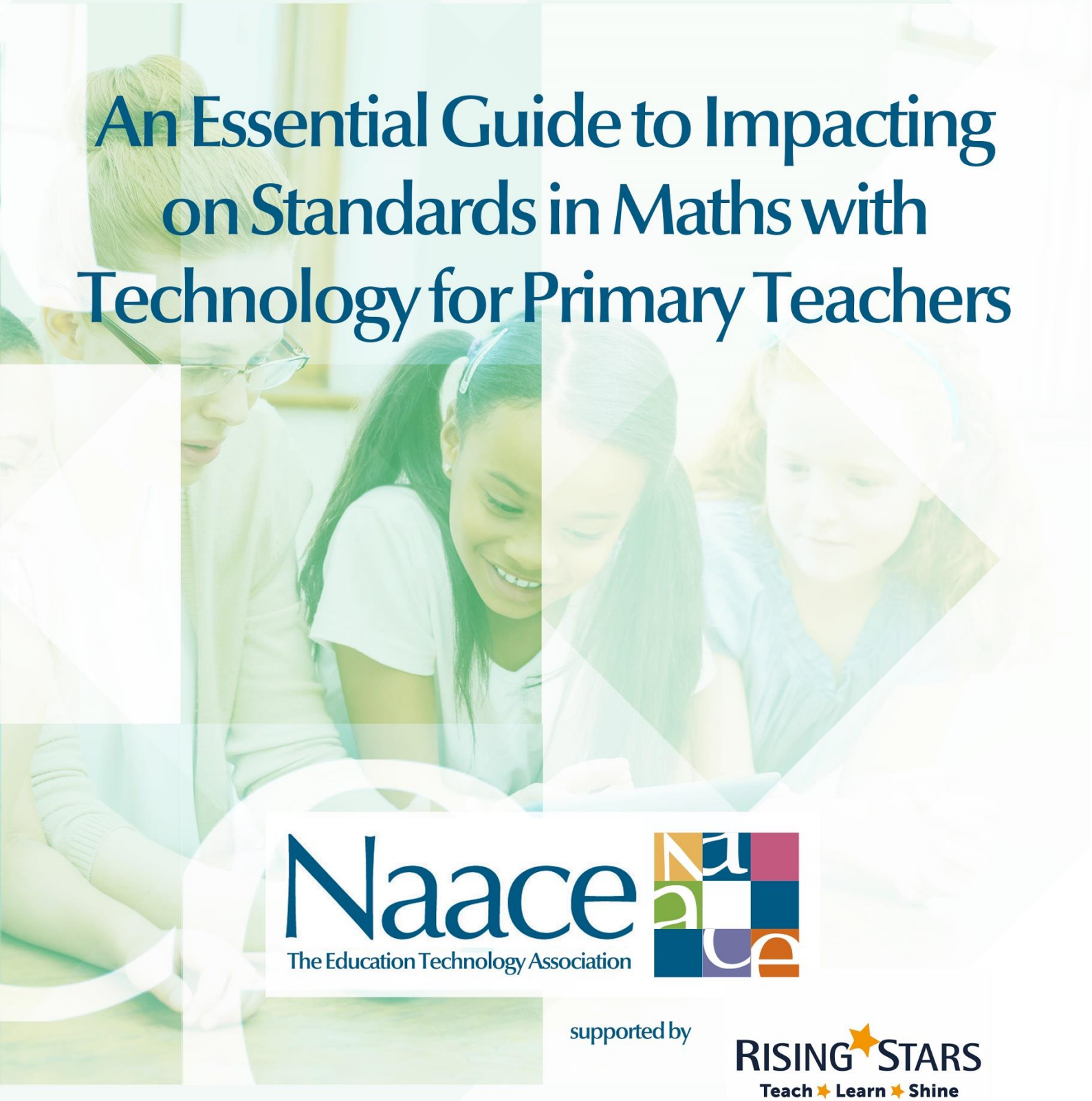

An Essential Guide to Impacting on Standards in Maths with Technology for Primary Teachers

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A Naace Publication by Dr Carol Porter
Series Editors: Mark Chambers, Dr Carol Porter, Tim Scratcherd

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Foreword from the Sponsor

As one of the leading UK publishers for mathematics and computing resources and a proud publishing partner of Naace, we are delighted to sponsor the *Essential Guide to Impacting on Standards in Mathematics with Technology for Primary Teachers*. Here at Rising Stars, we firmly believe that technology can play a vital role in helping teachers to improve teaching and learning across the curriculum. This guide will evaluate the place of digital tools within the maths curriculum and help teachers to judge the impact certain hardware and software can have on learning in the classroom.

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Featured products

Switched on Computing: Maths through Computing provides four free units of work which use computing to help children to develop numeracy skills. Each unit provides clear teacher guidance on how to run the activities and includes links to both the maths and computing programmes of study. Download for FREE at www.risingstars-uk.com/socmaths

Rising Stars Mathematics is a new mastery textbook programme which blends print and digital resources to enhance learning and help teachers deliver high-quality maths lessons. You can find out more at www.risingstars-uk.com/rsm

About the Author

Dr Carol Porter has been the Technology Curriculum Support Centre Manager in Bury LA, offering training and consultancy advice on the computing curriculum, schemes of work, progression and assessment to teachers in Bury. She also develops training courses based around the 2014 computing curriculum and in effective uses of technology across the entire primary curriculum.

Carol is a Naace Fellow, a Naace Lead for Professional Development and Standards in Computing, and she serves on the Naace Board of Management.

Summary

This eGuide is intended to give primary teachers an understanding of

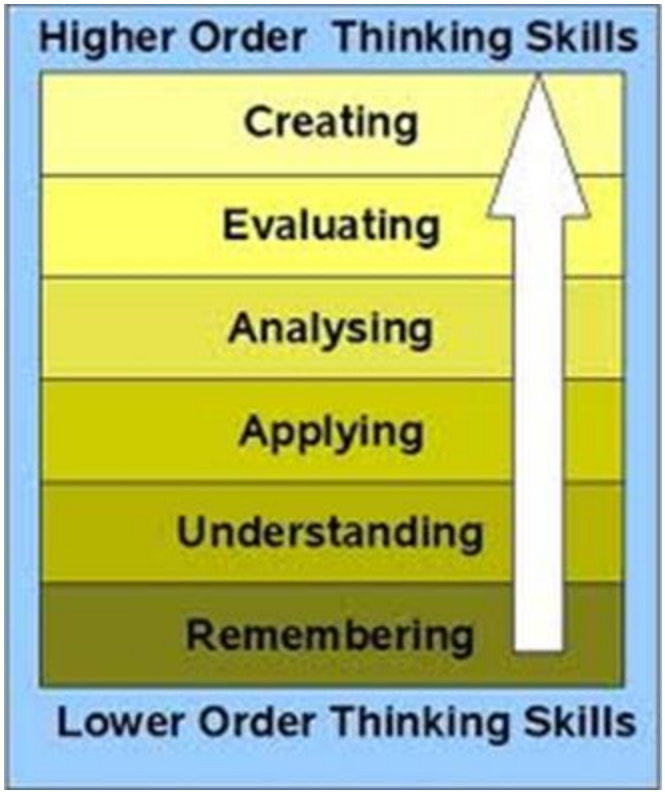
- which hardware, software and peripherals could be used in class to accelerate learning;
- effective management of resources;
- how to judge the 'value added of the use of technologies on learning;
- facilitation of children's independent consolidation activities; and
- the place of digital tools for teaching the 2014 mathematics curriculum.

Why Use Technology in Mathematics?

Ruben Puentedura has developed the "SAMR" model of how teachers integrate Apple technology into their practice. It has since been realised that SAMR can be applied to embedding almost all technology in pedagogical practice:

TRANSFORMATION		
Redefinition	Tech allows for creation of new tasks, previously inconceivable	IWB flipcharts are posted to class blog or web page to be viewed as homework ahead of the lesson i.e. 'flipped' learning; children apply their knowledge to solve problems facilitated by teacher in class
Modification	Tech allows for significant task design	IWB flipcharts contain web links, images, video and audio; text is word-processed and spell-checked; children have access to the interactive activities on their own devices
Augmentation	Tech acts direct tool substitute, with some functional improvement	IWB flipcharts saved and retrieved in subsequent lessons, images and other media incorporated
Substitution	Tech acts as a direct substitute, with no functional change	IWB used in exactly the same way as a blackboard
ENHANCEMENT		

There are clear links between SAMR and Bloom's Taxonomy:



- ‘Remembering’ is being able to recall relevant knowledge from long term memory
- ‘Understanding’ is being able to make sense of what is remembered
- ‘Applying’ is using the knowledge gained in new ways
- ‘Analysing’ is breaking the concept into parts and understanding how they are related to each other
- ‘Evaluating’ is making judgments about knowledge based on a set of guidelines
- ‘Creating’ is putting the knowledge together in an innovative way.

Some technologies simply offer ‘practice and drill’ activities, which represent “substitution” in terms of SAMR, and “remembering” in terms of Bloom. It is of course desirable that some things are just known, such as times tables and spelling patterns. This is the lowest level of cognitive engagement though, and should not constitute an end in itself; it is necessary to know these things in order that other, more cognitively demanding, tasks can be done efficiently and effectively.

It is important to quantify the impact of technologies on learning objectively. We may *feel* that a learning technology is effective, but is it worth the money it costs?

Consider this analogy.

It takes about an hour to walk four miles. You could cycle four miles in a much shorter time, or go much further in an hour.

BUT…

You have to buy a bike,

AND…

You have to learn how to ride it!

ALSO…

You should also buy a puncture repair kit and learn how to use that too.

School House Partnership has developed this useful tool to quantify the benefits of technology in learning, compared to its total cost of ownership:

<table>
<tr><td>Activity Description</td><td colspan="5">Analysis</td></tr>
<tr><td rowspan="4">A</td><td>Enhancement</td><td>Transformation</td><td></td><td>ICT tools required</td><td>ICT competence required</td><td>Transferability</td></tr>
<tr><td>B</td><td>D</td><td>Teaching/Teachers</td><td rowspan="2">F</td><td rowspan="2">G</td><td rowspan="2">H</td></tr>
<tr><td>C</td><td>E</td><td>Learning/Pupils</td></tr>
<tr><td colspan="3">Benefit
I</td><td>Cost
J</td><td>Cost
K</td><td>Benefit
L</td></tr>
<tr><td colspan="6">Impact
M</td></tr>
</table>

A	This section only needs detail, or even completing at all, if the tool is to be used for recording and passing on to others, as well as evaluation
B C D E	Enhancement and transformation are used to define the **spectrum of advantage** of using technology. The use of tech **enhances** the activity if it creates **efficiencies**, so that the activity could be undertaken without it, but with a lot of effort. The use of technology **transforms** the activity if it would be **impossible** or **very difficult** otherwise. The distinction between teachers and students is simply who uses the technology (but see benefit). Note that if neither enhancement nor transformation is occurring, then there is no point using the technology at all.
F	This is simply an assessment of what technology is needed to achieve the activity; hardware, software, data, internet access and so on
G	This section requires a judgement of the range and complexity of competences required by either students or teachers, to do the activity
H	This section refers to the specificity of the activity: is the idea, or concept, transferable into another subject or theme?
I	In this section, and in J, K, L and M, make a judgement. Use more qualitative measures, such as high, medium, low. Clearly, the more the activity is a transformation, rather than an enhancement, the more benefit accrues. Also, the more the use is by pupils, the greater the benefit.
J	This is not just the idea of one off financial cost. Of course the cost does include financial cost, but in school settings, hardware such as an IWB is generally available. If the hardware and software is generally readily available, then this implies a low cost. Software costs may not always simply be applications; they may be associated with obtaining gathering data. The potential for increased cost is present when students are using ICT, not just teachers. Key words for classifying costs are capital (or start-up) and revenue (or ongoing) costs, for hardware, especially maintenance. Hardware costs are reduced if the hardware can be used for many purposes. For example a well-used tablet is expensive to buy, but can have a wide

	range of uses in many areas of study. Conversely, a data logger is cheaper to buy but has a smaller range of uses. Note the need for CPD referred to in K below.
K	The greater the range and complexity of competences required, the greater the cost of the activity. For example, there is a datafile containing weather data available. It can be used as the basis for a relevant and engaging study into the actuality of climate change, but a range of competences with a spreadsheet are required. It should not be assumed that teachers or students have these competences, and the cost is increased by the time and expertise required to develop those competences in others. CPD costs are not just one off; they are subject to start-up and ongoing costs too. This is because staff come and go from the school all the time, and explains why, after a number of years, hardware and software can be found unused in cupboards.
L	If the idea behind the activity is one which can be used in other subjects, or with a wide range of different users then it is transferable and the benefit of the activity is increased.
M	Assessing impact is a matter of professional judgement. The characteristics of high impact activities include increases in engagement and motivation, rapid progress, improved attainment, and applicability to a wide range of users. Generally, activities where students are using technology to pursue enquiries, solve puzzles or work independently, are high impact.

Cost/benefit can be summarised thus:

	High Cost	**Low Cost**
High Benefit	OK	Good
Low Benefit	Really?	OK

Clearly, the lower the cost and higher the benefit, the better. Questions should be asked regarding the suitability of learning technologies that are high cost and low benefit.

Reader, you now have three tools for evaluating the technologies that will be suggested to you in the rest of this eGuide: SAMR, Bloom's Taxonomy and cost/benefit analysis. Please satisfy yourself before purchasing any technology for use at your school that it has the potential to:

- transform learning,
- facilitate a high level of cognitive engagement in your pupils, and
- offer good value for money in terms of cost/benefit.

Mental Starters

The most valuable and powerful contribution technology makes to maths learning is instant feedback. Children know, immediately, how they are doing, and can modify their thinking and problem solving approaches accordingly. There are many 'practice and drill' maths apps

that offer this, including Hungry Fish, Mr Wolf, Matific, the Motion Math suite of apps, King of Maths, the Math Racer suite of apps and Math Bingo to name but a few. Play Osmo is an app that helps develop mathematical spatial awareness by judicious addition of a clip on mirror to the tablet, and Skoolbo is a free online games platform that provides data back to the teacher to monitor and track pupils' progress.

Pupil response systems allow questions to be asked, answered, and marked immediately. ActivExpressions do this in conjuction with ActivInspire software from Promethean Planet; ActivEngage, NearPod and Socrative are apps that convert any hand-help device into a pupil response system. Teachers set questions in advance (or download them from the relevant online community), and children answer them either at their own pace, or as the teacher moves the class on through the question set.

There are many flipcharts suitable for mental starter activities for both Promethean and Smart interactive whiteboards on Promethean Planet and in the online Smart community respectively, and many are free to download.

Online games resources that provide instant feedback include Manga High and Primary Games Arena. Teachers should investigate these beforehand and select suitable games in terms of both ability and strand of maths.

Purple Mash from 2Simple contains a variety of maths games, and metrics can be obtained through the "teachers" area.

Main: Exposition

Keeping it simple, connecting a visualiser to your interactive whiteboard will allow demonstration of processes such as partitioning with dienes apparatus so that everyone can see. You could also use the record facility in the visualiser to capture this as a video to replay on loop for children to re-watch as often as necessary. Remember that there are visualiser apps for most tablets.

Flipcharts for Promethean or Smart boards for any maths topics, at any stage of ability can be downloaded, usually for free. Competent IWB users may well find it quicker to make their own flipcharts than hunt for something suitable online.

You are likely to already know about TES iBoard. Simply register, pay the subscription fee and download engaging interactive teaching resosources.

Within Purple Mash there are useful tools for teaching maths skills, including

- 2D&M – make and test nets of regular and irregular 3D shapes
- 2Count – make pictograms

- 2Graph – make block charts, bar charts (horizontal or vertical), pie charts and line graphs
- 2Calculate – a simple spreadsheet

"IWB" apps such as Explain Everything, Educreations and Show Me allow children to work through problems, for example grid multiplication, and record themselves 'thinking out loud' as they go. The resulting videos could be exported to the tablet camera roll and uploaded to the class web page or blog for peers to refer to for method consolidation, or for "flipped" learning.

Main: Independent

Independent maths groups need to be set meaningful tasks that consolidate their learning, and give opportunities to apply their knowledge to solve problems. You could do worse than set the group to work on one of the old interactive teaching programmes, which are still available here: http://www.taw.org.uk/lic/itp/ A teacher's guide to how to use them is also available, here: http://www.taw.org.uk/lic/itp/num_itp_guide_03.pdf

There are of course many IWB flipcharts available for both ActivInspire and Smart systems that your pupils could work through independently. Many apps could be used to support independent consolidation, such as King of Maths, Math Bingo, Hungry Fish, Mr Wolf, Motion Math and Math Racer (but not if they were also used during the mental starter!) Online maths games platforms like Manga High, Primary Games Arena, Sum Dog and Mathletics could also be used by independent groups.

You probably have plenty of calculators in your classroom, which all count as technological devices, and there are many calculator apps available for mobile tablets, from basic +, -, x and ÷ to full scientific calculators. Your attention is drawn to My Script Calculator, a free app that looks nothing like a calculator. You simply write your number sentence by hand e.g. 5 x 3 =, and the app will recognise the handwriting and give the answer. This app will correct user-errors, so 5 x 3 = 8 becomes 5 x 3 = 8 + 7. It knows about √, π, % and brackets. Remember that you also have a digital calculator built into your IWB software for demonstration purposes.

Spreadsheets are invaluable digital tools for number crunching, and it is recommended to teach spreadsheet skills as part of maths of science, not as an abstract IT skill. Microsoft Excel is suitable for use by upper KS2 pupils, but simplified spreadsheets such as Numberbox or 2Calculate are suggested for younger children.

Plenary

Possibly the easiest way to review a child's work and share it with the class is by putting it under a visualiser. Projections from visualisers can be annotated at the IWB without actually making marks on the original document. Pupil response systems such as ActivExpressions are great for checking understanding, and whilst the "exit ticket" in Socrative requires no advance preparation, it provides teachers with useful data regarding pupils' understanding.

Videos created by children using IWB apps like Explain Everything, Educreations or Show Me can be 'mirrored' onto the class interactive whiteboard for peer review.

Homework

What is the return rate for homework at your school? Traditional homework tasks can be really quite ineffective. Worksheets take time to prepare, can be the cause of traumas at home, and take so long to mark and return to the children that the impact of any feedback is significantly diminished. Factor in that when homework is done, the teacher doesn't really know whose work is actually being marked (mum's, dad's, big sister's), and the whole process approaches pointlessness!

Many schools subscribe to online maths homework providers like My Maths. Children receive instant feedback, and teachers get data. The drawback is that teachers still have no guarantee that the tasks are being completed by the pupils as intended, there is no 'second chance', and 'work in progress' cannot be saved.

Some schools are beginning to embrace "flipped learning" as a way of setting meaningful homework which children become highly motivated to complete themselves. Videos or IWB flipcharts are uploaded to the class web page or blog prior to the lesson, and pupils get the 'transmission' elements of their instruction at home. They can watch the videos as often as necessary until they 'get it'. At school, the teacher sets problems that require pupils to use and apply their knowledge – driving them up bloom's taxonomy, with the teacher present to support their higher level cognitive engagement where appropriate. The videos need not feature teachers' faces! They could be generated using the IWB aps mentioned earlier, so there would be no 'live' action – just the teacher's voice with animations on screen.

Some Teaching Resources (bibliography, web links, teaching tips, examples)

ActivInspire – free-to-download interactive whiteboard software that (amongst its other functionalities) can be used as a maths resource:
http://support.prometheanplanet.com/server.php?show=nav.29751&changeCountry=United+Kingdom

Bury Primary Computing Solution – a comprehensive computing SoW, that includes progression grids for each strand, assessment grids for each year group, medium term plans for each year group for each strand, cross-curricular links, suggested resources (hardware, software and peripherals), a glossary of Computing terms, and separate sections for EYFS and SEN practitioners. Clear links are given for embedding technology and computing skills into all other curriculum areas, including English and Mathematics:
http://tcsc.primaryblogger.co.uk/2014/12/12/bury-primary-computing-solution/

ITPs – interactive teaching programmes originally launched some time ago, and still of value:
http://www.taw.org.uk/lic/itp/ Instructions for use are here:
http://www.taw.org.uk/lic/itp/num_itp_guide_03.pdf

iVisualiser – an app that turns a tablet into a visualiser (note that a frame of some kind will be required to support the tablet above the child's work)

IWB apps:

- Educreations https://www.educreations.com/
- Explain Everything http://explaineverything.com/
- Show Me http://www.showme.com/

Manga High – an online games platform https://www.mangahigh.com/en-gb/

Microsoft Office Excel – a spreadsheet tool for use by upper KS2 children

My Maths – an online subscription service for maths homework
http://www.mymaths.co.uk/

Numberbox – a simplified spreadsheet application from Black Cat software. Sadly no longer available, so if you have it, keep it!

Osmo – clever gizmo that clips onto your tablet for interactive mathematical spatial awareness development https://www.playosmo.com/en/tangram/ and https://www.playosmo.com/en/newton/

Primary Blogger – a free blogging platform suitable for use by primary aged pupils
http://primaryblogger.co.uk/

Primary Games Arena – an online free-to-access platform for primary maths games
http://primarygamesarena.com/Maths

Promethean Planet – an online community of users, with support and resources, many of which are free. Be sure to create your login to the UK site, not the US site! (check the top right-hand corner) http://www.prometheanplanet.com/en-gb/

Pupil Response Systems

- ActivExpressions
http://www.prometheanworld.com/gb/english/education/products/assessment-and-student-response/activexpression/
- ActivEngage
http://www.prometheanworld.com/gb/english/education/products/assessment-and-student-response/activengage/
- Socrative http://www.socrative.com/
- NearPod http://www.nearpod.com/home.php

Purple Mash – a comprehensive online suite of software to support discrete skills development within the computing PoS as well as embedding technology across the wider primary curriculum: http://www.purplemash.com/

- 2Calculate
- 2Count
- 2Graph
- 2Design and Make
- Maths Games – see “Games” tab

Smart Notebook – free-to -download interactive whiteboard software that (amongst its other functionalities) can be used as a maths resource: https://www.smarttech.com/downloads

TES iBoard – an online subscription service with downloadable interactive teaching resources http://www.iboard.co.uk/

TTS – a supplier of peripherals suitable for use in EYFS and primary environments, including calculators: http://www.tts-group.co.uk/

Visualisers – put simply, these are just cameras on a stick! Link to your IWB to show children’s work, or to demonstrate techniques.

Naace has produced this series of Essential Guides, or "eGuides" in response to an identified gap in teachers' CPD. That is, how to use technology creatively and effectively to make significant impacts on learning and standards in other curriculum areas.

Naace believes that technology has a major role to play in raising standards in learning across the curriculum, provided teachers know how to adapt their pedagogies in order to maximise the potential gains offered by learning technologies.

Supported by Rising Stars

Naace has a network of qualified associates who can support your school. For further information contact: naacepde@naace.co.uk

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