriate authorities for the purpose of working with children.

The research will involve the pupils who will take part in the practical activities involving the use of BBC Micro:bit. Pupils who do not give their permission to be surveyed will be treated sensitively, with other engaging activities arranged for them to take part in while data is being collected.

Participation of the class will involve them taking part in completing a questionnaire, along with other pupils, which will take place in a classroom in your school during school hours following agreement from yourself. The questionnaire will take approximately 15 minutes to complete.

The data collection from the questionnaires will take place in a classroom. It will take place during class time or at another time deemed appropriate by teachers and pupils.

We will be the only persons involved in the research and will therefore be the only persons, apart from our University supervisor Dr Kieran McGeown, who will have access to the data gathered from the questionnaires. You can be assured that the pupils', teachers' and school's name(s) will not appear on any documentation or reports stemming from this project. All data will be stored in a safe place at St. Mary's University College, Belfast and destroyed at the end of the project.

We may present the findings of this research project in a research report, in articles, in journals and/or at conferences. However, it will not be possible to identify any school, teacher or child in these presentations.

Participation in this research is voluntary and you may withdraw your permission for your class to participate at any time. Your pupils/parents can also refuse to participate or withdraw from the research at any time. If you give permission for your class to participate in this research, then please indicate this by signing the agreement below. If you have any questions about the research, then please feel free to contact our supervisor at:

Dr Kieran McGeown, St Mary's University College, 191 Falls Road, Belfast BT12 6FE Tel: 02890 268324 Email: <u>k.mcgeown@smucb.ac.uk</u>

This research has been reviewed by our supervisor, Dr K.McGeown of St Mary's University College, Belfast and has been granted approval to proceed.

Yours faithfully,

Patrick Bradley Sean Paul Gibson I, \_\_\_\_\_\_ agree to allowing Patrick Bradley and

SeanPaul Gibson to complete the above research project with our class, \_\_\_\_\_. I

fully understand the terms on which this project will be completed.

Signed; \_\_\_\_\_

Date; \_\_\_\_\_

## Appendix 9 – Ethical Letters: Parent

Dear Parent/Guardian

I would like to invite your child to participate in research to determine the perceptions of pupils in primary schools towards the use of the BBC Micro:bit. The title of the research is **'A study of Northern Ireland Key Stage 2 pupils' perceptions of using the BBC Micro:bit in STEM education.'**. We are two undergraduate students from St Mary's University College Belfast and the research will be conducted by us. We have been vetted by the appropriate authorities for the purpose of working with children.

The research will involve the pupils who will take part in the practical activities involving the use of BBC Micro:bit. Pupils who do not give their permission to be surveyed will be treated sensitively, with other engaging activities arranged for them to take part in while data is being collected.

Participation for your child will involve taking part in completing a questionnaire, along with other pupils, which will take place in a classroom in your child's school during school hours following agreement from the Principal. The questionnaire will take approximately 15 minutes to complete.

The data collection from the questionnaires will take place in a classroom. It will take place during class time or at another time deemed appropriate by teachers and pupils.

We will be the only persons involved in the research and will therefore be the only persons, apart from our University supervisor Dr Kieran McGeown, who will have access to the data gathered from the questionnaires. You can be assured that your child's name will not appear on any documentation or reports stemming from this project. All data will be stored in a safe place at St. Mary's University College, Belfast and destroyed at the end of the project.

We may present the findings of this research project in a research report, in articles, in journals and/or at conferences. However, it will not be possible to identify any school, teacher or child in these presentations.

Participation in this research is voluntary and you may withdraw your permission for your child to participate at any time. Your child can also refuse to participate or withdraw from the research at any time. If you give permission for your child to participate in this research, then please indicate this by completing the attached consent form and asking your child to return it to the school. If you have any questions about the research, then please feel free to contact our supervisor at:

Dr Kieran McGeown, St Mary's University College, 191 Falls Road, Belfast BT12 6FE Tel: 02890 268324 Email: <u>k.mcgeown@smucb.ac.uk</u>

This research has been reviewed by our supervisor, Dr K.McGeown of St Mary's University College, Belfast and has been granted approval to proceed.

Yours faithfully

Patrick Bradley Sean Paul Gibson

### **INFORMED CONSENT FORM**

# 'A study of Northern Ireland Key Stage 2 pupils' perceptions of using the BBC Micro:bit in STEM education.

Please indicate below your decision regarding your child taking part in this research by taking part in practical activities and completing a questionnaire. The purpose of the research is to determine the perceptions of pupils in primary schools towards the use of the BBC Micro:bit in STEM education.

Please complete and sign either part A or part B below

#### <u>YES</u>

Part A. I do give permission for my child to participate in this research

Please write child's name in capitals\_\_\_\_\_

Please write your signature\_\_\_\_\_

### NO

Part B. I do not give permission for my child to participate in this research

Please write child's name in capitals\_\_\_\_\_

Please write your signature\_\_\_\_\_

I would be very grateful if you would ask your child to return this completed consent form to the school.

THANK YOU!

## Appendix 10 – Ethical Letters: Pupil

Dear pupil,

This letter is to give you information about a research project entitled 'A study of Northern Ireland Key Stage 2 pupils' perceptions of using the BBC Micro:bit in STEM education.'

This research will give you the chance to take part (during class time) in practical activities using the BBC Micro:bit and answering simple questions from a questionnaire. If you do not want to be surveyed there will be other tasks / activities arranged for you while the other pupils are taking part in the research.

#### Your participation in the research project is entirely voluntary.

We may use the results of this research project in our research. We, along with our university supervisor Dr Kieran McGeown, will be the only persons to have access to the results. There are no known or anticipated risks to you as a participant in this project.

Your name will not appear in anything to do with the research project. No names of schools or pupils will be used. All information relating to the questionnaire will be destroyed at the end of the project.

If you have any questions about this research project or would like extra information please ask one of us before, during, or after both the practical activities and you taking the questionnaire.

Thank you for your assistance in this project.

Yours,

Patrick Bradley\_\_\_\_\_

SeanPaul Gibson\_\_\_\_\_

DATE
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(SEE NEXT PAGE)

#### **INFORMED CONSENT FORM**

I have read the letter about the research project entitled 'A study of Northern Ireland Key Stage 2 pupils' perceptions of using the BBC Micro:bit in STEM education.' which is being conducted by Patrick Bradley and Seanpaul Gibson from St. Mary's University College Belfast.

I have been offered the opportunity to ask any questions about this research project and received satisfactory answers to my questions, as well as any additional details I requested.

I am aware that information from the questionnaire may be used in the research. I understand that it will not be possible to identify any schools, teachers or pupils in any reports or presentations associated with the project'

I was told that I may withdraw my consent at any time by telling Patrick or Seanpaul (the researchers).

**A.** With full knowledge of all the above, I **\*agree / do not agree** to participate in group interviews and questionnaire completion

Pupil participant's name (in capitals):

Pupil participant's signature:\_\_\_\_\_

Researchers' Names (in capitals): PATRICK BRADLEY & SEANPAUL GIBSON

Researchers'
Signature:\_\_\_\_\_

DATE\_\_\_\_\_

(\* delete as appropriate)