Junior College
Physics Department

University of Malta

MyPhysics

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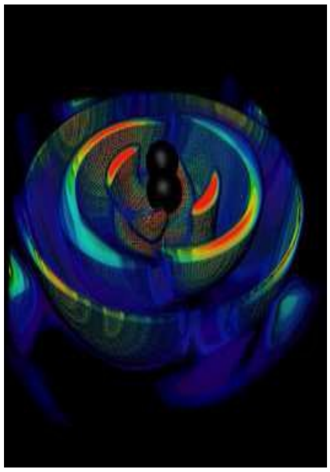
Welcome

Welcome to the first issue of **MyPhysics**.

This publication should interest anybody involved in the teaching of Physics though, possibly, it could appeal to students as well. It is essentially a forum in which all matters related to Physics can be explored by contributors and shared amongst readers. To this effect, we invite you to forward your contributions. We welcome your suggestions about effective Physics teaching, your views about the syllabus or the MATSEC examination or your concerns about the way we do things. We also welcome your expertise in specific areas of the subject and are keen to publish any article that can enlighten or broaden our knowledge.

If you think you haven't got the time for this, hang on for a moment. Though we certainly accept full articles of between 2000 and 5000 words, shorter submissions are very much accepted . So, come on, we are waiting to hear from you.

You can find further details about contributions on the back-page of this issue.



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"What I cannot create, I do not understand "

Richard Feynman

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Inclusion in the School Laboratory

By S. Debono

Many a research has been done on inclusion in the classroom for a spectrum of children with special needs. However, with the increasing demand for a holistic and practical approach to science, inclusion has not been fully realised when it comes to the dangers and pitfalls faced in the average school laboratory. In an attempt to bridge this gap I decided to investigate what potential problems lurk in the laboratory for students with physical disability and come up with some possible solutions. So, how inclusive are our school laboratories?

Rationale

The first question one might ask is: do we take inclusion as a starting point and see how laboratories meet the varied criteria or do we take laboratories and asses them on a certain area of inclusion? Inclusion is a vast subject for it incorporates both the cognitive and physical domains. If a child has cognitive challenges then these challenges will be equal in both the normal classroom and laboratory environments. However, if a child has a physical disability then the challenge is greater in the laboratory than in the classroom. So, this research took existing laboratories to see how well they measure up to inclusion through safety and accessibility.

Physical disability itself is not exhaustive for there is a continuum on which every person can place themselves. Even for persons who consider themselves without disability there comes a time when handling complex laboratory equipment can present a slight, but inconvenient, challenge (ever broken a test tube because the cork was too tight!); let alone somebody on the extreme side of the spectrum where this 'challenge' could result in dire consequences. Imagine a student in a wheelchair performing an experiment involving boiling water. If the apparatus were to suddenly get knocked over, the natural thing would be to jump back. How can he do this? The injuries do not bare thinking about.

Practicality, Safety and Attitude

A three pronged approach can be applied throughout when tackling inclusion in the laboratory: Practicality, safety and attitude.

Practicality: Practical accommodation and manipulation of apparatus or resources. Safety: Safe use of the above and general safety issues.

Attitude: Attitudinal barriers from staff and pupils.

Citing the above example a *practical* solution would be to design an experiment that can investigate the same principle without the need to endanger the student – if latent heat was being investigated, why not use melting ice instead of naphthalene? Another *practical* approach would be to bring the apparatus down to the student's level so that manipulation is easier. If hot liquids must be used then *safety* would involve considering what would happen if the arrangement were to topple over? Where would the hot liquid go? A simple solution would be to modify the student's workbench by putting raised edges to contain the liquid and having a *safety* plan in case of difficulties, like a 'walk' in shower unit situated close by. However, none of this is possible without the right *attitude* from pupils and teachers. A peer buddy system is com-

mon, where the student
with disability has a friend close to hand to aid, not take over, in experiments. This relies on a good helpful and patient *attitude* from the peer buddy. Good *attitude* is also required from the teacher in spending that extra time on preparing differentiated work. School management have to ensure a 'reasonable implementation' of any modifications which means a balance between meeting the needs of a student with limited mobility and financial restraints. Sometimes, economical solutions can give the same outcome as more elaborate and costly ones.

Mobility

More often than not students with limited mobility tend to have the use of a wheelchair to become mobile, but how mobile are they in the laboratory? Mobility is about the space required for successful manipulation and negotiation by the student in it. Isles must be at least 122 cm wide to allow for the wheelchair's turning circle. Doorways should be at least 82 cm wide. Mobility is paramount in view of emergency evacuation procedures in the event of a fire or hazardous chemical spill. In fact, worldwide, this seemed to be the most common concern for students with limited mobility.

The Wheelchair perspective

A person in a wheelchair sees the world from a different perspective – from a lower level. Doors can present a major problem. Many doors have a window through which one can see any potential hazards behind the door, so it is important that the window starts from the lower height of 109 cm. Door handles can also present a problem and must be placed between 87 cm and 122 cm. For people with limited dexterity door handles should be of the lever type with a maximum operation force of 22 N. Utilities, such as gas taps, should also be operated using a lever with minimum force and slightly spring loaded to prevent accidental activation. A wheelchair student must have at least 2 m^2 of floor space at his workstation and ample room underneath to allow clearance for the wheelchair. The student will be at his workstation for many hours and it is important that he doesn't have to stretch too much or sit side on resulting in neck strain. Bearing this in mind it is recommended that the working surface be 76 cm from the floor with an underneath clearance of height 74 cm, at least a width of 91 cm and a depth of 51 cm. Practically, the end of a peninsula bench proves to be the best place for the wheelchair student. Similarly, sinks and fume cupboards should have three accessible sides to the student with limited mobility.

Universal design

Designing or ensuring laboratories meet special needs' specifications can be an advantage to all it meets a *universal design*. Doors with lever handles instead of rotating knobs can also aid a person with his hands full. When it comes to safety, e.g. protective aprons, everybody stands to benefit from their use. Gas taps fitted with a lever stand to benefit both left and right handed people.

The Schools and students

A total of four schools were investigated: a girls' Junior Lyceum, a girls' church school and two boys' church schools. Three of the students have Spina Bifida and the other spinal muscular atrophy.

In one of the schools the student was not available to observe in situ because the parents were not keen to have their child labelled. However, on speaking with the facilitator it came to light that all the class do not have any practical sessions in the laboratory (incidentally, the workbenches were 97 cm high with cupboards)! Likewise, in another school the students do enter the lab but sit through teacher demonstrations at the end of the lab. In both cases, only the labs were measured up according to the guidelines discussed earlier. In one school there was a good example of 'reasonable implementation' – the table height was modified with four blocks of wood placed under the legs which gave the extra clearance needed for the student's slightly larger than average wheelchair. In another school the entrance door was narrow and part of the door had to be opened especially for the student. Also, the door had a 'lip' protruding from the floor which was evidently a problem for the student, taking a good five seconds to negotiate. This problem was found in another school which had a sliding door whose track was on the ground. Viewing perspective was another problem for one student in that the work bench got in the line of sight of the board. However, special arrangements were made when peering through a microscope; the microscope was placed lower down on a stool which allowed for easier viewing.

Generally, good safety practice was observed by all schools, with all of them having fire extinguishers, albeit some too heavy for students with dexterity problems. It was noted that one school lacked an emergency eyewash, opting for a shower in another classroom and another had a first aid kit inaccessible to a wheelchair student.

In all cases a peer buddy was evident and attitudes seemed honourable from students, teachers and facilitators. One facilitator was keen to learn more about health and safety and would have liked some kind of course – another example of *universal design* benefiting everyone.

Out of the three wheelchair students, all were happy with their treatment at school and the necessary arrangements made for them. One may ask the question; were they just saying this for fear of any backlash were they to show their real feelings? Bearing this in mind an extra student was interviewed– an ex-student – and his views were slightly different. He felt that he was being patronised when at first the school tried to dissuade him from taking Chemistry at 'A' level, feeling that they thought they knew better, but by sticking to his guns they accepted him and made modifications where necessary. However, the London examination board didn't expect him to sit the practical paper.

Conclusion

It's a shame that two of the schools decided to exclude all students from science practicals. Surely, a case of *universal design* where every student stands to **lose**! Out of the two schools where the student was observed both could go a long way in improving access to safety equipment like fire extinguishers and something to douse themselves in case of chemical spillages. Evacuation would be a problem in all cases because of student bags lying around.

The storage of stationary or a place to do an experiment can become more accessible by using a table with adjustable height. Bed trays also provide a convenient solution and can be hooked over the student's legs. Most bed trays have raised edges to allow for spillages. Another design of tray incorporates a bean bag that can mould round the legs. All these solutions are available at little cost.

On the whole, practicality was observed and reasonable implementations engaged. Safety was a cause for concern, not just for the student with mobility problems, but for all the students. Attitudes in school were good and helpful with all involved doing their best to accommodate the student. Maybe, things have improved from the times of that ex-student where attitudinal barriers almost prevented him from pursuing a career in science had he not stuck to his guns or, perhaps, true feelings were not displayed at the schools observed.

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Learning outside the classroom. Visiting the Institute for Energy Technology.

By M. Spagnol

This article describes how a properly conceived educational visit may serve to encourage science learning outside the classroom. The article particularly considers the experience of secondary school students visiting the Institute for Energy Technology. It tries to present suggestions for those teachers who might want to organise a half-day educational visit at the Institute. The description includes tips how teachers might prepare for the visit, a personal account of what the visit and sessions might involve and some suggestions how the visit might be followed-up.

Visiting the Institute for Energy Technology

For the last five years a regular occurrence in the school calendar of events at Liceo M.A. Vassalli has been the educational visit at the Institute for Energy Technology (IET) that forms part of the University of Malta. The visit is held in connection with the project 'Going Renewable' that annually involves Form three Physics students from our school in a number of activities. The aims of these activities are to convey to students (1) a deeper awareness on the use of renewable sources of energy; and (2) promote a greater understanding of the role of science and technology in every day life. The activities which take place throughout the whole scholastic year involve students in developing their own research projects, the setting up of an exhibition where all the students' work is displayed, a science fair and finally the climax of events, the visit to the IET.

During these years, hundred of students from our school had the opportunity to visit the Institute's buildings located at Marsaxlokk. At the Institute the students are involved in half-day sessions and presentations held by the members of staff and at the same time they also obtain a firsthand experience how renewable energy sources may find their application in a Maltese context. During the sessions the students also benefit from the experience of the researchers in the field as they had the possibility to discuss their own queries regarding their particular research projects.

Learning outside the classroom. Is it possible?

Far from being a simple excuse to escape from the formal setting of the school, an educational visit can ultimately serve as an excellent means as to how the theoretical scientific knowledge discussed in the classroom can be bridged with something more concrete and perhaps more relevant to the students. Learning outside the classroom can truly become a curriculum enriching activity (Adamczyk and Willson 2004, pp.56) since during properly conceived, well planned and effectively followed-up educational visits learning is based on something that can be presented as more real, meaningful and relevant to the students. Such a claim can be grounded on substantial evidence that indicates that good quality educational activities outside the classroom can lead to a better understanding of concepts that span traditional subjects (DfES 2006, pp.2), hence adding depth to the curriculum while concurrently promoting cognitive, personal and social developments in young people (O'Donnell, Morris and Wilson 2006, pp.1).

By involving the students in 'a learning outside the classroom activity' (O'Donnell et al. 2006, pp. i) the teacher is actually expanding the concept of classroom, giving some added value to the curriculum since typically, classroom-based instruction has a missing ingredient - 'the situations' (i.e., real experiences, environmental problems, local issues) and it is this factor that may invite true mind engagement (Yager 2003, pp. 6). In this way the experience through which the students undergo, may not just serve the purpose of complimenting what is done at school but actually places the students in a favourable position to elicit further learning. Through such activities students can obtain hands-on experience about the phenomena being studied, may find themselves directly engage in public discourses and debates about materials of scientific concern and have the possibility to interact with experts about particular issues. Hence through the novel situation they can actually be involved in activities that sometimes are missing or cannot be achieved if teaching and learning remained limited to the four wall of the classroom. It is however inevitable to say that for all this to happen and in order to maximise the positive outcomes from the visit, the teacher need to be clear about her/his own purposes for the visit and adequately plan beforehand.

Preparing for the visit

Before taking the students for an educational visit, the teacher clearly needs to consider the strengths and limitations of the site and prepare her/himself for any remote preparation needed.

First and foremost, the teacher needs to clearly set her/his own purposes for the visit, ascertain what material shall be treated along the visit and how this can be related to what is done in the classroom. At the IET the principal focus is energy technology and throughout the visit presentations are made on different aspects related to energy; energy use in buildings, energy conservation and renewable sources of energy. The students are also introduced to solar and wind energy and how these can find their application in a Maltese context. The researchers working at the Institute (Iskander, Farrugia and Fsadni 2000) state that:

'The programme aims at increasing the awareness level of students and teachers on the present energy situation in Malta and the detrimental effects that it is having on health, the environment and buildings. It also stimulates them to realise that their present social and living habits, whilst providing them with a temporary better quality of life, frequently conflicts with the long-term sustainability of that quality'.

When considering the areas being covered, it is immediately evident that the visit is mainly aimed for those students and teachers who want to delve further in the study of energy, particularly focusing on energy sources and energy efficiency. However as the visit progresses, it can be noticed that other aspects mainly related to heat transfer and current electricity are also considered.

When considering the size of the group it is advisable to take less than twenty five students for a single visit since at the IET space is very limited and most frequently presentations have to be carried out in the researchers' offices. An adequate number of students may also make it a single visit since at the IET space is very limited and most frequently presentations have to be carried out in the researchers' offices. An adequate number of students may also make it easier for the presenters to manage the group and actually involve all the students throughout the sessions.

Students should be advised to bring with them a packed lunch and drinks since the nearest food outlet is about ten minutes walk from the institute. In case of hot weather, it is also recommended to ask students to attend with their school tracksuit and sports shoes since during the visit they may be asked to move in different locations within the premises, even on the roof.

When considering accessibility at the Institute, one has to say that all rooms are on ground floor and hence accessible for students on wheelchairs. However the main entrance is not provided with a ramp and accessibility to the roof may also be problematic since the sole access is provided through a spiral staircase. Parking close to the Institute's premises is also limited however school transport can stop the students in front of the Institute's gate and the main premises can be reached after a 2 minute walk.

The premises of the Institute can be considered to offer no particular health and safety hazards. However the students have to be warned that on the roof there are no lateral supports and they should be conscious not to adventure themselves close to the edges. One has to say that in case of bad weather the visit to the roof is cancelled to avoid any further risks for the students. Teachers are finally advised to book as early as possible since only one daily visits per school is accepted. Bookings can be done by e-mail or by phone however an official letter from school is also required. Clearly certain arrangements for the visit such as those for transport have to be made at school prior to the visit.

The sessions at the IET

Once all arrangements have been made and the students finally arrive at the doors of the Institute, they are welcomed by a member of staff who dedicates the first part of the programme to explain how energy is utilised all over the world and its environmental effects. During this part the students shall also consider the local energy scenario, how renewable sources of energy may be utilised in order to decrease the dependence on fossil fuels and practical ways how energy can be conserved. The students may also clear out any particular queries about the topics being discussed or for instance ask questions about their own research projects. After a short break, the presenters share with the students some aspects regarding the current research being carried out at the Institute. Depending on the number of students present, they are split into two/three groups and each group has the possibility to attend the following sessions.

Energy use in buildings; At the Institute research on building design is being carried out and during this session the students look at different aspects that influence building design. During this session, the students observe how building methods may tend to ignore even the most basic measures in order to reduce the need for heating and cooling. The presenter also considers possible solutions to achieve an optimal design in relation to our local climate.

Energy from the wind; During this session the students are presented with some of the ideas emerging from the research being developed to evaluate the wind potential of the Maltese islands. The students eventually become familiar with the instruments used to monitor wind conditions and with the emerging data. Through the session, the presenter also illustrates how energy can be generated through a wind turbine and how different types of wind farms can be setup. Finally the students consider possible consequences resulting from the application of wind energy in a local context.

Energy from the sun; The following session shall be carried out on the roof of the Institute where the group can view the weather station and the photovoltaic systems present there. The presenter explains how research is currently being carried out over a vertically grid connected photovoltaic systems and a solar tracking photovoltaic systems. Both systems have been connected to the public grid. On the roof the students also have the possibility to look at the various features making up a solar water heater and discuss how these features maximize the effectiveness of the system.

Video shows: If time is available there is the possibility to watch some video presentations related to the topics discussed in the sessions.

Follow-up activities

It is important that the students reflect on and are encouraged to use the knowledge gained during the visit. For this reason it is vital that the visit is followed-up in some way or another. In order to achieve this, the students can be asked to;

develop a poster, a presentation or a model. Clearly the students should relate their research to the aspects treated during the visit. However as I have experienced myself when involving my students in these type of research projects, there is no limit to the inventiveness and creativity of the final results presented by the students who can come up with brilliant ideas even using simple or recycled material.

conduct further research at home so that when they return in class they can be divided in two groups and debate some controversial aspect that emerged during the visit.

write an article describing the visit and later place it in the school's website.

Teachers can also compile their own activity sheets if they want to emphasis some particular aspect of the visit. These activity sheets may be completed by the students at school or just after the visit so that they are able to think back on the important ideas that were discussed during the visit and maybe set the scene for some final considerations.

Final thoughts

Throughout the years, the annual visit to the IET has truly proven to be a valuable experience since it not only helped to generate an increased motivation towards learning Physics but it actually gave the students certain insights that cannot be possibly achieved if learning remained limited to classroom-based instruction. From the feedback I get after visits, students point out that the sessions at the IET helped them to understand better certain ideas because they can actually experience the particular situation. Hence learning is not just limited to what the textbook or notes suggest but it is applied to a particular context or situation. Moreover, students point out that the visit was important for them to appreciate that the different topics and even different subjects that are done at school are not separate entities but are intertwined and closely related to each other. Apart from this, the visit at the Institute adds an additional tool in the teacher's toolbox. It provides an alternative way how teaching and learning can take place since through the visit the students can benefit from the experience of the researchers and hence expand their knowledge in that particular area. At this point one also needs to appreciate that during these visits, the researchers do a laudable job when carrying out the sessions and as educators they manage to interact effectively with all the students. It is particularly through there effort, patience and dedication that the visit is made possible and is actually transformed in a true learning experience for all the participating

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For further details about the Institute for Energy Technology, Marsaxlokk visit :
http://www.um.edu.mt/iet

Is SEC Level Physics An Adequate Preparation for Studies at Advanced Level?

By C. Caruana, J. Farrugia, M. Muscat

The change from Physics intended for a small group of high achievers to Physics for all brought about a change in syllabus content. The Physics syllabus at Secondary School level is seen to have a dual role: to introduce students to Physics as a preparation for life and to prepare students who wish to continue studying Physics at higher levels. The study reported in this paper attempted to evaluate how far the second aim is reached: it investigated whether in students' and teachers' views, the Secondary Education Certificate (SEC) syllabus gave an adequate preparation to students who eventually studied Physics at Advanced level. Seventeen sixth-form teachers were interviews and 411 students filled in questionnaires by means of which they identified content areas and skills that were adequately covered at SEC level and others that were not. Most students felt that preparation in practical work and quantitative aspects of Physics was lacking. They felt best prepared in Mechanics and least prepared in Fields and Nuclear and Particle Physics. Most teachers described the SEC syllabus as superficial and failing to provide the students with the appropriate tools for the deeper Advanced level syllabus.

Introduction

Physics was first introduced in Malta as a subject intended for a small number of high achievers, initially offered only for boys and eventually also for girls (Mizzi, 1996). It remained so until 1979 when the subject became one of the four core subjects together with Mathematics, Maltese and English (Zammit Mangion, 1992). Between 1979 and 1994 all students in Maltese secondary schools studied Physics; in fact Physics was one of the compulsory requirements for entry into sixth-forms and University . As from 1995, students are required to possess a pass in any science subject for entry to sixth-form . (University of Malta, 2006) but all state schools and a number of non-state schools still offer Physics as the compulsory science subject, with the other science subjects offered as option subjects. The change from Physics designed for a small group of high achievers to Physics for all brought about a change in syllabus content.

The Physics syllabus at Secondary Education Certificate (SEC) level is seen to have a dual role. First it aims to introduce students to Physics as a preparation for life. However it is also expected to be attractive such that it inspires some students to continue studying Physics at higher levels. In this case, it also aims to prepare students to enable them to continue studying Physics at these higher levels. In the syllabus for Physics intended for local students between age 14 and 16 years, there are two aims related to the two roles that the syllabus is expected to cater for:

"… to contribute to the pupils' general education by helping them to make sense of the physical environment through scientific enquiry; to provide the basis for further study of the subject …"
(SEC Physics 2006-7, MATSEC 2003b, p. 2).

This shows the intention of providing students with an educational experience that caters for the needs of students who wish to further their studies as well as those who do not. But whether these aims are reached at all, and how these aims may be reached is another matter. A similar concern was expressed about the science curriculum in England in a recent House of Commons Select Committee report:

"The science curriculum at 14-16 aims to engage all students with science as a preparation for life. At the same time, it aims to inspire and prepare some students to continue with science post -16. In practice it does neither of these well …"
(HMSO, 2002, p.57).

When investigating the predictive validity of SEC level examinations for success at Advanced level (A -level), Farrugia and Ventura (2005) observed that students who do well in Physics at SEC level are likely to do well at A-level. In fact students with Grades 1 to 4 at SEC level were found to have 62.1% chance of obtaining Grades A to C at Advanced level (86.5% if starting with Grade 1; 82.7% if starting with Grade 2; 61.3% if starting with Grade 3 and 34.2% if starting with Grade 4). However determination of the Spearman Rank Order Correlation Coefficient resulted in a moderate correlation of 0.57. In a similar study based on results obtained by Junior College students, Pace and Bonello (2006) investigated the correlations between the SEC Physics results, the results of four informal assessments and the formal test held at the end of the first year at the Junior College and the students' performance in the A-level Physics examination. Their data consisted of the results of 159 students who finished their two-year course in 2000 and another group of 153 students who finished the course in 2002. They found correlations of $r = 0.488$ and $r = 0.442$ between SEC and A-level results. They noted no gender differences in the students' performance in the SEC and A-level examinations. They also found that students who had sat for Paper IIB at SEC level and had obtained Grade 4 still stood a fair chance of obtaining a good grade in the AM Physics examination.

A more recent study (Farrugia and Ventura, 2007) involving the whole Physics population sitting for Advanced level Physics in 2006 and SEC level Physics in 2004 (372 candidates) showed a correlation (Spearman Rank Order Correlation Coefficient) of 0.62. Most of the students with Grades 1 and 2 in Physics at SEC level were able to acquire Grades A to C at Advanced level. Quite a good number of candidates with Grade 3 at SEC level (68%) were able to obtain Grades A to C at Advanced level but a very sharp drop in performance was observed in the case of students with Grade 4 at SEC level. In fact only 33.6% of these students obtained Grades A to C at Advanced level. The authors observed that students with Grade 5 or lower at SEC level were unlikely to sit for the examination in Advanced level Physics or failed to obtain the higher grades if they did sit for the examination. In fact only 17 candidates out of the 372 included in the study sat for Advanced level Physics having started with a Grade 5 at SEC level. There were no candidates with Grade 6 or lower at SEC level who sat for A-level Physics in May 2006. The absence of students from the lower end of the SEC level range taking Physics at A level contributed to the moderate correlation obtained between the two levels. These results showed that while there is a relationship between the two levels, further investigation of the adequacy of the preparation provided by the syllabus at SEC level was required. The study reported in this paper attempted to evaluate how far one of the aims of the Physics syllabus was reached: it investigated whether in students' and teachers' views the SEC level syllabus for Physics gave an adequate preparation to students who eventually studied Physics at Advanced level. This was the main aim of the study carried out as a B.Ed (Hons) dissertation (Caruana and Muscat, 2006). The study considered different areas of the Physics preparation required such as the different Physics topics, practical work and Mathematical content.

Method

The first decision was whether to adopt a qualitative or a quantitative approach in order to tackle the research questions. Quantitative research is considered to be accurate and value free, since its tools help the researcher to be objective in the results and leave little space to divert from the actual facts.

One of its purposes is to provide predictions. Qualitative research, on the other hand is concerned with why a particular phenomenon is occurring. The study was based on a combination of both qualitative and quantitative methods since:

"the differences between the two approaches are often unclear and occur in a continuum; quantitative and qualitative approaches and methods are often combined to achieve the best results"

(Patton, 1987 p. 169).

The qualitative research tools adopted in this study were semi-structured interviews with teachers of Advanced level Physics while quantitative data were obtained through questionnaires with sixth-form students. These two methods were used in parallel in order to be able to compare and contrast the opinions of teachers and students and obtain the most reliable outcomes on which valid conclusions could be based through triangulation. Interviews conducted with teachers were semi-structured, which offered the opportunity for extensive questioning. Questions were addressed without excluding opportunities for adding on comment, opinions and personal experiences. Interviews were conducted with 17 teachers teaching in six sixth-form colleges. This provided the views of a relatively large number of teachers who come across students with a range of abilities. Due to the large number of respondents involved and the limited time available, students' views were collected by means of questionnaires. Many questions included in the questionnaire were based on responses obtained during eight interviews conducted with sixth form students. The questionnaire included questions designed to obtain the students' views about the level of preparation provided by SEC level Physics for their Advanced level studies and covered the areas of subject content together with information like gender, type of secondary school attended and year of study. Most questions were of a closed type where the numerical graphic rating scale, better know as Likert-type scale, was used to indicate the level of preparation acquired at SEC level. Some open-ended questions were included for the students to propose their opinions regarding particular issues, and to avoid any sort of bias, since closed-ended questions:

"do not enable respondents to add remarks, qualifications and explanations to the categories, and therefore there is a risk that the categories might not be exhaustive and that there might be a bias in them"

(Oppenheim, 1992, p. 115).

With the help of the teachers in the respective schools, 411 filled questionnaires were collected from students attending seven different sixth-form colleges. This ensured that the views obtained were coming from students with a range of different backgrounds and abilities. The students responding were from both the first year and second year of study and included both male and female students in order to investigate whether there were any differences in their opinion. Data for each question were analysed looking for differences according to gender, type of secondary school attended and year of study at sixth form.

Results

Teachers' views

The views about the gap between SEC and A-level Physics obtained from teachers who actually teach the Physics Advanced level syllabus was of utmost importance in this study. These people have a first-hand experience of what knowledge and skills a variety of students coming from different secondary schools bring with them. In this study, the questions presented to teachers during the interviews, touched on several issues related to the physics syllabi: the Physics content, the mathematical abilities required, practical skills and also the students' ability to communicate ideas in English. In general none of the 17 teachers interviewed were satisfied with the preparation of SEC level Physics for Advanced level. Many teachers described the SEC syllabus as becoming more and more 'superficial' with time:

SEC Physics provides students only with superficial information, whereas at A-level specialisation of the subject commences."

[Teacher A]

Teachers are deluded by the habits that students bring with them from SEC level Physics. They think that students are 'spoon-fed' at SEC-level and that they are not trained to link different topics to apply Physics in different situations as required at A-level.

"SEC-level is not so challenging and students tend to study by memorising most things. This is not possible in A-level. In A-level you get deeper into the subject and the topics are more linked."

[Teacher B]

For this reason many teachers said that students do not find what they expect in A-level Physics. They tend to choose it with the idea that the subject is much easier than it actually is and are shocked when they realize that it is hard. This problem is even bigger for students who had sat for Paper IIB in the SEC Physics examination Paper IIB. The syllabus for this paper is covered in lesser depth, which then results in further difficulty in adapting to the A-level content. As regarding practical sessions eleven of seventeen teachers interviewed, strongly think that students are not prepared well enough in practical work. They show lack of experience in handling the apparatus and using measuring instruments. Most explained that when A-level students enter the laboratory for their first session they look 'lost' as if they had never conducted an experiment on their own:

"In secondary schools, experiments are done mostly by teachers since students are given 15% of the SEC exam mark. So when students proceed to A-level they have to be taught to conduct the experiment on their own."

[Teacher C]

This problem was also mentioned by examiners in the SEC examiners' reports:. Teachers are doing demonstrations of experiments that can be done by students and this is definitely not recommended (SEC Examiners Report May 2002 and 2003MATSEC 2002, 2003a). Moreover, at A-level students find greater difficulty in accepting to conduct an experiment individually that is different from experiments done by their classmates.

When it comes to writing the report, students encounter several difficulties according to teachers. Many think that a practical report is just changing the tense from a typed instruction sheet, which is not and should not be the case at both levels. In addition, students encounter great difficulties in finding the results. Teachers expressed their disappointment in finding students who do not even know how to find gradients from a simple graph equation.

In fact the mathematical problem were mentioned several times. Teachers said that students do not appreciate the "beauty and creativity of solving a problem" and thus they encounter great difficulties in simple substitutions and problems which can be reasoned out. Although some blamed the SEC level Mathematics syllabus for this problem which is constantly being reduced, some pinpointed that the problem is more due to the fact that students are unable to link Mathematics and Physics.

When it comes to content, all the teachers are against the modifications that were made in the SEC Physics syllabus in recent years. Teachers said that many of the concepts which were eliminated from the Physics syllabus such as equations in electrical circuits and optics at A-level used to be useful at A-level. On the other hand the new topics introduced, specifically the Earth and the Universe do not help as much. Moreover teachers feel that certain phenomena such as the red-shift, are too complex for SEC-level and this gives more ground to the argument that this topic should not have replaced the previous sections.

With regard to the other topics, teachers affirmed that the bigger the gap between SEC and A-level in the topic, the bigger the difficulty students find in the same topic at A-level. In fact the sections liked most are usually those which are done in depth at SEC Physics such as *Mechanics*. However when it comes to *Circular Motion* students seem to struggle. This confirms that students find most difficulty with topics which are completely new to them. Among the 'difficult' A-level topics mentioned, *Electric Fields* and *Gravitation* were very common especially since these are abstract and intangible topics and thus the impossibility of visualising the concept contributes further to the problem.

The interviews carried out with teachers of A-level Physics have identified a number of areas in the SEC level preparation which call for improvement. Many of the views expressed by teachers are corroborated by the views offered by students in the second part of the study.

Students' views

The views of Physics students were of utmost importance in this study. However, the fact that certain factors and attitudes could have had a deep influence on the responses given in questionnaires had to be taken into consideration. In fact responses were analyzed keeping in mind the reasons given for choosing to study Physics at A-level, the grade obtained in SEC-level Physics, gender, the type of secondary school attended and their experience of SEC and A-level Physics. In this paper a brief outline of the students' responses will be reported, focussing mainly on their perception of the degree of difficulty of SEC level and A-level Physics, their views about the gap between the two levels and their views about the adequacy of the preparation in Mathematical skills, Practical skills and the different content areas.

It was interesting to note that out of 411 respondents 64.5% were coming from non-state secondary schools and 294 students were male. More specifically, 50.4% of all respondents were males coming from non-state schools who overall had obtained very good grades at SEC Physics. Most students had in fact sat for SEC Paper IIA and it was also evident that students do not usually choose to study Physics at A-level if they obtained a pass at SEC level by re-sitting the examination in the supplementary session.

Although many students claimed that the main reason for choosing A-level Physics was because it was a requirement for their future careers, 61.7% of students acknowledged that they liked Physics. Yet, results also indicated that the percentage of female respondents who do not like Physics is slightly higher than the percentage of male respondents who do not like it. A good number of students (57.1% of the male respondents and 60.7% of the female respondents) also stated that they chose to study the subject at A-level because it was actually among their favourites. This contradicts White (1996) who stated that it seemed unlikely that students choose Physics because they find it interesting since they consider it as a challenging subject.

Over 20% of the students chose Physics because they obtained a good grade at SEC level and a few others chose it just because subject options were restricted in their school and Physics was offered with their favourite subject. Over 20% of the students chose Physics because they obtained a good grade at SEC level and a few others chose it just because subject options were restricted in their school and Physics was offered with their favourite subject.

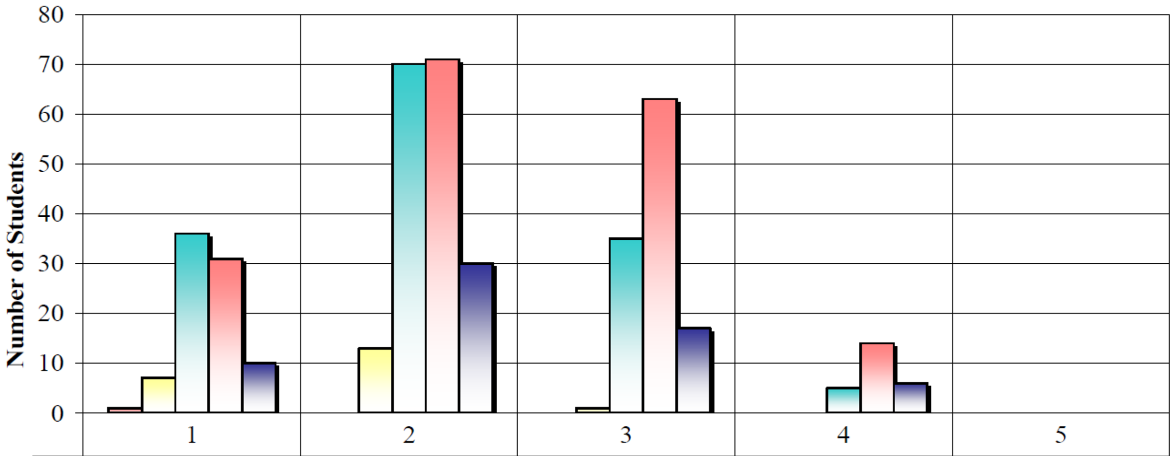
When comparing the difficulty of SEC level and Advanced level Physics, as expected, nearly all students said that A-level is harder. Figure 1 is a summary of the results of the correlation of the difficulty level of SEC and A-Level Physics according to students. Students ticked on a Likert scale the difficulty from 1 to 5: 1 being easy and 5 being difficult. Respondents were grouped according to the level of difficulty they rated the SEC level. Each group of respondents is represented in Figure 1 according to their judgement of the difficulty of A-level Physics. Their rating of the difficulty of A-level Physics is represented by the different coloured bars. For example taking the 85 students who considered SEC Physics to be easy (rating it 1), we find one student who also found A-level easy, seven who rated A-level Physics 2 in difficulty, 36 who rated A-level Physics 3 in difficulty and so on.

It is evident that no student said that SEC-level Physics was very difficult, so rating it 5. Con versely, only one student rated A-level Physics to be easy indicating that students find Advanced Physics harder.

Most of the students claimed that they found A-level Physics to be as they expected and only two students claimed that they found it easier than they had expected. A number of students, 29%, felt

that A-level is not a continuation of SEC level Physics because they felt that SEC level Physics is basic and misleads students to choose it at a higher level. This corresponds with what teachers said in interviews and implies that some students do choose Physics because they think it is an easy subject. A student commented:

"At SEC-level Physics is practically easy and so misleads the student that A-level Physics is easier than it actually is!"



	1	2	3	4	5
1	1	0	0	0	0
2	7	13	1	0	0
3	36	70	35	5	0
4	31	71	63	14	0
5	10	30	17	6	0

Difficulty of SEC Physics: Easy to Hard

Figure 1: The relationship between the difficulty level of SEC and A-Level Physics expressed by students

The main question investigated by this study was: What do students think about the gap between SEC level and A-level Physics? One of the questions required the students to rate on a Likert Scale how much they thought that SEC Physics prepared them for the A-level content. Only 28.3% of the students felt that the preparation was adequate, 38.3% felt that they had a fair preparation while 33.4% rated the preparation as poor. Males coming from non-state schools were the most positive in this question whereas males coming from state schools were the most negative. When comparing non-state school respondents in general, the percentages of both males and females who thought that the preparation was adequate was higher than that of students coming from state schools. Moreover it was interesting to note that many females seemed to think that the preparation was fair. In the rest of the questionnaire the students were given a list of the topics and the sub-topics covered both in SEC level and A-level Physics as well as other skills required in A-level Physics. They were asked to tick on a Likert scale the level of preparation they received in each of the topics and sub-topics.

One section dealt with practical skills. When referring to practical sessions, 55% of the respondents felt that the preparation at SEC-level was adequate, although there were more male than female respondents who claimed this. According to teachers this may be due to the low self esteem which many girls tend to have. The specific area in which all students felt that they needed more preparation was in analysing results obtained through practical work. The majority (67%) felt best prepared in graph plotting, which was the opposite of what the teachers had claimed. There was a vast discrepancy in how they gauged their preparation in handling of apparatus between boys coming from the state and non-state sector. In fact 64% of boys coming from non-state schools claimed that they were adequately prepared, as opposed to 30% of boys coming from state schools. Conversely, more females coming from the state sector felt adequately prepared in handling apparatus rather than those coming from the non-state sector. A student who felt that he needed more preparation in handling apparatus commented:

"At SEC-level, we were prepared very well except in the handling of apparatus since the experiments were carried out by the teacher herself."

Slightly over half the respondents (51%) thought that the level of preparation in mathematical skills was adequate, while the rest believe that this needs improvement. A particular student claimed that:

"SEC Physics has less mathematical calculation compared to A-level. It has more straight to the point questions like just filling an already prepared equation; unlike A-level which has extensive problem solving involved."

Students felt best prepared in working with equations whereas 57.7% of the male respondents and 71.3% of the female respondents stated that the preparation in trigonometric functions definitely needs to improve. Males felt better prepared in plotting graphs whilst girls felt better prepared in converting units. The majority of all respondents claimed that they were adequately prepared in Physical Quantities. A comparison between first year and second year students was made, in order to see whether they had converging or diverging opinions. Less second year than first year students felt that the preparation was adequate. The largest gap between SEC and A-level was seen in Scalars and Vectors where respondents from both sexes agreed with a similar percentage (46.2% of males and 44.7% of females) that the level of preparation was very poor.

On the whole, all students felt well prepared in the topic Heat, especially girls. However, both genders felt least prepared in two sub-topics: Heat and Temperature, and Pressure and Temperature. This might indicate that the removal of gas laws from the SEC syllabus, as suggested by one of the teachers, might have had a negative effect on the students at A-level.

Only 44.3% of the respondents believed that the preparation in Materials was adequate. The A-level topic Materials is not covered as a single unit at SEC-level. Stretching Materials is usually covered with Forces, whereas Energy in Materials is only mentioned in Energy Conversions. As regards to Stretching Materials, the vast majority of students claimed that they were well prepared at SEC-level. Conversely, the majority of the respondents thought that the level of preparation in Energy in Materials needs to be improved. This could be due to the fact that even though students are introduced to Stretching Materials where they investigate the relationship between the force and the extension in a spring, the connection between Energy Conversion and Stretching Materials might often be missing at SEC-level.

Another topic investigated was Electric Currents, where 53% of the students felt that in general, this topic was not adequately covered at SEC-level. It was interesting to note that Electric Circuits was the only sub-topic which was considered to be adequately prepared by the majority of both male and female respondents. Regarding Voltage, Resistance and Electrical Power, the majority of the respondents claimed that the preparation needs to be improved. Male respondents (62.9%) felt least prepared in Graphs, whereas female respondents (65.7%) felt least prepared in Voltage. As regards to Charge and Current, the responses were approximately divided evenly between adequate and non-adequate preparation. A student commented:

"More electricity topics need to be done, perhaps a project together with some mechanical practicals"

Fields is another topic covered in both SEC and A-level Physics. In general, the majority of the students (60.1%) felt that they were not adequately prepared in this topic. Fields includes Gravitational, Electrostatic and Magnetic Fields. The majority of both male and female students felt that they were not well prepared in Gravitational Fields. This might reflect the fact that Gravitational Fields are hardly mentioned at SEC-level, whereas at A-level, students have to learn the theory which is quite abstract as indicated by the teachers in the interviews. On the other hand both male and female respondents felt best prepared in Magnetic Fields, even though the percentages involved were not so high (51.5% for male and 50.7% for female respondents).

In general students seemed to be quite content with the preparation the SEC syllabus offered in Vibrations and Waves. In fact 58% of the students felt that they had adequate preparation. Teachers suggested that Waves is a descriptive topic in which girls tend to do slightly better. This might be the reason why a larger percentage of girls than boys, felt the preparation of The Progressive Wave and Sound Waves as adequate. Still, high percentages of both male and female respondents claimed that the preparation in The Progressive Wave needs to be improved. Students felt best prepared in Optics, even though this was not in accordance with the views expressed by teachers who claimed that since several parts were removed from Optics at SEC-level, students were finding the topic harder than they once did.

Most students felt that they were not well prepared at SEC-level in the topic Nuclear and Particle Physics. Teachers suggested that this could reflect the fact that the topic is often done at the end of the second year of the A-level course, when exams are very near. It could also be due to the challenging mathematical applications including logarithmic graphs. Indeed students felt least prepared in the section of Stability of Nuclei and Isotopes. Table I summarises the level of preparation by the SEC-syllabus in the different topics as indicated by the respondents.

	Adequate Preparation	Inadequate Preparation
Mechanics	72.6%	27.4%
Vibrations and Waves	58.0%	42.0%
Heat	57.3%	42.7%
Physical Quantities	52.1%	47.9%
Electrical Currents	47.0%	53.0%
Materials	44.3%	55.7%
Fields	37.9%	62.1%
Nuclear Particle Physics	35.6%	64.4%

Table I: Adequacy of the preparation in the different topics by the SEC level syllabus according to students

Conclusions and Implications

This study provided interesting findings worth taking note of especially since discussions intended to improve syllabi usually regard mainly the content and rarely consider the students' opinions about the subject.

Both 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. Teachers often described the SEC syllabus as superficial and which does not provide the students with the appropriate tools for the deeper Advanced level syllabus. The majority of the students felt that preparation in practical work and in mathematical skills was lacking.

Students felt best prepared in Mechanics and least prepared in Fields and Nuclear and Particle Physics. One of course expects a gap between SEC level and Advanced level as they are different levels of study after all. The question is whether this gap is too wide. It seems that with time, as SEC level Physics has sought to cater for students with a wide range of abilities and needs, this gap has widened and students and teachers alike feel the need to narrow this gap.

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. With regards to mathematical skills it seems that students may need to acquire mathematical skills beyond what is covered in SEC level Mathematics but perhaps more important is the need for students to get more experience of the use of Mathematics in the context of Physics at SEC level. This implies the need to re-introduce greater stress on the quantitative aspects of Physics in the SEC syllabus.

Another point regarded the practical work. The SEC syllabus requires students to submit the best 15 experiment reports. This may result in schools giving students only 15 practical sessions. The syllabus does not specify any restrictions about which experiment reports may be presented. This may lead to the presentation of experiment reports requiring the same practical and analysis skills or the presentation of reports for experiments which were carried out as teacher demonstrations. Such situations are likely to lead to the lack of practical and analysis skills observed by sixth-form teachers and experienced by students taking A-level Physics. This implies the need to make the syllabus requirements more specific with respect to the range of practical skills and analysis of results that must be involved in the 15 experiment reports submitted.

Obtaining or failing to obtain the Advanced level certificate in Physics will determine whether a student will be able to pursue a course and eventually a career in a Physics-related discipline. With such high stakes involved, it is evident that more effort must be put towards the alignment and bridging of the two levels and to ensure that the SEC level is an adequate preparation for studies at Advanced level.

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Homework: Fundamental or Redundant?

By P. Calleja

Introduction

Is physics homework considered an essential part of the learning process and does it really help students improve? These were questions that often came to mind whilst listening to debates about homework. Reading through different articles, I found that many educators disagreed about the importance that should be given to homework and that homework has always been somewhat of a controversial issue. I thus decided to carry out a research study to investigate ideas about homework amongst Maltese teachers and students. Results from this research study have shown that even in Malta there are conflicting ideas about the importance of homework. Many of the interviewed teachers assigned some form of physics homework and corrected it regularly while others believed that homework was useless. On the other hand, most students believed that they should be assigned physics homework and that homework was important in order for them to learn more.

Methodology

Quantitative methods were chosen as these would help to "emphasize the production of precise and generalizable statistical findings" (Rubin and Babbie, 2001, p. 44). For this purpose a questionnaire was used with three hundred and twenty Form 4 students from Malta's girls' Junior Lyceums. Questionnaires were administered with at least three classes from each school and results were then analysed quantitatively. Qualitative research methods were also used to get a deeper insight into the data that would be gathered from the questionnaires. Interviews were used with at least three teachers from each school and a total of seventeen interviews were carried out to elicit detailed information and help explain certain findings which would emerge from the quantitative analysis.

Homework: A controversial issue

A review of some of the literature about homework has shown that the issue of homework is a very controversial one and while some researchers claim that homework has positive effects on students, others argue that the effects of homework are negative. Claims supporting the idea that homework has positive effects include that homework "encourages student initiative, develops independent learning, and allows time for practice and application of what has been learned in school" (Coulter in Dunkin, 1987, p. 272). Two of the negative claims about homework are that homework does not leave any leisure time for students and that "it interferes with important family and community participation" (Kravolec and Buell, 2000, p.22).

Results from this study have shown that although only 50.7% of students stated that they liked physics, 86.4% believed that physics homework helps them in their study and comprehension of the subject. The study was also aimed at finding out how often physics homework was being assigned and results have shown that the majority of students (54.9%) were being assigned physics homework at least once a week. However, there were 12.6% of students who stated that they were rarely given physics homework while 4.1% stated that they were never given any at all. However the results indicated that students who were rarely or never assigned physics homework felt that they should get more homework. The teachers interviewed gave differing views about the importance of homework. It was found that in three of the five schools visited all the participating teachers assigned some kind of homework to their students. In the remaining two schools, there were conflicting ideas amongst the teachers regarding the importance of homework. In general, results from this study agreed with those presented by Bourke and Fairbairn (1993) who found that teachers considered homework to be important up to a certain extent and the focus was on the outcomes of homework. It was interesting to find that although the majority of teachers thought that homework was important, only few believed that it was essential.

Three of these teachers stated that homework was not important to help students learn. They believe that if they managed to capture the students' interest, the students in turn would understand the lesson better and this would be enough for students to succeed. Some of the students' comments such as: "If you learn from the lesson homework is not needed" reflected their teachers' thoughts about this matter. This shows that messages conveyed by the teacher will, to some extent, influence what students believe. Different aims were mentioned by teachers for assigning homework but in general, the aims of homework could be grouped into two main categories: one in which homework was aimed at helping the students improve and the second was to give the necessary feedback to the teacher.

Black and Harrison (2001), state that comments are more effective than marks as feedback and help students realize that assessment is there to help them learn more. Surprisingly, the majority of students in this study believed that homework helped them learn more irrespective of whether they received marks or comments and irrespective of whether the homework was corrected or not. This finding shows that the students are not only doing their homework to get feedback about what they know but they also give importance to the process of doing their homework.

Positive and Negative Effects of Homework

Most teachers believed that homework can have positive effects on students. Some of these benefits are evident in the following statements made by teachers:

- "Students who take homework seriously will delve deeper into the subject and understand it better".
- "If homework is planned well it gives students confidence".
- "Misconceptions are checked by homework and it helps students to keep studying".
- "It will help students be prepared for the types of questions that they will find in their exams".

As positive effects of homework Milbourne and Haury (1999) mention that homework helps students become more self-disciplined and helps them acquire time management skills. They add that it helps students learn how to work independently and become more responsible for their learning. Although these positive effects were not mentioned by any of the teachers interviewed, they were mentioned by the students themselves. This shows that at times the positive effects of homework may be felt by students but underestimated by teachers.

Out of the seventeen teachers interviewed, fourteen believed that homework could also have negative effects when it was given in large amounts because it over-burdens students, makes them bored of it and does not leave time for extra-curricular activities. Moreover, they also believe that homework which was copied had negative effects since this meant that the teacher was unknowingly giving the wrong feedback to the students.

Some teachers also pointed out that homework had negative effects if it was either too easy or too difficult and an association was also found between finding physics homework too difficult and disliking the subject. This shows that difficult homework may discourage certain students to such a degree that they cease to like the subject. Zammit Marmara (2007) claims that homework does not leave time for students to enjoy their childhood but surprisingly, results from this study show that very few of the students felt that homework did not leave them with free time. A possible reason to explain this is that students may be rushing through their homework. A possible explanation for this is the fact that teachers are careful not to give too much homework. Alternatively, when answering this question the students considered physics homework only and did not take into consideration other subjects.

Getting help with physics homework

The majority of students (75.1%) felt that at least some of the time they needed help with their physics homework and they usually turned to their friends for help. A possible reason for this is that parents may not be familiar with the subject and thus they cannot help. Nevertheless, parents can still help their children indirectly by for example, ensuring that their children complete their homework in the right environment with the least amount of distractions. Another way for parents to support their children would be to provide them with the resources they might need. Another possible reason why students start relying more on their friends is that at this age they might feel that they are getting older and wish to be less dependent on their parents. Therefore, the negative effect indicated by Kravolec and Buell (2000) that parents confuse their children when explaining homework would not have a large influence on results for this study since few students are seeking help from their parents.

Results have also shown that very few students ask for their teachers' help when they have homework difficulties. A possible reason is that students do not want to show their teacher that they haven't understood. It was also interesting to find that some students get help for their homework from their private lessons teacher. A possible solution for this would be that school teachers set certain times during the week during which it would be possible for students to ask their homework problems either individually or in small groups.

Time spent on physics homework

Studies by Postlethwaite and Wiley (1992) and Keeves (1992) have found that time spent on science homework has a positive effect on students' achievement. Results have shown that the majority of teachers interviewed believe that the above finding is true. The explanation given by most teachers for this belief was that in most cases, the teachers found that the marks students obtained in their homework gave a clear indication of the marks they would obtain in future tests and exams. It was therefore surprising to find that some teachers did not give any homework at all. These teachers found that the marks the students obtained were not giving a clear indication of how students would perform in tests. A possible reason for this was that the homework was being copied. Therefore, these teachers felt that it was better not to give any homework and use tests instead to ensure that students were not copying the work.

Conclusion

In conclusion, results have also shown that the majority of teachers were aware of the school homework policy and what it stated, but in general they did not follow it closely. If these policies are made more subject-specific it may lead teachers to follow the policy more closely and may also help to ensure that all students will be assigned similar amounts and types of physics homework. The study has shown that although homework is not necessarily fundamental, it is definitely not redundant since it helps students study, practice and revise what they have learnt at school. These were only some of the benefits that students and teachers felt homework had. Homework is also one effective way of assessing students and it gives an indication of how students will perform in future tests. Although homework was seen to have some negative effects, students' belief that homework is important and that it helps them learn more shows that homework is not redundant. Therefore when meaningful homework is given in appropriate amounts, it can help students improve and become more successful.

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MY PHYSICS

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