2020 cohort

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Does introducing maths questions into regular retrieval practice improve pupils' ability to tackle mathematical problems in science lessons?

Why do students struggle with applying learned mathematical skills to their science lessons and how can this gap between science and maths be bridged?

There is a significant crossover with the subject of maths within the science curriculum and content being taught in maths lessons frequently needs to be applied in specific science topics. At GCSE level, mathematical skills make up 10 %, 20 % and 30 % of the biology, chemistry, and physics content respectively (AQA, 2016).

Despite the prevalence of maths in science at secondary school level, students often struggle applying mathematical skills to science content (Dood & Bone, 1995; Needham, 2016) and there is a disconnect that can be condensed into broad issues including differences in teaching between departments, the terminology used, and teacher confidence and student attitudes.

One of the ways the gap between maths and science could be bridged is using retrieval practice which is already a regular component of teaching that has been shown to improve learning (Pastotter & Bauml, 2014) by getting students to recall knowledge they have gained from previous lessons and topics. It allows students to make links between different content that is being covered and these links can then be made between subjects, for example, between science and maths.

Regular exposure to maths questions in the format of retrieval practice could help increase confidence in tackling maths problems within science. It could build up familiarity with and skills in manipulating numbers, rearranging equations, using correct units, and interpreting graphs. Since using retrieval questions at the start of every lesson is a standard part of normal teaching practice within the science department of the school, it is a good opportunity to implement maths questions within this part of the lesson to see if it can help improve students' ability to link the two subjects.

Regular retrieval practice helps to transfer information back and forth between the working memory and the long-term memory (Agarwal, Roediger, McDaniel, & McDermott, 2020) and repeated exposure of topics can help to strengthen students' ability to retrieve information quickly (McDermott, 2011). The aim of this project is to

determine whether adjusting the regular retrieval practice of normal science lessons to include questions that use mathematical skills can improve students' ability to tackle maths problems in science.

The regular practice within lessons is to give students five retrieval questions to answer that involves recalling knowledge from previous science lessons and topics. In this study, the proposed plan was to introduce an additional set of maths-specific questions into this retrieval practice activity for one of my Year 9 classes. This took place over a six-week period, occurring in an estimated 10-15 lessons. Students answered these added retrieval questions as part of their normal starter activity within lessons and the marks achieved were collected in a mark book.

Prior to the introduction of the maths retrieval questions, students were set a pre-intervention assessment consisting of 30 questions on an online platform that was already in use by the science department for homework. The questions were specific maths questions based on the different mathematical skills frequently occurring within the science curriculum and was used to set a baseline that showed the students' mathematical ability before the introduction of the retrieval questions. At the end of the six-week period, a similar set of questions using the same online platform were to be given as a measurement of the impact that adding the maths retrieval questions to regular lessons had on students

The data collected during this study included individual student marks from the retrieval questions in each lesson and their overall score in the pre- and post-study 'Maths in Science' set of questions. This data could then be analysed to compare scores achieved in questions before and after the intervention and determine the impact of the study and could identify particular areas of maths that were frequently more challenging.

Specific maths skills were chosen as the retrieval questions, and these were rotated to give students the opportunity to be exposed to different maths skills as well as a chance to improve on their recall with second exposure to the topic. Where students answered questions from one skill and then answered other questions from the same skill the next time they came around in the lessons, there was a general increase in the marks received for those topics.

When comparing the overall trend between the marks achieved in the pre-study quiz and the post-study quiz, the intervention appears to have benefited those students who struggled with maths at the start of the study more than those who had a competent enough grasp of the maths skills in order to apply them to a scientific context. Those students who scored highest in the pre-study quiz achieved similar marks in the post-study quiz but the four lowest scoring pupils in the pre-study test all achieved at least a 100 % increase in their score when they took the post-study test.

There were several limitations of the study, however, mainly attributed to time constraints that meant in individual lessons, not all participants answered the retrieval questions fully, and there was no control group who did not receive the intervention to compare the results to. The structure of the retrieval questions was also meant designed to be a quick

snapshot of the content and did not allow for any in-depth analysis of maths-in-science problems.

Future areas of research could focus on addressing these issues, perhaps spreading retrieval questioning throughout a lesson to help strengthen the links between maths skills and new science content and provide opportunities for further analysis at the problems linking the two subjects. Another area for future research is an issue that was identified during the research for this project which is the language used by maths and science teachers and the fact that a common language was not yet standard practice in many schools.

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