

Useful Lessons from the Success of Physics Outreach in Jamaica

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Abstract: *Physics was very popular in the nineteen fifties, sixties & seventies – attracting some of the brightest minds. However, since the nineteen nineties, Physics departments in many countries are facing declining student enrolments. At the University of the West Indies, Jamaica, the number of students in Introductory Physics fell below 100 for the first time in 2006. An aggressive Physics Outreach launched that same year played a key role in nearly tripling that number. Details of that Outreach and some useful lessons are presented in this paper.*

Key words: *Physics Popularization, Physics Outreach, Physics Education, Interactive Teaching*

1. INTRODUCTION

During a recent visit to the Physics Department at a College in India, this author was told that the quality as well as the quantity of students applying for Physics Major in that College has been coming down. And, that is painful indeed. For, Science-cum-Technology is the royal road for any country to become a First World. And, Physics is “the science above all sciences,” as mentioned in 1899 by the first president of the American Physical Society [1]. The burning question is, “*What can be done to attract many bright minds to pursue Physics?*”

In many countries, Governments have realized the importance of Science and are taking efforts to promote Science. In India, the Government arranges Discovery Competition & Apparatus Competition for 8th & 9th Standard students; Science Camps for 11th Standard; Scholarships for higher studies in the Sciences for top-scoring 12th Standard students etc. Further, IAPT (Indian Association of Physics Teachers) arranges Workshops for students as well as Physics teachers. In spite of all these, during the 2014 IAPT Convention in Chandigarh, one could hear the painful statement that many bright Indians are running away from Physics.

2. SOME SUCCESS STORIES

Between 1998 and 2003, Germans doubled the number of students doing 1st B.Sc. Physics courses [2]. Between 1999 and 2014, Americans doubled the number of graduates with a bachelor's degree in Physics [3]. These two countries are big; and, they did spend a lot of money to achieve their aim. On a smaller scale, at the University of the West Indies, Mona campus in Jamaica (UWI), the number of students in Introductory Physics in 2006 fell to 81 (one third of its value in the nineteen eighties) – spelling disaster! The author of this paper launched an aggressive Physics Outreach that same year and managed to triple that number, spending much less money. Details of this Outreach, and some useful lessons are presented in this paper.

3. GOAL OF THE OUTREACH IN JAMAICA

The goal of Physics Outreach is to convey to the students and the general public the following messages: i) Physics is an exciting intellectual enterprise, full of fun and delight. ii) Physics is very helpful in understanding how things like TV, CD player, car, computer, mobile phone, X-ray, CT scan, MRI, etc. work. iii) Graduates with a degree in Physics have a good opportunity for employment locally as well as overseas. iv). The critical and analytical thinking developed in the study of Physics is of inestimable value in almost any field. v) Physics is the core subject for Science and Technology, and hence for national development.

Science Literacy is a ‘must’ for any nation in the 21st century. Hence, the Physics Outreach aims at reaching out to every person, through every possible means. This is not done just to increase the number of students studying Physics; nor is it done only to save the jobs of the lecturers. Instead, it is

done because the country needs Physics and physicists to graduate to the First World status. The Outreach work is split into the following target groups: i) CAPE (11th & 12th Standard) students, ii) CSEC (10th Standard) students, iii) Middle Schools, iv) Primary Schools, v) General Public, and vi) Physics teachers in High Schools. The programmes, tools and best practices are adjusted to suit each target group.

3.1. Physics Workshop for CAPE Students (11th & 12th Standards)

In Jamaica, many High School Physics teachers do not have a degree or interest in Physics. Further, several High Schools are not properly equipped to carry out their Physics experiments. Both of these have a strong negative effect on the students. To overcome these problems, some High School teachers were consulted as to the Physics topic on which they need the most help. On that topic, a Week-long One Day Workshops were offered in January 2007 for 205 final year students in High Schools. This week was carefully chosen during the semester break, so that the University lab & lecture theatres would be free, and during the time when 12th Standard students had finished their holidays and were back in School. Any School came for only one day; got the theory explained very well by an expert staff in two 90 minutes sessions in the morning, with a snack break in between. The Workbook given to the students and the use of Power Point as well as demonstrations enabled the sessions to be active and interactive. After lunch, the students did two experiments based on the theory they had learnt in the morning, one hands-on and the other computer-based. In each experiment, they had the close supervision and friendly assistance from one staff and four postgrads. The data analysis and lab report were done later on by the students, and were graded by their teachers.

There is wisdom in the Chinese proverb: “I hear, and I forget. I see, and I remember. I do, and I understand.” Hence, it was made sure that the students didn’t ‘just hear’ passively. During the 2 Theory sessions in the morning, sample problems were discussed and solved in the class. Then, the students were encouraged to solve some problems in small groups. During the 2 experiments in the afternoon, they got the opportunity to put into practice the theory they had learnt in the morning. It was ‘an all-day and intense immersion experience’ aimed at helping the students to understand, appreciate, get a feel for, and even ‘enjoy’ a topic in Physics – and not just memorize the formulae.

The Workshop was a great success. To satisfy the growing demands of High School teachers, these Workshops are now conducted every January for both 11th & 12th Standards. The 2009 Workshop was commended in the Newspaper article, “*Students Laud UWI Physics Workshop.*” [4]

The feedback of 700 students from 23 High Schools in the 2008 Workshop is given in Figures 1a and 1b. Figure 1a shows that 53% of the students found the Workshop ‘Very useful’ and another 36% ‘Useful’ – totaling 89%. Something similar is seen every year, offering convincing evidence to the need of such Workshops. A good education should reach out to both the head and the heart of the students – in agreement with the words of the Director of Public Affairs of the American Physical Society, Michael Lubell [5]: “Establishing an emotional connection is an essential precursor to communicating serious information. *Lighting up the amygdala gets the rest of the human brain to pay attention.*” The response in Figure 1a is primarily from the head; the response from the heart is given in Figure 1b. 91% of the students were glad that they came to the Workshop. And, that speaks loudly. In commenting on the Workshop, many students have used the following words: Educational, Excellent, Good, Great, Interesting and Wonderful. Further 91% have mentioned that they would recommend it to their friends. Thus a lot of free publicity is provided by the students themselves.

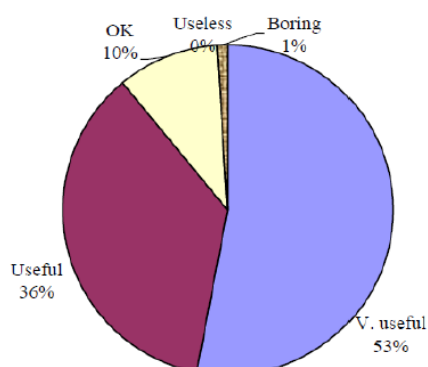


Figure 1a) The Workshop was:

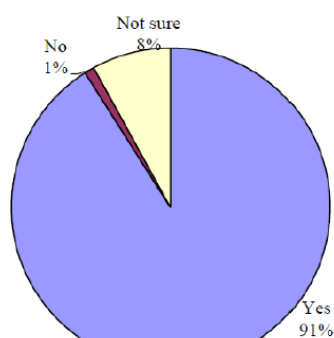


Fig 1b) I am glad I came to this Workshop

Nonverbal messages are very important in communication and hence deserve special attention. In one question, the students tell us whether they found the atmosphere during the Workshop: ‘Friendly’, ‘OK’ or ‘Unfriendly’. Usually, the response for ‘Unfriendly’ is around 1% - indicating that it is nearly impossible to satisfy everyone. However, if this crosses 2%, the Outreach Team explores the issue and takes necessary steps to avoid a recurrence of this.

3.2. Physics Field Trip for CSEC Students (10th Standard)

Seeing the success of the Workshop for 11th & 12th Standards, some teachers requested the Outreach Team to do something similar for 10th Standard students. Knowing that for this group an All-day Workshop is not necessary, three days of 10th Standard Field Trip was arranged in January 2010 to expose the youngsters to the following words of Poincare [6]: “The scientist does not study Nature because it is useful to do so. He studies it because he takes pleasure in it; and he takes pleasure in it because it is beautiful.” The students were given an opportunity to discover, experience and enjoy the beauty and fun in Physics, through the use of lively and interactive demonstrations, computer simulations and experiments – all related to their syllabus. Each day had a three-hour morning session, and another three-hour afternoon session. Any School can send its students for any one session. Each three hour session accommodates a maximum of 80 students only and is coordinated by 8 persons (staff + B.Sc. students), so as to promote close interaction and active learning. During each session, around 40 students spend the first 1.5 hours in the Hands-on Lab and the remaining in the Computer Lab; during the second 1.5 hours, they exchange their Labs.

The Field Trip became an instant success, with around 600 students from 14 High Schools; and they wanted the Field Trip again. Feedback from a teacher: “The experience was good and very informative, and the students learnt a lot. They are still talking about it.” Hence, that has become a part of the University calendar. The 2012 Field Trip attracted around 400 students from 13 High Schools. The results of the feedback are shown in Figures 2a & 2b. It is interesting to note from Figure 2a that 66% of the students found the demos and experiments in the Computer Lab ‘Very interesting’, while another 27% found them ‘Interesting’ - giving a total of 93% - and that less than 1% found them ‘Boring’. However, for the demos and experiments in the Hands-on Lab, 2.3% found them ‘Boring’, while only 35% found them ‘Very interesting’ and another 41% found them ‘Interesting’ – giving a total of only 76%. One possible reason for this big difference may be that the Computer Lab is air-conditioned, while the Hands-on Lab is not. However, the real reason is very likely the fact that the younger generation is hooked on to computers. And, the teachers need to take this into account in their Outreach as well as lectures.

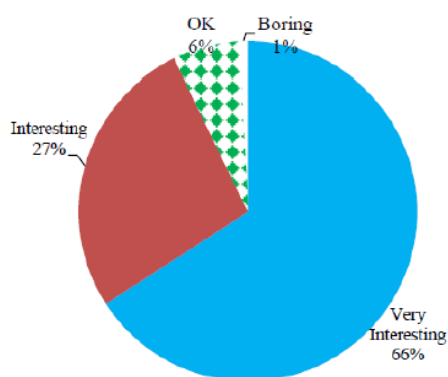


Figure 2a) The demonstrations & experiments in the Computer Lab were:

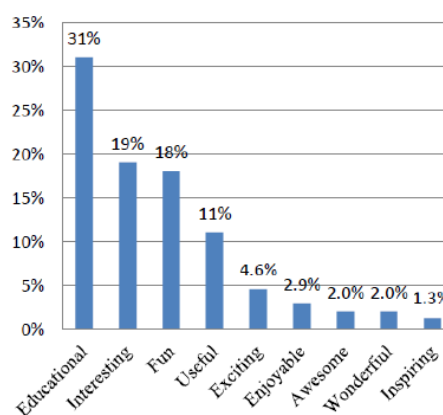


Figure 2b) I will describe this 10th Standard Field Trip to my friends as:

Further, 58% of the students found the Field Trip ‘Very useful’, and another 34% ‘Useful’ – totaling 92%. Similar results are seen in other years too, providing compelling evidence to the need for such Field Trips. Also, 86% of the students are saying that they would recommend this Field Trip to their friends. As before, a lot of free publicity is gained through the students themselves. In the earlier questions, the students tick one of the answers given. However, in the final question in the Evaluation, they are requested to describe the Field Trip to their friends using their own words. Their response is displayed in Figure 2b. The most commonly used words were: Educational (31%), Interesting (19%), Fun (18%) and Useful (11%) – these four together accounting for 79%. This clearly shows that **Physics education can be interesting and fun!**

The students had some very interesting statements too in the Evaluation. The most common one was, "I learnt a lot." The other frequent ones had the following themes: i) I had no idea that Physics would be so much fun. ii) In this Field Trip, individuals get exposed to fun while learning, using the senses beyond the wildest dreams. iii) A radical method to expose those who are struggling in their studies, to the world of Science. vi) The Field Trip instills new skills. The experience is one you cannot find anywhere. v) It was the best Field Trip ever.

3.3. Science Fairs for High Schools & Middle Schools

Science Fairs are arranged for High Schools & Middle Schools by the Faculty of Science one to three times a year in different parts of the country, usually for 2 or 3 days. During these Fairs, all the High Schools & Middle Schools near the Fair location are invited, and exposed to the various science programmes in the Faculty – including the admission requirements, scholarships available etc. Until 2005, Physics Department was just distributing its brochures. However, after the launch of the Physics Outreach in 2006, these opportunities have been seized to popularize Physics, using hands-on demos and computer simulations, among around 12,000 students. Feedback from a staff after one such Fair: "The demonstrations were extremely well received, and created a great deal of excitement among the students."

3.4. 'Science is Fun' Field Trip for Primary Schools

During the opening ceremony of the Sixth Conference of the Faculty of Pure and Applied Sciences, the former Minister of Commerce, Science & Technology [7] said: "Our children must be assisted to understand that Science is a frontier that can be conquered and loved. Their natural curiosity and inclination for enquiry must be assisted so that they can be challenged into discovery." In keeping with this, right from the launch of Outreach in 2006, the Outreach Team has been visiting some Primary Schools and entertaining the youngsters with hands-on demos. The curiosity and enthusiasm of the youngsters were very impressive. From their faces, one could easily see that they enjoyed the programme immensely. One of the teachers reported that her students were 'mesmerized. At the University level, and even at the High School level, one hears the prejudice that Physics is hard, and/or Physics is boring. However, the little ones in Primary Schools don't have any such prejudice. They enjoy Science/Physics and are very open to it. Hence, a Week-long 'Science Is Fun' Field Trip was arranged in May 2011 strictly for the final year Primary School students. The time was carefully chosen. It was after the University's final exam and before the start of the Summer Session, so that the lab and lecture rooms were free; and, it was after the final exam of the little ones so that they were free and were dreaming of their ascent to the High School.

Each day had a two-hour morning session, and another two-hour afternoon session. Any School can send its students for any one session. Each two hour session accommodates a maximum of 80 students only and is coordinated by 8 persons (staff + B.Sc. students), so as to promote close interaction and active learning. During each session, around 40 students spend the first hour in the Hands-on Lab, while the remaining spend their first hour in the Computer Lab; during the second hour, they exchange their Labs. To quote the invitation letter: "*We would like to offer your students a chance to enjoy Science for two hours, and discover for themselves that: i) Science is fun, ii) Science is cool, and iii) Science is good for them.*"

750 final year students from 17 Primary Schools in the Kingston metro area profited from this Field Trip, with high praise for the Programme. The following year, this privilege was extended to the rural students. Due to the big transportation cost and the shortage of rural Schools, only 225 students came from 7 Primary Schools. They enjoyed the Programme even more than the urban students. 49% found the computer games/experiments exciting, while another 48% found them interesting – giving an impressive total of 97%. This was 88% for the urban students in 2011. Compared to the urban students, fewer rural students have been exposed to the computers, and that explains the difference. A powerful message from this is the desperate need of Physics Outreach to the rural areas. A similar response was seen for the hands-on demos and experiments.

In the final question, the students write on a blank space the type of words they would use in describing the Field Trip to their friends. The results from 2012 are summarized in Figure 3. The leading four responses are: 'Fun' (24%), 'Interesting' (21%), 'Exciting' (20%) and 'Educational' (13%). Together, these account for 78%. It is very interesting to notice that the dominant response is 'Fun'. It is equally interesting to observe that 'Educational' is among the top 4 responses, meaning

that *fun and science education can go together*. The next four responses are: Best Field Trip, Wonderful, Nice & Enjoyable. Other descriptive words are: Amazing, Awesome, Fabulous, Fantastic & Great. The following are some interesting statements from the students: i) It was the nicest taste of Science I have ever had! ii) It was the most magnificent Field Trip I have ever gone to! iii) This has been the best day of my life! iv). When I finish High School, I would like to come to the University of the West Indies.

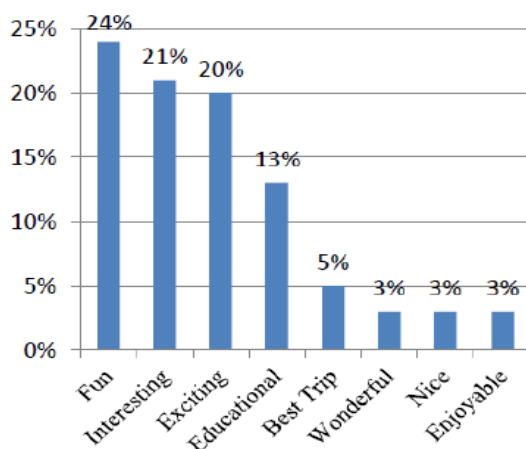


Fig 3) I will describe this 'Science Is Fun' Field Trip to my friends as:

It is worth comparing Figure 3 with Figure 2b. For the Primary School students, the mantra is “Fun laced with Education,” and hence the focus is on ‘Fun’. However, for the 10th Standard students, the mantra is, “Education laced with Fun” and hence the focus is on ‘Education’. The figures indeed reveal that the mantras have worked.

In the Computer Lab, the students have a lot of fun with video games i.e. computer simulations like ‘Launching a Satellite around the Earth.’ They are even given *a taste of research* i.e. the ‘Eureka’ experience of Archimedes. Using a simulation, the whole class gathers data on the force of attraction between the Earth and an object of mass m at a distance r from the centre of the Earth in two parts: a) r is kept constant at 1.00×10^7 m. For m (kg) = 10, 20, 30 & 40, they find the corresponding $F(N)$ = 40, 80, 120, 160. b) m is kept constant at 92 kg. $d = 6380$ km. For $r(m) = 1d, 2d, 3d$ & $4d$, they find the corresponding $F(N)$ = 900, 225, 100 & 56.

They are then challenged to interpret their data (i.e. discover Newton’s Law of Gravitation), and are motivated with a cash award. Every time, someone wins the award within a few minutes! This is a powerful tool to fan their child-like curiosity into a flame.

3.5. Interactive Show on ‘Science is Fun’ for Primary & Middle Schools

Some Schools are unable to take part in the Field Trip. The Outreach Team travels to such Schools and conducts the Interactive Show on ‘Science is fun’ to stimulate their interest in Science – with lively and interesting demonstrations and experiments in a highly interactive way, using dramatization, story-telling and dancing. These sessions run for 60 – 75 minutes and are limited to around 40 students at a time to keep them highly interactive. Literally, the students are given an opportunity to “*Taste and see that Science is fun.*” The feedback on these Shows in February 2014 to 290 students from 3 Primary Schools is given in Figure 4. 47% found the Show ‘Exciting’ and 51% found it ‘Interesting’ – totaling an impressive 98%. This gives a loud testimony to the power of these Shows. Further, 96% have mentioned that they would recommend it to their friends – thus giving free publicity. When asked to describe the Show in their own words, the leading 4 responses were: ‘Fun’ (26%), ‘Interesting’ (20%), ‘Exciting’ (14%) and ‘Educational’ (10%). It may be seen that these are roughly the same as those from the Field Trips for Primary Schools, as given in Figure 3. For, they deal with the same age group. Further, 31 students found it ‘Amazing’ and 28 found it ‘Awesome’. Some of the other words used were: A⁺, Best ever, Breath-taking, Brilliant, Colourful, Cool, Creative, Enjoyable, Fascinating, Great, Inspirational, Interactive, Lovely, Mind-puzzling, Must see, Nice, Spectacular. All these reveal the depth of the impact on the students by the Interactive Show.

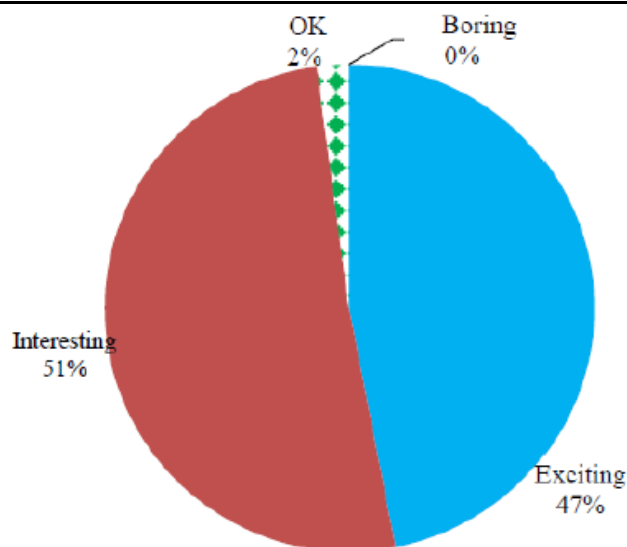


Figure 4) The Interactive Show on "Science is fun" was:

3.6. General Public

The students contacted by the Outreach Team form a very small percentage of the total population. Hence, right from the beginning, great importance was paid to reaching out to the general public, whose experiences and views on Physics form the background air the students breathe. To this end, the article, *"The Value of Physics"* was published in the newspaper [8]. Further, the author of this paper has given the following talks on Radio Stations, promoting the cause of Physics: i) On receiving the UWI/Guardian Life Premium Teaching Award, October 10, 2008, FM 93 News Talk, Jamaica. ii) Talk on "Physics Is Fun," Research Day, January 29, 2009, FM 93 News Talk, Jamaica. iii) Promoting the 10th Standard Field Trip, January 17, 2010, FM 94 RJR, Jamaica. iv) Publicizing the "Science Is Fun" Field Trip, May 22, 2011, FM 93 News Talk, Jamaica.

3.7. Physics Teachers in High Schools

As the American President Barak Obama [9] said, *"A great teacher is the single most important factor in a great education."* Accordingly, the Outreach Team has been trying to 'improve the quality' of the Physics teachers in the High Schools. Evidently, the knowledge-base of the teachers needs strengthening and reinforcement. This will increase their self-confidence and performance. Further, they need to be exposed to the latest computer simulations, charts, demonstrations and other gadgets, as well as the active and interactive strategies which make the classes more lively and productive. Finally, they themselves should be given opportunities "to taste and see that Physics is fun."

Ongoing Workshops have been used to achieve the above goals: Two Workshops were conducted for High School Physics teachers, where a difficult Physics topic was explained in great detail and supplemented with clear notes. Further, the techniques in solving problems were explained to the teachers using two or three examples, and finally they were requested to solve some problems in small groups. This exercise increased both the ability and self-confidence of the teachers. Solving problems in small groups is less threatening, and even motivating to the weaker ones. Two more Workshops were conducted to train the teachers on how to incorporate computer simulations into their teaching and lab sessions. The Workshop, "Tips for Putting 'Fire' into Your Teaching" has been conducted in 2 Universities and in a Teachers' College. In all these Workshops, the feedback has been highly positive.

Figure 5 summarizes the results on the Workshop, "Incorporating Computer Simulations into 11th & 12th Standard Physics" to 23 High School Physics teachers in November 2012. 35% found the Workshop 'Excellent', 60% 'Good' – totaling 95%. All of them said that they would recommend it to their friends. Some interesting comments: i) This Workshop revolutionizes the teaching & explanation of Physics concepts. ii) This Workshop was very informative and useful. iii) This Workshop must be a requirement for all Physics teachers for staff development.

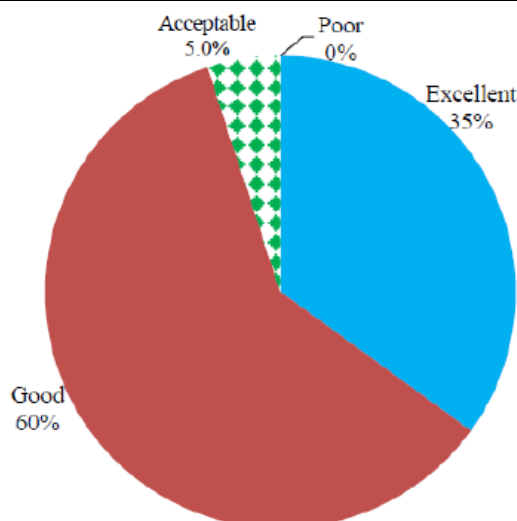


Figure 5) The overall quality of this Computer Simulations Workshop was:

Figure 6 summarizes the feedback on the Workshop, “Tips for Putting ‘Fire’ into Your Teaching” to 23 University staff in April 2012. 71% found the Workshop’s quality to be ‘Excellent’ and another 29% found it ‘Good’ – giving a total of 100%. All of them said that they would recommend the Workshop to their friends. Some interesting comments are listed below: i) This Workshop should be done for all High School teachers. ii) This Workshop would be useful for all University lecturers – especially the new ones. iii) I was definitely inspired today. I now realize how sacred ‘teaching’ is. iv) I want to be like the presenter when I grow up.

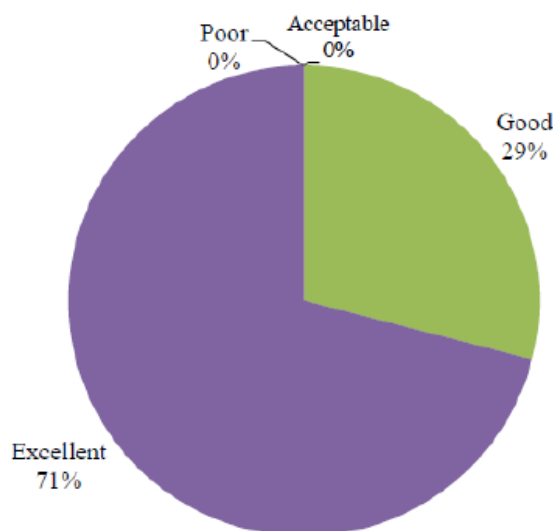


Figure 6) Overall, the quality of the Workshop, "Tips for Putting 'Fire' ..." was:

The High School teachers are encouraged to incorporate computer simulations, demonstrations and charts into their teaching. To this end, the following have been donated to each of the 56 teachers who had participated in the Computer Simulations Workshops: i) A CD with computer simulations, which may be used during the teaching session or lab session. The teachers were also equipped with practical training on how to use the simulations for a Lab. ii) One set of 4 attractive Physics Charts from the Contemporary Physics Education Project, U.S.A. – displaying the latest in Physics on 4 hot topics: Fundamental Particles and Interactions, Nuclear Science, Fusion, History and Fate of the Universe. The interesting poster, “Top 10 Reasons Why You Should Take Physics” from the American Physical Society, is placed in all the University level Physics Labs.

4. LAUNCHING OF THE SCIENCE RESOURCES CENTRE

The Science Resources Centre was launched, with the donation of 15 attention-grabbing demonstrations along with appropriate training, at St. Joseph’s Teachers’ College, Kingston in March 2013.

5. OUTREACH IN OTHER COUNTRIES

Due to the success of Physics Outreach in Jamaica, the author of this paper was invited to do something similar in the following countries: i) Belize, Central America in January 2013 & January 2015 by the University of Belize, ii) Grenada, West Indies in January 2014 by the Education Ministry, and iii) Trinidad, West Indies in January 2014 by a Principal – *“to show young people how cool Science can be.”* [9]

6. USEFUL LESSONS

A lot of good work is being done by Governments to promote Science, and by Physics Associations to promote Physics. However, every wise teacher knows that there is always something new to learn from others.

- Jamaica, with a population of 2.8 million, has one Physics Outreach Team. Then, for example, India, with 1250 million could have 446 Teams.
- It is not enough to have just any Team; one needs a Vibrant Team i.e. the Team members need to be bubbling with an infectious enthusiasm and boiling with a contagious passion for Physics. These are people who have their Physics in their head, heart, nerves ... all over the body. They love Physics; are excited about it and are anxious to talk about it! They consider it a blessing to be paid for talking about it (teaching & outreach) and writing about it (research).
- Instead of waiting for financial assistance from Government, it would be nice if the Physics Department in every College could start a Physics Outreach. The words of the former U.S. President John F. Kennedy (adapted to all) are very appropriate: *“Ask not what your country can do for you; rather, ask what you can do for your country.”*
- In the Outreach, it is wise to give special consideration to the less privileged and the rural ones. For, in this group are very many, whose talents have not been discovered and turned on yet. As the poet Thomas Gray [10] puts it:

Full many a gem of purest ray serene
The dark unfathomed caves of ocean bear,
Full many a flower is born to blush unseen
And waste its sweetness on the desert air.

- Unfortunately, many people have been brainwashed into thinking that Physics is hard and boring. The Outreach gives an excellent opportunity to undo this brainwash. Hence, in all the Outreach activities, the focus shall be on “fun” with the mantra: *“Taste and see that Physics is fun.”* The audience is not asked to hear Physics; read Physics; write Physics; learn Physics, etc. Instead, the audience is given an opportunity to taste Physics; enjoy Physics; discover Physics, etc.
- Jamaica’s Physics Outreach could be adapted to the educational set-up in any country.
 - **Students in 9th, 10th, 11th & 12th standards**

These find some Physics topics very difficult to understand (and their teachers may find some topics difficult to explain, due to lack of equipment and/or lack of experience). Weeklong One Day Workshops – similar to 3.1) above – on one such difficult topic are likely to be very helpful to the students; and their teachers would be very grateful for this assistance. This also provides an excellent opportunity to tell the students about the various pathways and career options in Physics – locally and overseas. Some of these students may have already been brainwashed that Physics is hard and/or boring. Letting them play with Physics simulations in the Computer Lab is very helpful in undoing this brainwash. Many such simulations are freely available in the website: <https://phet.colorado.edu/>. Some of them may even be used for a Virtual Lab.
 - **Students in 5th, 6th, 7th & 8th standards**

The author’s experience in several countries shows that nearly all of these students are free from the prejudice that Science/Physics is hard and boring. They are very inquisitive and open-minded. Their curiosity is worth comparing with the words of Einstein [11]: *“I don’t*

have a special talent; only a passionate curiosity.” Any country’s potential future Einsteins are right there in this Group. Arranging Physics Field Trips for this Group – similar to 3.4) above – is of enormous importance. For, these Trips give the little ones an excellent opportunity to “play and have fun with Science.” They are also very helpful in fanning the curiosity of the little ones into an Einstein’s curiosity. The ‘play’ could be made educational if the students are given a simple hand-out.

Some poor and/or rural Schools will be unable to come to the College (or the place where the Field Trip is arranged). The Outreach Team could visit such Schools, and conduct there the Interactive Show on ‘Science Is Fun’ – similar to 3.5) above.

○ **Physics on the Road i.e. Travelling Physics Shows**

In many countries, Science Fairs etc. are usually conducted in cities. The rural ones, and even those who live reasonably away from the metro areas, have great difficulty in coming to such Fairs in the metro areas. Travelling Physics Shows are excellent solutions to this problem. These have been organized very successfully by some American Universities.

○ **Physics/Science Teachers in Schools:**

These are the pillars of Physics education. The speed at which any country moves towards the First World status depends to a great extent on these teachers. Hence, it is of enormous importance to enable, encourage and empower these teachers to keep their classes active and interactive, lively and enjoyable. They could be turned into volcanoes, erupting with a burning passion for Physics. They could be enabled to experience the wisdom behind the words of Gail Godwin [12]: “*Good teaching is one-fourth preparation and three-fourths theatre.*” They could be trained to choreograph their lectures with demonstrations, computer simulations, hands-on activities, peer instruction, dramatizing, stories, surprise quizzes etc., so that their lectures become an intellectual ice cream in different flavors, and their class an ice cream parlor. They could be trained, as the Nobel Laureate Carl Wieman [13] put it, to “*move students from mindless memorization to understanding and appreciation.*”

○ **Quality versus Quantity**

In all the Outreach Programmes, it is wise to focus on quality rather than quantity. Better to produce a thousand curious, inquisitive and independently-thinking students rather than ten thousand mediocre students. For this, it is wise to keep the staff-to-students ratio to around 1:30 in any Programme. When the number of students is small, the staff can pay much more attention to each student. It is also very helpful to get the feedback from the students on every aspect of the Outreach Activity. For, there is so much to learn and to improve.

7. CONCLUSION

Physics Outreach in Jamaica has succeeded in communicating a little bit of the wonder, the poetry, the drama, the dance and the excitement in Physics to very many people – at a reasonably low cost. It has shown that ‘Education’ and ‘Fun’ can go together. It has enabled thousands of students in High Schools, Middle Schools and Primary Schools to “taste and see that Physics is fun.” It has played a key role in nearly tripling the number of students in Introductory Physics at UWI. It is good for other countries to take Physics Outreach much more seriously, and to attract some of their brightest students to pursue Physics. This would speed up their progress towards the First World status. As the Associate Executive Officer of the American Physical Society [14] put it: “If we could get members to go to K-12 schools and levitate a magnet or something, we really think these efforts would bring great rewards.”

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