

Integrating mathematics and science in secondary education classrooms: numbers and algebra

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Introduction

The transition from primary to secondary education is traditionally recognised as one of the most disturbing changes for students. In Spain, different factors seem to affect such disruption, including both non-academic and academic (González-Rodríguez et al., 2019); the latter factor is often related to variations in learning methodologies, teacher specialisation, and mathematical content. Secondary school education requires specialised teachers for each subject and, thus, a growth in the number of educators per student group. The mathematical content introduced during the first year of secondary education (e.g., algebraic language and simple linear equations) is rather demanding for students with scarce knowledge of mathematics (Pérez-Istúriz et al., 2019). To facilitate the transition from primary to secondary education, researchers suggest merging subjects into fields of knowledge, reducing the number of topics and teachers. This regrouping is supported by the new Spanish curriculum, implemented in 2022, when promoting the STEM (Science, Technology, Engineering and Mathematics) competence.

Objectives, intervention and method

In this study, we aimed to identify the mathematics emerging under an integrated content approach implemented at school and to compare whether such mathematics was addressed as requested in the curriculum (Jefatura del Estado, 2013). Six Spanish teachers (3 maths and 3 science teachers) instructed separately six student groups of 12-13 years old (first year of secondary education), following the same content materials. The intervention merged the mathematics and biology-geology subjects and distinguished seven units: Numerical and biological diversity, Divisibility and vegetables, Fractions and animals, Flowing layers, Fungi, Proportionality and percentages, and Plane geometry. For this poster, we analysed the numbers and algebra content appearing across the seven units agreed upon by the teachers. The study was undertaken under a qualitative approach and through a triangulation strategy matching the analyses of the seven units, the teachers' interviews about their practice, and the content described in the curriculum.

Results and conclusion

The analyses revealed that 12 out of the 23 items appearing in the block 'Numbers and Algebra' of the curriculum were addressed in four of the implemented units: 5 items were identified in Numerical and biological diversity, 3 in Divisibility and vegetables, 1 in Fractions and animals, and 3 in Proportionality and percentages. These 12 items were purely connected with numbers and not with algebra. This was mainly because the science teachers believed they were not prepared to instruct algebra, and the mathematics ones did not want to push them further. This is an unexpected finding

because students should become familiar with the algebraic language, operations with polynomials, and simple linear equations in the first year of Spanish secondary education. The difficulties of non-mathematics teachers in promoting high cognitive demands in mathematics have been reported by Diego-Mantecón et al. (2022) when integrating engineering, mathematics and technology disciplines in secondary education.

The science and mathematics teachers in our study also disagreed about what and how mathematical content should be presented to integrate biology and geology. Science teachers thought it was essential to introduce intervals for graphing in the context of biology, whereas the mathematics ones did not find it appropriate. The latter explained that students must possess an in-depth knowledge of the real number set. The six teachers were so overly fixated on integrating content that they did not consider essential mathematical content typically taught in the first year of secondary education.

Our findings suggest that the integrated mathematics and science curriculum requires continuous teacher development or co-teaching involving educators from different specialisations. The former could be a long-term solution since acquiring knowledge from different disciplines requires time. The latter could be a more realistic objective in the short term, although it would also require training and could challenge the institutions to sustain it economically.

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