Making a Difference

A Six Month School Improvement Initiative

Name	Simon Cox (SCO) - Director of Mathematics and Numeracy
Title of Project	Diagnostic assessment in Mathematics
Brief description of the issue you are seeking to resolve or initiative you wish to introduce (150-200 words)	The historical levels-based assessment culture has too often resulted in gaps in students' basic numeracy skills going unnoticed and unchallenged as teachers have been encouraged to move onto higher "level" work without ensuring that more basic skills are embedded and returned to with the frequency needed to ensure mastery. This project hopes to address this with the current Y10 cohort, who have begun studying a more challenging and rigorous GCSE mathematics course. Students will be set a weekly online multiple choice quiz which explores their understanding of key skills. "Wrong" answers are carefully chosen to explore potential misconceptions. Their performance will then be analyzed and a weekly "insight" into their performance will be obtained. This will then inform planning of a mini recap session within their mathematics lessons in which that misconception is addressed.
Target Cohort	Year 10 (set G4 initially, extending to more classes subsequently)
Research evidence for strategies to be used (400-500 words)	Misconceptions or shaky foundations in basic skills, particularly in calculation, can hold students back in their understanding of GCSE topics which reply heavily on strong foundations and conceptual understanding. Mathematics teachers often report that students drop marks in GCSE exams due to this - e.g. When expanding a pair of algebraic brackets we often find students making mistakes not with the algebraic ideas but with the multiplication or addition of negative numbers, something which they should have mastered by the end of Year 8 at the latest. This is supported by our exam paper analysis at St Mary's using Edexcel ResultsPlus - many of our Foundation (and even Higher) tier students dropped marks on questions we would never have expected them to due to mistakes with basic skills. The increased focus in the new GCSE on problem-solving makes mastery of these basic skills even more important than ever before. William Emeny, a mathematics lead practitioner from Wyvern College in Hampshire writing on his blog greatmathsteachingideas.com, carried out extensive research into students' starting points on entry to secondary school in Year 7. He found that gaps in basic skills were not limited to weaker students but were also apparent in students achieving level 5a and 6 in the KS2 SATs exams ("The Problem with Levels", Jul 3 2015). Emeny also explored which topics are the 'essential skills' required to access as many topics on the GCSE as possible. If pupils need to completely master certain topics in KS3 in order to be able to learn as much of the GCSE syllabus as possible, what are those topics? A diagrammatic representation of the links between topics was produced, with the node size scaled based on how many links the topic has, i.e. how many topics it is prior learning for. The larger the node, the more topics it is prior learning for. The largest nodes are the essential skills needed to be able to access the full GCSE. The diagram can be accessed here: http://tinyurl.com/Emenydiagram The large nodes were almost exclusively "number" based basic skills: four operations, decimals, negatives, order of operations, etc. This shows the importance of mastery of these skills to success in GCSE mathematics. Action is being taken in St Mary's mathematics at Key Stage 3 with a new scheme of work, DAFITAL, reteaching, spacing and interleaving but there is still a need for intervention at Key Stage 4 as these students have not been through the more thorough and challenging prior years but will face a GCSE paper that is poentially more difficult than ever before and more reliant on longer questions for which mastery of key skills is a pre-requisite.
Metrics **Baseline data and**	Initial data based upon analysis of completed GCSE paper by the target cohort. Weekly data will be collected from the target cohort after completion of the online multiple choice quiz.

data/evidence to be collected	Final data will be based upon analysis of another completed GCSE paper by the target cohort. It is hoped that an improvement in basic skills will be seen.
Actions Taken & Leadership Approaches (400-500 words)	The project was started initially with one Year 10 class (G4) studying towards the new more challenging Foundation tier paper - this was to enable any initial problems to be identified with a small group of students before rolling out to a larger group. The decision was made to set the multiple choice skills test for homework rather than use class time for completion. The reasons for this were twofold: to not reduce valuable curriculum time, and to reduce teacher workload (the homework was set online and was self-marking). Initial results were analysed by the class teacher and one particular misconception chosen. There were, in fact, multiple misconceptions from most of the quizzes but the most significant (in terms of its impact upon the understanding of more complex topics) was chosen to ensure a tight focus. This misconception became the focus of mid-lesson re-teach sessions for that week – teacher-led examples followed by increasingly difficult student practice across one or more lessons. Once the teacher was confident the gap had been closed, another misconception was identified – either from the same multiple choice test or from a newly set task, making sure that the misconception was returned to briefly a week or so later to try to ensure the key points were not forgotten. Interestingly, not all misconceptions were anticipated by the teacher, with some misconceptions being identified in unexpected areas of the curriculum such as plotting coordinates (students mixing up the x and y coordinates) which then has a knock-on impact on graph drawing and function transformations (an A grade topic which can nevertheless be answered incorrectly if coordinates are not used accurately). The project was then rolled out to a number of Year 10 classes, which provided the leadership aspect of the project. To minimise teacher workload, the multiple choice tests were set by myself for all classes involved via email directly to the students. This enabled a central analysis to take place, reducing possible variation in consistency of the analysis and identifying misconceptions which may exist across multiple classes. These misconceptions were then discussed in weekly meetings and possible re-teach tasks discussed. This collaborative element to the planning proved very valuable, taking the workload away from just one person and allowing the sharing of ideas and resources. The project was easily transferable to multiple classes and to large groups of students so no major additional issues were encountered at this point.
Evaluation of Impact What worked, What didn't & How do you know? (400-500 words)	Any formal attempt at evaluating the success and impact of this project has proven to be difficult. Looking at the Effect Size comparison of the paper sat earlier in the year and the paper sat later in the year shows a highly statistically significant score of 0.88. However, it is difficult to pinpoint exactly what caused this improvement. There are a number of factors involved: the class teaching over the year, the impact of homework tasks such as Method Maths past paper practice, the maturing attitudes of the students as they progress towards Year 11, in class and at home GCSE past paper practice, the school's DAFITAL process, and the project detailed here. As is often the case with any intervention programme, it could be any (or far more likely a combination) of these factors that has caused the improvement. Having said this, anecdotal evidence does point towards an improvement in the basic skills of the students, identified through marking of exam papers and through the experience of the teachers to recognise gaps in their students' skills. Students have performed increasingly well on questions towards the end of the papers which often rely on multiple skills for successful completion.

Indeed, when comparison are made between the class who were most involved with the project and other classes, we can see that on the majority of longer questions which are heavily reliant on basic as well as more advanced skills this class performed better – often significantly so.

The most noticeable examples of this are detailed in the table below:

Question theme	Class average %	Whole cohort %
Area of a circle	31.6	12.5
Inequalities	15.8	5.5
Volume	45.6	19.8
Probability	35.1	14.8
Best value problem	49.5	38.5
Money problem	100	76.5
Time problem	73.7	34.8

In conclusion, I think it is clear that the project has had an impact upon the basic skills of this group, and their subsequent success in answering longer style GCSE problems. With hindsight, I would have preferred more conclusive evidence of this but, due to the weight of other things happening in the mathematical education of these students, this has proven to be impossible.

Reflections
What would you do again, What would you do different & What will you do next?

The idea of identifying key misconceptions to be worked on in class is a powerful one, and a key focus of the school's DAFITAL programme. For this reason, the ideas trialled in this project will be embedded in mathematics department practice during the academic year 2016 – 2017.

There will be some adjustments made to the way this is done to make it easily transferable to a large cohort of students:

- Short in-class skills tests (student marked) will be used instead of the online assessments used previously. These will be generated via the MathsBox website (www.mathsbox.org.uk) and will focus on the same skills for a half term, before changing for the next half term. This is to ensure that homework time can be used for the highly effective Method Maths programme used across KS4 in the maths department.
- Plickers software will be used to continue the use of diagnostic multiple choice questioning within mathematics lessons.
- DAFITAL meetings will be used to discuss common misconceptions as a team, and identify possible ways of tackling these. This could include amendment of KS3 schemes of work to address these if appropriate.

Were a project like this to be repeated, I would think carefully about how the effect of an individual intervention might be isolated from the other interventions and teaching taking place.