Physics in Jamaica: Some observations and recommendations

Michael Ponnambalam
Physics Department, University of the West Indies
Kingston 7, Jamaica.

E-mail: michael.ponnambalam@gmail.com

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Abstract

This paper presents an "inside view" of Physics in Jamaica – using several surveys over sixteen years as well as the experience from twenty five years of teaching Physics at the University of the West Indies, Mona Campus, Jamaica and, as the Physics Outreach Coordinator, the interaction with thousands of students, from Primary Schools as well as Grades 9 – 13 in High Schools. Many of the problems seen in Jamaican Physics are seen in other countries as well. Hence, the recommendations in the latter part of the paper are likely to be useful to many other countries too.

Key words: Education, Teaching Methods & Strategies, Research in Physics Education.

Resumen

En este trabajo se presenta una "visión interior" de la Física en Jamaica - con ayuda de varios encuestas de más de dieciséis años, así como la experiencia de veinticinco años de la enseñanza de la Física en la Universidad de las Indias Occidentales, Mona Campus, Jamaica y el Coordinador de Física Outreach, la interacción con los miles de estudiantes, desde la escuela primaria, así como los grados 9.13 en las escuelas secundarias. Muchos de los problemas observados en Jamaica Física se observan en otros países así. Por lo tanto, las recomendaciones de la Parte Posterior de papel es probable para ser útil a muchos otros países también.

Palabras clave: Educación, Métodos de enseñanza y Estrategias, Investigación en Enseñanza de la Física.

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I. INTRODUCTION

Physics is an exciting intellectual enterprise, full of fun and delight. For example, a child marvels at the beauty of the rainbow in the sky. The physicist marvels at the beauty and order in a spectrum – a kind of rainbow in the lab – and gets paid for that fun! Further, Physics is very helpful in understanding how things like TV, CD player, cell phone, fan, refrigerator, air-conditioner, X-Ray, CT Scan, MRI, computer, car etc. work. The critical and analytical thinking developed in the study of Physics is of inestimable value in almost any field. No wonder, there are branches like Bio-Physics, Chemical Physics, Computational Physics, Engineering Physics, Geo-Physics, Medical Physics, and recently, Econo-Physics! Physics is the core subject of Science and Technology, and hence of national development. How is this "Physics" doing in Jamaica? This paper is an answer to that question.

II. THE SURVEYS

In 1996, Ponnambalam and Amarakoon [1] surveyed the students doing their first Physics course at the ***University of the West Indies (UWI)***, Mona Campus, Jamaica and got the responses from 191 (116 males and 75 females): on the facilities for Physics in their High Schools, why they do the Physics course, etc. In 2000, Ponnambalam [2] improved the questionnaire and obtained responses from 165 UWI students (105 males and 60 females). This was repeated again in 2011 with 151 UWI students (101 males and 50 females) to see any trend with the flow of time. Finally, with a desire to look at the picture from the angle of the ***High Schools (HS)***, this survey was done in 2012 with 466 students from Grades 12 & 13 from 20 High Schools throughout Jamaica (172 males and 294 females, who had come to UWI for their annual Workshop). These responses give interesting insights, as shown below.

III. HIGH SCHOOL PHYSICS

How has Physics been doing in Jamaican High Schools during the past 16 years? How do the students rate the facilities for Physics in their High Schools? The results are shown in Figure 1. It is interesting to see that for any year, the chart shows the standard “bell curve” *i.e.* majority of the High Schools are rated as OK *i.e.* average, while a few are rated as “Very Good” and “Very Bad” – the others being in the “Good” and “Bad” range. Another very interesting observation is that overall, there is improvement during the past 16 years. The percentages in the “Very Good,” and “Good” have gone up, while the percentages in “Bad” and “Very Bad” have come down. Although the changes are not big, they are definite and visible. This is a credit to the teachers and administrators in High Schools, the Ministry of Education and to the country at large. Another important observation is the substantial difference in the responses between the UWI and HS students. The HS students give a much better picture of the High Schools than those at the University. Why? One explanation is that only 20 High Schools were sampled (and this list of 20 includes all the top Schools for Physics in Jamaica). Another observation is the following: Among the students from the top High Schools, some go overseas, some go directly to Medicine and Engineering, and only some of the remaining take a Physics course at UWI.

IV. CAREER GOALS

Every year, at UWI, around three hundred students do their first year Physics course (Algebra-based Preliminary Physics or Calculus-based Introductory Physics). Why are they doing it? Do they want to major in Physics? If not, what are they hoping to get from their Physics course? The answers are given in Figure 2. For the sake of clarity, only the top 2 areas of interest, along with Physics, are displayed. Among the UWI students, around 30% *have* their eyes on Medical School; the value of 26% for 2011 is unusual. The percentage of students wanting to major in Physics has shown some increase between 1996 and 2000, and a very big jump in 2011. One reason is that recently several Applied Physics areas like Medical Physics, Alternative Energy etc. have been started. Unfortunately, the percentage wanting to be Physics teachers has stayed constant around 2% over the years in spite of the shortage of Physics teachers in High Schools in Jamaica. The major reason for this is the low salary for School teachers. But then, there is a good demand for Physics teachers in both USA and UK, where the salary is quite good. May be, this fact has not been publicized well enough. Further, a substantial difference is seen in the responses between the students from UWI and the HS. In the latter cohort, 47% have their eyes on Medicine and 28% on Engineering. Since Medicine and Engineering have tough entrance requirements, it is sene again that many of the bright minds are siphoned off, even before they come to UWI, as mentioned earlier.

Figure 3 displays the relevance of the first year University Physics course to the career goals of UWI students. (This was not done in 1996, and it does not apply to HS students, who were surveyed in 2012). Majority of the students do find the Physics course relevant to their career goals. On the other hand, while 69% (36% + 33%) found it relevant in 2000, only 53% (31% + 22%) find it relevant in 2011. What is worse is that while 17% (9% + 8%) found it irrelevant in 2000, 30% (17% + 13%) are seeing it that way in 2011. As of now, one explanation for these observations is that between 2000 and 2011, the mathematical background of the incoming students and their work ethic have gone down.

V. VIEWS OF PHYSICS

According to Zukav [3], “Physics, in essence, is simple wonder at the way things are – and a divine interest in how that is so. Mathematics is the tool of Physics. Stripped of Mathematics, Physics becomes pure enchantment.” Einstein spoke of his “rapturous amazement at the harmony of natural law” *i.e.* Physics. How do Jamaican students view Physics, or more accurately what are their *‘feelings’* about it? The answer is given in Figure 4. 26% of the students find Physics “fascinating” while another 39% feel that it is “interesting.” (Note: This question was accidentally omitted in the 2000 survey, and in 1996 it had a different format.) Interestingly, here, the responses from the HS students are very close to those of UWI students.

Figure 5 summarizes the students’ views about the usefulness of Physics to Jamaica. In 2000, 79% (50% + 29%) thought that University Physics was useful to the development of Jamaica; that number has come down a bit to 71% (39% + 32%) in 2011; for the HS students in 2012, that number is 83% (54% + 29%). Thus, it may be safely concluded that the majority of the UWI as well as HS students think that the study of University level Physics is important for the development of Jamaica.

VI. GENDER DIFFERENCES

In many cases, the differences between the male & female responses were minor. However, in the career choices, there is substantial difference in all the four surveys. This is shown in Figure 6. The traditional stereotype that females prefer caring-type Medicine, while males prefer action-type Engineering is evident. 54% i.e. majority of the girls in High Schools have their eyes on Medical School. In Jamaica, Medicine is in very high demand and has the toughest entrance requirements. The dramatic difference between females and males dreaming of Medicine is an indication of what is normally called “the marginalization of the Jamaican male.” The percentage of males in UWI being only 30% confirms the above.

Another area where the gender difference shows up is in the view of, or response to, Physics. This is summarized in Figure 7. Among males, 30% from UWI and 36% from

High Schools (HS) find Physics "*fascinating*", while the corresponding numbers are only 18% and 20% for females. Among females, 18% at UWI and 18% at HS view Physics as "*difficult*", while the corresponding numbers are only 12% and 5% for males. This again is a reflection of the traditional stereotype. By the way, among the current 12 staff in Physics at UWI, only one is female. On the positive side, this trend is changing. Among the current Physics postgraduates, roughly half are female.

VII. LECTURES

A comparison of the attendance at lectures of the recent students in 2011 and 2012 with that of an earlier generation in the nineteen eighties shows a substantial drop from around 85% to around 50%. There is also a drop in attendance at tutorials; but it is less. Surprisingly, the drop is higher for difficult topics which actually demand greater effort. This implies that some of the students have a low level of stamina for hard work. The above difference cannot be attributed to the usual excuse that the lectures are boring. There is absolutely no evidence for the statement that more teachers from the current generation are boring than from the previous generation. Actually, the evidence, if any, is in the opposite direction. For, in the earlier generation, no one had a personal computer, while now nearly all the lecturers have one and further many lecture rooms are wired. In addition, the Instructional Development Unit which was started on our Campus early this century has been hosting several Workshops to help the lecturers to improve their techniques in teaching.

The behaviour of the students during lectures and tutorials has degenerated substantially during the past 25 years. It is surprising to see some students eating or fiddling with their cell phones right in the middle of the lecture. These students rationalize their behaviour and don't see anything wrong. The sense of guilt is slowly decreasing in society at large, and that is seen even among University students, who are the future leaders! Hence, action is badly needed here – not just by the Church, but by the educational system, and indeed by every concerned citizen. All those who play a big role in the development of the "values system" of the society need to be tapped into – the media, the athletes, sportspersons, musicians, DJ's etc. Needless to say, it would be nice to nurture good role models; for, more people would like to see a sermon than hear one.

VIII. POOR WORK ETHIC AND UNDER-PERFORMANCE

In all Faculties except Medicine, it is seen that during the first two thirds of the semester, majority of the students take things very lightly and do not work hard. As a result, nearly every semester, many students overwork during the final one third of the semester. This leads to underperformance. Less than 3 out of 4 students complete the three year degree programme in three years. This puts an enormous burden on the Jamaican treasury, which pays 80% of the economic cost of the students. Further, when a large amount of material is learnt/crammed in a short time (and only once, just before the exams), it suffers from indigestion and exits quickly. This shows up in the following semester, when the students are seen to retain very little of the previous semester's material. This problem is not peculiar to Jamaica. It is seen in many other countries as well. In Canada, according to Slavin [4], "a major contributor to the increasing drop-out rate from the Introductory Physics course is deteriorating work ethic and work habits of the students." The depth of this problem in USA is described by Thornburgh [5] in Time's cover-page article "Dropout Nation."

Some Universities take attendance in each class. However, this is unpopular in Jamaica. Hence, other avenues need to be explored to solve the problem of underperformance. The approach of the famous author and motivator Dale Carnegie seems relevant here: Create a situation which will make the students want to study right from Day One. As of now, the students are seen working very hard on their own, close to the final exams. Why? The answer is simple: In most of our courses, the lab counts for 20%, the in-course test count 20% and the final exam 60%. This sends the wrong message to the students. They can pass a course without attending any lecture, tutorial or test! It is good to create an ambience which promotes daily, regular, steady, continuous and repetitive learning – which is more likely to be digested and retained. It is useful for the students to learn the beauty of the words of Longfellow [6] below:

Each morning sees some task begun,
Each evening sees it close;
Something attempted, something done,
Has earned a night's repose.

For this, the following steps are recommended:

A. Continuous assessment

The 16 weeks in a semester should be split into First Half (8 weeks) + Second Half (8 weeks), each half carrying a credit of 40 points, the remaining 20 coming from the final exam. The students will be assessed continuously – over a small amount of material most of the time. The first 4 weeks carry a credit of 2 points each. This assessment is done through graded tutorials as well as quizzes right in the middle of the class. *e.g.* After explaining a new concept and reinforcing it with an example, a quiz can be given. If the class is large, this quiz could be in an MCQ format. For extra large classes, where scoring will be a tiring job, the "clickers approach" can be employed, as done in USA. Here, each student sends the answer to the MCQ to the staff's laptop by pressing A, B, C, D or E in his/her clicker which has the student's ID. The grading is thus done automatically by the staff's laptop, which goes one step further by displaying a histogram of the answers given. The class will now discuss the quiz question together and arrive at the correct answer – with or without any help from the staff. One great advantage of this is that the students get a feedback on their performance immediately. At the end of the Fourth Week, the students are given mini-test 1 (with a credit of 7 points) on the material of the previous four weeks. Thus, during the first 4 weeks, the students have revised any topic two times (tutorial & mini-test), and have scored a maximum of 15 points. This is repeated during the second 4 weeks.

At the end of the 8th Week, revision test 1, with a credit of 10 points, is given, covering all the topics of the previous 8 weeks. The Second Half of the semester is just like the First Half. At the end, the students are given a Final Exam with 20 points, covering the material of all the 16 weeks. Thus, during the semester, the students have revised any topic four times (tutorial, mini-test, revision test, final exam) and hence are likely to remember it for a longer time. Further, there is no undue stress at all on the students at any one time; the stress is distributed. A student can miss the final exam (due to sickness or family problems) and still get an "A" grade!

B. Remedial programmes

Among the students who sign up for the first year Physics course at UWI, many are weak in Math and some in Physics. For some of them, this is caused by poor facilities in their High Schools. These students become frustrated and nervous during the semester – due to no mistake of theirs. It would be very wise to arrange a Two Week Intensive Remedial Programme for such students before the start of the classes, so that when the semester begins these students are ready and prepared – not just to learn Physics, but to enjoy it as well.

C. Active and Interactive Strategies

In teaching, we are dealing with students, who are not machines – but human beings with numerous distractions typical of the 21st century. That necessitates the use of expert communication skills and strategies. Are the teachers up to this task? Have they come up to the 21st century? Many teachers seem to be still in the 20th century, when they were born and when they received their training. Many are still following the old paradigm, shown in Figure 8a, where information is pumped into the student in exchange for the tuition fees. True it is that they are using power point presentations using laptops, instead of the transparencies and projectors. But, at the core, it is the same old game of "pumping in". The new generation needs the new paradigm, as depicted in Figure 8b, where the teacher has experienced with Einstein "a rapturous amazement at the harmony of natural law", and makes the teaching & learning sessions interactive, warm, lively, passionate – and even dramatic and poetic. In the old paradigm, there is an obvious difference between the teacher and the student: the teacher is the owner of the tank of knowledge, while the student is the receiver of knowledge. The teacher is "up", while the student is "down". In the new paradigm, the teacher has become a professional student, realizing that learning never stops.

Communication is more efficient when the parties involved are at the same wavelength. Hence, the teacher in the new paradigm dethrones himself/herself from the traditional pedestal of the teacher and promotes a family atmosphere in the class. Instead of feeling that a teacher should know and that the students are there to be taught, the new teacher behaves like a fellow human being – aware of his/her strengths and weaknesses, knowledge and ignorance. This enables the students to discover soon that their teacher is just an older student in the journey of life; a partner and facilitator in their learning. All these lay the foundation for better communication.

It is very useful to keep the classes interactive and engaging, and to promote active participation of every student in the class – both in small groups and in the larger group, as shown in Figure 8b. It is also helpful to dramatize the events being explained. For this, the new teacher just becomes the electron, proton, or whatever s/he is explaining; gestures and actions then follow freely. After all, the electron in an atom is just performing a dance; and most youngsters do love dance! Further, it is very wise for the new teacher to clarify complex concepts and equations through familiar examples and comparisons from all branches of knowledge, and from everyday life. e.g. While discussing the model of the hydrogen atom, the force of attraction between the electron and the proton (which maintains the atom) can be compared to the attraction between Adam and Eve (which maintains humanity), as described by Milton [7] in *Paradise Lost.*

> *" ... I feel*
> *The link of nature draw me; flesh of flesh,*
> *Bone of my bone thou art, and from thy state*
> *Mine never shall be parted, bliss or woe."*

The Instructional Development Unit (IDU) at UWI has been conducting Workshops to train their teaching staff in the arts of the new paradigm. It would be wise to arrange such Workshops for the High School teachers as well.

IX. CONCLUSION

The surveys indicate that since 1996, there is an improvement in High School Physics in Jamaica. Medicine continues to be the Number One goal of the Jamaican students. Majority of the students do find the Physics course relevant to their career goals, and would recommend it to others. However, the size of this majority is coming down. This merits serious consideration. During the past 25 years, a gradual erosion of the work ethic and "values system" has been observed. This needs an urgent intervention by all. The present assessment methods tend to promote procrastination and it is claimed that *Continuous Assessment* would produce better results. Further, a *Two Weeks Remedial Programme for Weak Students* is proposed, to alleviate some of the pains and frustrations by these weak students during the course of the semester. As for the teachers, some active and interactive strategies are proposed for better communication with the students.

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