Investigation into the Development of Numeracy across the Curriculum in a South Wales Comprehensive School.

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This dissertation is being submitted in partial fulfillment of the requirements of candidature for the degree of M.A. (Leadership and Education)

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This work is being submitted in partial fulfilment of the requirements for the degree M.A. (education) and has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.
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Abstract

In 2012, the Welsh government attempted to address the age-old problem of Welsh pupils underachievement in key skills by introducing the Literacy and Numeracy Framework, becoming statutory in 2013. One aspect to the improvement of mathematics skills of Welsh pupils could lie in cross-curricular work to develop the pupils’ application of numeracy skills. This small-scale case study looks at how one school approached this development and attempts to identify areas where cross-curricular numeracy could be further developed. The study comprised four main elements, a literature review, a survey of all school staff, an interview with the numeracy coordinator and an analysis of pupils’ national numeracy test results. The literature review showed that the performance of Welsh pupils in Numeracy is below that of the other U.K. countries and under performing in the international PISA tests. Responses from the staff survey showed a lot of positive aspects with regards to the appreciation of the need for a focus on numeracy, but also highlighted a number of issues, which could prove to be stumbling blocks to effective development of pupils’ numeracy skills. These issues were further emphasized through the interview with the numeracy coordinator although again there were a number of positive responses. The numeracy coordinator gave a number of suggestions of how the situation could be improved which agreed with elements of the literature research. Despite the negative aspects and the potential to further develop the aspect of numeracy across the curriculum, the analysis of results showed that there is a positive trend of improvement in these skills. In conclusion, the study shows that the numeracy skills of pupils appears to be improving and this could be due to the emphasis given to these skills through the LNF and the work done by the numeracy coordinator in developing the cross-curricular aspect of numeracy. At the same time, the study highlights a number of ways that the delivery of numeracy across the curriculum could be further enhanced but only if the will of school leadership lies in the same direction.
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List of Acronyms

BERA: British Educational Research Association
ESTYN: Education and Training Inspectorate Wales
GCSE: General Certificate of Secondary Education
LNF: Literacy and Numeracy Framework
NLP: National Numeracy Programme
NSP: National Support Programme
OECD: Organisation for Economic Co-operation and Development
PBL: Problem Based Learning
PISA: Programme for International Student Assessment.
Chapter 1: Introduction

Rationale
Poor literacy and numeracy skills have been identified as being among the most serious barriers to social and economic regeneration in Wales. The Basic Skills Agency (BSA) has estimated that over three-quarters of a million people in Wales need varying degrees of support to enable them to develop their basic skills (Basic Skills Agency, 2001).

From the outset of the devolved Welsh administration the education policy makers in Cardiff have prioritised the basic skills of Literacy and Numeracy. In the 2001 National Basic Skills Strategy for Wales, the National Assembly states that the cost of poor basic skills to industry in Wales is also substantial. Based on UK wide research, it is estimated that the cost to the Welsh economy is more than £588 million a year. In a global market that demands high skills, the number of adults with such poor basic skills has a major impact on our ability to compete (Basic Skills Agency, 2001, p.5).

The then Welsh Assembly’s vision was of a fully literate and numerate Wales, a place where no one lacks the basic skills most of us take for granted (Basic Skills Agency, 2001).

The importance of numeracy along with literacy has reached an all time high across Wales as a whole. A key reason for this is the low position Wales finds itself in on the rankings based on the surveys of the Programme for International Student Assessment (PISA).
PISA surveys the educational achievement of 15 year olds across 64 countries. 137 schools took part from Wales in 2012, where the main emphasis was on the subject of mathematics. The PISA survey also takes into account pupil background and attitudes as well as other aspects of the learning environment.

According to the 2012 analysis, the mean score of pupils in Wales has significantly decreased in mathematics between 2006 and 2012. For the Welsh government, a significant issue is that 38 countries, which include the other UK nations, outperformed Wales at mathematics. 21 EU countries significantly outperformed Wales and only four EU countries had mean scores significantly lower than Wales. Another worrying trend is the change in the attainment of the different ability pupils in the tests; PISA states that there has been a small increase in the proportion of low achieving pupils and a decrease in the proportion of high achieving pupils. (Wheater et al., 2012)

The report highlights that pupils are less strong on questions that focus on aspects of space and shape or that requires them to formulate situations mathematically in order to solve a problem. (Wheater et al., 2012, p.13)

PISA 2012 reports that the pupils in Wales are generally positive about their mathematics learning environment and have support from parents and teachers. The survey shows that the potential to achieve in mathematics in Wales has a weaker link with social-economic disadvantage than in other OECD countries. Wheater et al. (2012) go on to say that a very high proportion of pupils reported that their parents believe in the importance of mathematics and that pupils in Wales are more motivated to succeed and are more conscientious in mathematics than the
OECD average, as well as being confident in their own ability and suffering less anxiety towards learning mathematics. Welsh pupils also stated that the support from mathematics teachers was high and that these teachers employed a wide range of strategies in their lessons. The report also states that disadvantage was overcome by Welsh pupils better than pupils from other OECD countries with comparable socio-economic backgrounds.

The survey also identifies the performance of pupils in Wales in the main areas of mathematics. It finds that Welsh pupils perform well with procedural skills, however they perform less well on shape questions and on those questions where the mathematical skills needed were not explicit in the question.

An interesting positive note was made by Wheater et al. (2012, p.13) regarding gender: “Boys performed significantly better than girls in mathematics in PISA 2012, although Wales had one of the smallest gender differences and the gap has decreased since 2009.”

In the report Assessment of 5- to 14-year-old Children’s Mathematical Progress in Schools in Wales, Bryant and Nunes found that the main tests used in schools in Wales focused on procedural skills rather than reasoning skills, which corresponds to the findings of the PISA survey.

Bryant and Nunes stated that “A more thorough assessment of children’s mathematical ability would be provided by testing both mathematical procedures and mathematical reasoning” (2012, p.1) which reinforces the findings in PISA which indicate that Welsh pupils find the reasoning aspect of mathematics more of a challenge than procedural aspects.
The Welsh government has decided that the PISA tests will be the standard by which the success of Welsh education should be measured. Initially the target of being in the top twenty of PISA nations was the aspiration, however in September 2015 a numerical target of 500 in the actual test for schools became a new revised target for 2021. This score would put Wales in the top twenty of tested schools. Although a controversial issue, schools and school leaders and teachers are now faced with helping Wales achieve this target.

To this end, the Welsh Government (Wales. Welsh Government, 2013a) introduced the Literacy and Numeracy Framework (LNF) with it becoming statutory in 2013. As the name suggests, the LNF is a strategy to raise Key Stage 2 and 3 pupils’ levels of literacy and Numeracy, which should then follow through in Key Stage 4 resulting in a raising of achievement at GCSE level and an improvement in PISA results.

My study focuses on the numeracy element of the LNF and how this has been received and dealt with at the chalk face. I will firstly find out staff feel towards the LNF (in particular numeracy) and how are they attempting to implement the requirements of the framework. The next part of the study is to discover how pupils feel about the emphasis on the basic skills (specifically numeracy) and thirdly, to investigate whether the numeracy skills of pupils are improving through analysis of numeracy test data.

Research Statement
This study has taken place in a large (number on roll circa 1600) south Wales valleys 11 - 18 comprehensive school over a period of seven months. The school achieves approximately 60% A*- C grades at GCSE in mathematics. This level of attainment is
slightly lower than the local authority estimates for the school’s pupils. The level of attainment in mathematics is seen as a significant element in school improvement as the Level 2 inclusive score is a significant factor in the school finding itself in band 5 of the Welsh Government schools’ ranking system. The level 2 inclusive score is a measure of the percentage of a school’s pupils who achieve 5 A* to C grades at GCSE, inclusive of mathematics and English. The banding system used by the Welsh Government consists of five bands where schools are ranked by using a number of measures, with band 1 being the highest and band 5 being the lowest. The achievement in mathematics and English at GCSE by different groups of pupils is a significant part of the measures.

Therefore if this study can contribute positively to the raising of numeracy skills of the pupils at the school, then it will be of benefit to the whole school in raising the ranking of the school and the associated benefits that follow.

I am currently the Coordinator of Numeracy in another large comprehensive in south Wales and this study will help me to plan how to develop the numeracy skills of the pupils in my own school as well as giving school X information that will be useful to them.

The aims of the study are to

- Identify staff attitudes and feelings towards the contents and expectations of the LNF and how this affects them. The LNF is explicit in its stated purpose that it is not a strategy for mathematics and English teachers but that it is the responsibility of all teachers regardless of the subject being taught to further develop and enhance the numeracy and literacy skills of the pupils. Therefore the success of the LNF will
depend on how positively all staff (including leadership teams and support staff) approach this development.

The school in the academic year of 2013 – 2014 began a new coordinated approach to numeracy across the curriculum. This is led by a mathematics teacher, who has been given the role title of Numeracy Coordinator (NC). During the previous year the NC has produced a series of subject specific teaching materials which act as a standalone resource to help those subject teachers to contribute to numeracy development within their lessons. He also chairs meetings with subject representatives with regard to numeracy.

To research this area I sent out an online questionnaire to all the staff at the school (n=75, with 54 returns). The questions sought to discover how the LNF was perceived prior to implementation, what value staff place on numeracy skills, if they received adequate support and training and what further support they may need.

- **Identify whether the performance in numeracy by key stage 3 pupils at the school is improving.** The attainment in numeracy of three cohorts of pupils will be analysed to measure improvement. To do this the numeracy test results of the key stage 3 cohorts of 2013 - 2015 will be analysed to determine if any, and how much, improvement was made over the year.

  The numeracy results of the 2014-2015 year 7 cohort will also be analysed. The change in numeracy attainment of this cohort will be compared with the corresponding attainment of the previous cohort, which will identify if numeracy development is improving in the school due to the implementation of the LNF.
• Look at what could be done to further the progress of numeracy delivery at the school. I have used the information and insights gained from the interview with the numeracy coordinator and from my literature research to consider the way forward for the numeracy delivery at school X. Although this study has taken place at school X, I hope that it will give me an indication of how the development of pupils’ numeracy skills can be developed effectively in my own school.

Research Questions
From the research statement four research questions are refined which now form the spine and focus of the whole study. These are:

1. What are the attitudes of school staff towards the Literacy and Numeracy Framework and how it is being delivered at the school?
2. What is the current situation regarding numeracy as part of the whole school curriculum (Are numeracy attainment levels improving)?
3. What more can be done in the school to develop numeracy across the curriculum?

Ethical considerations
The permission for carrying out the study was obtained from the Headteacher of school X and from the Head of Mathematics. The questionnaires to the staff stressed the entirely voluntary and anonymous nature of participation. The aims of the study were made clear to the staff when the questionnaire was sent to them and it was made clear that the responses were anonymous. This contributed to a high percentage of respondents.
The data analysed for RQ 2 had all identification removed and only the quantitative features remained. Gender information was kept in anticipation of further research.

Before interviewing the Numeracy Coordinator, it was made clear as to the purpose of the interview and the interviewee was informed that he could decide to stop the interview at any time. He was also assured that no responses that could be prejudicial to his standing or that of the school will be included in any of the study. Any references to the school, its employees and the pupils were removed from the transcript.

All the research methods abided by the guidelines outlined by the British Educational Research Association (BERA) (2011).
Chapter 2: Literature review

Introduction

The implementation of cross-curricular themes in the schools where I have had the responsibility for teaching or leading mathematics has always had a haphazard feel in that it has been based on the ideas and experiences of the persons responsible and also has been significantly influenced by the resources available to these individuals. I intended to research the literature in an attempt to identify if there is consensus on the issues, beginning by looking for journal articles that may have some relevance as to why learners have issues with learning mathematics. I was surprised that there appears to be little recent research to be found into what are the issues surrounding low attainment in mathematics. On initial search the majority of relevant literature available were governmental publications. These are important, as all educational practitioners have to work within statutory frameworks. However it must be borne in mind that our political system encourages a short-term view of cycles of a few years and therefore policies are developed with political bias as well as educational grounding and therefore I have needed to look further into different journals. This has meant that my search had to move away from the UK as the majority of the research I found was undertaken overseas. In addition to this I wanted the literature to be up to date and the majority of my sources were written post the year 2000, however there are some sources pre-dating this, which I feel, are relevant to provide background or context to my study.

I looked at literature through three main themes.
Firstly to provide a context to the study, I looked at what is meant by numeracy and what is the political background to the need for reform in the development of numeracy skills. Unavoidably this literature comes mainly from governmental sources.

Secondly, I have looked at literature focused on the attitudes towards learning mathematics and to applying mathematics to problems. These studies have come in the main but not exclusively from North America and although it would have been pertinent to find material directly related to the situation in Wales and the UK, the issues surrounding mathematical attainment appear to be universal, and if educators in our schools had the opportunity, then maybe looking outward rather than inward may help to improve the lot for our pupils here in Wales. This second theme is relevant to research question 1, where I am investigating attitudes and perceptions of staff at School X towards the emphasis on the learning and development of numeracy skills.

My third theme, which relates directly to my research questions 2 and 3, is to look at what has been done so far in working to develop a cross-curricular approach to numeracy, problem solving and mathematical reasoning in different educational settings. This will help in identifying directions in which this study could enhance the mathematical and educational experiences for Welsh pupils, particularly those in school X.

What is Numeracy and what is the Issue?

In 1959, Crowther coined the term ‘numeracy’. Numeracy was defined as representing the mirror image of Literacy and a distinction was made between
numeracy and mathematics. Cockcroft (1982) defined numeracy further and implied that a numerate individual possessed two attributes: An ability to use mathematical skills in their everyday life and an ability to understand information presented in mathematical terms.

He also says that to produce numerate pupils then attention should be paid to the wider aspects of numeracy rather than to computation. The charity National Numeracy (2015 a) states that in order to maximise life chances, contribute positively to society and to build a strong economy, citizens should be fully numerate, however “We are currently failing to achieve this.”

The media also reinforces this bleak picture.

“Numeracy: Pupils struggle with sums in Wales says ESTYN” (BBC Wales, 2013)

“Wales’ focus on mathematics welcome as gap with England grows” (Evans, 2014).

Garner (2103) reported that UK literacy and numeracy standards have slipped down international rankings.

In 2012, the National Numeracy Programme (NNP) (Wales. Welsh Government, 2012 c) was launched that focused on four key areas:

1. Enhancing numeracy across the curriculum
2. Advancing teaching practice in numeracy
3. Supporting learners quickly and successfully
4. Communicating the power of numeracy.

The following table, taken from the NNP (Wales. Welsh Government, 2012 c, p.4) illustrates the difference between the attainment in Wales in Mathematics and the
other UK countries and also the OECD average. A 38-point gap is equivalent to an academic year of school education; the results for 2009 indicate that Welsh children are over half a year behind the OECD average and about half a year behind England.

These conclusions come from the PISA report, and it is therefore useful to revisit and further delve into the findings of the most recent of these reports.

The Programme for International Student Assessment (PISA) is a survey of the educational achievement of 15-year-olds that assesses students’ mathematics, science and reading skills and is organised by the Organisation for Economic Co-operation and Development (OECD). In the UK, the National Foundation for Education Research carried out PISA 2012 on behalf of the respective governments (Wheater et al. 2012). After the 2009 PISA assessment, the then education minister, Leighton Andrews (Andrews, 2010) stated that Wales had not fared as well as hoped and had not improved from the 2006 results.

In 2012 the conclusions of the most recent PISA assessment don’t make happy reading for anyone involved in secondary education in Wales. In the report Wheater et al. (2012) state that the attainment is lower than in 2009, with Wales performing at a level lower than the OECD average and lower than the other UK countries.
I argue that in any system for measuring educational performance a simple numerical ranking score is too simplified. However, PISA is the internationally recognised system, and is the one that is used by the government to measure their own progress and therefore is the measure that Welsh educators must work with.

In September 2013 the Literacy and Numeracy Framework (LNF) (Wales. Welsh Government, 2013a) became statutory for schools. This sets out how the whole curriculum can address the development of numeracy (and literacy) skills of pupils up to Key Stage 3 and focuses on the learners’ acquisition and application of the skills and concepts they have learned to complete realistic tasks. To help schools and teachers plan and implement the LNF effectively the National Support Programme (NSP) (Wales. Welsh Government, 2013b) was introduced which schools will use as a curriculum planning tool, and illustrates the emphasis on numeracy being across the whole curriculum. The report ‘Manifesto for a Numerate UK’ (National Numeracy, 2014) states that every teacher should be a teacher of numeracy.

National Numeracy, quoting the ‘Skills for life survey 2011’ by the Department for Business Innovation and Skills in 2012 states that 68% of 16-24 year olds achieve A*-C at GCSE but only 24% of young people are at the equivalent ‘Skills for Life’ level. (National Numeracy, 2014) demonstrating a significant difference in mathematical knowledge and numeracy skills.

**Attitudes Towards Mathematics Learning**

In any discussion into the effectiveness, success and/or improvement in the teaching of any subject the attitudes towards it must be considered as a significant factor. In particular, mathematics appears to suffer from negative
attitudes from learners. Gilroy (2002) paraphrases Schwartz, suggesting that students arrive in his classroom already discouraged and apprehensive about learning mathematics. This mirrors my own experience in the secondary classroom, where a number of 11-year-old pupils are negative about mathematics, especially those below the highest ability level, with an attitude of ‘I don’t like mathematics because I can’t do it.’ Gilroy (2002) notes that research suggests that effort and persistence, which are controllable factors, are more important to achievement than innate ability. This is strengthened by Rice et al. (2013), when they state that motivational constructs (attitudes, interest and value beliefs) are key factors affecting the ability of students to achieve desired outcomes.

Martino and Zan (2010) expand on this and give a model for the relation of students with mathematics, which consists of three interconnected dimensions – emotional disposition towards mathematics, vision of mathematics, and perceived competence in mathematics. These again concur with my own experience of leading teams of mathematics teachers, where I have found that these negative attitudes if not tackled and dealt with within the Key Stage 3 years (ages 11 to 14 years old) will ultimately adversely affect the achievement of the students in the GCSE examinations.

White (2004) asks why his students have problems with mathematics and gives a number of possibilities why they have trouble with quantitative problems. Is it, he asks, a failure of instructors to prepare the students with sufficient practice, or a failure of instructors in their expectations of students, or is the students’ prior knowledge of mathematics inadequate, have calculators had a negative
effect, is there a poor attitude towards problem solving or is there a need to demand more from students than in the past? In White’s (2004) experience, he has found some mathematics professors have reservations about Problem Based Learning (PBL) when they themselves learnt their mathematics through individual hard slog and not from group work. I suspect from my experience that the feeling amongst some teachers in the primary and secondary education system in the UK is similar. It should be considered that maybe the mathematics specialists have been used to individual endeavour and focused on the pure aspect of mathematics, thereby seeing the application of mathematics as secondary to the learning of discreet mathematical skills. Certainly my own school and university mathematical experience was along these lines. White suggests that this experience could cloud the educators’ minds when teaching pupils and may be a contributory factor in pupils’ reluctance and inability to solve problems and develop mathematical reasoning. Vandecandelaere et al. (2012) reinforce this view of a multi-dimensional model for barriers to success at mathematics when summarising studies carried out by Scheflout and Scheflout et al. and gives four aspects which educators should work on to improve learning environments for learners, which they name the equilibrium model. These four dimensions are motivation, self-regulated learning, effective feedback and coaching, and clear and effective learning tasks and activities.

What Has Been Done Elsewhere?

Having identified the need and desire for cross-curricular numeracy, I want to investigate how school X is expected to incorporate this type of approach into systems which traditionally have been divided into discreet subject areas with
little or no co-operation between them to develop learning activities to enhance the learning of the pupils.

To get an idea of what is possible I have looked at how some other schools have done this and if they have found it an effective and successful approach? White (2004) bemoans his experience of professors who see mathematics being tainted by being applied to practical problems. He then gives his opinion that the mathematics that is needed by students arose from the need to solve practical problems and he concludes that mathematics should be interdisciplinary and taught using a PBL approach. I agree with White but have reservations with the notion that mathematics is all about applying techniques to solve problems. Yes, this is obviously important, but there has to be a place for mathematics for mathematics sake, otherwise there will be a scarcity of the mathematical thinkers necessary to solve pure mathematical challenges, which, at the highest level, is essential for the advancement of the sciences. However this only applies to the very top of the ability range, and the majority of mathematics encountered by people is used for practical reasons.

Ackerson Piser & Walka (2010) describe a project approach to linking mathematics and biology. They concluded that there were benefits to this approach as the pupils not only discovered the importance of quantitative data with life sciences, they were fully engaged and having fun. It made them think about their studies and their relevance and importance to the world in a wider sense rather than just for the sake of study. Again, Ackerson Piser & Walka (2010) agree that there is potential for cross-curricular activity, however I found it disconcerting that they appear to be advocating this for the more able pupils. Conversely in my experience it is often the lower ability students who seem to
benefit most from seeing a link with their mathematical studies and other aspects of their life, other subjects and the world of work.

Hayes-Jacobs (1989) finds two problems with the way that cross-curricular work is sometimes implemented, firstly that some projects incorporate bits of each discipline and therefore lack focus, structure and depth, and secondly that in feeling territorial about their subjects, teachers may feel tension when their perceived view of teaching the subject is threatened. In my experience I have found both issues arising. By incorporating a subject into an ‘interesting project’ teachers have felt that their subject is being diluted or eroded in some way, and when a piece meal project is being devised including a bit of this and a bit of that there is an understandable lack of depth in any one particular curriculum area.

Hayes-Jacobs (1989) gives two criteria to ensure success in this style of work, firstly they must have carefully conceived design features and secondly there must be the space for both discreet subject work and cross-curricular work in the curriculum. In my own view, there is a need for an integrated approach to developing these activities involving teachers, but they must be given the time and resources to do this properly and as spelt out earlier, the government is looking for instant fixes to the numeracy issue, which does not give schools the capacity and time to work on these in enough depth and with the required cooperation.

Harris and Fitzgerald (2014) in developing a cross-curricular project for mathematics and technology, conclude that for these types of projects to succeed, the techniques (both mathematical and technological) need to have been taught first before being applied. Although I agree with this sentiment on
the whole, I feel that there is scope that with the right planning some projects could be used to introduce new topics in all curriculum areas.

Van’t Hooft et al. (2012) find reasons to be hopeful that the challenges to cross-curricular approaches can be overcome as they see the application of data and numerical skills as essential for life outside of school. One of the challenges they describe is the teacher needing to cover a textbook full of material, never mind addressing more complex topics such as numeracy. This is a familiar problem within the teams I have led over the last fifteen years. There is an emphasis to cover every aspect of the curriculum, with the resulting effect that important topics are not covered in sufficient depth. A learning programme which allows a degree of flexibility towards curriculum coverage is needed in the modern mathematics classroom, where teachers feel able to decide for themselves about covering some material in more depth and others with a lighter touch.

Frieman et al. (2011) see modern learning changing with more complex non-routine problem solving opportunities needed for the 21st century, incorporating cross-curricular skills. They look at how ICT can be used to develop more complex problem solving skills. The following diagram adapted from their study shows their desired view of the learning environment.
Although this goes beyond the scope of my study, it shows that the authors advocate a move away from the discreetness of traditional subject based learning. They are more specific about the mathematics curriculum suggesting that PBL approaches makes mathematical work more meaningful, authentic and relevant. The literature I reviewed advocated an integrated approach and it was difficult to find dissenting voices. However, Weir, (2010) in a study looking at cross-curricular English projects, identifies some potential pitfalls. These are:

- Lack of engagement of staff
- Lack of planning time
- Lack of focus and rigour
- Difficulties of organising group work
- Problems of assessment

These agree with my own experience as the major issues preventing wholesale success of cross-curricular numeracy.
Perlmutter (2013) discusses a project linking music and mathematics and the
telling statement is that the extra work for teachers is well worth the effort as it
enhances the pupils’ learning of the two subjects. Links between mathematics
and music are also investigated with some success by Rogers (2004) who
encourages teachers to broaden their horizons and explore the connections
between the two subjects. Edelson and Johnson (2003) highlight the lack of work
linking mathematics and music and give some ideas how this could be
strengthened.

Hughes (2011) describes a cross-curricular STEM (Science, Technology,
Engineering and Mathematics) project and advocates this approach with a
discussion on the success that can be achieved when teachers are willing to cross
established curricular borders. By asking students to answer the question “when
are we ever going to use this?” (a question all mathematics teachers must be
asked numerous times every term) Albrecht (2006) invites pupils to investigate
links with the real world and mathematics. Seeing these connections will go a
long way to making cross-curricular projects relevant to the pupils. Sion (2002)
illustrates the points nicely when he gives the example of a pupil going through
school studying every subject discreetly then leaving school and having to work
in a multidisciplinary world. Block (2009) also espouses the benefit of cross-
curricular teaching in helping students to find the relevance behind music
lessons.

Conclusions from the Literature

It is clear from the literature studied that the consensus is that cross-curricular
work is the way forward in the 21st century and a vehicle to motivate and
encourage pupils to study mathematics successfully, and therefore an effective way to achieve the priorities of Welsh Government and Welsh schools. From the reports of previous successful projects a key factor is allowing sufficient time, with planning and resources being allocated prior to the implementation of projects. This is a lesson to those demanding instant change as the level of planning necessary cannot be carried out instantly, which in my opinion is the reason attempts at cross-curricular work appear to have been ineffective to date.

To finish I will quote Blake where he concisely summarises my own feelings towards the needed cooperation between departments for cross-curricular work in numeracy. (2010, p.4),

...‘cross-curricular’ is more subtle (too): it is about actually doing something with your colleagues in other departments, getting away from subject boundaries and into activities that require a multidisciplinary approach. Scary? Exciting? Whichever way we take it, it makes a lot more sense for the world young people will get to inherit.
Chapter 3 Methodology and Methods

Methodology
Research for this study was based on a case study. My experience of leading teams of mathematics teachers has shown me that the improvement of attainment of learners in particular schools is just that - particular. Although strategies may be useful and transferable between schools, a study that is to benefit the pupils of a particular school must be focussed solely on that school. Therefore, I will be looking at the single case of the pupils in school X and the staff at school X. As Thomas (2013) states, a case study is about the particular rather than the general – I will be looking at what is happening in school X and will not be using this to make general assumptions about other schools. Of course I hope the results and conclusions of this study is useful to other schools including mine then all the better.

This study is hopefully the starting point for future work on numeracy in both school X and my own school, intending to identify the current situation and how effective this situation is and perhaps this will lead to some need for action research in my current school where, as McNiff and Whitehead (2005) state, some practical intervention may be needed to improve practices.

Thomas (2013) says that for a case study, data are collected from different facets and these data can be combined to tell the finished story. The subject is the body of staff and pupils of school X and these are being used as a case study of how numeracy is being developed.
Methods

RQ 1. What are the attitudes of school staff towards the Literacy and Numeracy Framework and how it is being delivered at the school?

To collect the data I have used a questionnaire to elicit attitudes of staff towards the development of numeracy learning in school X. This went online to all senior and teaching staff at school X and was anonymous.

RQ 2. What is the current situation regarding numeracy as part of the whole school curriculum (Are numeracy attainment levels improving and if so by how much)?

I interviewed the NC in school X to clearly identify what strategies are being employed at the school and what their hopes and expectation are for cross-curricular numeracy.

To identify just how effective the current strategies are in developing and improving pupils’ numeracy skills in school X I analysed the data of the past three years external numeracy test results. I hope to ascertain whether or not there is a progression in numeracy proficiency in the pupils and also whether there is any evidence that any improvement is increasing or decreasing year on year with the implementation of whole school strategies.

RQ 3. What more can be done in the school to develop numeracy across the curriculum?

For this question, I have used the responses to the interview with the NC to ascertain what in their opinion is the way forward and what is, in their view, desirable, achievable and realistic. I used the findings of my literature review to identify
specific examples of the successful strategies other schools have employed to
develop cross-curricular numeracy and how these could be applied at school X.

Reliability and Validity
The whole study is relevant, for the sole reason that the development of cross-
curricular numeracy has become a statutory requirement of all schools in Wales. It is
an issue for the Welsh Government as explained in the introduction and the
literature review. It is appropriate for school X in particular as the attainment of the
pupils in mathematics has reached a plateau and the local authority are scrutinising
the learning of mathematics, in particular, the skills of mathematical reasoning and
problem solving which are the numerical skills most needed for subjects across the
curriculum. Also the PISA questions most in need of development across Wales are
again that of mathematical reasoning, therefore developing mathematical reasoning
remains a priority for the school.

I sent a pilot questionnaire to colleagues in other schools to ensure that my
questions were valid and relevant. The final questions were adjusted in response to
this pilot exercise and my peers agreed that the final questionnaire was appropriate
and is valid.

The questionnaire was also valid in that the recipients are all part of the school and
as stated in the LNF, all teachers should be teachers of numeracy. I feel that this
requirement is also true of support staff as they should be working to the same goals
as the teachers and senior staff.

I am confident that the anonymous and confidential nature of the questionnaires to
staff will ensure that reliable and honest responses are given. There are
approximately 75 staff at School X and I received 54 responses back. This sample size gives credibility to the responses and conclusions drawn from them.

**Sampling**

I have used convenience sampling for this study. For the online questionnaire of staff at school X, I sent out questionnaires to the whole teaching staff. This was most convenient as the overall population is relatively small (n = 75), and the number of returns (n=54) has enabled me to obtain enough responses to give meaning and credibility to the data collected. As Simons (2009) states, where the case study is small, all the actors can be interviewed. For RQ 1, I gave myself the opportunity to identify the responses of the different categories of staff (senior staff, Subject leaders or teachers) to enable me to drill down further if I felt that it would be useful to do so after looking at the overall responses. In contrast, Simons (2009, p.34) also says that sampling decisions may be needed for other groups. However for RQ3, sampling was unnecessary as I could use the entire cohort of the Key Stage 3 results to analyse patterns and trends from the comprehensive quantitative data available detailing numeracy levels, attainment in mathematics and progress over the studied years.

**Triangulation**

I used triangulation to “compare and contrast [my] data and [my] perceptions of the data with the perceptions of others” (McNiff and Whithead, 2005, P.62).

I have tried to ensure that each aspect of this study complemented other parts of the research. The interview questions for the Coordinator of Numeracy were decided upon after the analysis of both the staff questionnaire and literature
review. This meant that the responses from the NC provide some triangulation alongside the survey and the discussions.

The third theme of the literature review that looked at practice in other schools was complemented and contrasted by the interview questions given to the NC.

Finally the data analysis of actual numeracy assessments results gives a good comparison to the other elements of the study in that it will show whether what is perceived by the different personnel involved in regards to cross-curricular numeracy development is actually having the expected or desired effect.

As Thomas (2013, p.83) states when looking at an example of a case study, “The inclusion of all the forms of data, argument, reasoning and analysis is a form of triangulation that should not be downplayed in its importance.” I am confident that the different threads of this study, the surveys, the interviews and the quantitative data will provide triangulation and will all contribute and complement each other in the final conclusions and recommendations.
Chapter 4. Results and Findings

RQ1. What are the attitudes of school staff towards the Literacy and Numeracy Framework and how it is being delivered at the school?

To investigate this question, I analysed the results of the questionnaires sent out to the teaching and support staff. Out of the 75 members of staff sent a questionnaire I had 54 responses, which is a 72% response rate.

The categories of the respondents were Senior Leader (3 respondents), pastoral Leader (2 respondents), Non-core subject leader (14 respondents), Core subject leaders (5 respondents), non-mathematics teachers (18 respondents), mathematics teachers (9 respondents) and learning support (3 respondents).

I used these categories to allow more depth in the analysis of the responses to the questions as the online survey software allowed me to track individual respondents answers as well as whole group responses.

To allow numerical analysis I used a Likert scale for the questions. As Jamieson (2004) explains, the Likert scale is used to measure a person’s attitude, giving a range of possible responses to a particular statement. The five possible responses are given a score from 1 to 5 corresponding to ‘Strongly disagree’ to ‘Strongly agree’. For each question, the respondent chooses one of five options, Strongly disagree (score = 1), Disagree (score 2), Neither Agree nor Disagree (score 3), Agree (score 4), and Strongly Agree (score 5). This allowed me to give a numerical score to each response. The questionnaire was used to get a feel for the staff attitudes towards numeracy and its’ implementation as part of the LNF at the school.
As well as the staff survey, I interviewed the Numeracy Coordinator (NC) to see how the issues appear from his perspective.

My first statement was used to assess whether the respondents felt that numeracy is an essential skill for pupils and, as I expected there was an overwhelming positive response.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither agree nor disagree</th>
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<th>Strongly agree</th>
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<td>1</td>
<td>0</td>
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I had expected a high proportion of respondents agreeing here, with what I felt was a given – that numeracy (along with literacy) is an essential skill for pupils. This was the case with the weighted average being 4.81, however, I was surprised that there was one member of the staff who disagreed. This respondent turned out to be a subject leader, and on looking further into their subsequent responses, I came to the conclusion that this response was an error as the remainder of their responses present a conflicting positive attitude to the importance of numeracy. Therefore I am satisfied that the questionnaire indicates that all staff are in agreement that numeracy is essential for a pupil’s educational achievement, which if numeracy across the curriculum is going to be successful is a definite must.

Next, I moved to asking whether the respondents believed that numeracy is the sole responsibility of the mathematics department.

This question is used to get an impression of how staff felt with regards to numeracy being an integral part of every subject. Across the whole staff there
was a significant majority (83%) who disagreed with the statement, which indicates a generally good attitude to wards delivering numeracy across the curriculum. The results were more spread than with the previous question. Therefore there are a minority of staff who don’t feel that numeracy should be their responsibility. After further delving, I was surprised to see that of the respondents who agreed that numeracy should be left to the mathematics teachers, 2 were senior leaders and three were subject leaders. Of the respondents that neither agreed nor disagreed, 2 were subject leaders. This suggests that seven of the people whose responsibility it is to plan the learning and teaching within the school are not convinced with the concept and ideals of the LNF. So, although a small minority in terms of the whole staff, this is a significant proportion of the lead staff that appear to have missed the main message of the LNF or who are choosing to disagree with this aspect of the curriculum. The question is now whether the LNF (in particular numeracy) can be applied effectively without more effort being put into convincing the leaders in schools of its worth? This, may however, be an indication of a lack of pre-planning and advance training by and from the Welsh Government. The next two questions may provide some affirmation of this.

When asked whether, the application of numeracy skills was important in their own specialisms, there was an indication of a strong feeling amongst staff that the numeracy skills should be applied in different subjects. This appears to complement the responses above in that the majority of staff don’t feel that it is the sole responsibility of the mathematics department to develop numeracy skills. The 7 respondents who don’t agree with the statement include 4 subjects leaders and a senior leader, again this is interesting if the aims of the Welsh
Government that all teachers become responsible for developing numeracy skills is to be realised.

It may be a concern for the development of numeracy that close on 30% of the respondents actually feel that they received inadequate information and training before the LNF became statutory. In defence of the school planners and leaders, I allude to my earlier point in which I make the observation that the Welsh government is expecting instant gains without the long-term approach to planning and training being adopted. This rush into full implementation and the pressure on schools to produce results in the short term has not given them the opportunity to train the staff effectively in this aspect of the curriculum.

This is echoed by the NC who feels that he received little support or training on the LNF and his role in ensuring that the LNF was implemented. In my own experience, the NCs have been expected to work on cross-curricular numeracy without and extra support or training. This therefore appears to be a wider issue, and as the NC states, a carte blanche approach would be ideal, but only if the appropriate level of support from the school leaders was provided.

The advent of the LNF inevitably means that there will be a change to planning for teachers and could also lead to additional planning. Do the teachers think this is necessary, that is, were they already planning for numeracy and do they think that the LNF is an additional burden to their work? When asked whether they have always considered the development of numeracy in their planning, a majority responded in the positive as illustrated in the following chart.
37 of the respondents state that they have always (pre-LNF) considered numeracy opportunities in their planning which is a significant proportion of the teaching staff. Interestingly, since the implementation of the LNF only 28 respondents replied that they now always consider numeracy opportunities in their planning and teaching.
One possible hypothetical explanation for this discrepancy could be that the initial focus of the work of the NC was on particular subjects rather than across the whole school curriculum that may have given the impression that the subjects not being concentrated on could relax this aspect of their planning. However this is conjecture and the responses do not provide the means for investigating this further.

34 of the respondents also stated that they have increased the amount of numeracy in their planning and of these, 26 state that an increase in their workload has resulted from the LNF being implemented at the school. At a time when there is an industry focus on increased workloads for teachers, this could be a concern if the implementation of the LNF is to run smoothly and effectively. If the LNF is perceived as extra work and an additional amount of work, then teachers may not be as receptive to the demands of the LNF as they may otherwise have been. Also if it happens as an extra, then the tendency may be to see numeracy as an ‘add-on’ rather than as an integral part of the learning of each subject.

There are 8 respondents who despite an increase in their planning for numeracy haven’t seen a corresponding increase in their overall workload. It can be surmised that they have altered their planning to allow a proportionally larger amount for numeracy without actually just adding it to their current planning systems. This indicates that there may be a benefit of identifying these teachers to find out exactly how they have done this, and use this to further progress the LNF effectively across the school. If teachers can see that increased numeracy
does not mean increased work for them then they will be more receptive to change.

The NC is confident that numeracy is being delivered well through the subjects and that teachers felt confident in including numeracy in their schemes of work. This situation has improved further since the LNF was introduced, and from my observations of his work, I concur with his view that through the team working that he has put into place, the delivery of cross curricular numeracy is developing apace.

When asked about the potential for numeracy in their own teaching, 27 of the respondents state that they agree that their teaching maximises the numeracy opportunities in their subjects. That this is 50% of the respondents, demonstrates that there is the potential for cross-curricular numeracy development to significantly increase at the school. Again when considered with the Government’s aim of all teachers being responsible for ensuring the numeracy needs of the pupils are to be met, then over half of the respondents feel that they have the potential in their teaching to do more than they are currently.

Interestingly, nine of the respondents who agree that whilst they always considered numeracy needs pre- LNF and disagree that they are consider this aspect post- LNF, also agree that they are not maximising the potential for developing numeracy in their subjects. It would be a good idea to look at these and seek out what opportunities that these individual teachers can identify, which could ensure that these opportunities are maximised. They may provide ideas and suggestions that can be used elsewhere across the school curriculum.
There is also a suggestion, that with 9 respondent doing less post- LNF than before, that there is a negative feeling towards the LNF and that due to this negativity that maybe, they are actually doing the bare minimum being asked for, rather than when numeracy was a voluntary consideration they may have been happier doing more. Again, these individuals and their thoughts should be sought out as they could be the key to the LNF being effectively rolled out over the long term.

Only 9 respondents felt that the numeracy skills of pupils had improved since the LNF started to be implemented. Although initially dispiriting, it must be borne in mind that the statutory LNF is only a year old and to see improvements in such a short time is hopeful at best. It is unfortunate that this isn’t realised by those in government who want to see immediate improvements.

The following chart shows an interesting set of results, as it appears that 11 members of staff feel that the LNF is having a positive effect on their own numeracy skills. I theorise that this could be down to them looking at the numeracy requirements during their planning processes. If this is so, then this is a positive side product of the LNF especially in light of the previous results where 9 members of staff did not feel confident in their own numeracy level.
From past experience of whole school cross-curricular initiatives, I am aware that it is their own subjects that are the priority for teachers and quite naturally so. It is the response from teachers that they don’t have time for their own subject let alone including extras that has been the bane of some cross-curricular coordinators. It is heartening to see therefore in the following responses a generally positive set of figures here with only 7 respondents saying that the LNF is adversely affecting their own subject. Two of these respondents are subject leaders who obviously have responsibility of writing the schemes of work etc., which need to include the elements of the LNF, and therefore will be considering where time can be cut from other parts of the course. This is an issue, as if there isn’t a cut in content, these teachers will be seeing the LNF as extra. However, there needs to be attention paid to making the LNF inclusive to the subjects and not as an extra, a recurring theme so far in this study.

However, NC feels that since the LNF has become statutory, all departments are keen to implement the LNF and that many departments actually would like to increase the amount of numeracy within their subjects.
As a mathematics teacher at a previous school, I actually felt that I was given the bulk of the responsibility of preparing groups of pupils for the national numeracy tests. Looking further into the responses from chart 5 it appears that the majority of the respondents in agreement were also mathematics teachers. I assume that this is probably the situation nationally, but it does need consideration, why, if the LNF is truly a cross-curricular issue, why do mathematics teachers feel that they are alone being given the responsibility for the numeracy tests. Also as a whole school progress benchmark should the test
results be a measure of performance by the mathematics teachers. This is an
issue, that senior leaders need to look at over the coming years.

**RQ 2. What is the current situation regarding numeracy as part of the whole school curriculum (are numeracy attainment levels improving)?**

At the moment, in school X, there is a Numeracy Coordinator who is also a mathematics teacher and he is responsible for ensuring that the numeracy element of the LNF is developed across the school. He is currently working with four departments; mathematics, geography, science and design technology. He has allocated a mathematics teacher to work alongside these departments to support them in implementing the LNF and providing resources where necessary. The departments involved are going through the process of mapping the LNF into their particular learning programmes although the NC feels that they are a little way behind other schools in this process. I can see why he thinks this, as the mapping process is at a more advanced stage in a number of schools I have worked with, although in my opinion he is being a little harsh on himself, as although the mapping process is still being undertaken, the actual development of cross-curricular work is at a more advanced stage than the aforementioned schools. NC has produced ‘Go For It’ booklets that enable the departments to use these stand-alone subject specific tasks to develop numeracy skills with their pupils. As well as subject based work; NC has also developed a numeracy strand to the pastoral lessons of pupils which are taught by the form tutors in morning registration sessions. These have been well received and are popular with the staff involved, and also positive feedback has been given by the pupils to NC. The mathematics department also gives a significant proportion of the teaching timetable to the development of numeracy skills and also to reasoning skills.
which are considered as complementary by the LNF. This is due to the PISA tests (Wheater et al. 2012) which use more complex reasoning numerical tasks to measure the numeracy skills of a pupil.

Other the last three years the pupils in Wales have had their numeracy (and literacy) skills tested through national tests and these give a numerical score for each pupil every year from year 2 (age 6 years) to year 9 (age 13 years). Although controversial and not altogether popular, these tests do give a convenient if crude measure of how the skills of pupils are developing and it is through the following analysis of the schools data on these tests that I will attempt to assess whether the numeracy skills of pupils are improving and therefore further to ascertain whether the measure in place at the school and NC are effective.

2015 saw the third cohort of pupils sitting the Numeracy tests, and for the first time it is possible to analyse a cohort of results from each year from 2013. From the current year 9 cohort (those pupils who have sat three tests at school X) the headline figure here is that out of the 268 pupils tested, 188 of these pupils (70%) have seen an increase in their standardised scores (standardised scores are calculated from the raw test score and the pupils age at the time of the test) from 2012 to 2015 and of these, 168 pupils made a significant improvement. To get a fuller picture we must look at the pupils making no significant improvement and those who have actually seen a negative change to their scores. Of the 42 (16%) pupils who made no significant change to their scores, 25 were already above the median and of these 13 are in the uppermost 25% of the year group. In the group of pupils who actually received lower scores 13 of
them are above the median and 2 of these are in the upper 25th percentile. If the average percentage increase of the pupils are compared it is seen that the upper 25% of the ability range improve by an average of 4.71% over the three years, the middle pupils (25th to 75th percentile) increase by an average of 3.63% and the lowest 25% improve by an average of 7.59% over the corresponding period.

These figures show that improvements are being made especially at the ends of the ability range. That there is work to be done in the middle ability band reflects what is regarded as the priority for GCSE mathematics at school X, that is the very able and the lower ability pupils perform relatively well at Key Stage 4 with regards to value added scores but the middle band still do not achieve at the same level. This therefore gives some indication of where the future focus should be in terms of focus groups and interventions.

In terms of the whole cohort, an interesting feature of the data is the mean and median average scores for each year. As the graph below shows, the mean values have increased each year, but the median, after increasing from 97 to 100 between 2012 to 2013 has stayed on 100. This suggests that the more able
pupils are achieving higher marks in the tests.

That there has only been three sets of data and that I have only looked at the standardised scores means that this analysis is quite crude, however, it does suggest an improvement in the numeracy levels of the pupils in school X is being made. It also points towards the pupils in the 25th to 75th percentile of the ability range not making the same level of improvements as the pupils in the top and bottom percentiles.

More interestingly, when looking at the succeeding cohort of pupils at their progress from year 7 to year 8, a similar overall picture can be seen, but the interesting finding is that the average pupil’s score has seen an increase of 2.7% over the two years. The current year 9 in the corresponding two years only saw an average score increase of 1%. This could suggest that subsequent years are improving as the LNF and the testing regime matures.

In terms of whether the mathematics department approach to the Numeracy aspect of the curriculum is a success it is ultimately the progress that is made by groups of pupils from one year to the next that is the key indicator not
necessarily the individual scores of each cohort. Therefore I am quietly confident that this data suggests that subsequent years are making better progress than the last and if this continues it should have a positive effect on future key stage 4 GCSE results.

**RQ3. What more can be done to develop numeracy across the curriculum?**

If we are to be confident that the LNF can be delivered effectively then we must also be confident in the teachers’ abilities to deliver the numeracy element of the LNF. The key to this is the teachers’ own confidence in delivering the numeracy element and even more acutely, their confidence in their own numeracy skills. An assessment of this confidence could give an initial indication of where to focus in service training at the school.

The responses shown in the above chart appear to show a positive result with the vast majority agreeing that they are confident in their own numerical skills. However 13 members of staff feel that they would benefit from additional support to further develop their own numeracy skills as illustrated in the following pie chart.
This is consistent with my past experience of attempting to identify training needs in a previous school where I was head of mathematics. In one particular INSET day, after surveying the staff on their confidence in numeracy and receiving an overwhelming positive response, I then asked the staff to complete some relatively straightforward numerical problems. What ensued was two-fold, a significant proportion of the staff did not have the confidence to tackle the problem and a significant minority was not able to successfully complete the tasks.

This experience is repeated by the NC who states that at the outset of the LNF, teachers in other subjects were not comfortable with numeracy and found it frightening. It was clear that members of staff were worried. However after working with certain departments, developing resources and providing them with support this feeling is replaced with a liking for teaching numeracy based skills and the continuation of cooperation between teachers has been received positively. NC also mentioned that although other departments have a little
trepidation, they are keen to get on board and work to develop numeracy across the curriculum. This positive feeling is essential if a success is to be made of the numeracy element of the LNF.

This area should be regarded as a priority, firstly to find a way of identifying areas of weakness in the numeracy knowledge base of the staff and secondly, to devise ways in which to fill these gaps.

I would suggest using the schools own expertise in the mathematics department to support other staff members in building up their mathematical skills, as this will encourage a non-threatening environment to help with what is quite often felt as a threatening subject – mathematics.

Only 26 respondents feel confident that they can contribute to the development of numeracy across the curriculum. To further press this point home, only 9 respondents disagreed that they would like more in school support in delivering numeracy through their subject.

This should then give a priority in that if the LNF is to progress effectively then there is a job of training to do followed by continued support until these members of staff are then confident enough to deal with the numeracy element themselves.

Therefore more time and effort needs to be put into identifying and addressing the training needs of the staff and it shouldn’t be taken for granted that all teachers are able to teach numeracy effectively without this additional training and support.
I have a concern that at times the NC is given the task of promoting the whole school numeracy agenda but without the necessary resources (mainly time) to really ensure that the quality of numeracy being included across the subjects is of high enough quality to ensure that the pupils are being developed as best as can be in this aspect. When asked about the support he receives NC stressed that there is a significant imbalance between the support for numeracy and support for literacy in favour of the latter. As the LNF gives equal focus on both numeracy and literacy, then this may be an issue if there are to be equally successful outcomes for both. The literacy coordinator at the school is a salaried post with corresponding time and resource allocation to fulfilling the role. Conversely the NC is unpaid for that particular aspect of his work and feels that there is not an equal amount of support given to him to enable him to develop his role. The NC further states that rather than being the rewarding position it could be, it is actual feeling more of a burden without the time and support he needs being provided. The school position is that the pupils’ numeracy skills are better developed than their literacy skills and because of this, literacy takes precedent over numeracy. This is also borne out in the GCSE results of English and Mathematics, where the mathematics results are higher than the English results. I also agree that to be able to tackle a more complex mathematical problem, there is a need for good literacy skills where the converse is not always true. A good level of numeracy is not a pre-requisite to dealing with literacy issues.

When asked what more could and/ or should be done to improve the numeracy development of pupils, NC gives a number of suggestions. Firstly, as alluded to above, he would like to bring numeracy in line with literacy, having equality with the literacy coordinator in terms of time and enumeration although he
recognises that this is unlikely to happen soon due to budget constraints. The NC advocates using the national test scores to identify learners’ needs and allocation of extra intervention as required where two teachers are given the responsibility of working with these pupils on their weaknesses. The test results allow this type of system to operate successfully, and again this is happening already in schools I have worked in and with.

Interestingly, NC advocates the development of cross-curricular projects as being useful to drive forward standards of numeracy. This dovetails nicely with the journals cited in the literature review where the authors value cooperation between the mathematics teachers and other subjects. In my view this approach is a valuable avenue to explore and is one of the areas that I am striving to develop in my current role as a whole school numeracy coordinator. Working together with other subjects will allow pupils to appreciate the value of numeracy as an essential skill outside of the mathematics classroom, and will benefit both the learning experience of the pupils and, as expressed in the literature review, it will enhance the professional lives of the teachers.

As seen from the brief analysis of the national Numeracy test results, for the school to ensure maximum impact from interventions etc. I suggest that they should concentrate on the 50th to 75th percentile of the ability range, as it seems as these are the pupils who are making least amount of progress from one year to the next. As I stated above, this is also the case in GCSE examinations, so effective focus and intervention with these pupils early in key stage 3 could make a significant difference in the key indicators of school performance later on. At the moment however, key stage 4 is given the priority for time and resources so
perhaps it is time for the Senior Leadership Teams of school X to look at the bigger long term picture and develop the pupils at as young an age as possible in the secondary school with the aim of improving key stage 4 results over time. Again, however, the government is pushing for instant improvement and there is little patience evident in allowing a smooth long term improvement to take place and therefore School Leaders are under pressure to ensure short term intervention is the priority.

Summary and Recommendations
It was found that the staff of the school are generally positive about the development of numeracy across the curriculum and that the Numeracy Coordinator has some effective strategies in place to further develop this aspect. It can be seen through the test results that the numeracy levels of the pupils are improving year on year and are benefitting from the push from the Welsh Government through the implementation of the LNF. However, progress is constrained by the time available to the numeracy coordinator in carrying out his role.

The challenge is to harness the positivity of the staff to push forward this aspect of learning. From what I have seen in this school and in others, there are clearly some avenues available which have the potential to further improve the skills of pupils.

Despite the budgetary constraints I feel that every effort should be made by the school to ensure that there is a specific role of Numeracy Coordinator with a corresponding allocation of time and resources. The role is too important and significant to button onto other teaching roles in the school.
Embarking with a system of identification of the needs of pupils using the national test results and a corresponding intervention process would be a significant step to ensuring that effective and efficient use of the Numeracy Coordinator’s time and efforts are made.

Given the appropriate amount of time and support, the Numeracy Coordinator could develop larger scale cross-curricular projects between two or more different subjects encompassing a significant amount of numeracy skills. These projects could also be equally used to develop other key skills such as literacy, thinking, and problem solving and reasoning skills as well as helping improve understanding of the different subjects.

The emphasis for the school should be to develop the numeracy skills of the pupils as early as possible and take a long term view which in my view, will result in significant improvement in the school’s overall attainment at key stage 4.

Of course, as stated a number of times above, these developments are all dependent on time and resources. Therefore the first step for a school and the Numeracy Coordinator would be to explore the potential for this extra burden on already tight school timetables and budgets. Doing this will be a challenge but ultimately if this challenge can be met, then the outcomes will only be beneficial for pupils and the school.
References


Appendices

Appendix 1 – Questionnaire Results

Qu. 1 Numeracy is an essential element in a pupils’ development.

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Qu. 2 Development of pupils’ numeracy skills should be left to the mathematics department

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Qu. 3 The application of the pupils’ numeracy skills within my subject is important

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Qu. 4 I am fully aware of the requirements of the numeracy element of the LNF

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither agree nor disagree</th>
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Qu. 5 I was adequately informed of the development of the LNF before it was introduced to the school.

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<th>Disagree</th>
<th>Neither agree nor disagree</th>
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Qu. 6 I received adequate training in delivering numeracy before the LNF was implemented.

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<tr>
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Qu. 7 Pre- LNF, I have always considered the opportunity for the development and application of numeracy in my planning and teaching.

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Qu. 8 Post- LNF, I always consider the development and application of pupils' numeracy skills in my planning and teaching.

<table>
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<tr>
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Qu. 9 since the introduction of the LNF, I have increased the amount of planning for numeracy in my subject.

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Qu. 10 the implementation of the LNF has increased my workload

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Qu. 11 I am confident that I am maximising opportunities for numeracy development within my subject in my planning and teaching.

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Qu. 12 I am confident in my own numerical skills

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Qu. 13 I would like to have in-school support to develop my own numeracy development

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Qu. 14 I am confident in delivering the numeracy element of the LNF through my subject

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Qu. 15 I would like in school support to help me to deliver the numeracy element effectively in my subject

<table>
<thead>
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Qu. 16 Since the implementation of the LNF, the numeracy skills of my pupils have improved

<table>
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<th>Neither agree nor disagree</th>
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Qu 18 The emphasis on the LNF is having a detrimental effect on the teaching and learning of my own subject

<table>
<thead>
<tr>
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<th>Disagree</th>
<th>Neither agree nor disagree</th>
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Qu. 19 The time spent preparing pupils for literacy and numeracy testing has had a detrimental effect on the teaching and learning of my own subject
<table>
<thead>
<tr>
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<th>Disagree</th>
<th>Neither agree nor disagree</th>
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Appendix 2 – Written Statement by the Welsh Government

Title: Statement on the Programme for International Student Assessment (PISA) 2009 Results

Date: 7 December 2010

By: Leighton Andrews, Minister for Children, Education and Lifelong Learning

In November 2009 132 schools took part in the second round of PISA assessments in Wales; the results are published today, Tuesday 7 December 2010.

The Programme for International Student Assessment (PISA) is a survey of educational achievement run by the Organisation for Economic Co-operation and Development (OECD). PISA assesses the knowledge and skills of students aged fifteen as they near the end of their schooling. Pupils are assessed on their competence to address real life challenges involving reading, mathematics and science. This aim differentiates PISA from other pupil assessments which measure their mastery of curriculum subjects.

PISA is carried out on a three year cycle. The first PISA study was in 2000. Wales participated for the first time in 2006. The number of participant countries has increased each year; in 2009 65 countries took part. Of these, 33 were members of OECD.

The national report setting out PISA outcomes for Wales is published on the website of the national programme manager for PISA in Wales, England and Northern Ireland, the National Foundation for Educational Research (NFER): www.nfer.ac.uk/pisa.

The international report which analyses PISA performance across the 65 participating countries including the UK can be accessed at:
www.pisa.oecd.org. Most of the references in the international report are made on a UK basis.

I expect schools and local authorities to undertake robust, evidence based self evaluation; we must also use tools such as PISA to consider our national performance and progress in an international context.

We did not fare as well as we would have liked in the 2006 PISA assessments and we all hoped that our policies would have yielded improvements by the 2009 assessments.

Sadly, that is not the case. The 2009 figures paint an even more disappointing picture of our performance and progress.

In both reading and mathematics Wales’ mean score was significantly lower than the OECD average and our UK counterparts. In science we performed at around the OECD average but significantly below the performance of other UK administrations. In all three domains the mean score for Wales and our international ‘ranking’ was lower than in 2006.

The tables below summarise the mean scores in each of the three PISA domains with a comparison to our 2006 results.

**Reading**

<table>
<thead>
<tr>
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<th>2009</th>
<th>Change(^\d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Score</td>
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<td>476</td>
<td>-5</td>
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</table>

**Mathematics**

Note that it is not statistically valid to compare the results across two PISA assessments in this way however it is reflective of overall performance and will be highlighted by many readers of the results.
PISA is a highly respected and robust measure of the relative performance of educational systems. These results cannot be argued away or excused. We need to face up to the harsh truth: schools in Wales are not delivering the outcomes that our young people need and deserve.

These results cannot be excused on the basis of low socio-economic status or the bilingual nature of our nation and education system. They cannot be excused by relative funding levels – Finland has similar per capita spend to Wales on education and yet performs consistently very highly in PISA assessments; Luxembourg spends far more than Wales but their PISA scores are no better than ours in reading and lower in science; New Zealand spends less per capita than we do but significantly outperforms us.

We must all take a level of responsibility for the problem and for resolving it. We need to refocus on higher standards, set our ambitions and expectations high and look for improvement in every aspect of our system.

The young people of Wales have the same potential as young people across the world.

Much of what we need to do will take time and it will be hard. It will require honesty, leadership and a new approach to accountability. Our young people deserve better but I am confident that I can rely on the whole sector to support the actions necessary to bring about sustained, positive change.
Appendix 3 – Interview transcript with Numeracy Coordinator

- Pre-LNF what was the situation of the school in terms of numeracy across the curriculum?

Prior to the LNF there was very little cross curricular discussion in the school. The mathematics department had liaised once with the science department to discuss the teaching of graphs but very little discussion with other departments. Although many departments naturally use numeracy in lesson time there was no tracking or assessment of the skills which pupils saw and experienced. The role of numeracy coordinator was created the same time as the introduction of the LNF.

- Do you feel that there was an issue regarding the numeracy skills of pupils’ pre-LNF?

I feel that generally speaking that numeracy is in a good place. Most teachers I have dealt with are confident teaching numeracy based topics in their SOW’s. The introduction of the lnf has made numeracy more important to all departments and I believe that pupils see more numeracy because of the lnf. The four depts. Departments in the numeracy plc have been using the go 4 it booklets especially in term 2 to support the preparation of the numeracy tests.

- What, in your opinion, were the attitudes of teachers of other subjects towards numeracy? (how much attention was given to numeracy within other subjects?)

Initially I felt that for many teachers that numeracy was scary and many were not comfortable. At a staff inset I took it was clear that some members of staff were worried. The departments which I have worked closely with DT, Geog and science, it is clear that numeracy is liked and teachers revel in teaching numeracy based skills. The introduction of the lnf and the creation of the go 4 it
booklets in the three subjects have been received well by these departments. I have spoken briefly to departments such as art MFL and RS and although there is slight trepidation I believe that the teachers are keen to introduce numeracy into their syllabus.

- As the build up to the LNF was taking place, what special training was given to yourself and others responsible for numeracy?

Generally speaking I have had very little support on the implementation of the LNF and my role as numeracy coordinator. Initially I was put on ERW/county run courses and other course run by companies such as sky rocket etc. I have a blank canvas to implement the LNF which I believe would be correct with additional support from SMT.

- The LNF gives equal attention to the development of literacy and numeracy. Is this reality?

There is definite imbalance towards literacy. The literacy coordinator is paid for her role. There is intervention where two members of staff take pupils out of form and lesson time for pupils to practice their reading. All pupils in year 7 receive a weekly literacy lesson as well as 6 hours of English. The literacy committee has been working together well and are ending the tracking and assessment methods for the LNF. Numeracy is certainly literacy's smaller brother. Generally speaking it is believed in our school that pupils are better at numeracy than literacy. GCSE results and national testing in KS3 also suggests this. SMT have said on several occasions that as a school literacy is the focus rather than numeracy.

- In your opinion does numeracy receive the appropriate priority in the whole school plan?
In my opinion no! I have had very little discussion about numeracy with SMT and how they plan to build/implement numeracy across the school. I am sure sometime they will ask what's going on. It has been left for me to drive numeracy. With 44 teaching hours, ks5 responsibility within the dept, form class, mainly exam classes etc I do not get enough time to work on the LNF and hence find it extremely challenging. I would go as far as say that it is a burden. I feel that the numeracy coordinator role done properly would be rewarding but time and resources are needed to do this. Without time and support its very difficult.

- As numeracy coordinator, do you receive the amount of support and resources you feel it necessary for successful implementation of the numeracy aspect of the LNF?

NO. I feel that our school does not value numeracy. Apart from being placed on courses I have had little support. Courses are great but I see what other schools are doing and the support coordinators get and compared to what I get.

- Are numeracy levels improving (both in what you experience as a mathematics teacher and through National testing) and do you expect this to impact the GCSE results in the future?

Implemented properly I believe GCSE results can only but improve. I feel although small in roads are being made that it is too early to be able to evaluate the effect of the LNF on GCSE results. I believe that the tests are damaging to our pupils development. As teachers we tell the pupils they (the tests) don't count and aren’t important which then is contradicting what the LNF sets out to do. I feel that it’s either we are in and do it properly but currently we belittle the tests. I think the government are making mistakes but it’s our jobs to do what they say.

- Please could you give me a brief overview of how the Numeracy aspect of the LNF is being implemented at the school now?
In the numeracy plc we have four departments; mathematics, Geog, science and DT. Each department has an individual mathematics teacher who works alongside providing support, resources and help. These departments are currently mapping the LNF. These depts. all have booklets which are based on the descriptors of the LNF. Although many schools have mapped and can assess all pupils and then report on each pupils progression wrt the LNF we currently are not even close. Eventually it is planned that each department will take a number of the descriptors and will be able to assess and report on their descriptors. This is the stage that the literacy plc is at. We have also created pastoral sessions based on numeracy in particular money.

- Have attitudes amongst teaching staff changed since the LNF became statutory?

I believe that generally speaking all departments are keen to comply and implement the LNF. I believe the literacy committee are making good in roads and all departments have tasks and know what they are doing, assessing and reporting on. Many departments want to increase the amounts of literacy and numeracy that they do.

- What further changes would you like to see to improve the numeracy development of pupils?

I would like to see intervention for pupils who need it based on their test results. For example under score 85 intervention groups 1. Intervention group 2 would be for pupils who scored between 88 - 105 as these would be our borderline pupils. I would also like to see a timetabled slot for numeracy in key stage 3 where pupils improve their numeracy skills through a cross curricular project.

- What would be your wish list in terms of resources/ support etc to help you in implementing the LNF?
I would like 2 extra teachers to work on numeracy intervention. This would be in line with literacy. I am interested in using packages such as BKSP*. I would like 1 extra lesson a week for all ks3, a numeracy lesson based on the descriptors of the LNF. I would like my hours to reduce and my pay to increase. I would also like a wife with big jugs and a love of knob who can cook beautiful food and who gives me money every Saturday to get shitfaced. I’d also like a pet pink unicorn and a Ferrari. I am more likely to get these requirements than the ones for numeracy.

- Have you had the opportunity to see what other schools are doing and if so could you briefly describe them?

Only on courses and never in practice

* BKSP is an online specialised programme designed to improve the basic skills of low ability pupils.