USING ICT IN SECONDARY SCHOOL SCIENCE TEACHING – WHAT STUDENTS AND TEACHERS IN TRINIDAD AND TOBAGO SAY?

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Abstract:

Over the last decade and a half, classrooms have become swamped with a range of electronic devices. Technology will continue to be more efficient, more versatile and indeed more abundant in schools and in classrooms. This study explores the views of students and teachers on the effectiveness of ICT in science teaching in terms of (i) levels of enjoyment derived by students, and (ii) usefulness of ICTs to teachers for their teaching. A questionnaire was used to elicit the views of students and teachers in respect of a range of ICT-based classroom activities. Qualitative and quantitative data collected through the questionnaires from 12 teachers and 100 students involved in science teaching and learning at a selected secondary school in Trinidad were analyzed. The results show that students enjoy ICT interventions in their lessons and teachers rank it high in many respects but, both students and teachers agree that ICT loses its appeal when its use is arbitrary and ill-planned.

Keywords: ICT, secondary school, science teaching, Trinidad and Tobago

1. Introduction

With the formal introduction of ICTs in secondary schools in Trinidad and Tobago in 2010 (Draft policy for Information and Communications Technology in Schools, Trinidad and Tobago, 2005), most schools have experienced some aspect of the technological revolution that is now a global phenomenon. Students the world over and indeed here in Trinidad and Tobago, takes for granted today a luxury that could have only been imagined to exist in classrooms a generation ago. Advocates for the shift have

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suggested that ICT infusion helps to visually stimulate students and that it encourages them to seek out knowledge for themselves and to share newly acquired knowledge with their peers. Teachers have easy access to teaching/learning materials and resources and in that regard, ICTs have made their job of planning lessons and designing in-class learning activities less onerous. Educators have realized the value ICT can add to student engagement, including the ease with which it facilitates student participation in the classroom and the intrigue it adds to the learning experience, but many have also noted that if not effectively and purposefully infused into learning experiences, ICTs can be a distraction and an overall useless accessory to classroom teaching. Experts in the field have advised that a judicious selection of appropriate ICT devices and applications, which takes into consideration the content to be taught, the type of students, the number of students and the expected learning outcomes, will yield meaningful learning (Abbott, 2001; Balanskat, Blamire and Kefala; 2006). Careful deliberation about the purpose too, for which the ICT infusion is being undertaken, will determine its usefulness.

In general, it seems that teachers and students use ICTs mainly for data handling, communication, information gathering, information presentation or leisurely exploration (Koehler and Mishra, 2009). A heavy reliance on a range of software and hardware tools such as laptops, video cameras, simulation/modeling programs, email and discussion groups, school intranets, interactive whiteboards and presentation software is needed for all the various reasons teachers and students use ICTs. There is no doubt that the versatility and evolution of ICT devices and the uses to which they will be put will continue. Even a decade after the introduction of the Draft policy for Information and Communications Technology in Schools on ICT, no formal studies exist in the Trinidad and Tobago, which examines the views of students and teachers about the effectiveness of ICT intervention in their classroom. Such an exploration seems far overdue and is therefore necessary if, for no other reason than to ascertain in some small way, implementation aspects of the policy. An examination of this kind will be instructive as it will inform the extent and the direction in which the evolution should continue for the Trinidad and Tobago context. It will also capture in a formal way, actual findings on the effectiveness of ICT-based activities in science teaching. From the perspective of schools, this study will indicate what specific features and capabilities of technology, inclusive of devices, support systems, are most effective, and hence what elements of technology schools should invest in. In the continued promotion of the ICT initiative, it is important to know how students are benefiting from the shift and how teachers are using the technology to enhance the classroom experience.

The gaps and concerns identified above prompted the current work. While there is convincing research and literature which speaks to the effectiveness of ICT

integration in the classroom in many parts of the world, the gaps and concerns continue to exist in Trinidad and Tobago. Informal feedback from both students and teachers suggests that students are highly responsive to the ICT intervention and teachers are pleased with its utility. It is uncertain however, if in fact ICTs and ICT-based classroom activities are enriching classroom learning and if it is, what aspects make it an effective classroom intervention.

Mandated by the Draft policy for Information and Communications Technology in Schools, teachers and students in all disciplines in Trinidad and Tobago are involved in some degree of ICT infusion in their classroom teaching. The researcher is a science educator, has conducted much research with science teachers and science students, and chose therefore to explore this research concern with science teachers and science students in the first instance. For the purposes of this work therefore, the focus will be on the views of students and teachers who have used and/or are using ICTs and ICT-based learning activities in science classrooms. The following two (2) research questions will be answered in this work:

1. What are students' views about the use of ICTs in science classrooms in Trinidad and Tobago?
2. What are teachers' views about the use of ICTs in science classrooms in Trinidad and Tobago?

In science teaching, ICTs can be extremely useful. ICT tools, video demonstrations and experimental simulations can replace, in large part, expensive laboratory equipment and reagents. Virtual science labs eliminate the need for many safety restrictions and easily facilitate several repeats of practical exercises. Laboratory demonstrations which cannot be enacted in the classroom laboratory can be easily experienced through ICT facilitated simulations. Video clips can give an almost life-like account of many scientific processes, concepts and applications. The use of ICTs therefore, to teach science has the potential to enhance understanding of practical tasks and can also motivate students to learn science by keeping them engaged in (visual capture and stimulation) and participating in (researching, designing and presenting) classroom activities.

2. Literature Review

Nicholls (2004) describes the use of "ICT in the classroom" by suggesting that the purpose of ICT intervention is to teach students how to handle information, how to generate new ideas and how to communicate these ideas. He goes on further to say that ICT-based models, demonstrations, simulations and experimentation present for students an opportunity to learn science through interaction with modern technology – an approach which can encourage the development of a 21st century learning skills-set.

Rogers and Finlayson (2003) described six different types of skills-based learning activities which ICTs can facilitate in the science classroom. These are communication, data handling, simulations or virtual experiments, information gathering mathematical modeling and practical engagement (eg. sensors and interfaces). In this work the views of science teachers and science students, on the usefulness and levels of enjoyment derived from classroom ICT-based activities which facilitate the development of some of these skills, are explored.

In other investigations involving ten secondary schools, Rogers and Finlayson (2003), found that of all the six uses identified above, simulations, attracted the largest number of favorable responses, with 95% of teachers reporting that the use of simulations resulted in learning objectives being more successfully achieved.

ICT has the ability to capture attention and focus through its visual appeal and in so doing can keep students engaged either visually, audibly or both, for periods of time greater than teacher talking would. Donelly, McGarr and O'Reilly (2011), reported that in classrooms where ICT devices and ICT activities were effectively used, students indicated that they were less bored and more enthused to pay attention when information was being presented. Willshire (2013) however found that the higher levels of enthusiasm attributed to ICT activities lasted only if a good variety of ICT-based activities were used, else the enthusiasm was short-lived. Furthermore, Gupta-Bhowon, Jhaumeer-Laulloo, Wah, and Ramasami (2009), pointed out that for certain skills based activities (such as titration), ICT simulations are but a poor replacement. In addition to selected variety and suitability of purpose of ICTs, teacher training and competency in successful ICT infusion is critical because as Bingimlas (2009) reports, without the necessary 'know how', teachers will experience 'barriers to integration' which they may not know how to overcome.

Sang (2005) discussed the frequency of ICT usage in the classroom and found that overuse of ICT devices and ICT-based activities was not pleasing to students while Donnelly, McGarr and O'Reilly (2011) looked specifically at the use of PowerPoint presentations to present information and diagrams and reported that students had mixed views on the use of PowerPoint in their science classes. Indeed, ICT infusion has the capacity to capture attention and engage learners, but Akdemir and Koszalka (2008) found that ICTs are not equally appealing for all learning styles. In fact in a large scale study involving science students across all levels of the secondary school Geist (2011), found that about one-third of the students surveyed were of the view that ICT infusion does not necessarily make science lessons fun, exciting and enjoyable and only 50% of the students were of the view that ICTs aided in their understandings of science concepts to a greater extent than traditional classroom dialogue.

The available literature therefore seems to suggest that ICTs are a welcome addition to the range of approaches and resources teachers have at their disposal to

execute classroom instruction, but there are mixed results about how useful, appropriate or effective ICT infusion is in the classroom. The extent to which it is used in the classroom determines in large part its overall brawn in the classroom but there is no question as suggested by both Bonds-Raacke and Raacke (2008) and Darlignton (2009), that ICT is an addition to teachers' repertoire of strategies – not only a versatile addition, but a necessary one in light of the evolving technological age that is upon us.

3. Methodology

3.1 Research Design and Context

An exploratory mixed methods approach was adopted in this work. The exploratory approach was adopted because as described by Singh (2007) the current work is concerned primarily with discovery and an attempt to gauge views, with the researcher being the explorer. A design such as this, Singh (2007) explains further is not conclusive, but explores the research questions, leaving room for further researches. Quantitative data were sought to explore levels of rating in respect of usefulness for teachers, and enjoyment for students of ICT devices and ICT-based activities. Qualitative data were solicited to reveal what were the general opinions of teachers and students about ICTs and their uses in the classroom. Analyses arising from both quantitative and qualitative data were cross-checked in an adaptation of the sequential exploratory mixed methods approach outlined by Creswell (2003) to arrive at answers to the research questions.

A sub-urban school in Central Trinidad was purposively selected for this work. It was one of the first schools to receive the Government of Trinidad and Tobago's subvention of laptops under the "One Laptop per Child" initiative which was introduced in Trinidad and Tobago in 2010. This school is well equipped with many of the ICT devices and there is even an ICT technician on staff to provide technical support. Teachers at the school also participated in a 2-day training workshop to expose them to the various skills and techniques that are necessary to integrate ICTs in the classroom. In spite of all the efforts and investments in ICT methods at this school the principal had raised concerns about the effectiveness and the benefits of the initiatives and had approached the researcher on two occasions requesting a formal study that will explore in the first instance, how students view the ICT initiative in terms of levels of enjoyment during classroom learning and secondly how useful teachers feel ICTs are to them for the design and execution of classroom learning experiences. An understanding of both these concerns will provide an indication of the effectiveness of the ICT integration initiative in this school, at the least.

3.2 Instrumentation and Methods

Two questionnaires were created, one for teachers and one for students. In both cases the questionnaires began with a list of different ICT-based activities, where a rating was requested on a scale of 1 to 5 (Section 1). Students rated their 'enjoyment' of the activities (Hate it, Dislike it, Don't mind it, Like it, Love it) whereas teachers rated the 'usefulness' of each activity. Teachers rated the usefulness of the activity on a five point scoring scale from 'Not at all useful' to 'very useful'.

The second part of each questionnaire (Section 2) was a list of general statements about ICT usage in the classroom and the participants simply ticked one of five boxes (Strongly Disagree, Disagree, Neither Agree or Disagree, Agree or Strongly Agree), and these were scored on a scale from 1 to 5 as well. The list of general statements for the student questionnaire was, for the most part, **different** from those on the teacher questionnaire, but there were some areas of similarities, though no identical statements. Finally on the questionnaire (both teacher and student), there was a space provided for any additional comments about views and opinions on the use of ICT-based activities in classroom science learning. This allowed for immediate and direct qualitative data which served to clarify further or reinforce the quantitative data obtained from the ratings.

The questionnaires for the teachers were emailed to the fifteen science teachers on the school's email listing and they were asked to complete and submit electronically. Students' questionnaires were printed out and they were allowed to fill these out during class. The third form of this secondary school was selected. Students at this level had been exposed to classroom teaching which involved the use of ICT-based activities for two years so they would have a good amount of experience with these devices and activities. The form level consisted of a total of 113 students aged 13 – 15 years distributed almost equally in 4 classes. Thirteen (13) student questionnaires were returned incomplete and these were discarded from the study, therefore a total of 100 students participated in the work (56 girls; 44 boys).

Students were reminded that it was a questionnaire of personal views and that there were no right or wrong answers. To avoid unfair or inaccurate results, conferring or sharing answers was discouraged. All teachers and students remained anonymous and the results were kept confidential. Twelve (12) teachers responded to the questionnaire. All these teachers teach some discipline of science to the students in the 4 participating classes.

4. Results

4.1 Attitudes toward Different ICT-based Activities – Questionnaire Section 1

Teachers' ratings of the usefulness of ICT-based activities and students' ratings of their enjoyment of ICT-based activities (as determined from the first section of the questionnaires) are shown in Table 1. In each questionnaire (student and teacher), a higher score meant a more positive response or a stronger agreement.

Table 1: Teachers' and Students' Views on Different ICT-based Activities

Activity	Average Rating of 'Usefulness'	Average Rating of 'Enjoyment'
	Teachers (n=12)	Students (n=100)
Research	4.22	3.72
Communication	4.12	3.82
Simulations & Video clips	4.04	3.89
Data Management	3.92	2.84
Practical Demonstrations	3.61	3.90
Presentation of Information (eg. PowerPoint)	3.53	2.91

While the data support simulations and video clips as a popular ICT activity among both teachers and students, teachers rated research as the activity for which they found ICTs to be the most useful. Students rated practical demonstrations as the most enjoyable activity ICTs have allowed for in their science classrooms. Using ICTs for the purpose of information presentations viz: PowerPoint presentations was surprisingly the least popular ICT activity for both teachers and students. Despite its low popularity score however, the qualitative responses provided by most students (questionnaire section 2) suggest that PowerPoint presentations were used very frequently by their teachers to teach science. The use of ICTs for the purposes of communication, which both students and teachers identified as activities such as emailing, blogging and group chats, was very popular (p=4.12 for teachers and p=3.82 for students). It is not entirely clear whether the communication is school-related or social, but both students and teachers use ICT resources for this purpose very often. Data management, which included things like keeping records of students marks and preparing tests and quizzes (for teachers) and typing up journal entries or essays/assignments (for students) scored a high popularity among teachers (p=3.92) but was the least popular ICT activity for students (p=2.84). Overall, all six ICT activities were considered 'useful' by teachers, with each scoring an average rating above 3.0 and with a fairly narrow range in the ratings. Within the student dataset, four ICT activities were considered enjoyable by students, with a fairly narrow range in the ratings. These were: Practical demonstrations, simulations & video clips, communication and research. Data

management and information presentation were considered the least enjoyable ICT activity among the students.

4.2 Teachers' Views of ICT – Teacher Questionnaire Section 2

Section 2 of the teachers' questionnaire contained a set of statements about particular aspects of ICT activities. Again, the scale was 1 = 'strongly disagree' to 5 = 'Strongly agree' (Table 2). Quantitative data analysis revealed that PowerPoint emerged as a frequently used ICT tool in science lessons and qualitative responses indicated that this aspect of ICT was used mainly when whole-class lessons were taught. Teachers seem convinced that students will pay more attention to notes/information if these are projected on a screen. Teachers' written responses about their use of PowerPoint were suggestive of the fact that visual capture through projection on a screen via PowerPoint presentations or video clips somehow grasps students' attention and keeps them focused on what is being presented. Two teachers indicated though, that the degree of grasp and focus which presentations, video clips or computer simulations achieve is initially very high, but that it is often short-lived. In other words students will not remain focused on the presentations for long periods of time – an observation that was explicitly reported on by (Donnelley et.al., 2011).

Table 2: Teachers' opinions of ICTs and their uses

Statement	Average rating of agreement (Teachers) n=12
I use PowerPoint often to display notes/information and diagrams	4.42
Students are more attentive when I use PowerPoint and computer simulations/videos	4.33
Students enthusiasm levels in class are high when I use ICTs	4.01
My lessons' objectives are more effectively met when I used ICT activities in my lessons	3.43
ICTs are useful teaching/learning tools	3.42
Overuse of ICTs in lessons bores students	3.41
ICTs enhance the classroom experience for students	3.37

Teachers clearly believe that not only are there higher levels of student enthusiasm in the class when ICTs or ICT activities are used to teach science, but that intended lesson objectives are more effectively achieved when ICT activities are used in lessons. They agree to a large extent (p=3.42) that ICT devices are useful teaching/learning tools and that they have the potential to enhance the classroom learning experience for students (p=3.37). Teachers seem however to believe that ICT devices and activities should be used in moderation in the classroom to accentuate teaching and to ignite learning as they share the collective view that overuse of ICTs will quickly bore students. All 12 teachers articulated in their written responses that there is much "value" in the use of

ICT devices and ICT activities for the purpose of teaching and learning but they agree unanimously that it is not an intervention that will work well if it is used in every single lesson and in every class. One teacher even suggested in her qualitative response that ICT activities might yield higher educational outcomes if it is used sparingly rather than frequently.

4.3 Students' Views of ICTs – Student Questionnaire Section 2

The student questionnaire also contained a set of statements about the use of ICT devices and ICT activities in the classroom and the scoring was just as in the case of the teachers: 1 = Strongly disagree' to 5 = 'Strongly agree' (Table 3). The results indicated that students found ICT activities very appealing: They make science lessons fun and enjoyable (p=3.95), they make science easier to understand (p=3.74) and interesting (p=3.70). Even though students indicated in section 1 of the questionnaire that PowerPoint presentations were not a highly useful ICT activity to them, they agreed to a very high extent that (p=3.88), that they preferred reading notes from PowerPoint presentations than from the board. In their written responses, student explained that video clips are 'amazing' and makes it 'much easier to understand' concepts than 'old-fashion teacher explanation' or reading a textbook. Most of them indicated that they liked the graphics, sounds and colors that PowerPoint presentations, videos and computer simulations presented to them. These they suggest, made them 'want to learn science.'

Table 3: Students' opinions of ICTs and their uses

Statement	Average rating of agreement (students) n=100
ICT activities make science lessons more fun/enjoyable	3.95
I prefer PowerPoint presentations/videos/simulations instead of writing notes	3.88
ICT activities make science easier to understand	3.74
ICTs and ICT activities make science interesting	3.70
An ICT activity is easier than a 'normal' hands-on class activity	3.62
I would like if all my science lessons had ICT activities	2.55
I prefer virtual investigations/simulations (using ICTs) instead of real experiments in a real lab	2.41

The only statements with which students had average disagreement with were 'I would like if all my science lessons had ICT activities' (p=2.55) and more significantly, 'I prefer virtual investigations/simulations (using ICTs) instead of real experiments in a real lab (p=2.41). Students clearly appreciate and enjoy the infusion of ICT devices and ICT activities in their science learning experience, but it seems very apparent that they are not prepared to discard the traditional hands-on approach or even teacher-directed

instruction. In some written responses, students suggested an approach for ICT integration in which ICT devices and activities can be used 'early in lessons' to 'arouse interest' and 'capture attention' and later towards the end of lessons to 'summarize and consolidate the lesson'. One other suggestion emerging from students' qualitative data was that ICT activities should be used to 'complement' in-class hands-on activities 'but only sometimes.'

5. Discussion

In both the student questionnaire and the teacher questionnaire, simulations and video clips emerged as a highly popular ICT activity, an observation that was also found by Willshire (2013) and even earlier in the technology evolution by Rogers and Finlayson (2003). In both published cases, the views and opinions were sought from students and teachers with characteristics similar to the participants in this work. Simulations, video clips and demonstrations are excellent for illustrating abstract concepts and complex relations and designs in science, therefore have a high degree of relevance in science lessons, and may account for the high ranking it scored by both science students and science teachers in published works as well as in the current work. For example, the processes of nuclear fission and nuclear fusion, which cannot be replicated in a school's laboratory, can be brought into the realm of reality through the use of video simulations for students in a physics class.

In spite of the versatility which simulations and virtual experiments allow for, Georgiou et al. (2007) emphasize that it will be a mistake for science teachers to opt to teach and illustrate every concept or every phenomenon using virtual experiments or video simulations. This was clearly reflected in this work (p=2.55) when students were asked if they would like ICT activities in all their science lessons. The ease of access, low cost and independence which virtual methods can be lauded for make it very tempting for science teachers to choose them for classroom activities, but Darlington (2009) cautions that for those hands-on activities that facilitate the development of measurement and manipulative skills, the simulations are a poor substitute. Students in this work were unanimous in their views on this – almost all students said, in some form, through their written responses that there was a high place for hands-on practical activities in their science classes. Indeed it seems, that even with the high attraction of ICTs and ICT-based activities, students in Trinidad and Tobago still prefer to learn by doing than by seeing or hearing. Taking careful note of this finding therefore, teachers are advised to always bear in mind the intended learning outcome or skill development before selecting an ICT activity over a hands-on activity for classroom learning.

Students in this work expressed a view that ICT activities should be used sparingly instead of frequently, a view that echoed clearly from the work of Sang (2005)

in which students suggested that "m*ultimedia should be an enhancement, not a replacement.*" In fact, a number of students in this work, through their written responses, alluded to the fact that simulations are more effective if they are used in conjunction with hands-on experimentation. Also noted, though implicitly, in the report by Sang (2005), but expressed clearly in this work is the caution that arbitrary use of ICTs just for the sake of using them can create a dispassionate learning environment. When students are unable to see the value ICTs adds to their learning they are prepared to reject even the best intended ICT integration effort. This notion was explicitly stated in the written responses obtained from 53% of the students in this work.

A most interesting observation which emerged from this work was the apparent contradiction in view held by students about the use of PowerPoint. Students ranked PowerPoint as the least enjoyable (p=2.91), however when asked specifically about the use of PowerPoint over traditional methods of information presentation, students gave it a fairly high rating (p=3.88). While it is not clear from this work why there is this apparent contradiction in views, the work by Donnelly, McGarr and O'Reilly (2011), may give an indication. Donnelly et.al (2011), reported that students easily become tired of ICTs if they are subjected to 'ICT overload' – if ICT is foisted upon them in every lesson – for example if students go from History class to Geography class to Science class and all of these lessons are taught using PowerPoint presentations. This may perhaps explain the low, disapproving results (p=2.55) obtained when students were asked to indicate their opinion to the statement "I would like if all my science lessons had ICT activities." However, when asked to consider ICTs against traditional approaches the results were much higher (p=3.88). It would seem that students like PowerPoint presentations, and noting that it is the most frequently used ICT activity among teachers in this work (p=4.42) students perhaps experience PowerPoint overload which may account for their general view that ICTs should not be used in all lessons but instead should be selectively used in science teaching. Further exploration of students' views and opinions with specific emphasis on PowerPoint overload will be necessary to explain completely this observation revealed here.

Students' learning styles too seem to influence their views on the use of ICT-based activities in the science classroom. The qualitative responses given by students in this work seem to suggest in a general way that students who viewed themselves as spatial and kinesthetic learners felt hampered when having to interact with simulations and video clips when learning about dynamic processes such as chemical reactions or circuit arrangements while those who see themselves as linguistic or interpersonal learners were very positive about the use (or overuse) of ICT-based activities such as reading through PowerPoint presentations or quietly sitting at a computer terminal following instructions and making observations. These findings are instructive for teachers not only science teachers and not only for teachers in Trinidad and Tobago but

as Le Fever (1995) and Akdemir & Koszalka (2008) also explained that the use of ICT devices and the selection of ICT-based activities should be carefully crafted into science lessons in ways that match the learning style diversity of the class. In other words, even if ICT devices and activities are used, some segments of the lesson should include activities for those learners who do not fully appreciate ICT intervention.

It would seem that in the Trinidad and Tobago context, there is an undeniable favorable response to ICT related activities in science learning. Students reported that science lessons were more fun, enjoyable and interesting when ICTs were used in their execution (p>3.70). Many even indicated that the infusion of ICTs made science easier to understand. Abdullah (2014) cautions however that if ICT infusion makes the classroom experience 'too relaxed' for students, that students will not treat the lesson seriously and that the lesson may fail to achieve its intended objections. This too is noteworthy for science teachers in Trinidad and Tobago, as it highlights the need for them to ensure that even when they strive to make classroom learning fun and exciting for students, that they should not forget that instruction and activities should always be tailored to ensure that meaningful learning occurs as well.

Teachers and students in this work indicated through quantitative and qualitative data, that computerized notes and diagrams are not only vivid and attention capturing, but can be used repeatedly and can be easily edited for use in classroom teaching. In general, students like the visual appeal ICTs offer in the classroom and teachers like the fact that they can use ICT tools for research purposes when preparing class notes, activities and worksheets. In the latter aspect, this work aligns well with that of Koehler and Mishra (2009), who also found that the research utility that ICTs facilitate was a highly popular use among teachers in general (science and non-science).

6. Conclusion

ICT devices and ICT-based activities, when effectively infused in science teaching can facilitate greater learning in the science class. It has the power to engage students and to open up new avenues of knowledge accessibility. However, a balance must be arrived at between using computer simulations, demonstrations, PowerPoint presentations, virtual experiments, real hands-on, practical activities, and traditional collaborative group work. The absence of modern ICT approaches in a science classroom will make the science learning experience dull and antiquated and will not facilitate the development of a 21st century skills-set among students. It would also make it almost impossible for teachers to give students a feel for some processes and phenomena that otherwise traditional teaching and learning methods would not allow for. On the other hand, transforming the science classroom into a virtual environment devoid of real demonstrations or apparatus would not be a true image of what science is – it is after

all, a hands-on subject. A heavy reliance on computers to teach science creates distance between teacher and students and serves only to make the learning process impersonal and uncompassionate. The fact is that students enjoy the awe and novelty of occasional ICT infusion, but do not want to be victims of ICT overload. When used judiciously, ICT can make science easier to understand and enjoyable for students, but teachers still have to plan their lessons and instruct, explain and elaborate, bearing in mind the range of learning styles in the classroom. It will be a mistake for any teacher of any subject to believe or to expect that technology could do the teaching for them or make them less accountable to the profession.

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