



Challenges Faced by Maltese Students Studying Advanced Level Physics

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Abstract

One of the aims of the Secondary Education Certificate [SEC] Physics syllabus is “to provide the basis for further study of the subject”. This research plans to determine the degree to which the syllabus is fulfilling this aim. In this study, seven post-secondary Physics teachers participated in semi-structured interviews and 200 students provided feedback to a questionnaire. Areas in which the SEC Physics syllabus is not preparing students well enough to further their studies in the subject were identified and suggestions were given to help improve the situation. Findings from this study confirm that there is an academic disparity between SEC and Advanced Matriculation [AM] Physics. This disparity is found mainly in the areas of: the abstract nature of the concepts, problem-solving skills, mathematical physics, and language. The study also confirms that there is a large amount of rote learning involved in SEC level Physics as students tend to memorise knowledge rather than understand the reasoning behind it. As a result of this students learn superficially and struggle to understand the complex concepts taught in A-level Physics. In order to prepare students better for post-secondary education, SEC Physics students should be given the opportunity to answer questions which involve higher level thinking and to solve more complex mathematical problems. Furthermore, more frequent practical sessions, a greater degree of student involvement and a greater emphasis on the link between theoretical ideas and practical work is also recommended. A shift of emphasis is required from teaching content to teaching higher order thinking skills.

Keywords: *Physics, Syllabus, Academic disparity, Underprepared students.*

1. Context of study

At the end of compulsory secondary schooling, students in Malta sit for the SEC examinations. Students who obtain the necessary grades can then further their studies in the subjects they choose and then sit for the Advanced or Intermediate level Matriculation Certificate examinations. These examinations allow access to university [1]. While in the past, Physics was the main science being taught in post-secondary institutions; the yearly examiners' reports presented during the last decade indicate a decline in the number of students choosing to further their studies in the subject.

Many students enter post-secondary education underprepared for the content of AM Physics. This results in low course completion rates and underachievement [2] [3]. When the preparatory work presented at the lower level is too basic, or the disparity between the two levels is too large, the grade obtained at SEC level would not be a good indicator of future performance and students may be misled into choosing the subject at AM level.

2. Methodology

Since they are the two main stakeholders involved in the teaching and learning of post-secondary Physics, AM Physics students and post-secondary Physics teachers were asked to participate in this study.

An online questionnaire was completed by 200 of the 3430 students who had applied for the AM Physics examination between 2011 and 2018. This implies that using a 95 % confidence level, the statistical inferences resulting from the questionnaire have a margin of error of 6.73 %.

To obtain a more complete picture, the views of post-secondary Physics teachers were also taken into consideration. Seven teachers from six different post-secondary institutions participated in semi-structured interviews and generated data about the challenges faced by Maltese students when studying AM Physics.

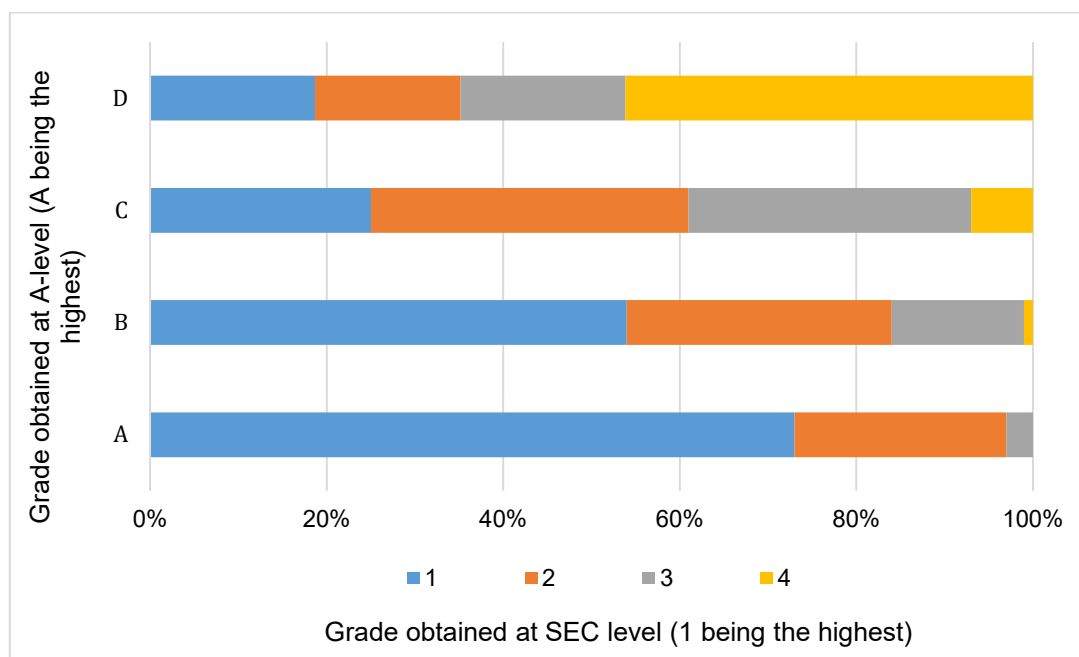


3. Results and implications

3.1 The disparity between SEC and AM Physics

Graph 1 indicates that students who obtain better grades at SEC level tend to perform better at AM Physics.

Graph 1 Grades obtained at SEC level and the corresponding grade at AM level



Although the grade obtained at SEC level seems to be a good predictor of performance at AM physics, it does not reveal much about how well prepared students are to further their studies in the subject. One of the causes of underprepared students is the gap between the skills and requirements for success at SEC level and those required at higher levels [4]. If the skills acquired through SEC Physics are too basic, then students choosing to further their studies in the subject will be underprepared. Data found in Table 1 confirms that a significant percentage of students [59%] find this disparity to be slightly excessive or excessive.

Table 1 Students' feedback on the disparity between SEC and AM Physics

The gap between the level of difficulty of SEC Physics and that of AM Physics was:	Very small	Small	Adequate	Slightly excessive	Excessive
Percentage of respondents	2 %	8 %	31 %	32 %	27 %

Six of the seven interviewed teachers agree that the disparity between the two levels is too large. Three teachers also affirmed that SEC Physics mostly requires lower-order thinking which results in students choosing to memorise content rather than understand it.

3.2 Mathematics and problem-solving skills

Students at secondary level lack problem-solving skills and struggle with mathematical calculations and higher order thinking skills [5]. If students are not being prepared well to solve mathematical calculations at SEC level, it will be hard for them to succeed at a level which requires the application of Mathematics to solve unfamiliar problems [6]. All teachers agreed that while SEC Physics prepares students well to be able to recall and work out simple mathematical problems, it does not prepare them to apply what they know to unfamiliar situations or to solve complex, multi-step problems. Furthermore, results also showed that 60.5 % of student respondents were incorrectly taught fundamental mathematical relationships such as directly proportionality. The general notion students



had about 'direct proportionality' was, "one value increases as the other increases". Furthermore, 79.5 % of the participating students believe that the use of Mathematics should be emphasized more in SEC Physics.

3.3 Language expression

Past studies showed that most students are concerned about the fact that they may not understand the exam question and find difficulties in expressing themselves in English [7]. 78.5% of participating students agreed that they were able to use proper English to explain concepts, however, six out of the seven interviewed teachers stated that students are not being well prepared to understand the questions being asked and to express themselves using proper English.

This divide between students' and teachers' perspective may be due to the fact that students are trained by teachers to memorise and recall through working many past papers. Therefore, it may be the case that students are given the wrong impression of being well-prepared to describe concepts when in reality, they were well-prepared to recall a particular response.

3.4 Teacher's pedagogy

The teacher's pedagogy can also affect the number of underprepared students [4]. Students confirmed that negative teaching styles, such as teaching for exam purposes, prevented them from understanding concepts well at SEC level. Teachers argued that learning by memorising has negative effects on student preparation and performance. Both stakeholders seem to think that SEC Physics should focus more on teaching students to think rather than recall. In this manner one can ensure that concepts are well understood.

3.5 Content knowledge

Six out of the seven interviewed teachers confirmed that when covering topics in which the students have good grounding from SEC level, students find the concepts easier to grasp. Furthermore, during lessons the students are more confident and participate more. Four of these teachers also observed that they cover material quicker and encounter fewer problems when there is good grounding.

Five teachers believe that misconceptions hinder students from understanding and that it is harder for students to unlearn and adjust previously learned information than it is to learn something completely new. Teachers should therefore be aware of common misconceptions in order to address them.

In an open question on how to better prepare students for AM Physics, thirteen students suggested that compulsory Physics should cover a wider range of topics, such as 'Quantum Physics', in order to make learning less strenuous at post-secondary level.

3.6 Experimental work

Four of the interviewed teachers stated that, at post-secondary level, students struggle to conduct experiments on their own. This was especially so when working with circuits. In an open question about how to improve experimental work in SEC Physics, around 20% of the questionnaire respondents mentioned that students should be given the opportunities to work independently. Furthermore, both groups of participants confirmed that at secondary level, students should be asked to do investigations rather than being shown demonstrations or given recipe type instructions to follow. Thirteen students commented that there needs to be a more evident link between practical and theoretical work. Furthermore, all interviewed teachers agree that SEC Physics does not prepare students well enough to properly consider precautions and errors in practical work. Five of the teachers elaborated that students have a list of precautions and errors learned by heart but cannot relate precautions to their proper errors or apply them properly depending on the experiment.

In considering mathematical calculations related to practical work, four teachers stated that students are able to calculate the gradient of a simple straight-line graph but struggle to arrange equations to straight line form and extract information by associating the gradient to the equation.

3.7 Challenging areas of AM Physics

Both student and teacher participants confirmed that post-secondary students tend to find: 'Thermal Physics', 'Electric Currents', 'Electrostatic Fields', 'Magnetic Fields and Electromagnetic Induction', 'Atomic, Nuclear and Particle Physics' and 'Quantum Theory' difficult. In fact, all interviewees mentioned that students struggle to understand and grapple with the abstract concepts linked to these topics. Furthermore, according to interviewed teachers, students cover 'Waves', 'Electricity' and 'Magnetism' superficially at SEC level. This leads to students not understanding what terms such as 'Voltage' and 'Current' actually mean and hence relying on their memory to answer exam questions.



3.8 Conclusion

It seems as though SEC Physics teachers can better prepare students for post-secondary Physics courses by ensuring that during the SEC course students focus on higher order thinking skills, language, problem-solving and mathematics.

Four of the seven teachers interviewed would like SEC Physics to cover more content and go into more detail. The remaining three teachers disagreed and said that compulsory Physics should only cover specific topics and ensure that they are well-covered. These teachers argue that since only around 11% of the students who sit for the SEC Physics examinations further their studies in the subject, covering more content would prove detrimental to the majority of students.

The SEC Physics syllabus must therefore take into consideration students who do not wish to further their studies in the subject and who simply need to get a pass in order to satisfy sixth-form entry requirements. This implies that it may be the right time for this syllabus to be reviewed and split up so that one course would focus on preparing students for further studies in physics while another course would focus on creating scientifically literate citizens.

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