Making the strange familiar: emphasising the role of mathematics across the curriculum

Aim of the project

By working collaboratively with other departments and concentrating on the language and processes used in the teaching and learning process, the Knowledge Network aims to enable learners to better apply their mathematics to unfamiliar situations.

Dimensions of the study

The Knowledge Network established at Swavesey Village College was intended to enable teachers from different subjects to share ideas on cross-curricular projects in a more collaborative way. We took this approach in order to address how, in our experience, learners compartmentalise their subject content and struggle to apply their skills and knowledge across areas.

Originally the Knowledge Network involved at least one member from the maths, science, English, geography, ICT, history, and ethics departments, but this number is continually increasing. The tasks were trialled with the Year 7 cohort, approximately 240 students, who are taught in mixed ability classes.

Summary of main findings

Establishing a Knowledge Network ensured that mathematics is no longer perceived to take place just in the mathematics classroom. Benefits included:

- Students recognising key skill applications across subjects
- Deeper pupil understanding within maths
- Developing the ability to reconstruct and apply knowledge to unfamiliar situations
- CPD opportunity for staff to plan collaboratively.

Background and context

The school day at Swavesey Village College is set up in such a way that it is easy for children to experience five 'snippets' of a bigger picture. Addressing this disjointed learning should help students recognise the key skills and processes that span across subjects, and ultimately deepen their understanding.

Following a successful application to the NCETM, we created the mathematics Knowledge Network as a vehicle with which to enlist the help of other professionals in developing learning resources that excite both teachers and students. However, moving the emphasis from initiatives being led by the mathematics department to working collaboratively with other departments resulted in the formation of the Knowledge Network. The initial meeting discussed that the emphasis was about linking up the learning for our students, and this became the theme that we followed.

Our thinking was that learners should be able to work in a wide range of contexts where the skills of representing, analysing, interpreting, evaluating, communicating and reflecting happen naturally regardless of subject area.

Teaching processes and strategies

A purpose of the Knowledge Network was to highlight and develop resources for areas of the science and mathematics curriculum in particular, where these processes could be enhanced through collaborative teaching and the development of a CPD model that also allowed time for team teaching and reflection. With changes to both the Key Stage 3 mathematics and science curriculum it seemed the ideal time to make some lasting changes.

We wanted to incorporate projects into schemes of work that linked skills across subjects and then refine them as necessary. After looking at the new Key Stage 3 science curriculum, the ICT curriculum and also the geography curriculum we found that there were many areas in which some re-evaluation and mutual planning would mean joined up 'thinking and learning' for our students.

For the first project we looked at the areas of reflecting, communicating and procedures which apply particularly in mathematics and science; we felt these were essential for Year 7 to understand as early on in the year as possible.

Reflecting	Communicating	Procedures
Making connections	Discussing methods and results	Collecting and analysing
Reflecting on approach	Using precise language and symbolism	Using accurate representations
Thinking and reasoning	Communicating outcomes	Monitoring accuracy of results
Reflecting on findings	Communicating in a range of different forms	Manipulating
Reflecting on alternative solutions		Using and applying Procedures

Groups of students were allocated three key processes and provided with a writing framework as a prompt sheet to consider where these skills had been used. Using this strategy enabled students to focus their thinking and fully understand a few of the skills; they then had the benefit of listening to how all the other skills were used during the student-led plenary presentations.

The project involved students using work from a science experiment in their maths lessons, and was adapted from the Nrich task on establishing the relationship between Celsius and Fahrenheit (http://nrich.maths.org/public/viewer.php?obj_id=5608&part). We invited someone from StemNrich to talk to the science and maths departments so that we could gain a better understanding of developing links and tackling the barriers that can occur when science gets particularly 'mathsy'. For example, some students have difficulties constructing and analysing graphs in science, yet could apply these skills in a maths lesson.

The findings

The project is still very young and it is not yet possible to quantify results, although some findings are already emerging.

Student outcomes:

- Students were more confident in identifying curricula links themselves, demonstrating their ability to reconstruct their knowledge
- By working in groups, students have been able to raise issues with peers that may have been left unsaid in a classroom-wide environment and which could have negative impacts in other subject areas
- In the science and maths project students were able to understand how the results collected from the science experiment could be extrapolated to help find the information they were looking for
- Students used a line of best fit after plotting their points and most were comfortable with using the negative parts of the axes
- During the tasks, many students understood where they were using the skills of reflecting, communicating and procedures, and used the intended vocabulary in their presentations. Feeling comfortable using the correct vocabulary during conversations emphasised the understanding that students had of the terminology and demonstrated their awareness of using the words in context
- A 'learning how to learn' culture was inadvertently created, where students reconstructed the way they thought and understood how to apply terminology
- Planning creatively and the delivery of cross-curricular activities enabled students to become more independent and divergent in their thinking; the language learners use when discussing mathematical concepts are being developed with an appreciation of the process rather than the solution

The students began to see how each subject supports each other and are not separate 'entities' existing on their own.

(Victoria Orviss, Head of Ethics)

CPD benefits for teachers:

- We realised that Point, Evidence, Explain (PEE) used in English and now humanities correlated with the 'convince me' Assessment For Learning (AFL) method used in maths; the concept is the same but different language was being used and therefore consistency needs to be promoted
- The staff mentality towards lesson planning has changed from 'What do I need to teach the students and how can I do this?' to 'What do I want the students to learn and how can they learn it?'
- The role of the teacher has also been changing, from being the leader of the lesson to a facilitator of the task

Working with other departments has brought to light a lot of the common areas that we teach. It has also enabled us to share teaching methods and therefore broaden the experience our pupils have in every classroom.

(Laura Everton, teacher of mathematics)

Utilising the mathematical expertise of colleagues to embellish concepts within other varied curricula resulted in delivering more exciting, innovative lessons for the students.

(Jane Cooper, Business Links coordinator)

Research methods

We collected attitudinal feedback from students and teachers involved with the Knowledge Network tasks. Some of this was gleaned from the pupil presentations where they commented on how they felt the tasks had gone. An informal discussion was also held amongst the staff involved to gauge their views on the tasks. Some projects were assessed using a style based around the Assessing Pupil Progress (APP) strategy, whereby outcomes of the task are measured against level criteria rather than being given a numerical mark. This enables both staff and students to accurately identify how and where they have applied specific skills, and highlights which elements they need to improve.

Conclusions

From a teaching CPD perspective, the Knowledge Network has demonstrated that this style of working deepened our understanding of how students learn. It enabled us as classroom

practitioners to identify areas where we can make the links between the content and the skills our students use in all other areas of the broad curriculum.

As the number of projects undertaken increases, students will have the opportunity to really appreciate how interlinked the curriculum is across departments, and join up the lessons they have experienced that day. Other project examples include music and maths where students' ability to add fractions mentally increased dramatically when put into the context of musical notes. Also, the citizenship project enabled students to understand how statistics can be manipulated to show a particular outcome in the context of voting and elections, questioning the validity of data presented to them.

Having worked with the Year 7 cohort, we will follow that year group throughout Key Stage 3 and continue to plan collaboratively and apply cross-curricular tasks. The resources created to date with Year 7 have already been built into the schemes of work for the next cohort. Also, with the maths GCSE becoming more functional, we envisage the skills developed during Key Stage 3 will complement the strategies required for the new GCSE exam.

Students are now more able to contextualise learning in real life situations; taking what they are already doing in other subjects and emphasising the links. They seem to enjoy the independence these cross-curricular tasks create, as they can be creative in their thought processes. All subjects equip students with the skills to solve problems in different situations, and the Knowledge Network helps them to combine these to paint the big picture at the end of each day.

Suggestions for further reading

Boaler, J. (2009) *The Elephant in the Classroom: Helping Children Learn and Love Maths* London: Souvenir Press Ltd

Cotton, T. (2004) Inclusion through Mathematics Education *Mathematics Teaching* 187 pp 35-39

De Geest, E. and Watson, A. (2004) Instilling Thinking *Mathematics Teaching* 187 pp 41-43

Ernest, P. (2010) Add It Up: Why Teach Mathematics? *Professional Educator* 9 (2) pp 44-47

On the Nrich website you will find numerous free mathematics enrichment materials (problems, articles and games) for teachers and learners from ages 5 to 19 years: http://nrich.maths.org/public/

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