2020 cohort

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Can Physics Investigations in Mechanics Improve KS3 student's Extended Responses and Working Scientifically Skills?

Introduction

This project was motivated by a departmental target to improve the skills of KS3 students before they began their GCSEs. Students were underperforming on skills-based questions in GCSE tests, particularly written skills and those around experiments.

To do this, unit 1 of the year 9 physics curriculum was redeveloped to incorporate a more coherent strategy to teaching these skills.

Teaching Literacy and Working Scientifically Skills

A review of the literature suggested several possible strategies to improve student's scientific literacy through improving inferencing, comprehension and vocabulary. Kispal (2008) found that inferencing is hard to directly teach because it depends on a range of factors including background knowledge and cultural capital, but that the teacher's own inference can be effectively modelled. Students are most receptive to this kind of modelling at KS3. A report by the Education Endowment Foundation (2018) found that age-appropriate comprehension strategies can deliver six months additional progress, and Kesty (2018) suggests using science-related reports and news articles to do this. Conkerton (2021) also adds textbooks and suggests activities could include fact finding from articles and summarising them. The literacy toolkit by the Victoria State Government, (2019) recommends explicit teaching of tier 2 and 3 vocabulary and active reading of texts, where the students have an accompanying task. It is clear from these ideas that the students must be provided with opportunities to read throughout the project.

The working scientifically skills the students need to learn are broken down into five categories on the AQA Entry Level Certificate specification they have to follow, those being:

1. Experimental design
2. Working safely and making measurements/observations
3. Recording Data
4. Presenting Data
5. Identifying Patterns/Relationships

Various teaching resources websites were mined to find good examples of how to scaffold these skills. Wenner (2020) gave a particularly good breakdown of how to teach graph skills in stages, separating stages such as axes design and describing relationships.

One of the topics on the curriculum is energy resources. It was decided this would be run as a project using the structure described by Tsoubaris, Bencze, Curtis, & Zouda (2020) that encourages students to think about science's place in a wider society using reflection, teaching and their own

research. This would give the students plenty of practice at reading and analysing text and an opportunity to present it at the end.

Using Multi-Lesson Projects to Teach Skills

To bring these skills together, the curriculum was split into four projects outlined in **figure 1**. The Energy Resources project required them to reflect on their current knowledge, to read lots of short articles about energy resources and summarise the information into a group presentation they delivered in the final lesson.

The Energy, Forces and Acceleration projects were based around a practical in which they had to understand the aims, plan a method, record data, execute, then analyse and evaluate after. They were given opportunity to practice their writing through the methodology and evaluation. The students were given a carefully designed worksheet to guide them through the practicals that tested all of the required working scientifically skills. They also received further reading in the application lessons of energy and forces.

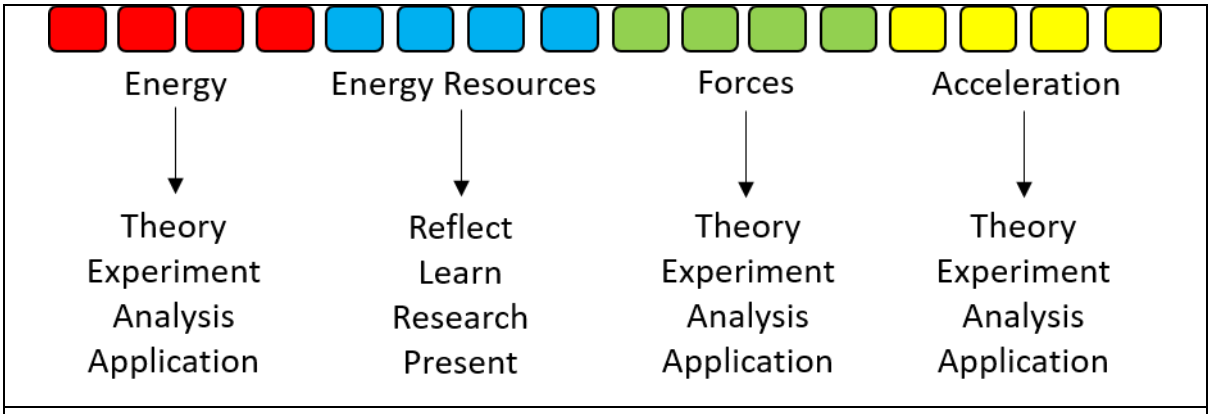

Figure 1: Breakdown of the project structure

These lessons were delivered to nearly 300 students in year 9 by their usual teachers. Afterwards, the students and teachers were given similar questionnaires to measure their perceptions of how effective the projects were and four teachers were interviewed in detail. 153 students completed the questionnaires.

Student and Teacher Perceptions of the Project

The students were split into higher and lower ability groups to analyse their questionnaire responses. The only question that showed a significant difference in their responses was the first question, which asked what their favourite project was. **Figure 2** shows that the energy resources project that required more reading and a presentation was the most popular with the higher ability students, but there was no preference for this project over the experimental projects for the lower ability students.

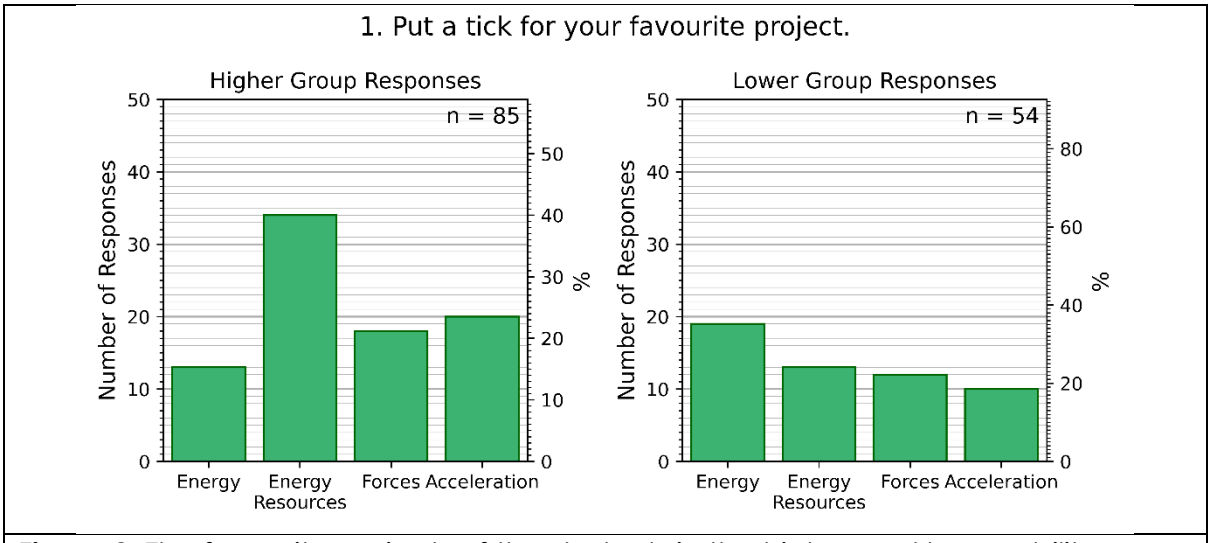

Figure 2: The favourite projects of the students in the higher and lower ability groups.

Figure 3 shows the student's and teacher's perceptions of whether they thought the projects improved their extended writing, planning, analysis and evaluation/explanation skills. The students gave higher median scores for extended writing and analysis. It was perceived that planning and analysis skills were the most developed by the project and extended writing the least.

Four teachers were also interviewed in more depth with a structured questionnaire. From analysing these responses, three main themes were identified.

Student Learning

- Teachers were satisfied that their students had learned the content, although lower students struggled to retain the knowledge.
- Skills such as equation solving and planning practicals were perceived to be well developed. The scaffolded practical sheet received direct praise.
- Many students lacked the science capital to access some topics (e.g. tidal power) but they enjoyed linking science to the real world.

Adaptation, Variety and Differentiation

- Teachers were satisfied with the quality of the resources. However, they also requested more differentiation for lower ability groups, which they took upon themselves.
- More variety in tasks, particularly starter tasks, might improve engagement.
- The lack of required planning by teachers was clearly appreciated by all teachers.

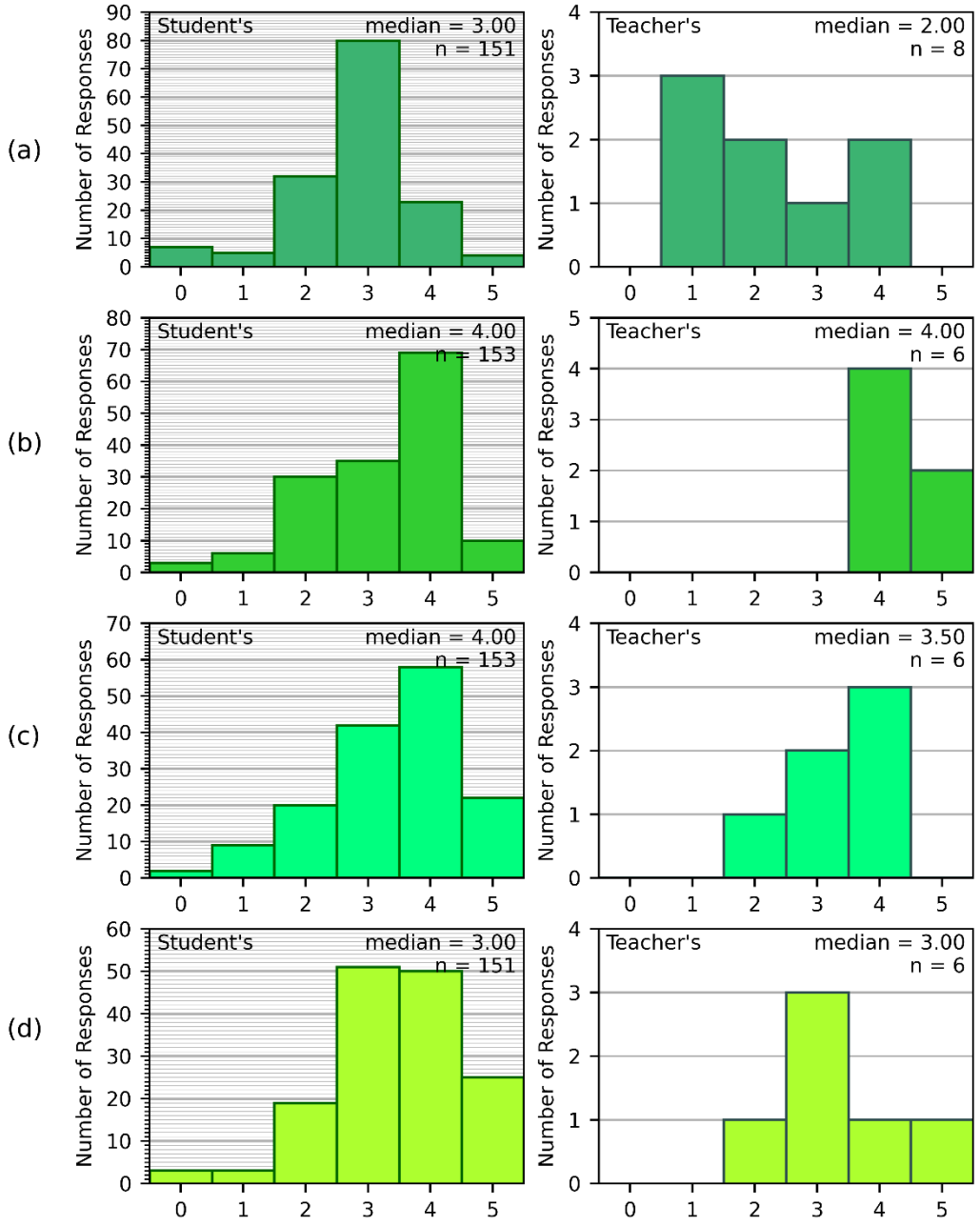

Figure 3: Comparisons between student's and teacher's perceptions of whether the following skills had improved:
(a) Extended Writing (b) Planning Skills (c) Analysis Skills (d) Evaluation and Explanation

Project Structure, Timing and Curriculum

- ❑ Teachers felt pressed for time to deliver the knowledge content within this structure.

- One teacher also questioned the practicality of the planning time that must have been devoted to the whole project.
- The overall project structure was popular though, as it gave consistency, a long-term outlook and more purpose for the students.
- A suggested change was to move the practical from the second to the third lesson.
- The project has inspired reflection on the current curriculum by some. One teacher liked this way of learning, but felt that with the knowledge demands of the current curriculum that the choice of curriculum should be changed to accommodate this project style of learning.

Conclusions

The project aimed to see whether doing multi-lesson projects could improve literacy and working scientifically skills in Year 9 students. The students and teachers engaged well with the projects, and the students planning and analysis skills were perceived to have improved, but less so their extended writing. It is clear that more thorough work would need to be done with these projects to improve their literacy. Having more time to teach the knowledge content and better differentiation of the resources was something most teachers wanted but they still liked the structure. It has been suggested the underlying curriculum should be reconsidered by some.

It should be noted that the results of this study are based on just a single school, and that the context of other schools should be considered if trying to implement these ideas somewhere else. Nevertheless, a large sample of 153 students were questioned here which gives our results validity that can often be difficult to achieve with small-scale education research.

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