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Student perceptions on physics teaching and its impact on science subject choices in Trinidad and Tobago High Schools

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In this article a semi-structured focused interview was used to elicit from a purposively selected group of upper secondary school science students in Trinidad and Tobago, the reasons why physics was not their preferred science subject. Their explanations for evading the study of physics were explored and are reported herein. All the students involved in this work had some prior exposure to physics and while many admitted that certain physics topics could be interesting and/or helpful to them, they maintained that physics would still not be their first choice science subject. In general, students offered explanations linked to difficulty levels, specifically mathematical difficulties; the abstract nature of physics; the perceived irrelevance of the subject, and the less than appealing methods of delivery, as reasons why they chose not to pursue physics.

Key words: subject preference, teaching methods, upper secondary education

Introduction

The Trinidad and Tobago education system consists of four levels: these are pre-school, primary, secondary and tertiary education. Basic education consists of 12 years of core curriculum with four different levels: lower primary education (Standard 1-3 between the ages of 7-9 years), upper primary education (Standards 4 and 5; 10-11 years), lower secondary education (Forms 1-3; 12-14 years) and upper secondary education (Forms 4- 6; 15-18 years). All students in each level are expected to achieve the learning outcomes as prescribed by the official curriculum documents which articulate content and guide instruction. The content at each level builds on what was taught at the previous level so that information is progressively presented, and more complex analyses are used as students move from one level into a more advanced level. The body of knowledge targets skills and learning processes, but also addresses value issues to some extent. The science content covers eight areas: (1) living things and their survival; (2) life and environment; (3) matter and its properties; (4) force and motion; (5) energy; (6) earth science; (7) space and astronomy, and (8) nature of science and technology.

At primary school all students are exposed to these eight areas in teaching sessions that are designated for science instruction. One science teacher per school is assigned to each level in the primary system, so, for example, the Standard 1 class will have just one teacher. This teacher has responsibility for teaching all science curriculum areas to their assigned students at that level. At the secondary level the situation is different. At each level there are subject specialist teachers who deliver instruction in each major curriculum area. As with the primary level, all students in lower secondary school are taught science in all eight content areas. This means that all students entering upper secondary school would have been exposed to a broad based science curriculum. Upper secondary students are free to select the subjects they would like to pursue and often this selection is guided by the subject areas they like and/or the career they foresee for themselves. At this level, it is not compulsory for students to pursue a science subject. Each subject at this level is taught by teachers trained in the respective subject matter (teachers must hold a tertiary level content degree (B.Sc.) in the subject that they are teaching at upper secondary level). In Trinidad and Tobago, science classes at the upper secondary level have historically been populated by high academic achievers with many of them choosing to pursue studies in at least two of the three primary sciences – biology, chemistry and physics. (Trinidad and Tobago, Central Statistical Office, 2008). Many of these students upon graduation would continue on to university to pursue degrees in one or two of the primary sciences and several of them would go on to become science teachers in the particular discipline/s in which they would have attained their degree.

Over the last decade or so, two inter-related trends that may be causes for concern have been observed in Trinidad and Tobago:

1. Progressively fewer students are opting to pursue physics at the upper levels of their secondary schooling (Trinidad and Tobago, Central Statistical Office, 2008).
2. A growing and continuing shortage of physics graduates and subsequently of such graduates becoming physics teachers (Smithers & Robinson, 2013).

Both these trends are of concern to physics educators in Trinidad and Tobago as they seem to suggest that something is happening, either inside or outside the physics classroom, that is causing students to shy away from the subject. Reid and Skryabina (2002) highlighted similar concerns in work done to explore students' attitudes towards physics and found that many upper level secondary school students were unwilling to pursue studies in physics beyond levels at which it was compulsory to do so. They concluded that when compared to other science disciplines, physics was highly unfavourable among secondary school students. Findings like this, taken in the context of the observed trends in physics education in Trinidad and Tobago, hint that now might be an opportune time to look carefully into our physics classrooms to see if the reasons for upper secondary school science students' defection from physics can be found therein.

Jenkins and Pell (2006) indicate that physics is not the preferred (first choice) science for most secondary school science students. Anecdotal evidence in the Trinidad and Tobago context reveals that many students are not overly enthusiastic about pursuing studies in physics beyond levels at which the subject was compulsory. In fact many students indicated that in the absence of coercion and/or a deliberate consideration of future academic and career paths, they would not select physics as a first choice science subject. This is not to say that some students do not select physics for further study, but the number that does is very low when compared to other subject selection numbers in science (Trinidad and Tobago, Central Statistical Office, 2008).

Educational literature, at the international level, abounds with research that has explored secondary school students' attitudes to science in general and to physics in particular (Williams, Stanisstreet, Spall, Boyes & Dickson, 2003; Woolnough, 1994), and while not much is known about students' perceptions and attitudes to science and/or physics in Trinidad and Tobago, there is some indication that students view science, and in particular physics, with less than positive attitudes (Maharaj-Sharma, 2007). Jenkins and Pell (2006) revealed that students in England who willingly opt to study physics at the upper secondary levels have cited a deep interest in careers in engineering or in the petrochemical industry as the main reason for their selection of the subject – only a very few have cited interest, relevance or enjoyment of the subject as reasons for their pursuance of physics at this level. In both settings, internationally and in Trinidad and Tobago, factors such as delivery methods and teacher competency in the context of the scientific process have been raised as issues that might impact on students' attitudes, but it is not clear from any of these works why students deliberately avoid studies in physics.

This lack of knowledge about why students do not willingly opt to pursue physics at upper secondary school levels and beyond was the motivating factor for the current work. This work examines science students' experiences particularly of the teaching and learning of physics to search for explanations as to why these students are not willingly pursuing physics at the upper secondary levels. In particular, attempts have been made to gauge students' views about the nature of physics and about how it is delivered in the classroom setting. The aim here was to explore the reasons why physics is not the preferred science subject of upper secondary school science students. With this intention in mind, the following two research questions guided the approach adopted in this work:

1. Why is physics not the preferred science subject of upper secondary school science students?
2. What influence, if any, do teaching methods have on upper secondary school science students' reasons for not selecting physics as a first choice science subject?

Literature review

Almost two decades ago, Watson, McEwen and Dawson (1994) made the claim that students who find a subject interesting will tend to select it for further study. More recently, in work that explored students' interest levels in science, Fensham (2006) reported that there is a direct relationship between students' interest in a subject and the likelihood that they will select it for study at higher academic levels. In Trinidad and Tobago, students use words such as "interesting" and "boring" fairly loosely, so it is not entirely clear what they mean when they say; for example; "physics is boring" or "physics is hard". In work done in the local context it was revealed that more than 60% of students pursuing science had negative perceptions of the subject and, while the scope of that work did not include perceptions about physics in particular, the findings did indicate that students were turned-off by a number of physics topics (Maharaj-Sharma, 2011). In other related work, Otero, Pollock and Finkelstein (2010) described what is labelled a 'disconnect' between the ways of learning in physics and the methods of teaching in physics. In their findings they reported that many physics teachers teach the subject in the same traditional way it was taught to them and that for most purposes, the traditional methods are ineffective in promoting learning among today's students. In addition, Lyons (2006) also revealed that, by their own admission, teachers have indicated that their own physics learning experiences were dominated by a lot of teacher-telling, note-taking, text-book reading and teacher-led demonstrations and that very little 'real' emphasis was placed on discovery learning, explorative investigating or problem solving practical activities.

With the research suggesting that there is very little difference in the way physics was taught two decades ago and the way in which it is presented today, it is not surprising that today's students decide to not study physics as it appears out of synch with the cognitive, social and technological levels at which they operate. Gregson (2000) as well as Skamp and Logan (2005) report that with globalisation and the explosion of technology, the student body has evolved over the years and students will no longer be satisfied sitting quietly in a classroom and being told 'about' concepts or have concepts 'explained' to them; they want to 'find out' and to 'discover' for themselves. Students have a more hands-on approach and if the classroom experience does not provide them with opportunities to learn through active engagement and physical involvement they are likely to lose interest in the subject and be inclined to reject it (Gibson & Chase, 2002).

In addition to deficiencies in delivery methods, Speering and Rennie (1996) found that if students feel that a subject is 'hard' – abstract or too mathematically demanding, in the case of the science disciplines – they are likely to evade opportunities requiring them to study that subject. Relevance too can be a deterrent, as Reid and Skryabina (2002) and more recently Dusen and Otero (2012) have pointed out, when deciding on the choice of subjects to pursue in tertiary education, students were very selective in their choices and only enrolled in those courses that were relevant to them either for further study or for the career path that they envisaged for themselves. With particular reference to physics, Broggy and Clelland (2008) found that even at the tertiary level, significantly fewer students were pursuing physics courses and majoring in physics. Many university students cited the didactic traditional teaching methods used in their prior physics learning experiences as a major turn-off and some reported that the discipline itself was, in their view, very abstract, mathematically challenging and irrelevant to their future goals.

Gibson and Chase (2002) as well as Reid and Skryabina (2002) have suggested that both lines of reasoning – traditional methods of delivery and mathematical abstractness – are in fact linked and that delivery methods influence the perceived abstractness of the subject. Reid and Syryabina (2002) posited further, that it is possible to dilute students' perceived abstractness of physics by employing appropriate and contemporary teaching/learning pedagogies in the delivery of the subject. They report though, that such a transition is not an easy, rapid or automatic one and that while professional development will go a long way to achieving the desired end, teachers' attitudes to the profession and their willingness to embrace change are key factors.

The literature seems to suggest therefore, that challenge level, relevance and interest are factors students consider when selecting subjects for further study. It suggests further that these factors are influenced by, or at least linked to teaching methods and experiences through which prior learning occurred and that all of these ultimately impact on students' decision to select or not select a subject for further study.

Methodology

This work is broadly phenomenological and seeks to understand the relationship between students and the study of physics through examining the perspectives of upper secondary school science students in Trinidad and Tobago on physics as a subject choice. Student perspectives were solicited using a semi-structured focused interview consisting of 12 questions. The questions were designed to explore two things: 1) the various reasons students gave for not selecting physics as a first choice science subject and 2) the influence of teaching methods on students' reasons for not selecting physics as a first choice science subject. Within the confines of these two parameters, the interview allowed students to comment freely and in detail on the teaching/learning experiences they encountered in the classroom. The interview protocol was designed by a group of senior lecturers working in the field of science education at the School of Education, The University of the West Indies St. Augustine, Trinidad and Tobago. The original protocol went through several revisions before the final version was agreed upon by the group.

The interview format was piloted with a group of 65 Form 3 students who were at the point in their schooling where they would have already been exposed to all three science subjects (biology, chemistry, and physics), and were required to select the subjects they would like to pursue in Forms 4 and 5. Though the current work targeted Form 4 students, the pilot was done with Form 3 students because it is at this level that students are required to select subject for further study. In this selection process students are encouraged to interrogate deeply their views, feelings and interest in respect of various subjects. Since the interview questions focused on these very areas, the Form 3 group was ideal for the purposes of piloting.

The aim of the pilot exercise was to determine if students had difficulties understanding the questions and also to gain some insights into what typical responses to the questions might be. The results from the piloting indicated that students understood what each question asked and, in all cases, they responded completely and rationally. Once the pilot was reviewed the full study used the questions as the key data collection tool. The data sought for this study highlighted the reasons students gave for selecting or not selecting physics at a point in time after the subject selection process was completed and for this reason Form 4 students were selected for this work.

Participants

Forty-eight secondary school students, all in their Form 4 year of schooling participated in this work. A convenience sampling approach, as articulated by Cohen and Manion (1994), was adopted to select the students from four schools across Trinidad and Tobago. This sampling approach was used because the teachers of these students had held previous discussions with the researcher about the diminishing number of physics students in their classes and they were interested in exploring the issue further. The group of students was diverse in terms of academic ability, geographical location, socio-economic status and cultural origin. The age of the students ranged from 15 to 17 years and the group consisted of 23 boys and 25 girls. All students were pursuing at least one of the three sciences – biology, chemistry or physics – in their current course of study. They had all been exposed to several aspects of all the sciences in their earlier years of schooling. At this level the students had already selected their subjects, and the aim was to elicit from them why physics was not their preferred science subject. It should be noted that in this group there were a number of students who were not pursuing physics but there were also some students who were in fact pursuing physics even though it was not their preferred science subject.

Data collection and treatment

This work is contextualised within a qualitative research paradigm and proceeded via the grounded theory approach as described by Smith-Sebasto and Walker (2005). In this approach, collected units of data obtained from students' responses were coded and compared against one another to arrive at categories and properties. The person-to-person interview format as articulated by Merriam (2001) was used to collect data from the participants. The interviews were conducted during the months of February and March 2013, which corresponded to a period when the students would have settled into Form 4 and would have already spent one academic term studying the various subjects they opted to pursue. The researcher liaised with the teacher from each participating school to arrange a time and place that was convenient to conduct the interviews. The students were informed of the nature of the project and were asked to participate on a voluntary basis. All students agreed. Each interview lasted about 15 minutes and in most instances it was possible to complete the interviews for all the students in a given school on one day.

The group of 48 students comprised students in two sub-groups:

1. Students who were pursuing physics, even though it was not their preferred science subject. These students were pursuing physics either because it was a fixed offering which could not have been omitted from the group of subjects they selected, or because they were encouraged to pursue physics by their teachers or their parents. These were labelled G2 students.
2. Students who were not pursuing physics, but were pursuing another science subject. These were labelled G3 students.

The G2 students were critical because even though they were pursuing physics, it was not their preferred science subject and their explanations of why physics was not their first choice science subject were valuable to this work. The G3 students were not pursuing physics so their reasons for not selecting it were also significant to this work. The interviews for both groups were audio recorded for authenticity and these were replayed and reviewed several times, during the verbatim transcription process, to ensure that the process was valid and accurately reflected what the students said. Instances of inaudibility or ambiguity were noted and the researcher contacted the respective class teacher and student to request a one-on-one with the students to clarify uncertain responses. This procedure was done during the first week of May 2013.

The transcripts were reviewed and arranged separately for each group (G2 and G3). The grounded theory, constant comparative method was employed to analyse the transcriptions. In this context, small units of the transcriptions were coded at a time to assign codes within units. This process included a review aspect in which the transcribed data were constantly reviewed during the coding to ensure that the codes eventually assigned were reflective of what the data were saying. Codes generated within units and also among units were subsequently compared. In the comparing process related codes were linked together and similar codes were grouped together to arrive at broader themes for the data in an ongoing iterative process.

Two strategies, peer reviewing and member checking, were employed in this study to establish trustworthiness or credibility of the findings. Firstly, in the peer review process, copies of the transcripts were given to a senior research fellow who is a colleague at the researcher's institution for independent analysis. Both individuals subsequently met to compare and discuss the codes assigned as well as the emerging themes. The second strategy, member checking, involved taking the data (interview transcripts) back to the participants, and asking them to clarify responses and/or issues emerging from the analysis. The member checking process also sought to ensure that the interpretations drawn from the data were in line with the participants' meanings.

Findings

Qualitative analysis of the interview transcripts revealed the emergence of three broad reasons offered by students for their unwillingness to select physics as a first choice science subject. These were:

- challenge level linked to mathematical difficulties or perceived abstract nature of physics
- irrelevance of physics to them personally or otherwise
- the use of unattractive traditional teaching methods in the delivery of physics lessons

The data revealed that the reasons listed above were not due to the same causes and/or experiences in all instances. In fact each of these broad reasons was arrived at through the coding of students' explanations with the researcher being guided by the search for why physics is not the preferred science subject of upper secondary school science students. It should also be noted that the requisite mathematical background knowledge needed to pursue physics at this level was covered in the mathematics curriculum that is compulsory for all students at all level. While their responses were varied in terms of (i) explanations offered and (ii) the depth of these explanations, the recurring similarities were undeniable.

Challenge level

A very strong and frequently expressed view/explanation offered by the students as a reason for why physics is not their preferred science subject was that physics is a highly challenging subject for them. The challenge was articulated in two different ways: 1) challenging due to mathematical difficulties and to a lesser extent 2) challenging due to perceived abstractness of the subject. Out of the 48 students interviewed, 31 of them used words and phrases in their responses that conveyed the idea of physics being mathematically challenging or much too abstract.

Among their many responses, students were adamant that "physics involved too much mathematics", or that "the mathematics part makes it too hard". The other element of challenge for the students – abstractness – was captured in phrases like "I don't understand what is happening" and "I cannot explain or figure out heat transfer by radiation….even when miss explain it". These two notions linked to challenge level were captured quite explicitly in the following interview extracts from two of the students:

Researcher: Are you currently pursuing physics?
Student1: Yes.
Researcher: Was it a subject you selected?
Student1: No.
Researcher: How come you are doing it then?
Student1: It was one of the subjects in this group....you have to select from the 6 groups which one you want in form 4... this group has Spanish and IT... I wanted to do those subjects... but it also had physics... so I had to do it...
Researcher: So why didn't you want to do physics?
Student1: It is a hard subject... too much mathematics in it. I am weak in maths... maths is hard and it makes physics hard too...

Researcher: Are you currently pursuing physics?
Student2: No.
Researcher: So why didn't you choose to do physics?
Student2: A lot of physics is hard to understand...
Researcher: What do you mean when you say hard to understand? Give me an example.
Student2: I cannot visualize it... like when miss explain conventional current... what is that?...and I cannot understand how energy is not destroyed... Where does it go?

The perception of abstractness and/or the feeling of physics being difficult because of its mathematical components was captured in some form in 60% of the interview transcripts analysed. Students who were not pursuing physics as well as some who were pursuing physics expressed these sentiments with equal passion. From among the G2 group (students who were pursuing physics), seven of them indicated that in spite of the mathematical challenge the subject posed to them and/or the abstractness of the subject, they were encouraged to pursue physics by their teachers or their parents or both, because these adults felt that physics important for later studies or necessary for getting a job. An example of one student's response which captures such sentiments is as follows:

Researcher: Are you currently doing physics?
Student3: Yes.
Researcher: Did you select it as a subject you wanted to do at form 4?
Student3: No.
Researcher: So, why are you doing it?
Student3: My teacher said I was good at it... She told my parents... And my parents made me do it...
Researcher: Did you tell them that you didn't want to do physics in form 4?

Student 3: Yes.
Researcher: So, why did they make you do it?
Studens3: They said it was important because I might want to do engineering and I will need physics.

Perceived irrelevance

While challenge level was a very strong emerging reason for why students shied away from physics, it was also clear from their responses that the perception of physics as being irrelevant to them personally and to their lives was another reason why the students were not interested in pursuing physics beyond the level at which it was compulsory. It was evident from several of the interviews, that even though physics was presented to students in class, very little effort was made to show students the everyday relevance of the physics they were learning. Nineteen of the 48 students spoke explicitly about this perceived irrelevance which is highlighted in the following two interview extracts:

Researcher: Are you currently doing physics?
Students4: No.
Researcher: So why didn't you choose to do physics?
Student4: Physics is not important to me.... I don't need it for what I want to do.
Researcher: What do you want to do?
Student4: I want to do art and then graphics design.
Researcher: Do you know that there is a lot of physics in graphics design?
Student4: No.... it is just about knowing how to draw...
Researcher: What if I could show you what physics there is in graphics design, would you consider doing physics then?
Student4: Maybe....if it will be useful to me....but I don't think it is useful to me now.

Researcher: Are you currently doing physics?
Students5: Yes.
Researcher: Did you select it as a subject to do?
Student5: No.
Researcher: Why not?
Student5: It is not relevant to me.... I don't need this subject in my life....
Researcher: Why do you think it is not relevant to your life?
Student5: Because I'm not really interested in science...I might go into business.

Responses similar to those in the above two excerpts were quite common among the students which suggested that some students felt that physics was not important to them and that it has no relevance to what they wanted to do later on in their lives. Students conveyed very clearly in their responses that even up to the Form 4 level their experiences had not pointed out to them any significant usefulness, relevance or importance of physics to possible career paths they considered for themselves. Even those who were pursuing physics because they were coerced into it by an influential parent or teacher reported in their interview responses that they did not see why physics was important to what they wanted to do. They admitted that they had been told that it was a subject needed for things such as "admission into university" or "to become a pilot", nonetheless, they still thought it to be an irrelevant subject to them. In fact, those who were coerced into doing physics agreed almost unanimously that they would have preferred doing something they thought was more relevant to them. The students used phrases like "doing something more useful" and "doing a subject that I can really use" to convey the message that they did not see the relevance of physics.

Teaching methods

Very surprising and interesting were the less-than-kind comments almost all the students made about their experiences in science generally, but specifically regarding the teaching of physics. Forty-six of the 48 students responded, with bitter criticisms, about their dissatisfaction and rejection of the methods employed by their physics teachers. Words like "boring", "dull" and even "foolish" were used freely and repeatedly by many of the students to express how they felt about the way their teachers taught physics. When asked to explain in detail what they meant by their comments and to give specific examples students spoke at length about their teachers' use of textbook narration for note-taking purposes and textbook reading for the purposes of information dissemination. Students were also very vocal about their physics classes being dominated by teacher-telling when they would have preferred student-doing. The repeated comments by students about "no practical activities" and "very few experiments" were surprising given that physics, as are the other sciences, is prefaced on the assumption that learning in the science disciplines occurs most effectively when students are provided with opportunities to engage in hands-on learning through exploration, discovery and inferential communication. The following excerpts from three students who were pursuing physics (G2 students) capture three different aspects of students' dissatisfaction with the teaching/learning strategies used by their teachers and reflect the views of many of the others interviewed in this work.

Researcher: Explain to me how your teacher teaches physics to the class.
Student6: She reads from the textbook and we follow along…
Researcher: Is that all that she does?
Student6: No, sometimes she will call out the notes from the textbook and we will write it in our books…
Researcher: And has this been helpful to you?
Student6: No….it is very boring…..and we have to write it even if we don't understand it…
Researcher: So can't you ask a question if you do not understand something?
Student6: Yes, she says we could ask questions….but she can't explain it to the class….most times she just tells us to go home and read the textbook and we will understand it.
Researcher: And do you do that?
Students6: Sometimes…..but what sense is that?….The class so boring….she only reading and we only writing….that is why I don't like physics…

Researcher: Explain to me how your teacher teaches physics to the class.
Student7: Well he talks a lot….he tells us about the topic and explains it…
Researcher: Is that all he does?
Student7: Sometimes he will draw a diagram or a graph on the board while he is explaining.
Researcher: So what do you do when he is doing this?
Student7: Sometimes I write down stuff I feel is important…he tells us we should do that while he is talking.
Researcher: So besides him talking and you writing, what else do you do in your physics classes?
Student7: Nothing else.
Researcher: And does this help you to learn the physics?
Student7: No….sometimes he doesn't explain it simple enough and I don't understand it.
Researcher: What would you like him to do to help you to understand better?
Student7: He should do some activities….to let us see what is happening…. like to build a circuit instead of just explaining about series and parallel circuits…I would like that.

Researcher: Explain to me how your teacher teaches physics to the class.
Student8: Our teacher talks a lot about the topics and she will show us some diagrams sometimes….once she showed us a video about nuclear pollution.
Researcher: What else does she do?
Student8: She writes a lot of notes on the board and then explains the notes to us.
Researcher: Do you understand the topic when she explains it?

Student8: Not always....but I write the notes in my book.
Researcher: What do you think will help you to understand the topic better?
Student8: If we did the experiment on the topic...or if we could build the model.....or do something physical....or see a video...
Researcher: Does your teacher do this sometimes?
Student8: Not really....I don't think our class ever went to the lab.....but I know the other class went.
Researcher: Why do you want to do experiments and go into the lab?
Student8: So I could understand the stuff better.....I know that will make me like physics more.
Researcher: Do you like physics now?
Student8: No...not really....it is just boring to listen to her just talk and explain all the time.

The above excerpts convey a very telling message. Teaching and learning in the physics classroom seems to be stuck in the traditional paradigm – didactic and dominated by much teacher-telling, textbook-reading and note-taking. Students' responses indicate that they are crying out for a more practical, hands-on approach to be adopted in physics teaching and learning. Through their responses the participants in this study are saying that traditional teaching methods and approaches are unappealing to them and are responsible for much of their disinterest in the subject. Those who were not doing physics (G3 students) were equally critical about the methods used to teach physics to them based on their past experiences studying the subject. Many of the G3 students also cited teacher-controlled methods as a huge turn-off and spoke about the need for teachers to use more drama, video simulations and experiments when teaching physics to make it "more interesting" and "easier for students to understand".

Discussion and concluding remarks

This research is an attempt to explore and to understand; albeit on a small scale; the status of physics education in Trinidad and Tobago. It has long been suspected that upper secondary school science students were turning away from the pursuance of physics. In fact, informal observations based on unempirical data linked to registration numbers and throughput in the physics discipline in secondary schools across the country and even at the tertiary level have lent undeniable support for this suspicion. This work provides empirical data and findings that show that upper secondary school science students in Trinidad and Tobago are deliberately avoiding studies in physics. Many of them are not selecting it at the upper secondary levels and even those who are studying physics at this level are pursuing it either because it is an offering that is fixed along with the other subjects they wish to study or because they were coerced into doing it by an influential adult in their life, not necessarily because they want to study physics.

This work has uncovered three reasons why physics is not the preferred science subject of upper secondary school science students. Reasons linked to mathematical difficulties/challenges/abstractness of physics as revealed in this work, are not surprising as Reid and Skryabina (2002) have articulated that students usually shy away from that which they perceived as hard and gravitate easily to studies in areas that they perceive to be easy. In light of this finding it is clear that the challenge is for teachers to be creative and innovative as they seek to find ways to teach physics that will progressively move students from familiar concrete contexts into the more abstract contexts and content levels. Dusen and Otero (2012) have advised that when progressive approaches are used by teachers to help students build relationships within subject matter material students then view the subject with greater openness and appeal.

What was surprising in this work was the perceived irrelevance of physics which many students cited as a deterrent to them studying physics at the upper secondary school levels. They spoke about physics not being relevant to certain career paths they wanted to follow and alluded to the fact that they were not told by anyone about how physics could be important to them. The data revealed that some students were in fact interested in jobs and further studies in fields where physics plays a role, but that students simply did not know this. It would appear that, in addition to teaching the discipline, teachers need to highlight to students the importance of physics to them personally and to their lives in the future. In fact, Otero, Pollock and Finkelstein (2010) have pointed out that in the Colorado's Learning Assistant Model, there is a deliberate component in which trainee physics teachers are schooled in ways of delivering physics content through the use of contextually relevant scenarios, events, occurrences and historical episodes. This they argue provides students with opportunities to see the role of physics in their lives at that moment as well as the contribution the subject has made in the past to influence developments and the scope that it has for the future. The implication, therefore, is that physics teachers in Trinidad and Tobago may need to reorient their thinking and the way they plan physics instruction to deliberately include aspects of relevance so that students will recognise the worth of the subject to them personally and to their lives in the past and in the future.

Particularly troubling was the tremendously high number of students (96%) in this research who pointed out that the use of unattractive teaching methods was a major turn-off for them with many of them giving detailed and unflattering accounts of learning experiences in physics they had in earlier years of schooling. A few students admitted that they believe that physics could be an interesting subject, but indicated clearly that delivery methods must be changed if students are to be attracted to studies in physics. The clear message is that physics teachers are being called upon to make a pedagogical shift away from traditional methods of teaching to more contemporary classroom approaches. Embedded within this call for a pedagogical shift are aspects of both abstractness and irrelevance as described above. It seems that if our teachers make conscious efforts to move away from traditional methods of teaching physics and choose instead from among the many contemporary approaches available, and combine these approaches with their own creativity to contextualise physics content that students will be encouraged to pursue studies in the subject. In that regard, therefore, the findings of this work should serve to provoke physics teacher to re-examine their classroom approaches and practice with a view to expand and improve their pedagogical knowledge, skills and competencies in the area of physics education. Reid and Skryabina (2002) have described this as an essential attitudinal shift that physics teachers must make if we are to address the worrying concerns we are witnessing in physics education at the moment.

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