Final Report

Abstract

At Bishop Challoner Catholic College in Birmingham, a STEM project entitled “Rockets in Motion” took place during the autumn term of the 2010-2011 academic year. The project ran through a series of after-school sessions led jointly by the science, technology and mathematics departments. Through this project we explored the role of algebra in science, technology and engineering. The project not only provided an enriching experience for the students involved but also supported the professional development of the teachers involved. Within the school there is a clear vision of how to support STEM across the curriculum and we will share our findings in this report.

Aims of the STEM Knowledge Network

The initial aims of our network were as follows:

1). To design and create a STEM project incorporating the science, technology and mathematics departments.

2). To develop opportunities for professional dialogue between the core STEM departments within the school.

3). To highlight the role algebra plays in real-life modelling situations through the creation of a STEM project.

4). To plan opportunities for incorporation of the use of algebra in STEM projects within the school and wider teaching community.

Background

The STEM project theme was the design and creation of a rocket. The students, with support of the technology department, used computer aided design to create the rockets. The latest Dartfish technology, which is already used within the physical education department, was employed to analyse the performance of the rockets. The mathematics department provided support with analysing rocket motion and modelled predicted flight paths using algebraic equations.

The project ran during the first term of the 2010-2011 academic year. It began in the mathematics department where students were exposed to the equations that model rocket motion. After a few weeks working with these equations students moved to the technology department to design and create their rockets. Students discussed suitable materials to use and thought critically about the design of their rockets, ensuring things like stability and air resistance were taken into account. After creating the rockets students tested them with the science department. The motion was analysed using Dartfish software. To conclude the project students drew their experiences together and produced a presentation that was shared with all involved in the network.

Whilst initially the output of the network was a STEM project for students to engage with and enjoy participating in, the professional conversations during the planning phase allowed links to be made between science, maths and technology departments to support the running of similar projects in the future.

A description of the STEM Knowledge Network

The STEM knowledge network involved teaching staff from a range of departments across the school. Teachers from science, technology, product design and mathematics were all directly involved in the project and the PE department also provided technical support and training with the use of Dartfish software.

The network initially met in the final term of the 2009-2010 academic year. A series of meetings took place to discuss the project and identify a target group of students to be involved. In late June a small group of KS3 students were chosen to work on the rockets project. Students were selected if they were deemed to have a natural flair in the STEM subjects. In September 2010, selected students from the new Year 7 cohort were also invited to join the STEM project. A draft timetable for the project was agreed between all staff involved in the network.

The network met regularly during the project to ensure smooth transition between the different disciplines. As the network developed, new ideas for future projects were discussed and outlined under the leadership of the school STEM coordinator.

What has been learned:

The student experiences of the rockets project gave some fascinating insight into the perception of maths in STEM projects:

"My opinion of maths has changed. Before I thought it was just numbers and algebra but now I can see the 'behind side' to it!"

This perhaps summarises in 'child-speak' exactly the purpose of such a project. It is all about the application of skills learnt in one discipline in other subject areas. Moreover, what is important is, being given the opportunities to actually apply skills rather than just talk about applications in class. Another student commented:

"I liked the fact I was doing maths but not really thinking about it. I just did it without realising."

Students also started to hint at the rich variety of applications of mathematics:

"Sometimes maths can be just this is how it is done but, now I understand better because I can see how it works."

Students were also able to identify some of the skills they had learnt in maths but used in the STEM project:

"We used diameters, radius, and looked at thrust minimisation."

Naturally some students preferred the creative design of the rockets:

"I enjoyed the project. I liked the science and maths although it was all good. It was interesting to see the technical side and then design our own rocket."

There was also a tremendous amount learnt by the teaching staff involved in the network. As the project progressed it became clear that algebra was not the driving force, rather, teachers' enthusiasm for STEM. What materialised was that the project was opening up lots of opportunities for general professional dialogue on STEM that was not always algebra related. From talking to staff involved in the network it

became apparent that their enthusiasm for STEM had often materialised from their own school experiences. Network members talked about projects they remembered taking part in at school and how this had influenced their understanding of their own subject area. In this sense the network could fully empathise with the experience of the students involved in the project. Members of the network could often point to uses of mathematics within STEM but algebraic applications were mainly limited to things like substitution into formulae for areas and volumes.

We also found that staff voluntarily helped in other STEM sessions even if they were not leading them. Once again this reflected the commitment and dedication of those involved in the network. As a result of attending other parts of the rockets project the maths teachers soon realised that some of the design software being used in technology could be harnessed for use in core mathematics curriculum teaching particularly for shape, space and measure topics.

Perhaps an obvious, but nonetheless important, consequence of the network was the sharing of good practice across curriculum areas and the better understanding and appreciation of the work done in a range of subject areas.

The impact on teachers' practice:

The "Rockets in Motion" project was an enjoyable experience for those students involved but it also had an impact on teaching staff directly and indirectly involved with the network. The impact was seen both within curriculum areas and also across curriculum areas.

The impact on teachers' practice was huge as a result of the establishment of the STEM knowledge network. Many informal conversations took place during lunch and break time and it allowed staff from departments that would not normally network the opportunity to learn from each other and share common experiences.

We also found that members of the network began to learn through the students. When working on a computer aided design package one technology teacher commented:

"I did not know you could use the program this way, student X taught me to do this. He said that's how you had shown him to do it."

This idea of exchange of information via a go between, in this case the students, proved an interesting outcome from working closely together as a network.

There was a buzz about the project from those staff directly involved with the network. Many of the teachers who worked on the project described a renewed level of enthusiasm within their own teaching. In particular teachers found they were highlighting applications of maths, science and technology within their day-to-day practice on a more regular basis. Perhaps this was because the STEM network was at the forefront of their mind. Some network members described going out of their way to mention and highlight, within their own teaching, links and applications to other curriculum areas.

As part of the network the PE department provided support and training for science teachers. With this training, science staff can now utilise performance analysis software (Dartfish) for experiments within their own curriculum area. This training and support was provided due to the good-will of the staff involved and reflects the willingness of staff within the school to support each other for the benefit of the students. The PE department even provided technical support for the project in the delivery of this aspect. The member of the network involved in this training said:

"As far as I was initially concerned Dartfish software was a program that could be used by the PE department and had little or no relevance to science. With the training and support I have been given I can now see how aspects of the software could be used within my own teaching. Without the STEM project I would have had little inclination to learn how to use this software. Now I am glad I did."

There were a number of occasions when members of the network highlighted how students involved in the project had used generic phrases such as:

"…like we did in the rockets project"

during their curriculum lessons. In this sense STEM was positively reinforcing work within lessons and enabling students other than those directly involved with the project to sense that what they were being taught could have 'real applications'. This helped teachers spend less time justifying the reasons behind work covered in lessons and instead spend more time on acquiring new skills and applying them.

Next Steps:
STEM is a vibrant area of ongoing development and key focus for cross-curricular work within Bishop Challoner. There are a number of avenues we are looking to explore further:

STEM leadership: We are investigating the possibility of training students involved in the "Rockets in Motion" project so they can act as STEM Leaders within the school. Potentially these students could help deliver the same project next year or, support other STEM projects within the school.

Other STEM projects: The school is involved in a number of other STEM projects including: an amplifier project (to run in the January term with support from STEM Ambassadors); a gardening project making use of the school allotment; a T-Shirt project where students design, make and market their products; a residential trip to Wolverhampton University.

A number of other STEM projects have already taken place including a wind turbines project, led by the Small Piece trust, for a group of fifty KS3 students and an anodising aluminium project. The cohort of students involved in the rockets project will also take part in the amplifier electronics project during the Easter term. This will involve working with the science and technology departments.

Continuing the STEM Network: The STEM Knowledge Network will continue to meet on a regular basis (approximately once per half term).

Embedding STEM projects within the curriculum: For a week in the summer term of 2011 the KS3 curriculum will be suspended so students can focuss on the Personal Learning and Thinking Skills (PLTs). During this time we will be looking to run an extended STEM project over several days with a whole year group.

Supporting other schools: Bishop Challoner has recently become the sponsor school for a new academy in North Solihull. We will look to support the creation of a STEM knowledge network within this school and offer advice on how to deliver STEM projects to their students.

Advice to teachers who may want to try something similar:
In terms of advice we suggest the following.

1). Setting up a knowledge network and running a STEM project

- Obtain senior management support for your network and arrange an agreed time for the network to meet.
- Create a flexible timetable that allows staff in different departments to help support the STEM project and network when it is convenient to them. Be aware that teachers from a range of departments will often have commitments on different nights of the week. Having said this, with STEM projects, often students will move between departments and so the onus is not always on the same members of teaching staff. STEM projects can often be less work due to shared responsibility. Across one term the commitment for a department might only be one or two hours of time.
- Start small. Identify a group of students you wish to work with (ideally no more than 15). We felt working with a bigger group would be far more difficult to manage. Choosing students from across a Key Stage may also be advantageous. You may also want to work across a couple of departments to start with rather than trying to involve all STEM subject areas at once.
- Identify core people in each department willing to lead on STEM. To sell this, encourage teachers to remember what it was they enjoyed about 'their' subject at school. You will often find the fondest memories were those of working on what we would now deem to be STEM projects. Choose willing staff that can be flexible with their time and go the extra mile to support the students.

2). Monitoring and roll-out of the project

- Communication needs to be good from the outset. Have a plan and stick to it. Nominate someone to monitor the project and ensure all involved are briefed when students move between departments.
- Ensure the person monitoring the project checks students are attending on a regular basis.
- For schools with a VLE, set up a STEM area. This can act as a resource pool for staff to share ideas and centrally collate resources used in the project. A similar project can then be run in future.
- Arrange an extra-curricular activity to reward students for their involvement in the STEM project. We took students to the National Space Centre.

3). Sustainability of the network

- Maintain the momentum of the network by arranging future projects for the same group of students. At this stage you might like to consider involving more departments in the network and also more students. Do this as early as possible.
- Continue to hold regular STEM meetings with key staff to draft future projects.
- Look for funding for small-scale projects. There are many funding bodies willing to support STEM projects.
- Look for ways in which a project can support work in the community. Would someone from local business be willing to sponsor such work?

References and resources:
See attached PowerPoint on the use of algebra in rocket motion.

Details of those involved in the STEM Knowledge Network:
The following staff at Bishop Challoner Catholic College were involved in the STEM Knowledge Network

Mr Thomas Carpenter (Maths)
Mrs Rebecca Clarke (Technology)
Dr James Coughlan (Maths)
Mr Rob Hall (Science)
Mr Nicholas Moon (PE)
Miss Tracey O'Toole (School STEM Coordinator)
Dr Eddie Pass (Science AST)