Using I.C.T. to promote Science in the World Around Us Curriculum

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Abstract
This investigation has been designed to determine the extent of science teaching in primary schools in Northern Ireland; and whether I.C.T. is a suitable method of promoting the teaching of science within the World Around Us curriculum. The context of this research is provided by an Education and Training Inspectorate (ETI) report, based on a survey carried out in January 2014 to evaluate the implementation of the World Around Us curriculum in primary schools.

The main research questions for this investigation were:

1. How much science is taught as part of the World Around Us curriculum?
2. What are the barriers, if any, to teaching science in primary school?
3. What is the role of I.C.T. in the promotion of science in the curriculum?
4. Could Fronter, a virtual learning environment, promote science in the curriculum?

Questionnaires and interviews were undertaken in two schools in Newry, Northern Ireland. The researcher chose schools in two different settings in order to obtain a fairer representation and cross-section of school types and environment. Previous global studies correlate with the findings of this investigation, which show the main limiting factors for teaching additional science to be:

- a decline in the number of science specialist teachers,
- a lack of teacher confidence,
- a lack of resources
- unsuitable topic choices

Additionally it was found that the use of 'ready-made' Fronter courseware would be beneficial for the promotion of science in the World Around Us curriculum, although it was found that this may not be the best I.C.T. resource available.

Further research could include investigating the methods for choosing topics within schools; the number and influence of science specialist teachers in primary schools; and other methods of delivering science through I.C.T.

Introduction

This piece of research aims to examine the extent to which science is being taught in primary schools, the potential barriers to teaching science and explore the role of I.C.T. in the promotion of science in the Northern Ireland Curriculum. In particular, the role of Fronter, a virtual learning environment (V.L.E.) which has been provided by C2K as a development of the previous Learning NI platform that was used to integrate I.C.T. into all subject areas, is investigated. The context of this research is provided by an Education and Training Inspectorate (ETI) report, based on a survey

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carried out in January 2014 to evaluate the implementation of the World Around Us in primary schools.

The Northern Ireland Curriculum (2007) states that "the purpose of learning about the World Around Us is to provide opportunities for children to develop an awareness of Information and Communication Technology (I.C.T.) and its impact on society and the world around them." This highlights the natural links between these two curriculum areas and hopefully the positive impact each can have when used symbiotically, on the development of important life skills. It is hoped that the development of I.C.T. in primary science will add to pupil interest and motivation so that children's curiosity and desire for understanding will enhance their science learning.

Prior to the publication of the current revised curriculum in 2007, issues were raised in particular by the South Eastern Education and Library Board regarding the inclusion of science in the World Around Us area of learning. "The Board is also concerned that unlike trends in the Republic of Ireland, England and Wales, the importance of Science and Technology has been downgraded through its incorporation into 'The World Around Us' in Key Stage 1and 2. Members were also concerned that the importance of Science and Technology in the later Key Stages must not be lost." (2005) This research aims to investigate the impact this amalgamation has had on the presence of science in the curriculum, seven years after its introduction.

In March 2014, the Education Minister, John O'Dowd, speaking at the 'Smart Technology' celebration event in Belfast, which was delivered by Sentinus, said that a component workforce will be required to meet the expected demand in STEM jobs in the coming years: "It is therefore important that we spark the interest at primary level in the hope that the initial interest can be developed, nurtured and enhanced later in academic life." However it is important to note that the teaching and learning of science will develop other important skills, which are not just required for a job in the STEM field. Other arguments for the good quality teaching of science include; the development of transferable skills such as problem-solving, the ability to ask questions and draw evidence based conclusions and the ability to care for and look after our fragile planet. An objective of this research is to highlight the importance of the development of these skills through science and I.C.T.

Literature Review

Millar and Osborne (1998) state that "it is our view that the enormous impact of the products of science on our everyday lives, and of scientific ideas on our common culture, justify the place of science as a core subject of the school curriculum, studied by all young people from 5 to 16." Davies (2011) notes many reasons why science should be an important part of the primary curriculum. These reasons include the 'scientific literacy' argument that recognises our need to be able to relate to the rapid changes in science and technology in today's culture in order to make everyday decisions. "Scientific literacy is the capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity." (OECD, 2002) Davies' view aligns with that of Millar and Osborne (1998) who state "the science curriculum for 5 to 16 should be seen primarily as a course to enhance general scientific literacy." This would appear to be the most salient argument and its importance is supported throughout the Northern Ireland Curriculum guidelines for The World Around Us, which suggests that children's experiences should include "asking questions about why things happen" and "talking about topics which arise naturally from children's own experiences." (CCEA, 2007) Furthermore, Davies proposes the so-called 'saving the world argument'. Both Davies and Harlen and Qualter (2014) agree that science has an important part in the primary curriculum to ensure that children "know enough science and know enough about how science works to avoid perpetuating our throwaway, energy-wasting, planet-polluting society."

(Davies, 2011) By example, teachers can build on children's natural emotional responses to plants and animals, to help them to do something positive to protect the world around them. It is also important that children can make responsible decisions about the application of scientific knowledge to understand how technology can impact both positively and negatively on society. "This becomes more and more important as science and technology takes an expanding role in our lives." (Harlen and Qualter, 2014)

In Northern Ireland in 2013, there were 114 schools who had achieved the Green Flag status awarded by the environmental charity, Keep Northern Ireland Beautiful, as part of the Eco-schools initiative. To achieve this award, schools must study at least three topics. Some of these topics include; Energy, Water, Biodiversity, Global Perspective and Climate Change. (Eco-schools N.I., 2014). The scientific basis of these is clear and the completion of this work to a high standard ensures the school receives the prestigious flag. This again highlights the significance of scientific skills to look after and care for our environment. However it is important that schools do not rely on these scientific topics to be the major or indeed only source of science teaching and learning in the classroom.

The third argument outlined by Davies is that of 'transferable skills'. Davies states that "when children are engaged in scientific enquiry they are learning a systematic approach to problem-solving that they can apply in other parts of their lives." (2011) The Northern Ireland Curriculum highlights that all areas of learning should allow for the development of skills in; hypothesising, planning, gathering and interpreting evidence and evaluating. Clearly, not all subject areas lend themselves as easily to the development of these skills as science does.

In the educational system in England, Harlen and Qualter (2014) note that since their last publication in 2009, research indicates that there has been a "down-turn in the attention to science." They list several reasons for this including; the end of national testing in science and a move towards a focus on skills rather than content taught through cross-curricular topics. In addition to this, "the introduction of National Literacy and Numeracy Strategies further relegated it to an 'afternoon' subject in many schools." Boyle and Bragg (2005) It is possible that these are the same reasons for the depletion of science in the Revised Northern Ireland Curriculum; its removal from the 11 plus transfer test, an emphasis from ETI and "Every School a Good School" on raising standards in Literacy and Numeracy only, and the holistic approach to teaching and learning outlined in the revised 2007 curriculum.

In 2008, reports from MATRIX: The Northern Ireland Science Industry Panel highlighted the importance of innovation, research and development in Northern Ireland's Science, Technology, Engineering and Mathematics (STEM) industries. In 2009, DE and DEL published the STEM Review and a draft STEM Strategy. Both of these emphasised a need for more links between industry and education. "These reports indicate that we need to ensure that Northern Ireland's young people have the skills, knowledge and understanding in STEM-related subjects in order to take advantage of job opportunities in these fields and contribute to the country's economy." (CCEA, 2014). This initiative is aimed at Key Stage 3 pupils to encourage an interest in STEM subjects. However the Association for Science Education in Northern Ireland is "concerned about the retention of science students within the STEM pipeline." (ASE 2013) This is due to science not being a compulsory subject for GCSE, so the time available to retain the maximum number of science students is short, and is reliant on pupils having a positive attitude to science at age 14. "Scientific enquiry in primary schools provides an ideal opportunity to enthuse youngsters with the 'awe and wonder' of science and introduce them to the scientific method in a less exam-driven environment." (ASE, 2013) Their main concern is the lack of prescription in primary school science has resulted in less content being

taught. As a result they are calling for a short statement of statutory content to be taught by the end of primary school.

As children's interest in science is vital for effective science learning, particularly in developing their confidence, Murphy and Beggs (2003) carried out an extensive survey of primary children's attitudes to science in England. They found that most of the older children (10-11 years) had significantly less positive attitudes than younger children (8-9 years) towards science enjoyment, even though the older children were more confident about their ability to do science. Further to this, Murphy and Beggs observed the relationship between gender and attitude to science. The results showed that the effect of age was much more significant than gender. However girls in general were more positive about their enjoyment of science and were a lot more enthusiastic about how their science lessons impacted upon their environmental awareness.

In April 2006, ETI published a survey on the 'Supply of Science Teachers in Post-Primary Schools in Northern Ireland.' The survey was carried out to "determine the extent to which post-primary schools in Northern Ireland have sufficiently qualified science teachers to meet their statutory requirement to provide pupils with broad and balanced science courses." ETI (2006) The background of the survey observes how science inspectors noted problems with the supply of chemistry and physics teachers and about the pool of qualified teachers available to provide substitute cover. The survey highlighted the degrees held by science teachers in the schools; biology (31%); chemistry (22%); physics (13%); BEd. degree in primary education specialising in primary science (8%) and the reminder (26%) degrees in engineering, environmental science and mathematics. In addition to this, in only 50% of absences was a suitably qualified substitute teacher employed and of the 42 substitute teachers used in 2004/05 and 2005/06, 45% were retired science teachers and 16% were newly trained science teachers. These figures highlight a 'vicious cycle' in Northern Ireland and beg an obvious question; how can we keep pupils interested in science if we have no-one sutibaly qualified to teach them?

Goodrum, Hackling and Rennie (2001) referring to the primary educational process in Australia, state that "Australian educational jurisdictions have developed modern and progressive curriculum frameworks for school science; however, there is a considerable gap between the ideal or intended curriculum and the actual or implemented curriculum. There is great variability between schools in the quality of science education." They also state that where science is taught, it is taught through 'hands-on' activities. They note that although this methodology is effective, it could be asked; are the pupils engaged? Are the hands-on activities used as 'fun and filler' or as purposeful 'hands-on and minds-on' lessons?

In 2008, professional learning and curriculum development with respect to primary science was evaluated in Northern Tasmania. In the results, 30% of teachers mentioned that science was taught as an integrated subject, and that roughly 50 minutes a week were spent teaching science. Teachers then identified that, on average, they felt that 80 minutes of science a week would be ideal. Only 30% felt their school was well equipped, and this low figure is echoed in the research of Goodrum et al. (2001) where 40% of teachers named resources as a limiting factor. 40% of teachers felt confident teaching science, however only 20% indicated that a lack of science knowledge was the barrier. This would suggest that a lack of resources and support were their biggest issues.

In 2012, Scotland issued a report evaluating Science practice in the primary schools. The evidence presented in this report suggests that children and young people are developing a range of knowledge, understanding and skills in the sciences and overall, learning and teaching is strong, effective and improving. "Children and young people, practitioners, parents and members of the wider sciences community are encouraged to become engaged with each other and with Education

Scotland staff, to share practice and address areas requiring development." (Education Scotland, 2013) As a result of the study, key strengths and areas for development have been identified and examples of good practice have been published to help teachers develop science in the primary school.

ETI are currently investigating the implementation of The World Around Us in primary schools in Northern Ireland. An online questionnaire was issued to principals on the 6th January 2014 and survey visits have taken place. A general report will be published at the end of 2014 and it will focus on the effectiveness of the curriculum.

The above examples are from more extensive global research into the provision of science in primary schools, where science still remains an individually taught subject. It is hoped that this research will help inform the exploration of Northern Ireland's World Around Us programme in 2014. This global research should help to highlight key issues experienced in other countries and the reflections and action plans put in place by their governing bodies should provide ideas and support for a similar process regarding primary science in Northern Ireland.

In 1998, Harlen anticipated that "the foremost foreseeable change in the learning and teaching of primary science over the next ten years would be the impact of information and communications technology (I.C.T.)." The use of I.C.T. can facilitate more constructivist teaching in the primary school, where children build knowledge out of their own experiences, supporting the development of skills and positive attitudes whilst promoting understanding of the concepts of primary science. Ball (2003) categorises four ways in which I.C.T. is used in primary science; as a tool, as a reference source, as a means of communication and as a means for exploration. It is hoped that the development of I.C.T. in primary science will add to pupil interest and motivation so that children's curiosity and desire for understanding will enhance their science learning. This aim is shared by Webb (2008) who, when discussing the impact of I.C.T. in science education, argues that, "because of the affordances of I.C.T., students get a more in-depth understanding of complex science concepts."

Furthermore, skills in I.C.T. are becoming more important in our modern society, particularly in education. "It is without question that I.C.T. has a primary place in 21st century skills and 21st century learning." Voogt et al. (2011) The Northern Ireland Curriculum has emphasised an importance of the development of I.C.T. skills through its incorporation into teaching and learning. Harlen and Qualter (2014) observe that "not only have the technologies available increased but the greater confidence of teachers in using them has enabled I.C.T. to become more integrated into teaching and learning." Voogt et al. (2011) argue that "teachers not only need to have basic I.C.T. literacy skills; they need to learn how to use I.C.T. in pedagogical settings and how to integrate I.C.T. into the curriculum." It is therefore important that teachers are provided with opportunities to gain experience and relevant training in I.C.T.

Fronter is a virtual learning environment, which has been provided by C2K as a development of the previous Learning NI platform that was used to integrate I.C.T. into all subject areas. Fronter "is an arena for learning, for teaching, for interacting with peers and colleagues, for organising, for sharing, for documenting and for improving people's lives through education." (Fronter, 2014). For Fronter to be suitability used in the classroom, particularly to link science and I.C.T., it is important that teachers receive appropriate training to become 'Fronter literate'.

This project aims to research the extent of science taught in the primary school as part of the World Around Us curriculum. If the research highlights an unbalanced programme, the research aims to determine if there are any main reasons for unequal provision, in particular regarding science. The

research also aims to determine if I.C.T. is a suitable vehicle for promoting science in the changing classroom, with particular focus on the Virtual Learning Environment, Fronter, that has been provided to schools throughout Northern Ireland. I aim to create a Fronter room to support the teaching of science in the Foundation stage. This resource will be trialled and evaluated at a later date and can be extended if appropriate. It is hoped that through the provision of a modern, relevant, simple resource that focuses on the main science skills, that teachers will feel confident and supported in the teaching of science in the primary school.

Ethics

This study was conducted in line with the Code of Practice for research by St. Mary's University College (Appendix 1) and the BERA Ethical Guidelines. (2011) Before carrying out this study, the aims and methods that will be used to conduct the research were explained to the Principal and relevant teachers of the participating primary schools. A preliminary visit to the primary schools allowed the researcher to further discuss the project with the Principal and discuss any concerns or queries the schools may have. During this visit a hard copy of the questionnaire was provided and letters of consent were drawn up to be given to the teachers participating in the questionnaire and in the interviews. The letter explained the nature of the study and the assurance of confidentiality. It was made clear that the replies to the questionnaire were anonymous and all voice recordings from interviews were destroyed immediately after the completion of the project. Teachers were given the option to decline inclusion in the study and a forum to address further concerns was provided.

Research Methodology

"We believe that the development of a world-class education system depends on high quality educational research." BERA (2014). This view endorses that of Reiss et al. (2010) who state that educational research has a "commitment to inform the direction of education and to make a positive impact on learning, individual learners and society in general." As a result, it is extremely important that research is valid and useful. Valuable research involves careful preparation, relevant statistics and an awareness of the limitations inherent to the methodology.

The intention of this research was to determine the degree of science taught in primary schools, and if I.C.T. would be a suitable method of promoting it in the World Around Us curriculum. The main research questions were:

1. How much science is taught as part of the World Around Us curriculum?
2. What are the barriers, if any, to teaching science in primary school?
3. What is the role of I.C.T. in the promotion of science in the curriculum?
4. Could Fronter, a virtual learning environment, promote science in the curriculum?

This research was undertaken in two primary schools in Newry, Northern Ireland. The researcher chose schools in two different settings in order to determine a fairer representation and cross-section of school type and environment. However I am aware of the limitations imposed on the interpretation of the results obtained from only two such schools.

Quantitative, Qualitative and Mixed Methods Research

Denscombe (2007) defined qualitative research as that "which takes the form of words and images; qualitative research includes collecting data for analysis from a range of methods including observations, documents and interviews." On the other hand, quantitative research can be defined as research that explains "phenomena according to numerical data which are analysed by means of mathematically based methods, especially statistics." Yilmaz (2013) Blaxter et al (1996) indicate that both methods are valid and useful for a researcher.

The basic rationale of the mixed methods strategy is that "by combining qualitative and quantitative methods one can utilize their respective strengths and escape their respective weaknesses." (Tashakkori and Teddlie, 1998) It is acknowledged that where the researcher relies on one single method, the research may be limited, biased and even invalid as "qualitative or quantitative represents only one, perhaps not very useful, way of classifying methods." Cohen et al. (2011)
Methods of data collection used in this study

To research the degree of science taught in the primary schools, and the role played by I.C.T. in the teaching and learning of science, the investigation was undertaken using a combination of both qualitative and quantitative research. The methods chosen for this research study produced a range of data which successfully provided responses to the research questions set.

Questionnaires
Questionnaires were used as a method of quantitative research throughout the course of this study. The use of the questionnaire is probably one of the most common methods of data collection. One of the reasons for using this method of data collection is that it is relatively easy to administer. Cohen et al (2011) state that "the questionnaire is a widely used and useful instrument for collecting survey information, providing structured, often numerical data, being able to be administered without the presence of the researchers and often being comparatively straightforward to analyse."

Denscombe (1998) states that, "a questionnaire needs to be crisp and concise, asking just those questions that are critical to the research." This view is furthered by Gillham (2000) who notes that "developing a questionnaire that will yield worthwhile data is difficult." The main issue relating to this view is the use of open and closed questions in the questionnaire. "Most questionnaires are composed entirely of closed questions." Gillham (2000). A closed question is one where the possible answers are predetermined. When the answers to a closed question are in terms of opinions, beliefs and judgements, a small range of answers is much less likely to be representative and forces responses into predetermined categories. Closed questions are relatively straightforward to analyse as only the frequency of a response needs to be discovered. Generally open questions are used less as they are more difficult to analyse and are more troublesome to answer. Gillham argues that open questions can lead to a greater level of discovery, but that their number and kind have to be restricted in order to justify their "cost". Additional advantages for using questionnaires include; low cost in time and money, easy to obtain information from a lot of people very quickly, respondents can complete the questionnaire when it suits them and respond anonymously. Bell (2005) suggests that the questionnaire should be piloted, "all data gathering instruments should be piloted to test how long it takes the recipients to complete them, to check that all questions and instructions are clear and to enable you to remove any items which do not yield usable data." Bell further argues that piloting questionnaires informs the researcher of the enhancements that need to be made. Changes and improvements can be made if necessary on the advice of the pilot group. Dowling and Brown (2010) comment that it is essential that the researcher does everything they can to "foster a good response rate". In addition, they state that respondents should be provided with "advance warning" of the forthcoming questionnaire through a letter. This letter may also explain the rights and responsibilities of the participants and the purpose of the research. Such practice will ensure that any ethical issues arising can be addressed. Bell (2005) concurs that written approval should always be obtained.

A preliminary visit to each of the participating primary schools was conducted in order to meet the Principal to discuss the overall project and its aims along with the questionnaire. Each of the school principals was given a hard copy of the questionnaire to read and make comments on the questions. The principal then issued each of the participating teachers with a letter of consent to participate in the questionnaire. The questionnaire was created using the online resource Survey Monkey using

mostly closed questions, and several optional open questions. The questionnaire was emailed to each of the participating teachers for completion. Paper copies of the questionnaire were also provided to each school so that participants could choose a method of completion. The electronic versus hard-copy response rule also provided some insight into the teachers' confidence of using I.C.T.

Interviews

Another method of data collection used during this research was interviews. One of the main reasons why interviews have been selected as a data collection method is that it enabled the researcher to collect detailed information regarding the use of I.C.T. to promote science and in particular, the use of Fronter as a tool to promote learning. The World Around Us and I.C.T. co-ordinators from one of the participating schools were interviewed. As stated previously, the interviews were mainly structured but the inclusion of some open ended questions allowed for the exploration of points where necessary. A Dictaphone was used to allow the researcher to listen to the interview and analyse the responses. Written consent was obtained prior to recording in accordance with the ethical issues guidelines.

Denscombe (2007) highlights some of the advantages of using interviews as part of a mixed method of data collection. He states "when the researcher needs to gain insights into things like people's opinions, feelings, emotions and experiences, then interviews will almost certainly provide a more suitable method". Dowling and Brown (2010) also provide reasons for using interviews as part of a mixed method approach, "the advantages of the use of interviews to a large extent mirror the limitations of questionnaires".

However, as with all research methods there are disadvantages of using interviews as a research method. Bell (2005) highlights some of the disadvantages of using interviews as a research method. "Interviews are time consuming, it is a highly subjective technique and therefore there is always the danger of bias. Analysing responses can present problems, and wording the question is almost as demanding for interviews as it is for questionnaire." Bell (2005) concludes on interviews by saying, "even so, the interview can yield rich material and can often put flesh on the bones of questionnaire responses."

Fronter Creation

Virtual learning environments (V.L.E.) are being increasingly used by teachers in the classroom, and "in some cases an increasingly imaginative use of V.L.E.'s can potentially blend school and home together." John and Wheeler (2008). Much of the current research supports the idea that V.L.E.'s can be of benefit to pupils if used properly; with well-designed activities that encourage deep thinking and learning.

Tolmie & Boyle (2000 cited in Salmon 2003) state that V.L.E.'s need to be carefully designed, arguing that "high quality interaction, full participation and reflection do not happen simply by providing the technology." Activities need to be engaging and support "deep learning." Bronack et al (2006) describe the "online learning environment as a unique and immersive place for students to learn."

When discussing the introduction of Fronter into the Northern Ireland education system, Northgate (2012) stated, "this new provision has been designed to create a dynamic, future proofed, flexible service which will deliver increased access to a rich pool of learning resources. It will help develop skills which will equip learners for the future." When announcing the new contract the Education Minister, John O'Dowd said: "It will give teachers and pupils access to the best learning resources from across the world and will bring these resources into the classroom."

Fronter (2014) state that when their product is used by "great teachers who make education engaging, adapted, available, measurable, collaborative and fun, learners can flourish." Fronter was chosen by the researcher as the platform for promoting science in the World Around Us curriculum because of its ability to be easily manipulated, it's clear and simple creation and its accessibility within the class for all learners.

Following the interviews with the World Around Us and I.C.T. co-ordinators and after examining the schools World Around Us policies and plans, the topic of Pirates from the foundation stage was chosen to trial the creation of a Fronter room to promote Science in the World Around Us curriculum. A brainstorming session of possible ideas was preceded by research using the Internet and current teaching schemes and resources from St. Mary's University College library. The core science skills of observing, inferring, measuring, communicating, classifying, recording, interpreting and predicting were taken into account and included where relevant.

The colourful pages of the room were designed to engage the children and the use of coloured text was also chosen to aid any children with specific literacy difficulties including dyslexia. This was chosen because "when reading the Web, poor coloured text is one of the key problems encountered by people with dyslexia" McCarthy and Swierenga (2010). A simple child-friendly layout was used to promote the use of the room during a whole-class setting that could engage children with a range of abilities. Simplicity was key in design to ensure that all the information was viewable on one screen, without having to scroll up or down. As a result, each lesson was separated into two pages; an introductory page that contains the learning intentions and the lesson stimulus and an activity page, with the problem delivered through story, with accompanying instructions and activity.

Presentation and Analysis of Data

Questionnaires

Of the 39 questionnaires issued in total; 25 to School A and 14 to School B, a total of 36 replies were received; 23 from School A and 13 from School B. (Appendix 2) All of these replies were made using the online questionnaire.

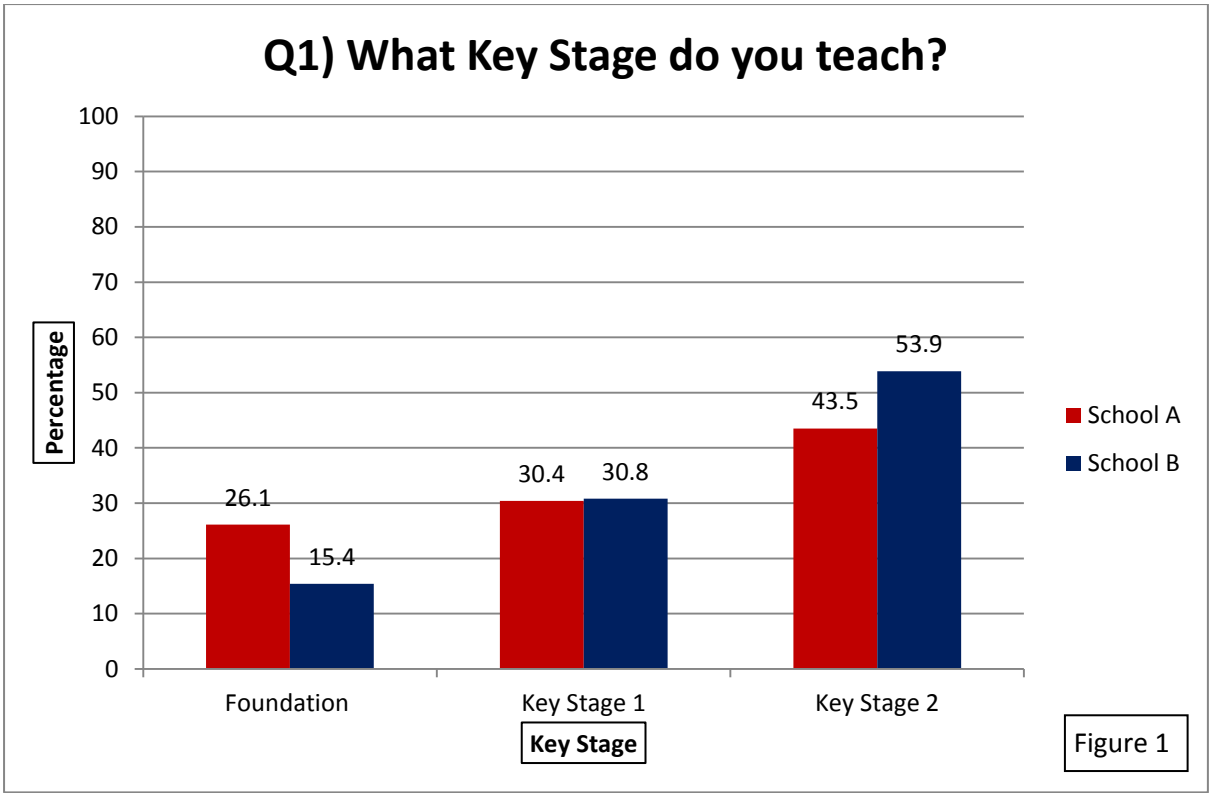


Figure 1

Teachers were asked to identify how often they taught Literacy, Numeracy and the Worl Figure 2 Us (W.A.U.), and the average length of these lessons.

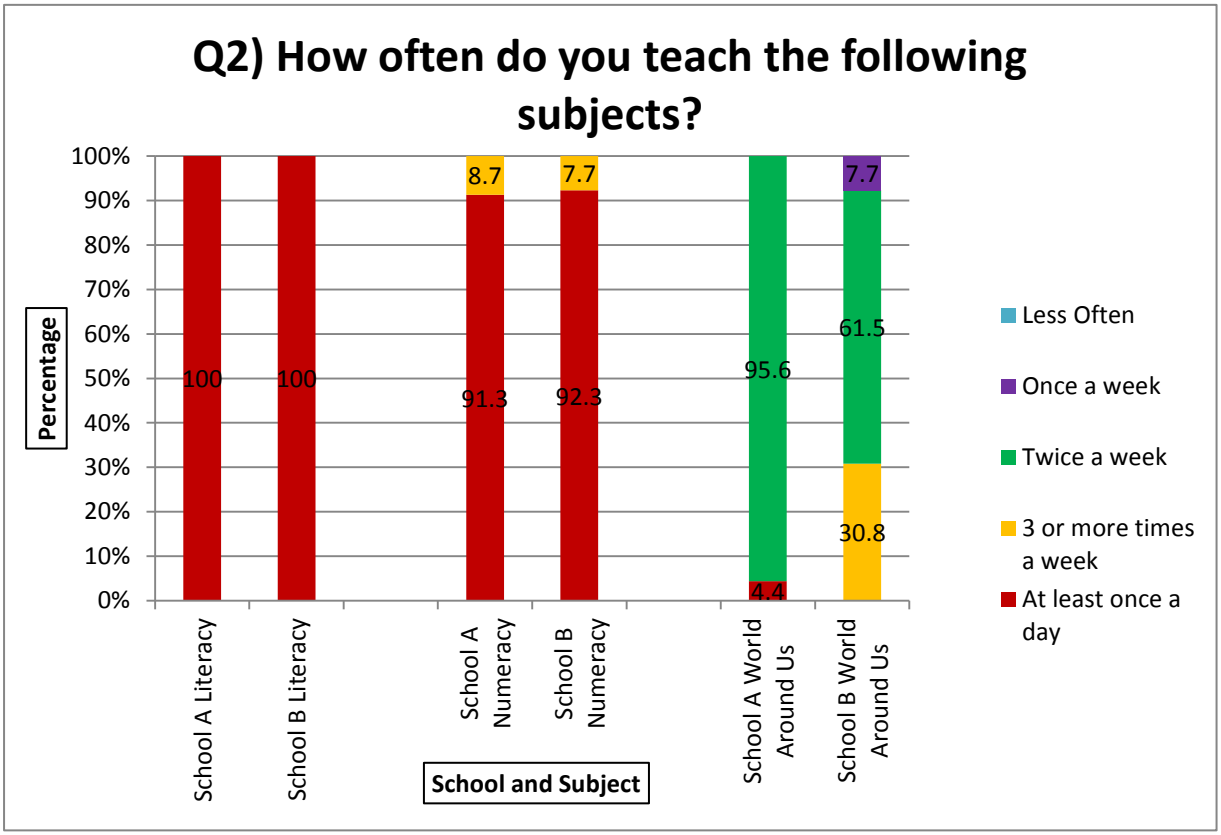
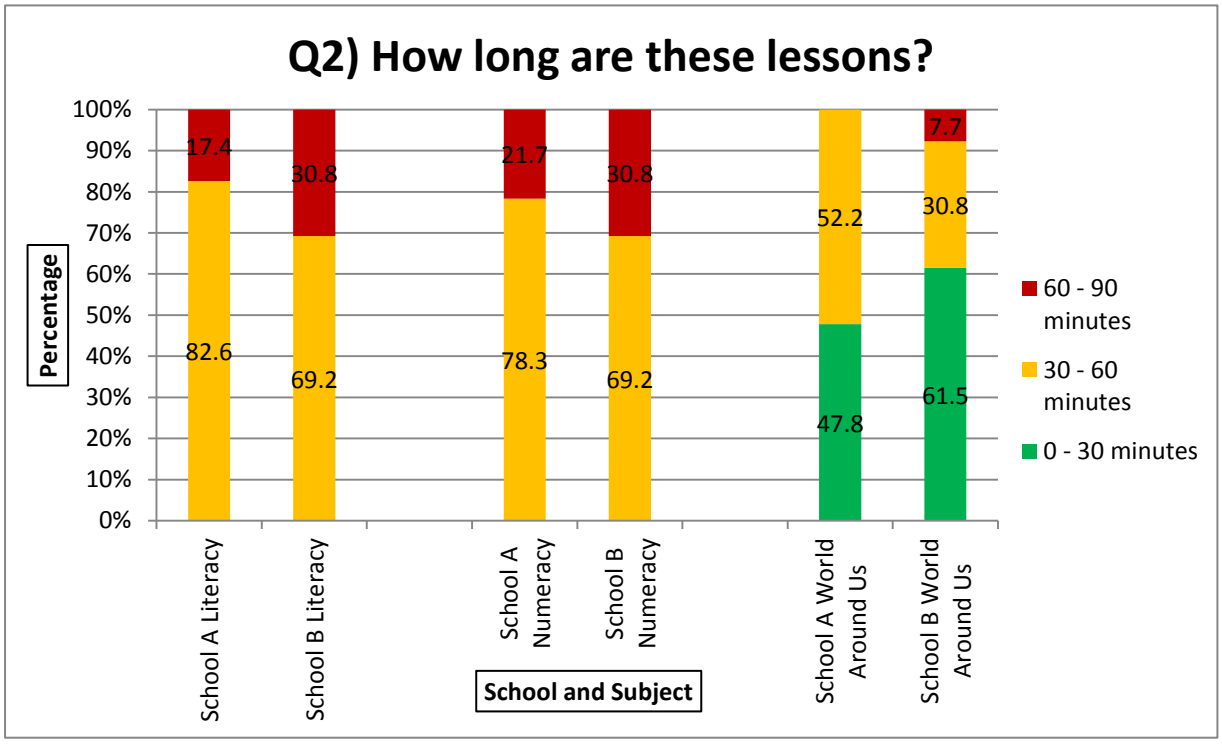


Figure 3



100% of teachers surveyed in both schools taught Literacy at least once a day, with all responses indicating that the lesson length ranged anywhere from 30 – 90 minutes. The trend for the frequency and length of Numeracy lessons in both schools was similar. These results contrast significantly with the time dedicated to teaching W.A.U., with most teachers in School A stating that they taught two 0 – 60 minute lessons a week. School B had a larger range of lesson frequency and length.

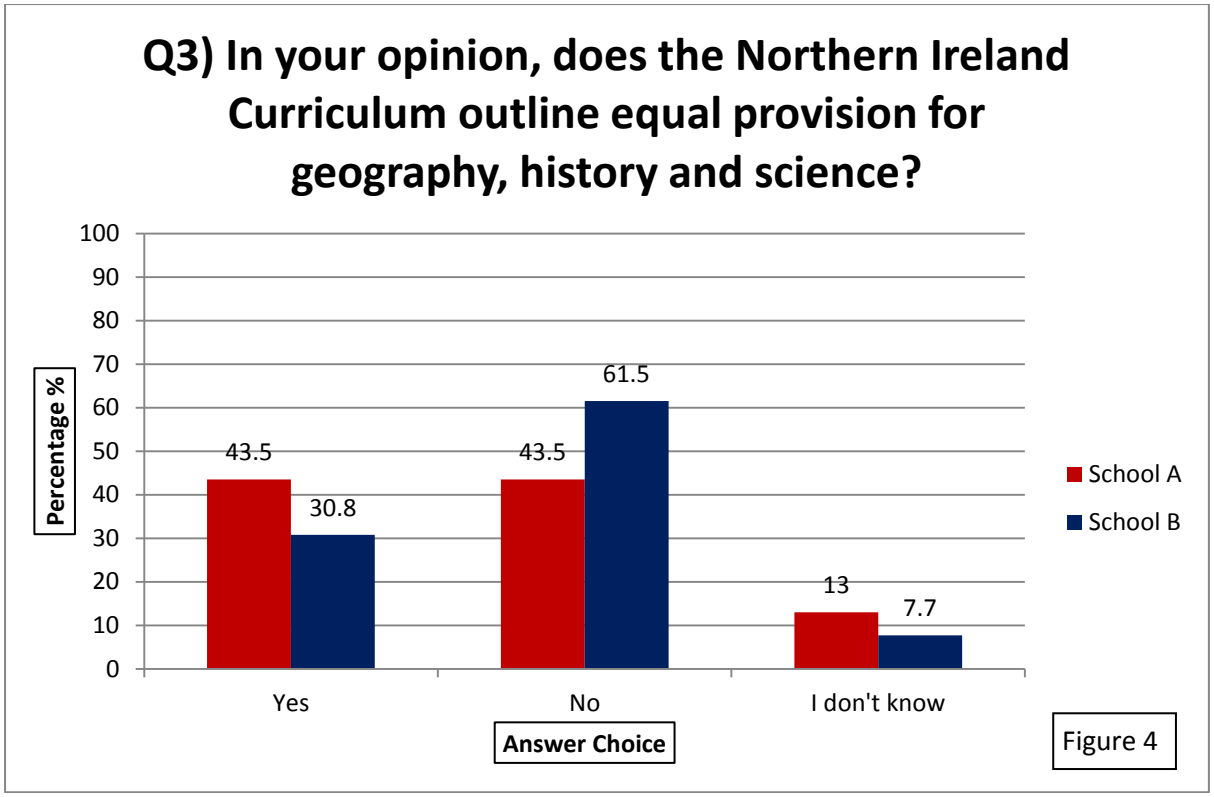


Figure 4

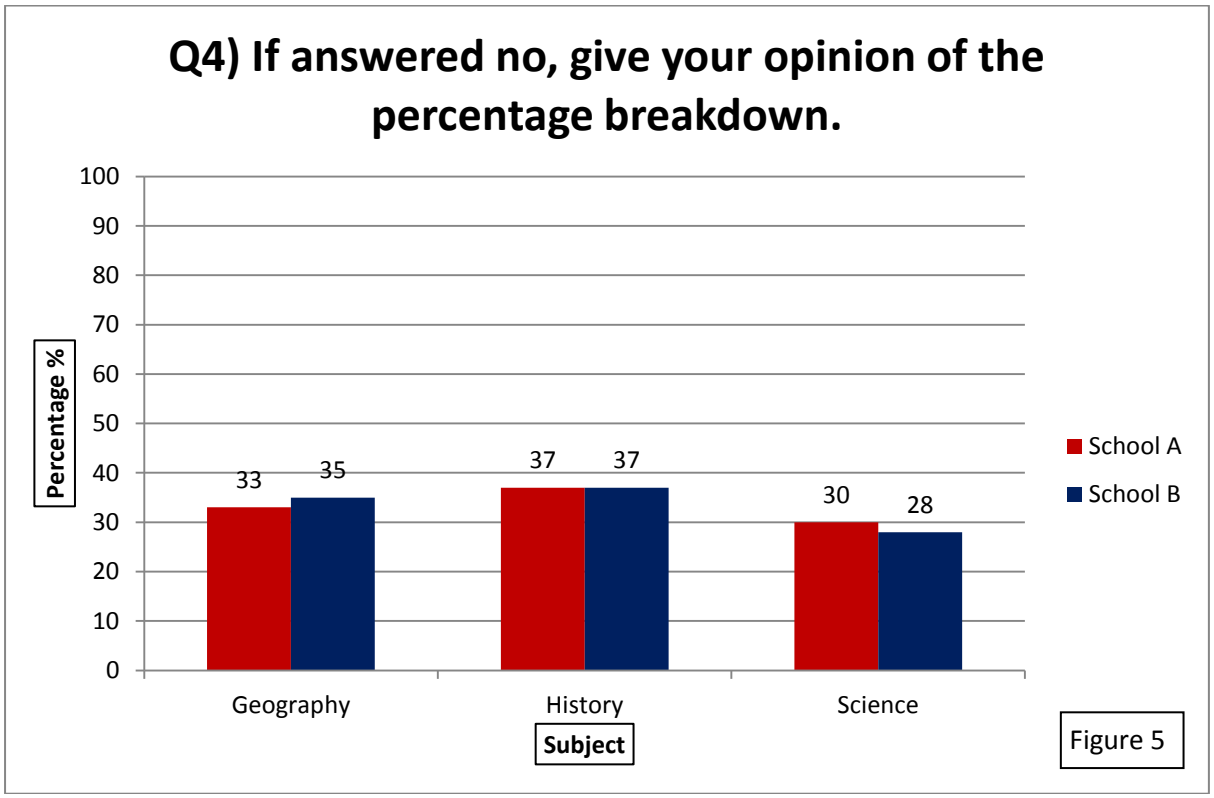


Figure 5

Responses indicate that even though a large number of teachers believe the curriculum does not provide equal provision for each of the three component areas, there is no clear outcome as to

which subject dominates. Figure 5 shows that science received the lowest percentages. These results show that the curriculum could be open to interpretation as the general statements of learning for science, history and geography are not directly comparable and therefore any attempt to compare is by definition subjective. A broad range of answers could also have been provided as perhaps teachers are not fully familiar with the curriculum or have become entrenched in the current school topic plans, without review of the learning intentions in accordance with those provided in the curriculum.

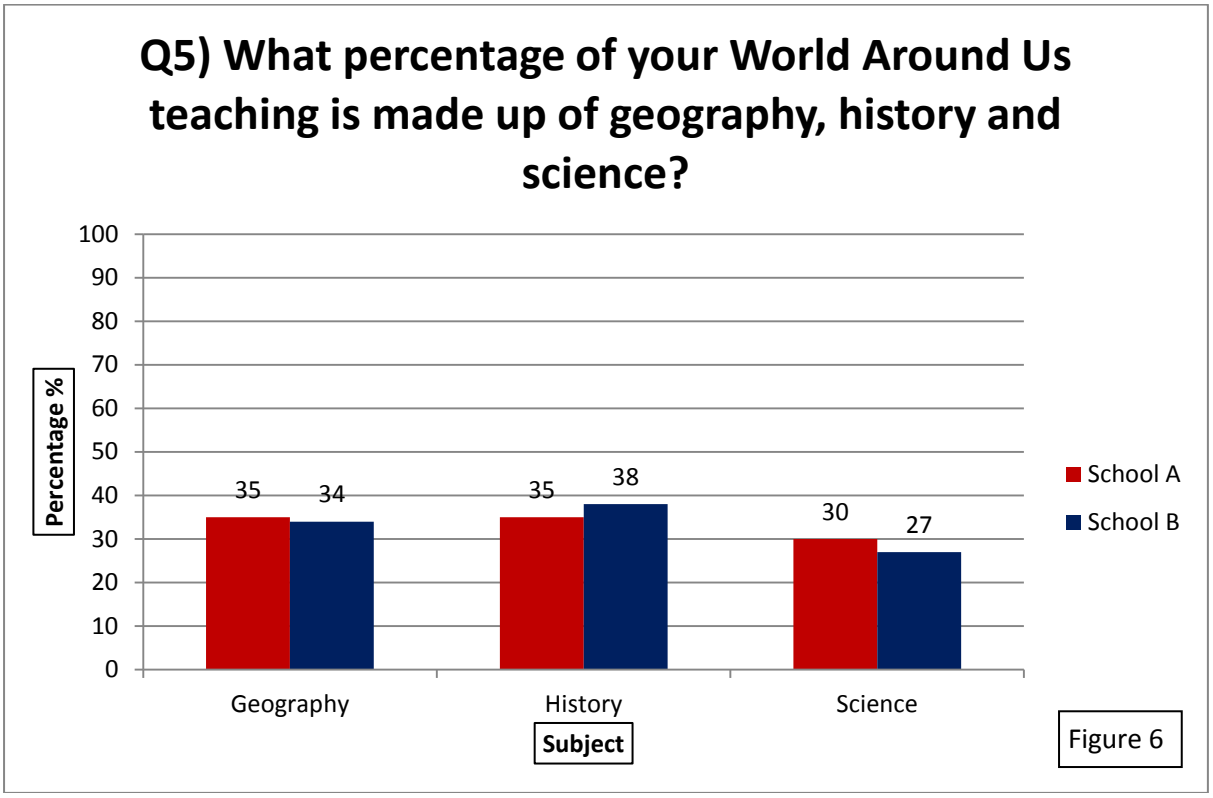


Figure 6

In School A, teachers believe they teach equal amounts of geography and history, and less science. However the responses from School A to question 4 showed teachers believed the provision in the curriculum did not value geography and history equally.

As shown in figure 6, the responses from School B do follow the same trend as that revealed in the question preceding it. During this school year, a focus of the School Development plan of School A, is to review the planning of W.A.U. This could have affected the results as the teachers are planning for a more balanced W.A.U. curriculum.

Question six was an optional open question that allowed teachers to reveal potential reasons for their unbalanced teaching of the W.A.U. In total there were only nine responses, with five from School A and four from School B. Some of the reasons suggested from School A were; "In foundation years the focus is on 'My Place in the World' and 'Where I Came From' which lends itself more to Geography and History" and "Some topics lend themselves better to Geography and History and it

can be hard to make meaningful links with Science, unless it is a science-based topic. I think it varies a lot with the topic chosen." Reasons provided from School B include; "Very little guidance given towards science at present", "Topics rarely have an even balance of all three subjects", "Topics in Foundation Stage lend themselves more to history and geography" and "Integrating Science into topic format can be difficult." This question provided approximately the same feedback as was determined during the short interviews with the I.C.T and W.A.U. co-ordinators.

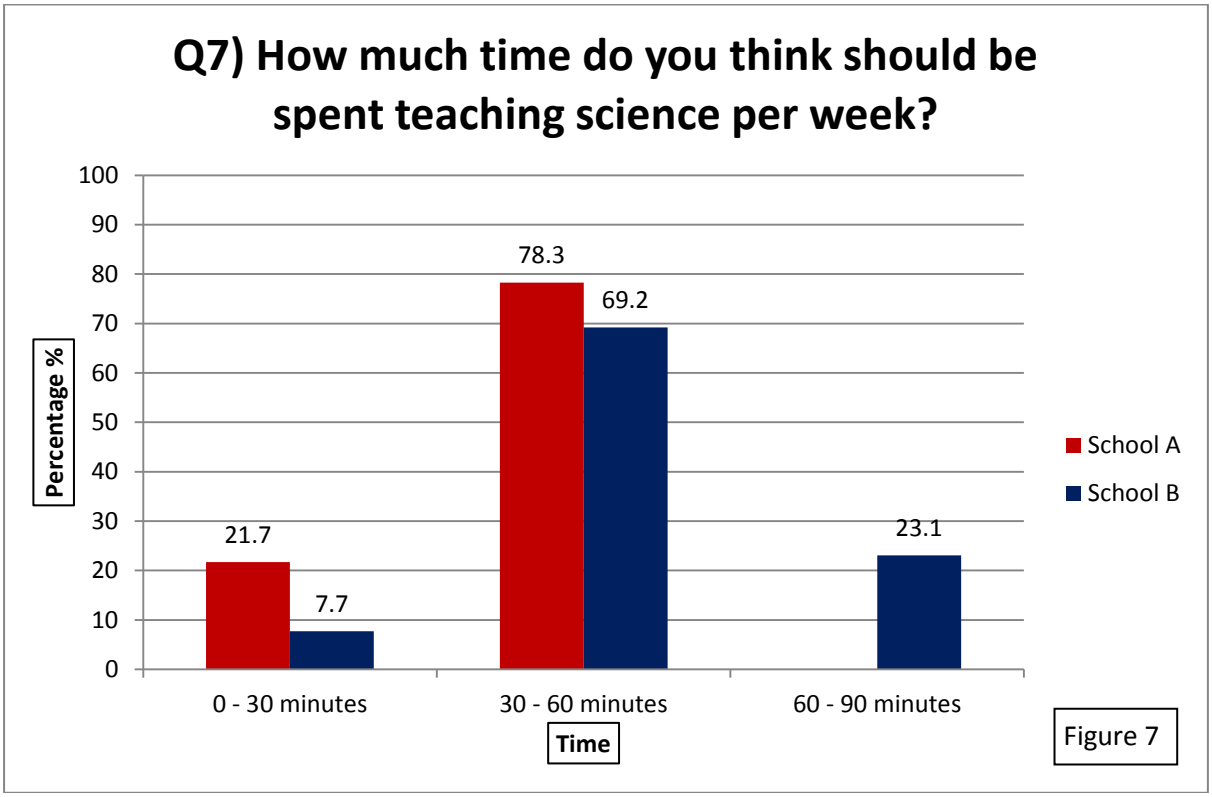


Figure 7

Question seven highlights the impact that teachers' opinions could have on the teaching of science in the classroom. This question could be seen to reflect individual teacher's opinions of science and their opinion of its use and benefit to the children in their class. It could be extrapolated that teachers are teaching less science than they believe to be ideal, because World Around Us is taught on average approximately one to two hours per week, across all three subject areas, yet teachers feel that science should be taught for between 30 to 60 minutes a week.

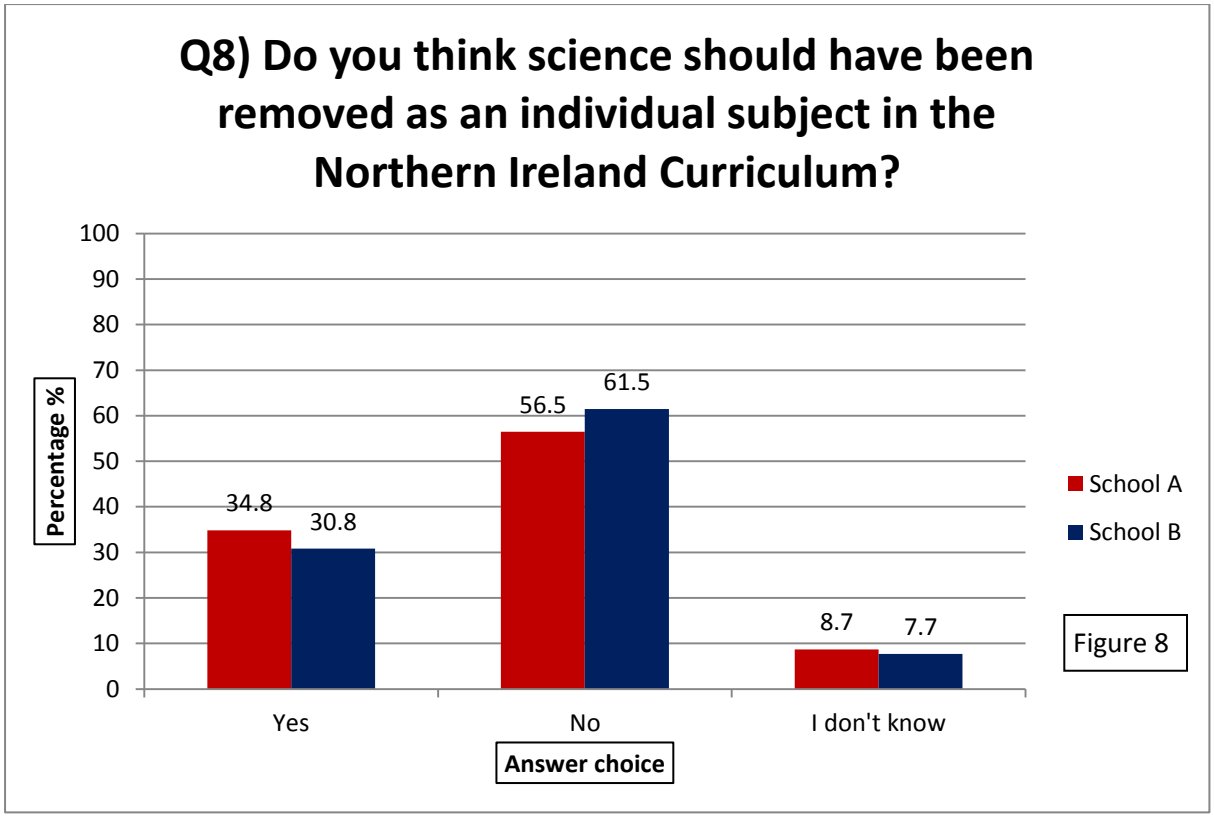


Figure 8

It can be seen in figure 8 that the vast majority of teachers felt science should not have been removed as an individual subject. The reasons for this could arise from the fact that teachers feel that when science is taught individually, it is clearer for the teacher and learner, there is more direction and training, and that children could be missing out on important skills that only separate science teaching can provide.

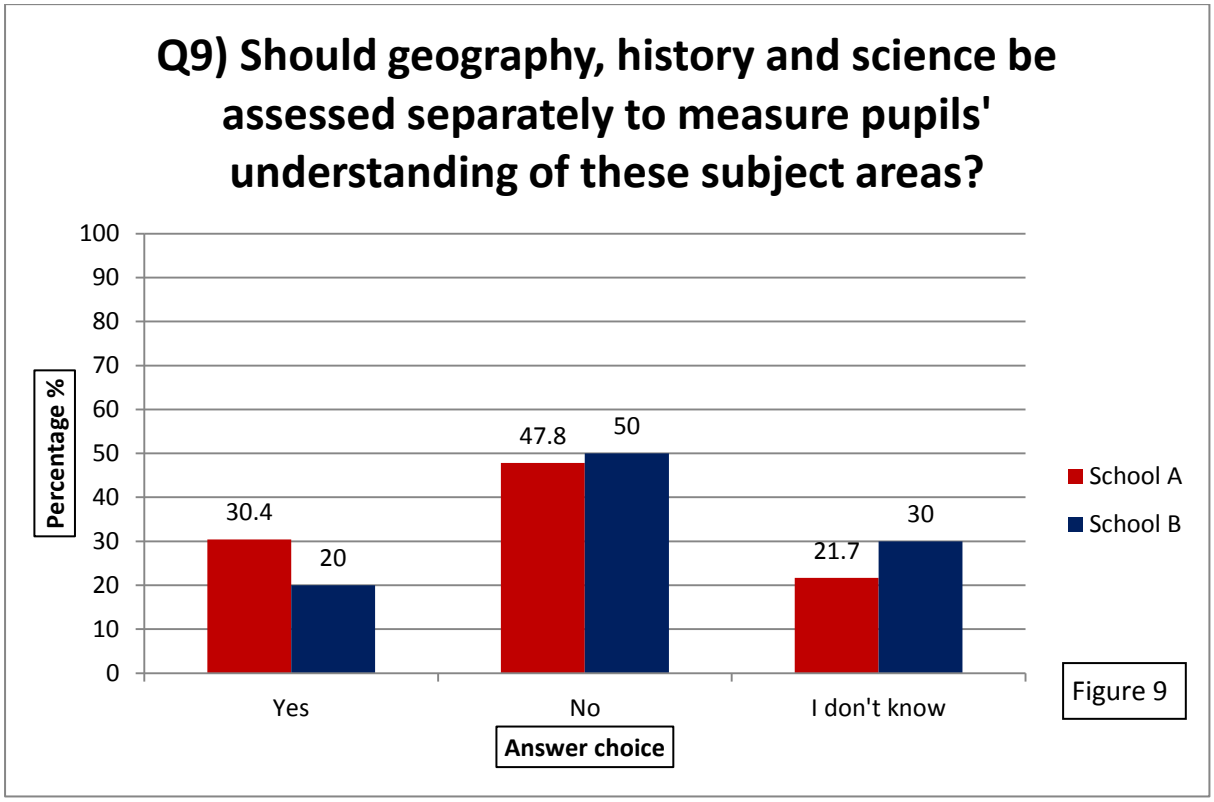


Figure 9

Next, they were asked if each of the components should be assessed individually to ensure understanding of each area, or whether an overall assessment of the children's understanding of the W.A.U. was sufficient. Figure 9 shows the same trend for both schools; with the dominant view being' each of the component parts should not be assessed separately.

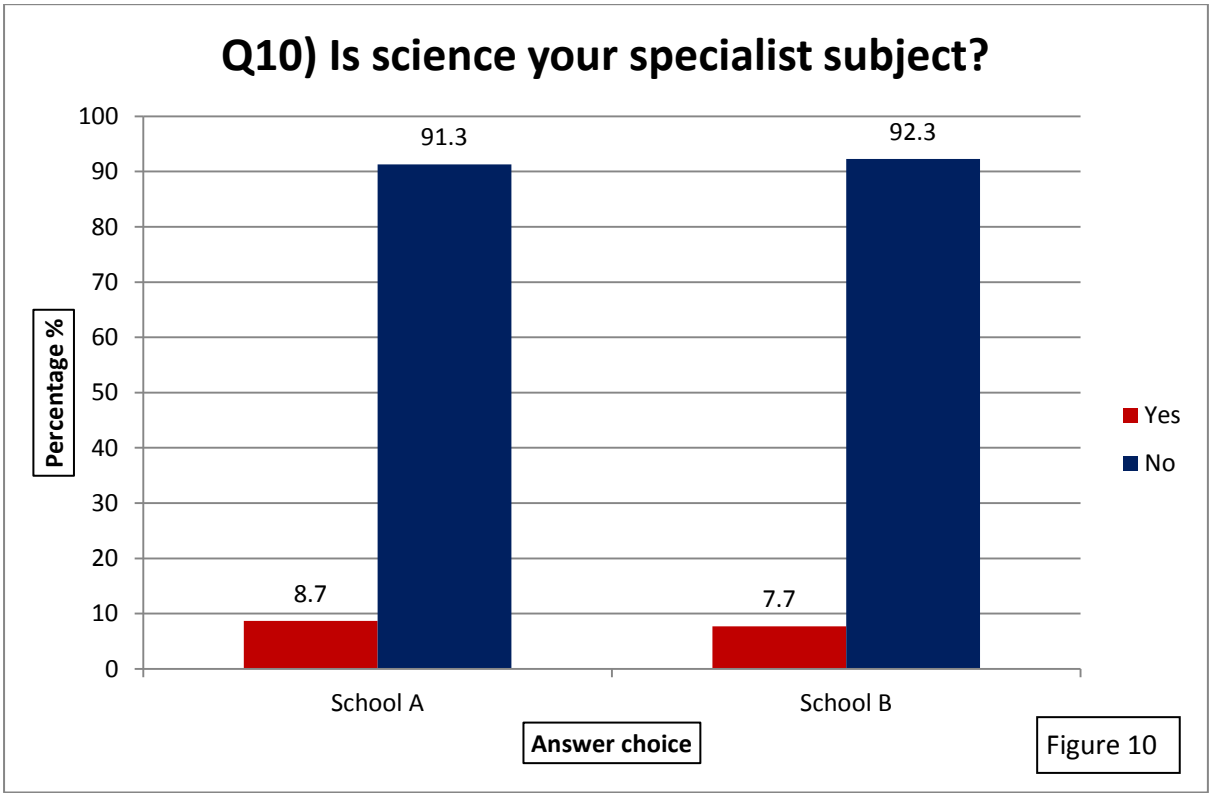


Figure 10

The very few number of science speciality teachers supports the research carried out in April 2006 by ETI on the "Supply of Science Teachers in Post-Primary Schools in Northern Ireland." As this was only a limited piece of research with only two participating schools, a definite conclusive statement cannot be made, however it could be observed that there are very few science specialist teachers working in schools, strongly suggestive that the slow decline of science is a historical problem. Subject specialists are more confident in promoting their expert area to both the children in their class and to their fellow colleagues.

Q11) Please select one answer to each of the following questions:

School A School B	Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
I am confident in teaching science.	0% 7.7%	43.5% 38.5%	17.4% 30.8%	26.1% 23.1%	13.0% 0%
My lack of science knowledge is a barrier to teaching additional science.	13.0% 0%	26.1% 15.4%	8.7% 23.1%	52.2% 53.9%	0% 7.7%
My school is well resourced for teaching science.	0% 7.7%	69.6% 69.2%	26.1% 15.4%	4.4% 7.7%	0% 0%
I have an interest and enthusiasm for teaching science.	0% 7.7%	13.0% 23.1%	39.1% 30.8%	39.1% 38.5%	8.7% 0%
My pupils have an interest and enthusiasm for science.	0% 0%	0% 7.7%	0% 15.4%	65.2% 53.9%	34.8% 23.1%

Table 1

Despite both schools having few science specialists, almost 40% of teachers in School A felt confident teaching science. In School B, even with 7.7% of science specialists within the school, none of the respondents strongly agreed to feeling confident in teaching science. This may be because they felt the school was not sufficiently resourced to support their teaching, or that they had in fact lost interest in the subject area as there was a 0% response to teachers strongly agreeing to have an interest and enthusiasm for teaching science. A total of 52.2% of teachers in School A determined their lack of science knowledge to be a barrier to teaching additional science along with 61.6% in School B. As such a large proportion of teachers feel under-confident and under-resourced for teaching science, and have little interest in the subject area, this could have a major impact on the quality and perspective teachers are providing for children about primary science, despite most of the teachers agreeing that the children in their class enjoy science.

Q12) In which of these areas of Literacy, Numeracy and the World Around Us do you integrate I.C.T. the most?

School A School B	1	2	3
Literacy	26.1% 46.2%	52.2% 46.2%	21.7% 7.7%
Numeracy	65.2% 53.9%	26.1% 38.5%	8.7% 7.7%
World Around Us	8.7% 0%	21.7% 15.4%	69.6% 84.6%

Table 2

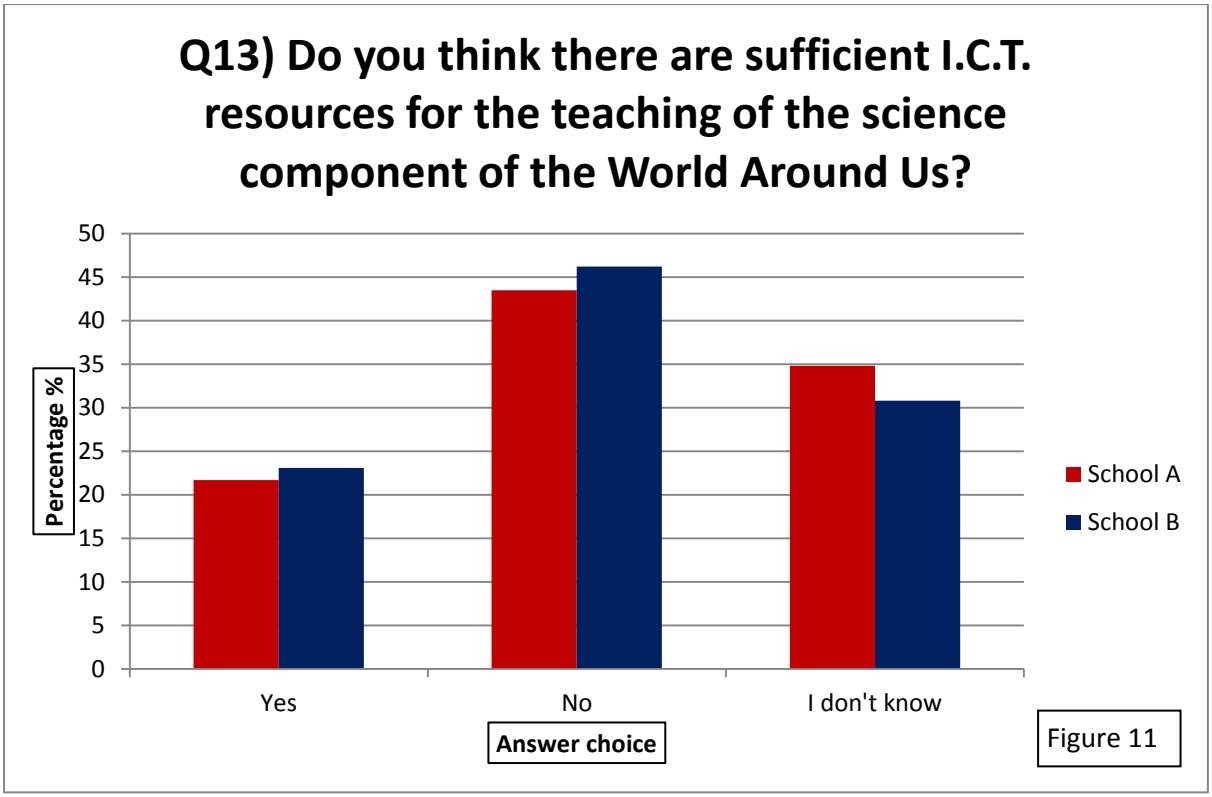


Figure 11

Although the results in table 2 and figure 11 show that I.C.T. is being used in the classroom, it is mainly being used to promote literacy and numeracy. Teachers may be more familiar with good literacy and numeracy I.C.T. resources, but not those to support the W.A.U., particularly the science component.

Question fourteen was an optional question that asked the respondents to list some of the resources they use when integrating I.C.T. and science. The responses from School A included: "Various websites: Topmarks, I.c.t.games, Sciencekids etc.", "There are some apps on the I Pad which are useful and BBC school or individual lessons on the TES website" and "BBC Learning Zone, teachers tv, Equella, Fronter, Clounagh website, many websites." Of the examples given, only one response mentioned Fronter. Although money has been allocated to promote Fronter in schools, it seems that teachers are still not confident in using it in the classroom. This may be because of a lack of specific training, or that the time required to create specific rooms is too great. This point was reinforced by teachers in both the additional comments question and in the interviews.

Q15) Please select one answer to each of the following questions:

School A School B	Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
I am confident in using I.C.T. as part of my teaching.	0% 0%	0% 7.7%	8.7% 0%	30.4% 30.8%	60.9% 61.5%
My lack of I.C.T. knowledge is a barrier to integrating more I.C.T. into other subject areas.	39.1% 53.9%	52.2% 38.5%	4.4% 0%	4.4% 7.7%	0% 0%
My school is well resourced for I.C.T.	0% 0%	0% 0%	0% 7.7%	34.8% 30.8%	65.2% 61.5%
I have an interest and enthusiasm for I.C.T.	0% 0%	0% 0%	4.4% 0%	43.5% 46.2%	52.2% 53.8%

My pupils benefit from the integration of I.C.T.	0% 0%	0% 0%	0% 0%	26.1% 15.4%	73.9% 84.6%
I have received appropriate I.C.T. training.	0% 7.7%	0% 0%	13.0% 7.7%	65.2% 53.9%	21.7% 30.8%
I am confident in using Fronter to support teaching.	0% 7.7%	21.7% 7.7%	26.1% 30.8%	43.5% 53.9%	8.7% 0%

Table 3

Almost all of the respondents, felt confident using I.C.T. as part of their teaching. Teachers also revealed that they believe they have sufficient I.C.T. knowledge which does not restrict them from integrating I.C.T. into any subject areas. This would therefore suggest that teachers believe it is a lack of subject specific resources which is the limiting factor for the integration of I.C.T. and science.

In both schools, almost 100% of teachers stated that they have an interest and enthusiasm for I.C.T. and 100% of teachers in both schools agreed that the children in their class benefited from the integration of I.C.T.
The final statement, as shown in table 3, reinforces a previous point, from question fifteen about teacher confidence levels when using Fronter.

Question sixteen was an optional short text question that allowed respondents to make any additional comments. There was one response from each school; School A: "C2K have not provided a lot of training to familiarise teachers with the new computer transformation and teachers who have little confidence in I.C.T. are now even more put off as they don't understand how to navigate the new system. Teachers were told that a lot of new rooms would be created for their use in Fronter as it takes a massive amount of time to create one room for one topic for one year group. If rooms were there for teachers to access they would be more inclined to use them for example, Egyptians is a topic taught and teachers in primary five use that Fronter room." The single response from School B states; "I.C.T. is the main resource nowadays for supporting learning in area of W.A.U. It means topics can be more interesting and stimulating and links can be made on many different levels to enhance the learning. Classrooms used to have more of an emphasis on science for example, nature tables are absent from classes and plants and flowers are lacking in the classroom environment. Much of this learning in Science was incidental but very important and skills were being developed for example, observation."

Interviews
Two teachers from School A; the W.A.U. and I.C.T. co-ordinator, were invited to participate in an interview to determine responses to the key research questions, for example; how much science is taught as part of the W.A.U. curriculum?, What is the role of I.C.T. in the promotion of science in the curriculum?, Could Fronter, a virtual learning environment, promote science in the curriculum? The two teachers were asked a set of questions (Appendix 3) which were provided to the teachers prior to the interview. Many of the questions and responses echo those from the questionnaire.

The second question determined if equal amounts of literacy, numeracy and W.A.U. were being taught, and the reasons for this. Responses included, "Children need to learn the important life skills associated with literacy and numeracy more, if they are to become contributors to society," and "The focus on raising standards in literacy and numeracy means there isn't enough time to teach the W.A.U. every day, even though I would like to." These responses highlight the influence that 'Every School a Good School' is having on the focus in primary classrooms.

Following this, the teachers were asked about the provision of the W.A.U. outlined in the curriculum. Responses included "It is hard to really know if the areas are balanced because it is just a sequence

of learning statements that are hard to compare and therefore determine if there is equality between the learning areas" and "I think there is more provision outlined for history and geography, however it is up the me (as the W.A.U. co-ordinator) and the school management team, along with our teachers to ensure that our teaching is balanced between these three important areas." These responses reinforce earlier points about the subjectivity of the curriculum itself and the role of schools in promoting each subject area equally.

Following this, the teachers were asked to comment on their own teaching of each of the three areas. Both respondents agreed that it was hard to teach each subject area equally as sometimes the topics for the year did not lend themselves to each area. However it was noted that in the school there is a focus in their development plan on addressing the imbalances within the W.A.U. programme. The participants were then asked to comment on any potential barriers to teaching more science. The responses provided included, "I don't think I have the knowledge to do very scientific experiments, and I don't think the school has the resources either" and "I think that with new plans and the correct corresponding resources, better science could be taught throughout the school." These responses highlight the teachers view on the importance of resources to support teaching and learning. These responses suggest a lack of confidence and subject knowledge as a barrier to individual teachers' promotion of the area of science.

The last two questions aimed to obtain responses regarding the use of I.C.T. Both respondents said they integrated I.C.T. daily in literacy, numeracy or both, mainly because they were familiar with good online resources to support teaching and learning in that area. The interviewees highlighted that although they tried to integrate I.C.T. into their science teaching where possible, they found it harder to find good quality resources that enhanced the learning. Both teachers felt that good quality 'ready-made' Fronter rooms would be a very useful resource for use in their W.A.U. teaching.

Discussion and Conclusions

This study aimed to research the extent to which science is taught in the primary school, the main barriers that prevent the teaching of additional science in the primary school, the role of I.C.T. in the promotion of science and whether Fronter, a V.L.E., would help to promote science.

The emergent findings suggest that practitioners feel that there are not equal amounts of geography, history and science being taught in the primary classroom. It appears that the responsibility of the promotion of science falls on the schools themselves and therefore the principal, senior management team, W.A.U. co-ordinator and individual teachers, as the main reason highlighted by the teachers for the unbalanced teaching of the W.A.U. is the topic. Some topics do not lend themselves to the equal inclusion of all three subject areas so it must be asked, why are these topics being chosen? Guidance issued by CCEA suggests schools should "not attempt to contrive links for the sake of ensuring all three contributory elements are reflected in each topic. Rather, take a holistic view at the long term planning stage, teachers should ensure that children are provided with balance across the three contributory elements within the year, key stage and school." CCEA (2007) Further research would encourage the asking of the question 'what is the selection process for choosing topics?' and to further investigate this within a range of schools; is it the recycling of old topics that teachers know children enjoy?

Teachers' confidence may be another important issue to address as, if teachers do not feel confident, they may be unwilling to devote time to planning and teaching good-quality, investigative lessons where the outcomes and findings of experiments may be unknown prior to their completion. Consequently, it is important that teachers have a good attitude and enthusiasm for teaching science and feel confident in delivering these lessons. It could be suggested that these schools, and perhaps others, should review the teachers' opinions of science and, if necessary, use at least one of

their annual staff development days as a training course, providing teachers with the skills, topics, ideas and resources they need to be component in teaching science.

In addition to teacher confidence, other barriers highlighted a lack of subject knowledge of science, the subjective nature of the curriculum document and a reliance on resources to support teaching and learning which are not available for teachers to use, as schools are believed to be under-resourced. It would be beneficial to model to teachers how good-quality science teaching can take place with minimal or simple resources and then review the provision of more specific science resources in the school.

It was clear from the research that W.A.U. is not taught as frequently, or for as long, as literacy and numeracy. The reasons for this may partly arise from the influence of the ETI and the DENI document Every School and Good School which aims to raise standards in literacy and numeracy. Although it is clearly vital that children become competent in these areas of learning to become contributors to society, it seems possible that the emphasis upon the teaching and learning of literacy and numeracy is having a detrimental effect on other subject areas. This particular finding could relate to the research conducted by Boyle and Bragg (2005); which posed the question: is the W.A.U. is becoming an "afternoon subject?"

From the responses, teachers indicated approximately 30 – 60 minutes of science a week would be ideal. On average, teachers spend 1 to 2 hours teaching World Around Us and typically split this time equally across science, history and geography. This indicates a potential disconnect between ideal teaching time for science and actual classroom practice. It would be interesting to investigate the motivation behind this response; is more time needed to cover curricular content or develop and nurture the specialist science skills? In addition to this, there is no written guidance provided by the Northern Ireland Curriculum or Department of Education which denotes how long should be spent teaching each curricular area, it is the school that decides the daily timetable. After reviewing the timetables from both School A and School B, it was surprising to observe that although The Arts is another combined area consisting of art and design, drama and music, each of these areas were timetabled separately, while the W.A.U. was scheduled not as each of its component parts, but remained as one combined area.

The questionnaire also revealed that the majority of teachers in the two participating schools believed that science should not have been removed as an individual subject. It would be interesting to explore this area further to deem if the amalgamation of learning areas has in fact had a detrimental impact on their position and value within the curriculum.

The research, albeit from a small sample, indicated that there are relatively few science specialist teachers. This supports the suggestion that a current lack of interest in science is not a new crisis, but a long standing one with only a small number of the current generation of teachers choosing to specialise in it. This correlates with the study carried out in April 2006 by ETI regarding the 'Supply of Science Teachers in Post-Primary Schools in Northern Ireland.' This raises an important issue that needs to be addressed now. With a large push towards STEM subjects in secondary and grammar schools, and increased employment arising from these areas, it is important that children are provided with the correct opportunities to motivate, nurture and inspire their interest in science. Further research could involve the investigation of the number of science specialist teachers in primary schools and the impact that their expertise has had on the teaching, learning and promotion of science in the primary school. It would also be interesting to observe science specialist W.A.U. co-ordinators and note how they have used their leadership position to encourage and support these specialists' skills throughout the entire school community.

Additionally, it was concluded that the creation of 'ready-made' Fronter rooms would be beneficial as teachers believe there are not enough either resources or I.C.T. resources to support the teaching of science and the creation of Fronter rooms is time-consuming. The room in this research project focuses on a cross-curricular method of teaching science through story and is suitable for the foundation stage. It is hoped that this approach will encourage links between literacy and science and allow for more meaningful connections between learning. This may also allow for more time to be devoted to science as discussions that may occur when reading the story during a literacy lessons may uncover scientific concepts.

However it is important to note that a reliance on an I.C.T. resource to teach science should not develop, as practical and explorative opportunities are also needed to best encourage the development of scientific thinking and skills. When planning for science, teachers should aim to explore this concept, and determine if I.C.T. is limited in some areas where first-hand experience is more beneficial, for example; looking at images of different leaves on the internet versus discovering and touching different leaves on a nature walk.

It should be noted that throughout the design and development of the Fronter room, there were many aspects of the process that the researcher felt were inhibitory. After reflection and evaluation of the Fronter design process, several key issues were highlighted. The room design tools are too simplistic, and lack basic functionality, such as the ability to resize text boxes or to customise text applied to images. As a result, the user interface is unexciting and appears dated. Also, one of the main features of Fronter is its ability to bridge the gap between school and home. This works well as the inclusion of tests and votes can be used to individually assess children's understanding of the learning, particularly in the case of older pupils. However, the features do not work as well if the room is to be used in a whole class situation. It would be useful if a whole class setting could be switched on to allow, for example, a series of plenary test questions to be displayed and several children could select an answer under the teacher's sign in, without having to individually access the room, which may be difficult for children in the foundation stage to do efficiently.

In conclusion, if used effectively, I.C.T can help promote the teaching and learning of science in the primary classroom, however additional factors such as teachers confidence and provision of other resources also needs to be addressed to ensure the best quality science learning experiences are being provided for children.

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