Maths and Biology Skills for Life.

Sarah Owenson Swindon Academy with Michelle Heath Swindon Academy, Bryn David, Isambard Community School, Claire Sleath, Isambard Community School, , Ian Lynne BBSRC.

Context

As a biologist who has always struggled with maths I am well aware of the limitations imposed on my scientific understanding because of my inability to access mathematical processes sufficiently. As the world of bioscience develops becoming data rich using technologies such as transcriptomics, proteomics and metabolomics a graduate of bioscience who cannot utilise mathematical skills will not progress in these fields.

As a teacher of biology in a 0-19 Academy I believe the association of biology as the soft science that doesn't require an understanding of maths is too readily accepted by staff and students alike. The purpose of our study was to ensure students at KS3 (age 11-14) saw the relevance of maths skills in biology lessons at an early age, well before choices were made for A levels. We worked with two local schools to develop a series of lessons taught by mathematicians and biologists collaboratively focussing on scale factors, surface area to volume ratio and the use of graphs. Throughout these lessons we wanted to make the link between maths and biology explicit.

In the long term we hope students will acknowledge this transference of maths skills in the biology classroom. They might then consider the study of maths at AS level or free standing qualifications by attending a maths lesson for "ologies". At the very least they should embrace the need to complete compulsory mathematical modules at university.

Key Objectives

Pupils to utilise mathematical skills to study biological problems (transference of skills)

Mathematicians and biologists will prepare and deliver the lesson series modelling the collaborative nature of biology and maths

Both mathematicians and scientists have an increased awareness of the skills required across different areas of the curriculum

The Lesson Content.

The level of scientific understanding of KS3 students directed us to base our lessons on fundamental biology. Students are well versed in describing the structure of a cell, but are rarely provided with the opportunity to explore the size. In the first series of lessons students were introduced to scale factors by the teachers and given opportunities to practice these calculations. They were then provided with measurements of a cell and asked to make 2D or 3D models of the cell and its organelles to scale.

Students are able explain to us the structure of the lungs or small intestine without a detailed mathematical understanding of why those structures work so well, so the second group of lessons

focussed on surface area to volume ratio. Students were required to calculate volumes and surface areas of a selection of cuboids and then produce 3D models. They then investigated the potential movement of substances in and out of the model. Graphical analysis followed permitting students to draw conclusions as to the structure of the lungs so as to maximise the movement of gases.

The final series of lessons promoted students to investigate rates of reaction using enzymes. Pupils collected data from traditional experiments where pH and temperature were the independent variables and produced graphs with curves of best fit to highlight trends in the results.

Pupils Perspective

Pupils were energised during these lessons. They enjoyed the extra challenge brought to the lesson by the mathematical element and were able to identify maths and science skills incorporated into the lesson objectives. They commented positively on having a maths and science teacher in the room, saying "it made it easier to understand". The work produced during the lessons was of a high standard and the collaboration during the tasks was excellent. In a mixed ability class very little differentiation was planned into the lesson – but the higher ability students led the learning as they worked through further questions that they posed themselves.

Staff Perspectives

"The joint planning before the lesson was really useful and allowed any variation in teaching methods to be ironed out. The preparation of mathematical starters before science lessons has obvious benefits. The ability to explain a theory from a different perspective was powerful. It was also good practice for a maths teacher to see how maths topics are taught across the curriculum".

"I very much enjoyed working with a maths teacher, I felt more confident in the delivery of that part of the lesson and the collaborative nature made the lesson more dynamic"

"Open ended discussions enabling mapping of content to take place, sharing knowledge and skills and seeing students in a different environment"

It was also noted during discussions following the review meeting that lower ability students need to have the mathematical elements simplified in order to achieve the science objective being taught.

Recommendations

It is our belief that the sooner students acknowledge a link between maths skills and biology, the more likely it will be that they embrace aspects of the biology curriculum that require mathematical knowledge.

We have found that teachers working collaboratively to plan and then work collaboratively in the classroom had a positive impact on our students as they felt they had more opportunities to learn. Biology teachers were more likely to teach lessons with high mathematical content with a maths teacher's support. Discussions during the project have already enhanced the understanding of each

subject in relation to the other. On potential idea is to assess these skills in a similar way to those skills in the science APP programme.

The schools involved intend to continue to use these lessons next year and in other lessons making the mathematical aspect explicit to the students.

The support of SLT in this project was invaluable to enable staff to develop resources, collaborate, network and deliver the lessons.

Barriers

The main barrier to the success of the project was time, school are very busy places with many agendas to be met. Staff invested their own time to ensure this project was a success.

Collaborative teaching is a significant investment and schools need to think creatively to ensure opportunities like this are available to staff in the future.

Evidence of success

Pupils will have completed a series of lessons using maths in a biological context.

Pupils will have completed a short questionnaire before and after the project which highlighted a change in perception.

Teachers will have produced a resource for maths and biology teachers to teach collaboratively which can then be used by other schools

Mathematicians and biologists will be more aware of the other's curriculum @ KS3 by some cross curricular mapping of skills. This could then be extended to KS4 or 5.

Pupils appreciate the need for good mathematical skills in biology lessons .

Next Steps

Members of the group intends to invest time to map the KS3 curriculum in maths and biology to ensure the number of opportunities for lessons such as those described above are made available to students across KS3 and beyond.

Swindon Academy Analysis - ANNEX 2

How imp. do you think biology will be for the job you want to do when you leave school?

Before			
really	imp	it might	not imp
27	19	50	4
After			
35	35	24	6

How imp. do you think maths will be for the job you want to do when you leave school?

Before			
really	imp	it might	not imp
46	38	12	4
After			
53	35	6	6

Is maths imp. To help you understand biology

Before			
very useful	sometimes	rarely	not at all
39	46	12	4
After			
very useful	sometimes	rarely	not at all
41	41	6	6

Is it better to only teach maths in maths classes

Before			
Yes	Not really	No	
27	35	35	
After			
Yes	Not really	No	
30	41	30	

Can you think of examples where you have used maths to help you explain ideas in a biology (or other science) lesson?

Responses Before (26)			Responses After (17)	
Graph	13		Graph	11
Processing	4		Vol	1
			Processing	1

Was it useful to have two teachers working together in these lessons

Responses After	
Yes	17

Swindon Academy and Isambard Analysis - ANNEX 3

How imp. do you think biology will be for the job you want to do when you leave school?							Can you think of examples where you have used maths to help you explain ideas in a biology (or other science) lesson?	Responses Before			Responses After	
	Before							Graph	15		Graph	
	really	imp	it might	not imp				Processing	8		Vol	
	18	32	45	5				no	12		Processing	
	After							speed	5			
								pressure	2			
How imp. do you think maths will be for the job you want to do when you leave school?							Was it useful to have two teachers working together in these lessons				Responses After	
	Before										Yes	
	really	imp	it might	not imp								
	54	29	14	4								
	After											
Is maths imp. To help you understand biology												
	Before											
	very useful	sometimes	rarely	not at all								
	30	55	11	4								
	After											
	very useful	sometimes	rarely	not at all								
Is it better to only teach maths in maths classes												
	Before											
	Yes	Not really	No									
	14	48	25									
	After											
	Yes	Not really	No									