



## The Effect of a Number of SEC Subjects on A-Level Physics in Malta

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### Abstract

*This study investigates the progression from Secondary Education Certificate (SEC) to Advanced (A) level Physics, and inherent problems for students and teachers in Malta. The four research questions dealt with: (a) the changes in the SEC Physics syllabus in 2012; (b) SEC Physics as foundation for A-level Physics; (c) the sufficiency of skills and knowledge from SEC Mathematics for A-level Physics; and (d) correlation between SEC Physics, Mathematics and English Language and A-level Physics. A mixed methods approach was used: 165 questionnaires from second year A-level Physics students, 16 questionnaires and five interviews with A-level Physics teachers, four interviews with SEC Physics teachers and a focus group with second year A-level Physics students. Teachers considered the 2012 SEC syllabus – following the changes – as an insufficient foundation for A-level Physics, increasing the gap between the two levels. They considered a good grade in and understanding of SEC Mathematics desirable for A-level Physics. Students considered SEC Physics as a good foundation for A-level, and regarded Intermediate Mathematics as the threshold for A-level Physics. Respondents acknowledged the importance of English language skills in understanding A-level Physics questions. The correlation coefficients for SEC Physics, Mathematics and English Language with A-level Physics were 0.54, 0.45 and 0.41 respectively.*

Keywords: SEC Physics, SEC Mathematics, SEC English, A-level Physics, correlation.

## 1. Introduction

### 1.1 Aim of the Research Study

The research study was aimed to elicit the effect of SEC Physics, SEC Mathematics and SEC English Language on A-level Physics in Malta. It involved analysis and investigation of: (i) the changes in the 2012 SEC Physics syllabus; (ii) SEC level Physics as background for A-level Physics; and (iii) SEC Mathematics as preparation for A-level Physics. Finally, the correlations between SEC Physics, Mathematics and English Language and A-level Physics were considered.

### 1.2 SEC Physics as a preparation for A-level Physics

One expects that SEC and A-level Physics are strongly correlated because they are the same subject at different levels. But, “it seems that students’ experience of the SEC level Physics syllabus may be giving the impression that Physics is an easy subject but when they come to Advanced-level studies they find that Physics is much more challenging than expected. ... Teachers and students felt that there is a considerable gap between SEC level and Advanced level in all the major areas of Physics, including practical work, mathematical skills, and the content itself.” [4, p. 18] Repercussions can be noticed, especially in terms of student numbers for A-level Physics [7] [8].

### 1.3 Is SEC Mathematics Relevant to A-level Physics?

Physics is the most quantitative science subject, depending heavily on “many mathematical skills to prove and quantify the different physical laws and principles.” [1, p. 682] Moreover, “a good grade in GCSE mathematics is often required if students wish to take A-level Physics.” [6, p. 757]

### 1.4 The Role of English Language in Physics Examinations

Language is crucial for student learning, particularly regarding concepts of Physics. [3] According to the literature, students’ proficiency in English and Maltese influences abilities and performance in science examinations. [5] Reading ability is extremely important for student achievement in Physics [9] and there is “a significant positive relationship between English and Physics achievement.” [2, p. 199]



## 2. Methodology

A mixed research methodology with triangulation was used: 165 questionnaires distributed to Sixth Form second year A-level Physics students and 16 questionnaires to Sixth Form Physics teachers; nine face-to-face interviews, five of which with A-level teachers and four with SEC Physics teachers and one focus group with Sixth Form second year students to obtain in-depth opinions from participants going through the 'experience'. The 2017 A-level Physics and 2015 SEC Physics, Mathematics and English Language grades were obtained to compute relevant correlation coefficients. The five themes of the study emerged.

## 3. Analysis of Results

### 3.1 The Changes in the 2012 SEC Physics Syllabus

The changes in the 2012 SEC Physics syllabus included: (i) new themes and grouping of topics; (ii) a new section 'Historical and Science, Technology, Society Connections'; (iii) new learning outcomes, with the removal of some others; (iv) increased weighting (from 15% to 20%) for 'Design and Planning of Experiments' in the written part of the examination; and (v) presentation of 15 experiments or 13 experiments and an investigation for school-based assessment. Moreover, regarding the latter, students were expected to present two experiments from each theme instead of any fifteen.

The study revealed that 68.8% of Sixth Form teachers considered the changes in the SEC Physics syllabus as 'not so helpful' to them and 62.5% considering the changes as 'not so helpful' to students either. Regarding changes in the extent and mode of student preparation for A-level Physics before and after the 2012 syllabus changes, 56.3% of A-level teachers considered students as prepared at 'the same' level while 43.7% deemed them 'less prepared'. Notwithstanding this percentage difference, during interviews, the majority of teachers declared that following the 2012 changes, the SEC Physics syllabus lacked the necessary detail to help students in higher order thinking, increasing the gap between SEC and A-level syllabi. One notes that 63.0% of the students and 81.3% of the teachers concurred that the transition from secondary to post-secondary level was challenging.

### 3.2 Is SEC Physics a Good Foundation for A-level Physics?

The majority of students (55.8%) believed that SEC Physics is a good foundation for A-level since they considered the two levels as only slightly different. Half the teachers (50%) considered SEC Physics as 'not so good' a foundation for A-level and claimed that some topics could be delivered better. Students, at 63.6%, and teachers, at 81.3%, considered A-level Physics as a continuation of SEC at a higher and harder level. When students were asked about their difficulties, the result was statistically significant.

Considering the six options – (i) discontinuity between SEC and A-level; (ii) understanding concepts, theories and laws; (iii) confusion in the meaning of symbols and symbolic equations; (iv) application of mathematical skills to solve physics problems; (v) language difficulties in expressing oneself; and (vi) none of the above – slightly below a third of students (29.9%) considered that their difficulties in A-level Physics concerned 'understanding physics concepts, theories and laws'. The predominant percentage of teachers (27.7%) agreed with the students by choosing the same option. A further 27.7% of the participating teachers considered that student difficulties stemmed from inability in 'applying mathematical skills to solve physics problems'.

For 22.16% of the students, the most difficult topics at A-level were Mechanics and Fields. Furthermore, Circular Motion and Rotational Dynamics, Electrical and Gravitational Fields were considered as the most difficult sub-topics (which are not covered at SEC level).

A chi-square test between SEC and A-level Physics gave 133.24 showing a strong statistically significant relationship between the two levels. In fact, most students with grade 1 (95.7%) and grade 2 (77.4%) in SEC Physics obtained grades A, B and C in A-level Physics, and the majority of the students (57.4%) with grade 1 in SEC Physics achieved grades A and B in their A-level.

### 3.3 Is SEC Mathematics an Adequate Preparation for A-level Physics?

Almost all students (94.5%) and all teachers (100%) agreed that mathematical concepts were important for Physics. Out of the four options (25%, 50%, 75%, and 100%), 39.4% of the students and 50% of the teachers stated that as much as 50% of the A-level syllabus requires Mathematics. In both



cases, the student responses resulted to be statistically significant with respect to gender, with the highest percentages attributed to females.

The chi-square test between SEC Mathematics and A-level Physics was 101.52 showing a strong statistically significant relationship. Moreover, 88.5% of the students with a grade 1, 71.6% with a grade 2 and 50.6% with a grade 3 in SEC Mathematics obtained grades A, B and C in their A-level examination.

However, 58.8% of the students did not feel prepared to work out A-level Physics problems with their SEC Mathematics background. While 71.5% of the students stated that they required Intermediate level Mathematics for A-level Physics, 62.5% of the teachers stated that a good grade in SEC Mathematics would suffice for A-level Physics. However, during interviews, teachers stated that an Intermediate level in Mathematics or a very good understanding of SEC Mathematics would be a bonus because it was difficult to teach mathematical concepts too due to time constraints.

For A-level Physics students, the most difficult mathematical topics included Graphs (43.1%) and Algebra (33.3%), mostly differentiation, integration and trigonometric functions. One notes that these topics feature least in the SEC level Mathematics syllabus.

### **3.4 The Correlation Coefficients between SEC Physics, Mathematics and English Language and A-level Physics**

All teachers agreed that English Language skills were important to study Physics. Out of the four options – (i) understanding Physics concepts well; (ii) understanding the question properly; (iii) answering by applying knowledge into writing; and (iv) none of the above – 39.8% of the students and 36.6% of the teachers agreed that English Language skills greatly helped the students to ‘understand the question properly’, with the second most popular reply being to ‘answer accordingly by applying knowledge into writing’.

A chi-square test between SEC English Language and A-level Physics gave 67.69, showing a high statistically significant relationship. Moreover, those students who did well in SEC English Language have also done well in their A-level Physics examination: 94.7% of students who obtained grade 1, 84.0% who achieved grade 2 and 60.2% with grade 3 in SEC English Language obtained grades A, B and C in their A-level Physics.

Comparing the three chi-square test values, the largest value (at 133.24) was for SEC and A-level Physics grades and the smallest (at 67.69) relating SEC English Language and A-level Physics. Moreover, the correlation coefficient between SEC Physics and A-level Physics was found to be 0.54, that between SEC Mathematics and A-level Physics resulted to be 0.45 while the value for SEC English Language and A-level Physics was 0.41.

## **4. Conclusion**

Indications from this study show that A-level Physics cannot be regarded as a ‘stand-alone’ subject. Knowledge of the subject ‘per se’ does not determine students’ performance in A-level Physics, as a number of other factors influence the final result. Apart from necessarily needing a solid knowledge of concepts and laws covered at SEC level, an A-level Physics student requires the ability for higher order thinking and reasoning, mathematical skills and sufficient English Language competence for proper question comprehension and articulation of the answers.

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