Supporting mathematics and numeracy in museums, libraries and archives

Julie Ward
Museum Educator
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Supporting Mathematics and Numeracy in Museums, Libraries and Archives

This guide is for staff at Museums, Libraries and Archives (MLAs) to help develop good maths learning projects. These projects can provide real opportunities to explore mathematics in interesting, fun and enjoyable ways using the resources that they uniquely have access to. Teachers or group leaders will also find this guide useful in considering partnership working with MLAs that can provide stimulating environments for the exploration of mathematics and other curriculum areas.

This guide includes –

1. Background information
2. Mathematics curriculum – a brief outline
3. Recent projects in the Yorkshire region – brief outlines and case-studies
4. Other project ideas
5. Specific Learning Outcomes
6. Sources of help and information – organisations, websites and resources.

1. BACKGROUND INFORMATION

*Maths is fun – Maths is easy – I’m good at maths!*

These are phrases that people (young and old) should be able to say rather than the more usual negative statements.

How often do we hear someone say negative things about their maths skills or even say it ourselves? Many people even seem to take a certain amount of pride in announcing their numeracy skills are lacking and forget how much we all use mathematical skills in our every day life – estimating, money, areas and plans, size, cooking, building, decorating, finance and many more.

Figures quoted in the Moser Report, Improving Literacy and Numeracy – A Fresh Start (www.lifelonglearning/mosergroup/), states that 40% of adults have problems
with numeracy and it suggests that 1 in 3 adults are unable to calculate the area of a room or their amount of change when shopping. Limited numeracy can be as serious as poor literacy for the individual, in certain jobs and indeed for the economy.

Making Mathematics Count: The Report of Professor Adrian Smith’s Inquiry into post-14 mathematics education (www.mathsenquiry.org.uk) emphasises the importance of maths for everyday life and for the future.

The National Numeracy Strategy (which now forms part of the National Primary Strategy) SAT results (2005) show that Primary Schools are continuing to make progress in mathematics, as the numbers of 11 year olds achieving the expected level rises. The KS3 National Strategy and the proposed changes to 14 – 19 education all emphasise maths skills. The Government's White Paper on 14-19 Education and Skills makes clear that all school children will need to try to achieve a sound level of competence in the maths needed for life skills and the phrase functional maths is used. The essential mathematical life skills to be included in functional maths as stated by the QCA (Qualifications and Curriculum Authority) are:

- Relevance - functional maths should be relevant, interesting and realistic.
- Thinking skills - the functional maths curriculum should describe processes and ways of thinking as well as content.
- Conceptual understanding of maths - students need to learn why procedures work, not just how.
- Use of technology - ICT should be integral to functional maths learning.
- Assessment of functional maths should reflect the full range of thinking and skills experienced by students in the programme and should include ICT.

At each level in education, and through life skills for adults, mathematics has a vital role to play and MLAs can provide a wide range of opportunities to develop education programmes supporting learning outside the classroom. MLAs currently develop education programmes covering a wide variety of curriculum areas such as history, science, geography, art and design, music and drama, and the mathematical
elements of many of these education programmes can be further developed with careful thought and planning.

Many of the activities that can make maths fun and achievable are practical, real life activities outside the classroom which build on skills that have been learnt in school. Museums, galleries, libraries and archives can provide real opportunities in interesting and secure environments to help develop pupils’ understanding and skills in enjoyable and creative ways. These projects may also change their perception of maths and numeracy skills.

Projects and programmes developed by MLAs are often linked to the schools history curriculum, although there has been much work done developing creative projects using art, creative writing, dance or drama. With recent funding such as Creative Minds funding through the Yorkshire Forward (regional agency) there has been increasing numbers of projects focusing on science and technology following the Government’s target of -

- Raising the profile of STEM (science, technology, engineering, maths) subjects in schools, promoting them as fun, exciting and relevant to everyday life
- Improving students’ interest in STEM subjects
- Ensuring that there is a flow of well motivated, high quality people from schools who have an interest in, and an understanding of engineering related subjects.

However, mathematics is usually identified as part of a science or technology project rather than the main emphasis of a project. The Museums Alive! For Schools YMLAC Report (November 2005) identifies ‘extensive provision is evidenced for history, art and design, English and Science…but provision is more limited for ICT, mathematics, modern foreign languages and music at all key stages.’ This report also shows that teachers prefer programmes that are provided to have direct links to the curriculum.
So why are MLAs not getting involved in more mathematics and numeracy projects? Perhaps some reasons are –

- Lack of confidence of MLA staff to develop projects using mathematics
- Concerns that teachers will be unable to bring groups out of the classroom for subjects such as mathematics
- Visitors (families, schools, groups and individuals) may not be interested in mathematics related projects due to preconceived ideas about their abilities and how interesting it will be.

There is a wide range of possibilities and opportunities that MLAs can provide. The curriculum outline and case studies provide ideas and suggestions for developing maths projects outside the classroom, using the stimulating resources and expertise that MLAs can provide.

2. MATHEMATICS CURRICULUM – A BRIEF OUTLINE

Mathematics Curriculum or National Numeracy Strategy (NNS)

Numeracy is defined as a proficiency which involves confidence and competence with numbers and measures. It requires an understanding of the number system, a repertoire of computational skills and an inclination and ability to solve number problems in a variety of contexts. Numeracy also demands practical understanding of the ways in which information is gathered by counting and measuring, and is presented in graphs, diagrams, charts and tables.

The Dfes (Department for Education and Skills) website (www.standards.dfes.gov.uk) gives details of each curriculum area including full details of the mathematics framework for each year and term. LEA advisory staff or consultants, Advanced Skills Teachers or teachers at local schools can all provide advice to ensure that activities and programmes are appropriate to age and ability of the pupils.
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<td>Systems, Measurements using parts of the body etc</td>
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### Ma4 Handling Data

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**NB – Ma1 – 4** are the sections in the programmes of study. Ma1 'Using and applying mathematics' has now been incorporated into each of the other units.

**The Primary Strategy** (Excellence and Enjoyment – A Strategy for Primary Schools launched in 2003) set out a vision for the future of primary education where high standards through teaching 'basic skills' will still be emphasised, but with an increased focus on creativity, mathematical investigation and problem-solving. This strategy sets out to …‘empower primary schools to take control of their curriculum and to be more innovative and to develop their own character’.
SETNET
The Science, Engineering, Technology and Mathematics Network (SETNET) is a UK-wide charity that promotes Science Technology Engineering and Mathematics (STEM) awareness, especially among young people (www.setnet.org.uk). Local communication is through local ‘SETPOINTs’ and there are offices in North Yorkshire, South Yorkshire, West Yorkshire and Humberside. Currently the primary function of SETPOINTs is to serve as single, authoritative sources of information for teachers about what local and national STEM materials and activities are available to enrich their teaching, and to offer both advice and assistance in delivering these activities to schools.

The new (to be established June 2006) Regional Science Hub (where science as a term includes all STEM subjects) will link into the new National Maths Learning Centre. The new National Centre for Excellence in the Teaching of Mathematics (NCETM) will be launched in June 2006 and forms part of the Dfes recommendations from Professor Adrian Smith’s report ‘Making Mathematics Count’.

3. RECENT PROJECTS IN YORKSHIRE
Outlined below are a few projects that give a flavour of the potential for maths related projects.

Rievaulx Abbey Courtyard Garden English Heritage is working with a local special needs school to develop a medieval themed garden (2005/6). As part of this project pupils have surveyed the area, drawn plans, recorded archaeological finds and developed designs for the garden.

North and East Yorkshire Ecological Data Centre are developing training sessions to encourage more young people and adults to get involved in biological recording particularly using identification keys and databases.
Arty Maths courses were developed and delivered by Maths Specialist Teacher, Steve Reeder, which demonstrated how art gallery collections can be used to support the Numeracy Objectives for KS1 and KS2.

Hull Central library is working with children to create, investigate and develop magic tricks, which includes scientific and mathematical principles. This Creative Minds project links to the library resources.

York Archaeological Trust developed Sagas and Sums workshops working with seven local primary schools (Y6) as part of a Study Support programme. This Viking project explored and investigated a wide range of literacy and numeracy activities including coordinates for excavating a Viking burial and using a horizontal abacus as part of a Viking marketplace activity.

Malton Museum worked with English Heritage and KS3 pupils to investigate and survey the medieval houses of Wharram Percy deserted medieval village and use these measurements to make their own computer generated images of what the houses may have been like.

The National Railway Museum have developed workshops and education programmes that use practical bridge building workshops to illustrate scientific, mathematical and engineering principles.

CASE-STUDIES

York City Archives and astronomical records of the 18th century
York City Archives (funded by YMLAC through the Creative Minds programme) developed a series of lectures for two local specialist school VI form groups. The lectures focused on the achievements of past astronomers, particularly the accuracy of their measurements, recording and calculations. One lecture led by Martin Lunn (from York Museums Trust) explored astronomical observations of the late 18th Century and their importance in the history of astronomy. The observations (archive material) of York astronomers Goodricke and Pigott were discussed using archive material from York City Archive. These observations included studies of comets,
early observations of the planet Uranus and most importantly detailed observations of the variable star Algol and its unique interpretation as an eclipsing binary star.

Another workshop entitled ‘From Aristotle to Einstein’ explored the development of theories of the universe that led to the concept of orbital motion and its importance in our understanding of nature. This session also considered how observations of the motion of the planets led to empirical laws that were later explained by the physical/mathematical theory of Newton and the observations of the planet Mercury that led to the new theory of gravity developed by Einstein.

Contact: Sarah Costly – York City Archives

The Creative Minds of Monks

This programme of workshops was developed in partnership between York Museums Trust (St. Mary’s Abbey) and English Heritage (Byland Abbey). The one-day workshops were designed to encourage KS2 pupils to use mathematical and scientific skills to explore St. Mary’s Abbey and Byland Abbey. A number of activities were enjoyed by pupils throughout the day.

During the maths based activities pupils -

- estimated and measured the ruins of the abbey building. A number of units of measurement were used, including medieval and metric
- used a replica medieval quadrant and a modern clinometer to measure the height of the abbey walls
- used a trundle wheel and long tape measures to map out the area of the abbey floor
added their findings to a plan of the abbey, marking out the highest walls and longest walls

explored tessellations through floor tile patterns at Byland Abbey.

During the science based activities pupils –

explored the arches present in the abbey building

through a practical hands-on activity, pupils built two styles of arch, and investigated the forces they can withstand by loading each arch with weights

recorded the data from their findings and chose the most successful arch by marking each against a number of criteria

explored the development of compasses, focusing on those used in medieval times. Pupils handled replica early compasses, and using knowledge of magnets discussed the scientific principles at work

made a simple compass using a horseshoe magnet and an iron nail. The accuracy of the compass was tested with a modern compass. The aim of the activity was to mark out the cardinal points on a map of the abbey site.

explored why the abbey is aligned the way it is, using the results from their maths activities throughout the day - this includes the importance of having south facing windows, and other geographical features which were present when the abbey was built.

Contact: Janine Taylor - Learning Co-ordinator York Museums Trust

‘Time Detectives’ – More than Statistics

The idea for this Creative Minds funded project led by Beck Isle Museum, was to take a local community and study the statistics and impacts that came from the Great War and the lasting effects within the community. The data was gathered from local primary sources including war memorials, period newspapers and Green Howards Regimental and Beck Isle Museum’s collections. The project was developed in partnership with Kirkbymoorside School.
Using these resources pupils studied –

- How many men/women fought in the Great War from the community?
- How many returned?
- For those who did not return what was the cause of death? (Were they killed in action, died of other causes, died of wounds, remained missing, wounded and so on)
- The impact of the numbers that did not return.
- Who were the youngest and oldest local soldiers?
- What were the main units local men served with?

Scientific developments that changed warfare during the period, and what life in the trenches was like for the British ‘Tommy’ was explored through museum visits along with hands-on sessions.

Pupils recorded information from local war memorials; this also helped to encourage students’ interest in their local monuments and their parish church. Although the project focused on Science, Technology, Engineering and Maths, aspects of citizenship and community belonging were developed.

The students constructed an ‘Excel’ database which can be used to extract and interrogate the data and look for patterns. This database will be further developed so that other schools and the museums can use it.

‘The enthusiasm of all the students, teachers and teaching assistants has been wonderful and this has been one of the most rewarding projects the museum has
undertaken. Our hope is that having researched the fallen of the Great War from their community that these names will now be ‘More than Statistics’ and the Memorials and Monuments will have a place of meaning for all. The young children today will be the future guardians of such heritage and projects like this help to define and promote this’.

Contact: Rodger Dowson – Freelance Project Designer & Co-ordinator

Motheamatics - ‘The Winged Skull and 8,000 Other Moths’ was an education project that centred on an exhibition of the Allis Collection of specimens of British moths from the 19th Century. It is one of the finest collections in the country and has been in store for many years at the Yorkshire Museum. The moths were on public view (2005) at Shandy Hall, Coxwold (the home of Laurence Sterne, 18th Century author of ‘The Life and Opinions of Tristram Shandy’).

The children at Husthwaite Primary School became moth-spotters and moth-breeders during the summer and autumn of 2005 as part of the classroom became a miniature breeding laboratory for a variety of different species including the Death’s Head Hawk Moth, Puss Moth, Pebble Prominent and Red Underwing. Caring for the caterpillars and monitoring their development became a morning routine for the children and the prodigious amount of fresh leaves that caterpillars require was soon noticed.

It was decided to keep one of the Pebble Prominent caterpillars in a separate box and to monitor how long it took the larva to eat an entire leaf. The sound of a caterpillar munching a leaf is not difficult to hear and the systematic way they embark on their breakfast, lunch and dinner is very impressive. After a day the leaf was half gone and in its place, scattered on the floor of the box, was a large number of pieces of caterpillar ‘frass’ – a word the children enjoyed learning for obvious reasons. So we counted the frass and found that after two days the leaf had entirely vanished.

Counting the frass was easier if it was collected in groups of 5 so the children multiplied until we determined that 2 leaves = 70 pieces of frass. Then we re-ordered the material and worked out the number in groups of three as a class activity.
It was then a simple matter to count the number of leaves on a branch from the Poplar tree, then to start to consider the number of branches on a Poplar tree and estimate numbers of caterpillars, moths and so on.

So ‘Mothematics’ was born and flourished for a brief period in a North Yorkshire School.

Contact: Patrick Wildgust – Laurence Sterne Trust
4. OTHER PROJECT IDEAS

There is a wide range of maths related projects or programmes that could be developed using the diverse nature of collections and the ideas below with the outlines of recent projects give some suggestions for ways in which mathematics can be explored.

MLA as a business and public space
MLAs can be explored as a business particularly the layout of the building (including the entrance, displays, study areas, shop and café) or the stocking and selling of stock in the shop or café. The design of new exhibition areas provides opportunities for projects working with groups to develop these areas, which can include many mathematical skills including measuring, plans and problem solving.

The work of MLAs including cataloguing books, archives or collections, recording data, using databases and providing information can all be used to develop meaningful projects using mathematical skills.

MLA collections
The diverse nature of collections held by MLAs can contribute to the development of a wide variety of projects. These could include –

- Using medical collections and archives to explore the spread of diseases in the past (time and distance) and changes to populations.
- Textile collections can be used to explore patterns, shapes, transformations (rotation and reflection), how textiles were used in the past including cost and quantities, import and export.
- Natural history collections can be used to investigate symmetry in plants and animals, using identification keys, database information such as size and weight.
- Roman objects, sources and books can support the study of Roman numerals, measurements, surveying techniques, building plans and designs, Roman roads and Hadrian’s Wall.
Historic vehicles ranging from bicycles to cars, trains and aeroplanes can be compared to modern vehicles for speed, efficiency and cost. Map-reading, navigation techniques or a study of wheels could all be used to support the maths curriculum.

The study of dinosaurs, for example comparing size, weight, distribution, scale, ratio and speed.

Archaeological techniques provide many opportunities for supporting maths activities including using maps, surveying, drawing plans and scale drawings.

Maths Trails have been developed by some museums and sites, which can offer learning experiences for all ages. Trails can be tailored to fit into certain topics, or include a whole range. Challenging pupils and helping to improve their mathematical thinking, not just their observational skills. The questions should provide opportunities for children to explore and develop strategies for solving a variety of problems. For example,

Can you think of a way to estimate the number of mosaic pieces used in this picture?

5. SPECIFIC LEARNING OUTCOMES

Learning and discovery are at the core of many MLA’s work and the learning activities are driven by the Inspiring Learning for All Framework, developed for museums, libraries and archives across the UK.

Inspiring Learning for All adopts a broad and inclusive definition of learning as its starting point:

‘Learning is a process of active engagement with experience; it is what people do when they want to make sense of the world. It may involve the development or deepening of skills, knowledge, understanding, awareness, values, ideas and feelings or an increase in the capacity to reflect. Effective learning leads to change, development and the desire to learn more.’
Inspiring Learning for All is based on the firm belief that every experience has the potential to encourage learning and the Generic Learning Outcomes identified by the Inspiring Learning for All Framework fit very well with learning outcomes identified through schemes of work and project plans developed by teachers. The Generic Learning Outcomes are

- knowledge and understanding
- skills
- attitudes and values
- enjoyment, inspiration and creativity
- activity behaviour and progression

Below are some suggested specific learning outcomes that can be achieved when developing mathematical projects and programmes.

**Developing problem solving skills finding solutions and testing these**
(Knowledge and understanding and skills)

**Develop the ability to think logically and solve problems** (skills)

**Communicating the results to others** (skills)

**Understand how maths is used to interpret the world in which we live** (attitudes and values)

**See the relevance of maths outside the classroom** (attitudes and values)

**Engage in challenging and stimulating mathematical challenges** (enjoyment, inspiration and creativity)

**Be motivated and involved in mathematical activities or solving mathematical problems** (activity behaviour and progression)
6. SOURCES OF HELP AND INFORMATION

Organisations or other contacts

- Business Education Partnerships (BEPs) or Education Business Partnerships (EBPs)
- LEA advisory staff or consultants (contact your LEA)
- ASTs (Advanced Skills Teachers – subject specialists)
- Specialist schools (mathematics and IT – check out using website http://www.specialistschools.org.uk/schools/search/default.asp)
- UK Maths Trust (http://www.ukmt.org.uk/) although usually maths tests and quizzes in schools.
- Association of Teachers of Mathematics (http://www.atm.org.uk/)
- The Mathematical Association http://www.m-a.org.uk/
- SETNET (Science, Engineering, Technology and Mathematics Network) www.setnet.org.uk
- National Centre for Excellence in the Teaching of Mathematics (NCETM) www.nectm.org.uk

Websites

http://www.censusatschool.ntu.ac.uk/default.asp
Ideas for using information http://www.bbc.co.uk/schools/starship/
Interactive games KS1 www.mathsnet.net/
GCSE and A Level information http://www.waldomaths.com/
KS3/4 curriculum information, puzzles and quizzes http://www.cimt.plymouth.ac.uk/
Centre for innovation in maths teaching http://www.cut-the-knot.org/content.shtml
Interactive mathematics miscellany and puzzles
http://www.mathsyear2000.org/
Resources and information including a maths museum

American web site with ideas for activities – business orientated activities

http://www.kevinsplayroom.co.uk/
NgFL site with lots of maths web site links

http://www.kjartan.co.uk/
The writer of Murderous maths series includes books and puzzles

http://www.mathemagic.org/
York based resources

http://www.mathsisfun.com/
Quizzes, information and resources for teachers

http://motivate.maths.org/
A real-time videoconferencing project for schools that enables students of all ages (5-18) to work with professional mathematicians and scientists, and with other school students their own age both in the UK and internationally.

Mathematics problems, games and articles

http://www.mrhall.org/math/realmath/realmath.htm
Converters and activities

http://www.murderousmaths.co.uk/
www.standards.dfes.gov.uk gives details of each curriculum area and there are full details of the mathematics framework for each year and term.

www.spartacus.schoolnet.co.uk/REVmaths.htm
List and descriptions of a wide range of maths related sites)
BOOKS AND OTHER RESOURCES

For younger pupils (KS1/2)


For older pupils (KS3/4)

Guedi, Denis *The Parrot’s Theorem* Pheonix books ISBN: 0753811073


For teachers

Numeracy through problem solving is a sequence of five modules which develop students’ ability to use mathematics together with other skills, in tackling problems of concern or situations of interest in everyday life.

In Plan a Trip students plan and undertake a class trip using costings, scheduling, surveys and everyday arithmetic - Written by Malcolm Swan, Barbara Binns and John Gillespie with Hugh Burkhardt and the Shell Centre Team, published by Shell Centre & Longman 1987 - 1989.

Also in series - Design a board game, Produce a quiz programme, Be a shrewd chooser.

*MathFest! – Some ideas to help you run your own public maths event. (VHS video)

OTHER


Eastaway, Rob How to take a penalty: the mathematical curiosities of sports Robson Books Ltd ISBN: 1861058365

Guedj, Denis Numbers: the Universal Language


Hoffman, Paul, The man who loved only numbers; story of Paul Erdos and the search for mathematical truth Hyperion books ISBN: 0786884061


Wells, David You are a Mathematician Penguin Science ISBN: 014017480X

Wells, David, Mindbenders and Brainteasers Robson Books Ltd ISBN: 1861055625

*Mathematics Appreciation and other books by Theoni Pappas

*In Code– the story of a 16-year old schoolgirl from Ireland who took the world by storm with her innovations in the field of cryptography and codes.

*Teaching Mathematics with Fathom Student guide on using the latest software to analyse student-collected data

*Geometers SketchPad 3 – dynamic geometry software available from £29
**REPORTS**

*Making Mathematics Count*: The Report of Professor Adrian Smith’s Inquiry into post-14 mathematics education 2004 (www.mathsenquiry.org.uk)

*Ideas for Museums, Galleries and Heritage Sites*  
(50-page document prepared by Maths Year 2000)

**Museums Alive! For Schools** YMLAC Report (November 2005)

**Improving Literacy and Numeracy – A Fresh Start**  
www.lifelonglearning/mosergroup/

* Resources available from John Bibby of aa42 email ged@enterprise.net address –  
1 Straylands Grove, York YO31 1EB

*Report written and compiled by Julie Ward (March 2006)*  
*Freelance Museum Educator*  
jgward@hotmail.co.uk
The Creative Minds project works with museums libraries and archives across the Yorkshire and Humber region, to provide young people with learning opportunities in science, technology, engineering and maths (STEM).

This ground-breaking project is the first of its kind in the country and is managed by MLA Yorkshire.

Creative Minds is funded by Yorkshire Forward the regional development agency for the Yorkshire and Humber region.