Reviewing Science Education in Trinidad and Tobago through the Lens of the COVID-19 Pandemic

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Abstract

This paper explores how the COVID-19 pandemic can act as a lens for educators and scholars to more clearly define some of the issues hampering effective science education in one Caribbean territory. The pandemic clearly revealed certain phenomena in Trinidad and Tobago (T&T) including: the poor state of public scientific literacy; limited public understanding of the nature of science; an antagonistic dynamic with respect to public trust in science; and the lack of comprehensive remote/online pedagogical options for science. These issues have implications for the teaching and learning of science in T&T. In particular, science educators are encouraged to consider: a border crossing approach to teaching science; explicitly teaching the nature of science; adopting a science in context approach to science education; and working on developing digital pedagogies for teaching science that honour inquiry and concrete hands-on experience with phenomena. While the article is primarily about Trinidad and Tobago, it may be relevant to those interested in the development of small island states, including other Caribbean territories.

Keywords: science education; education in Trinidad and Tobago; COVID-19; Caribbean science education

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COVID-19 was designated a pandemic by the World Health Organisation in mid-March 2020 (World Health Organisation [WHO], 2020). One of the first international impacts was the disruption of normal schooling. Within a couple of days, schools were closed, students were isolated to their family homes, and parents/guardians were expected to assume a greater role in their children's education. The immediate response of several formal school systems was to make education available through remote and online means. Teachers from elementary to tertiary levels did what they could to carry on teaching and learning using a range of software such as Zoom, Schoology, Google Classroom, and WhatsApp. Additionally, academics and educators began taking stock of the unfolding situation; speculating about implications of the continuing pandemic on the future of education, while cognisant of the uncertainty of how or when the situation would end.

I began working on this paper in June 2020. At that time, several influential articles about COVID-19 and education had been published internationally (see Basilaia & Kvavadeze, 2020; Daniel, 2020; Zhang et al., 2020). On a regional front, several online webinars had taken place tracking the local situation and suggesting ways to move forward (see UNESCO, 2020; Moore, 2020). Arising from these, several general trends with respect to the unfolding situation were becoming clear, especially the innovation shown by educators to keep education going using digital platforms. At the same time, however, rising inequitable access to these innovations were also being recognised: in particular, for children without digital devices and internet services; parents who were unable to support their children (perhaps because of poor educational success themselves), and the lack of appropriate options for children with special needs. Further, some were suggesting that the present circumstances (beyond these immediate trends) were revealing deeper fault lines in our existing educational systems, for example, the inability of traditional curriculum content to sustain self-motivated learners capable of coping in times of crisis.

With respect to science education, I noticed that internationally, several calls for special journal issues had been publicised, for example, the *Journal of Science Teacher Education* (Verma et al., 2020), and *Science and Education* (Erduran, 2020). The *Journal for Activist Science & Technology Education* (JASTE) had already published a special issue about the pandemic in June, 2020 (JASTE, 2020). One of the key assumptions of Larry Bencze and Steve Alsop (editors of this special issue) was that the COVID-19 situation created a portal that could be used to reimagine science education and create a better society.

Inspired by this insight, this article records my attempt during June-August 2020 to determine what the pandemic means in my local science education context. I realised at the time of writing that the situation was fluid, and that by the time of publication unforeseen pandemic developments may have occurred. Nevertheless, I hoped that much of what I uncovered would still be relevant. While this article is primarily about Trinidad and Tobago (T&T), the insights recorded may also be relevant to those interested in the development of small island states, especially Caribbean territories.

Methodology

Trinidad and Tobago is the southernmost nation in the Caribbean. The twin-island republic gained independence from Britain in 1962 and currently has a population of 1.4 million (Government of Trinidad and Tobago, Central Statistical Office, 2017). Extending from its colonial past, the education system follows the British style, where there are four levels of education: early childhood, primary, secondary, and tertiary. Education in T&T is compulsory for ages 6–11 (Oxford Business Group, 2020) and has been provided freely for over 40 years for primary and secondary levels. Additionally, there are several well-established tertiary education institutions where students can extend their schooling, including: The University of the West Indies (St. Augustine); The University of Trinidad and Tobago; and the College of Science, Technology and Applied Arts of Trinidad and Tobago. Up until June 2020, the tuition for a first qualification at any of these tertiary institutions was also fully funded by the T&T government. The uptake of education in the country has been good. In 2015, there was 95% enrollment of students across primary and secondary schools, and the overall literacy rate among citizens was about 99% (Oxford Business Group, 2020) .

Science is a required subject from the beginning of primary school to the end of secondary education. Integrated/general science is taught in primary school, extending to the first three years of secondary school. In the terminal two years of secondary school, every student is required to do at least one science subject—either integrated science, a pure science, or an applied science. Official curriculum guides for these levels specify that science is to be taught in a spiraling fashion (i.e. with topics being repeated so as to deepen student knowledge as the years progress) (Government of Trinidad and Tobago, 2013, 2014; Caribbean Examinations Council, 2009). The efficacy of this method of science education is difficult to determine, since there are very few local large studies in this area. However, the latest Program for International Student Assessment (PISA) results place T&T third in science in Latin America and the Caribbean, and overall approximately 2 years behind the average science performance of the countries in the Organisation for Economic Cooperation and Development (OECD) (Soledad Bos et al., 2016).

Research Questions

I have been a science educator for the past 25 years. Since the onset of the COVID-19 pandemic, I have been trying to make sense of what this phenomenon is revealing about science education in Trinidad and Tobago. The specific questions that guided this paper are:

1. How did the COVID-19 phenomenon unfold in Trinidad and Tobago?
2. What does the COVID-19 pandemic reveal about science education in T&T?
3. How can these revelations be applied to reimagine science education in a local context?

The specific methodology used to answer these questions was hermeneutic phenomenology—reasoned inquiry that seeks to discern the inherent nature or essences of phenomena by analysing lived experiences (Moustakas, 1994; Munhall, 2007; Polkinghorne, 1989). According to Nazir (2016) the salient features of hermeneutic phenomenology are: (i) the refusal of subject–object dichotomy; (ii) the avoidance of scientistic reductionism; (iii) the search for essences; (iv) the acceptance of the personal nature of coming to know; and (v) the importance of bracketing during the research process. In conducting this research I found these features valuable, as this methodology allowed me to focus on my lived experience of the COVID-19 phenomenon as data; include a certain amount of personal reflection and inductive/deductive thinking as part of the research process; and explore the research questions in all their complexity as the phenomenon presented itself to my consciousness.

I began the research process by formally writing daily descriptive notes of the COVID-19 phenomenon through the various events I experienced on traditional media platforms (newspapers, television, and radio); and digital platforms (government websites, school websites, and popular social media forums). In keeping with a hermeneutic approach, the analytical process began immediately, in the form of interpretive side-notes written on my descriptive notes as the phenomenon unfolded. This process gradually evolved into seeking essences, which are essential structures that give meaning to a phenomenon, using established phenomenological procedures (Polkinghorne, 1989) including overall examination of my data (descriptive notes); clarification of the essential structures of the phenomenon; and iterative writing to describe what these structures meant for science education. In keeping with Nazir (2016), while conducting the research I consciously practiced bracketing by keeping the science educator personality in the foreground and consciously keeping track of my pre-suppositions throughout the production of this paper.

The COVID-19 Response in Trinidad and Tobago

On the announcement of the COVID-19 pandemic by the WHO in mid-March 2020, the Trinidad and Tobago government began putting mechanisms in place to manage the situation. The ministries of health, communication, and national security began working together to lead the local response. Some of their key actions over the first weeks were: the immediate closing of schools; the closing of the country's borders; and the shutdown of all non-essential workplaces and services. In practical terms this meant that while no official state of emergency was called, the country was in a state of special lockdown. Citizens were expected to stay home and only go out for essential requirements like food, pharmaceuticals, and medical attention. Citizens were also strongly advised to: practice social distancing; limit congregation to groups of no more than five; regularly sanitise hands and hard surfaces; and wear cloth face masks in public spaces. The government held daily media conferences to appraise and educate the public about the unfolding situation. Through this avenue the public learnt that a parallel health care system was being organised, consisting of separate primary care, stepdown, and quarantine facilities. Testing of suspected cases began. Identified cases were isolated to the parallel health care system. Over the next few weeks these measures were widely hailed to be effective (Hunte et al., 2020) as the number of known COVID-19 cases rapidly declined and by the end of April, local spread seemed to have been prevented. Indeed, during this time the country recorded relatively low numbers of confirmed cases—just below 120 infections.

As a result of the success of this first defense, the government began a phased reopening of the country early in June 2020. By the end of June 2020 most normal activity had resumed, except for mass sporting and entertainment events. Additionally, persons were still being cautioned to wash hands, wear masks, and limit social gatherings to no more than 25 persons. The borders were still shut, but the exercise to return citizens who had been stranded abroad at the onset of the pandemic was underway. This latter effort was being managed via a process that required the quarantine and medical clearance of returnees before they were allowed to interact with the local population. During this exercise several imported cases were caught, but the general sentiment was that the situation was under control and the country had avoided the serious problem of local community spread.

The situation changed on July 22, 2020, when a new non-imported case was found. By July 31, 2020, 20 new cases had been recorded, leading to the speculation that local spread had begun. On August 1, the government confirmed that local cluster spread was occurring and reintroduced some measures to limit population movement in an attempt to maintain control of this new wave of infection. The new measures were in no way as drastic as the initial special lockdown, but consisted of a shift system to limit the number of public servants working at any one time, and a limiting of public gatherings to 10 persons. The tone of the governmental management team seemed to have changed from "preventing local spread" to "managing with the new normal". By August 15, 2020, there were 497 recorded cases, and the country's health status had been changed to local community spread.

With respect to education, schools were immediately closed in mid-March. Many teachers tried to sustain teaching and learning through digital means (similar to what was happening internationally), while the T&T Ministry of Education rapidly worked to create its own official remote and online education options—activating two main arrangements. Classes for various levels and subjects were aired on a daily schedule on local television stations. Although these classes were synchronous, they did not allow for interaction between teachers and students. Rather, they took the form of traditional remote instruction sessions, where teachers presented information, did worked examples of relevant questions, and performed teacher centred demonstrations of practical activities.

A Moodle-type online learning platform called the School Learning Management System (SLMS) was also created (Government of Trinidad and Tobago, Ministry of Education, 2020). In addition to providing course pages with model classes and suggested resources for every subject and every level in the school system, the SLMS was designed to allow every teacher in the school system to create subject classrooms and hold synchronous classes with their own students via a certain type of conferencing software called BigBlueButton.

Up to the time of writing of this article, the effectiveness of the government's alternative educational arrangements was unclear. Early media reports described teacher and student complaints about the lack of devices and internet connections to access e-learning options, along with a lack of experience in using these (Doodnath, 2020). The local teachers' unions raised concerns about the ability of teachers to effectively teach online without prior training, and the unrealistic expectations of students to learn in the absence of physical teacher presence and concrete learning aids (Paul, 2020). Other media reports raised concerns about some children receiving more opportunities than others, based on class and economic status (Mendes-Franco, 2020). In response, the minister of education tried to reassure the public that activities were taking place to sustain education in an unprecedented time. Schools remained closed for the first 8 weeks of the pandemic. In mid-June 2020, secondary schools reopened to allow students in Forms 5 and 6 to write the regional terminal exams administered by the Caribbean Examinations Council. In late June 2020 it was announced that schools would restart in mid-July for elementary students writing the secondary entrance assessment (SEA) (11–plus exam) to be conducted on August 20. Other than for these two special groups of students, all other students were to remain at home until September 1, 2020, when all schools would fully reopen. To accommodate the limited opening of schools, special provisions were put in place to prevent the spread of COVID-19, including the regular sanitisation of buildings, temperature checks at entrances, installation of handwashing stations, regulated movement of students during the school day, and limited class sizes. These measures seemed to be working well until the concern about local spread of the virus began in late July, when contact tracing exercises to isolate the new infections led to the identification of several schools as being sites of active or suspect cases. These schools were immediately reclosed. At a government media briefing in the first week of August it was announced that primary schools would be reclosed. By August 15, 2020 it was announced that the SEA exam would still take place on August 20, 2020 and that all schools would remain closed at least until December 2020.

Implications for Science Education in Trinidad and Tobago

During the pandemic, I began to observe certain phenomena being enacted in the public domain related to science education: public scientific literacy; public perceptions about the nature of science; public trust in science; and the digital teaching of science. In the rest of this paper, I discuss some of the ramifications of these phenomena on local science education in the future.

Public Scientific Literacy

It is well established that scientific literacy is the major goal of science education (Jenkins, 1990). Early supporters of the scientific literacy movement established that science is the study of the physical world, and that a major component of scientific literacy is the understanding of the knowledge, laws, and theories it generates—which explain how the world works (Bybee, 1997). Over time, other researchers also recognised that scientific knowing at the end of science teaching is often obfuscated by misconceptions (wrong understandings of science phenomena), often created by naïve (partly correct) science ideas (Pfundt & Duit, 1994), and alternative ideas (non-science explanations of science phenomena derived from cultural or spiritual sources) (Jegede, 1995) that learners bring with them to science classes.

Educators have long expressed concerns about the state of scientific literacy resulting from schooling in T&T (Kutnick & Jules, 1988; Maharaj-Sharma, 2007). The pandemic reinforced these concerns and clearly revealed the poor level of public understanding of basic science knowledge in the society. In the early days of the special lockdown, leaders of the T&T pandemic response realised that acting effectively to prevent the spread of COVID-19 required citizens to have a basic scientific understanding of certain topics (e.g. germ theory, disease prevention, and disease mitigation) in order to achieve widespread public compliance with the health measures being recommended. During the pandemic, a number of opportunities for supplementing public understanding of these topics were created, such as daily media briefings with various experts who increased awareness and engagement. A number of unofficial forums were also quickly organised by other concerned citizens (e.g. call-in media programmes, blogs, and social media boards), which allowed the public to share their knowledge and seek clarification on the relevant science about the pandemic. From these forums, two things became clear: (i) the lack of public understanding of the basic science surrounding COVID-19, and (ii) the healthy existence of misconceptions, naïve ideas, and alternative ideas about the nature and spread of germs. Here are some examples of public ideas coming from these sources (call in tv program; popular social media forum; informal tv interview; call in radio program—in the order listed) about germs:

> "Bacteria and viruses are the same thing." (*Misconception*)
>
> "If rubbing alcohol on hands would kill the virus, then drinking it would be even more effective". (*Naïve idea*)
>
> "Eating spicy food would make a person immune to the virus". (*Alternative idea*)
>
> "A person could not catch the virus in church since faith in God will make one immune". (*Alternative idea*)

Some science educators may be initially surprised by the existence of these ideas, since the topic of germs is introduced at the primary level (Government of Trinidad and Tobago, Ministry of Education, 2013) and spirals through the school curriculum into topics like types of organisms, disease prevention, and sanitation (Caribbean Examinations Council, 2009; Government of Trinidad and Tobago, Ministry of Education, 2014). However, a review of new international literature should refute that surprise, as researchers have found similar findings in other countries during these pandemic times (Sahoo et al., 2020; Schmidt et al., 2020).

In reflecting on the T&T context, I believe these commonly held public ideas reveal two things relevant to science education: (1) They reinforce the notion that learners are not blank slates, but come to the science classroom with alternative or naïve ideas. If this existing knowledge is not taken into account, learners can end up with compounded misconceptions about how the world works—or they may simply reject the science knowledge in favour of their previously held notions; (2) Educators must consider the tenacity of alternative ideas, in particular the difficulty in replacing non-science, spiritual, and cultural knowledge about physical phenomena with science knowledge. June George (1999) calls these alternative ideas “indigenous knowledges”; and implies that in the local Caribbean context these ideas are persistent because they are often entangled with the learner’s identity and larger way of being within their home community.

George’s (1999) work overlaps with that of international researchers (see for example Aikenhead & Jegede, 1999) who have studied the difficulties indigenous populations face in learning accepted western science. Aikenhead and Jegede (1999) suggest that science education in some contexts should explicitly acknowledge alternative knowledges and teach them alongside canonical science knowledge. For example, when teaching about stars to local aboriginal people in Northern Canada, Aikenhead (2002) recommended teaching the accepted western science about the nature and structure of stars within the physical universe alongside the long held local astrological knowledge of native peoples. The differences between the two types of knowledge can be acknowledged but no value judgement about which knowledge is better or worse, right or wrong, should be made. It is left to learners to use each form of knowledge as they see fit in their daily lives.

This approach to science teaching is called “border crossing”. It is opposed to the mainstream approach to science education which is aligned with the conceptual change model that seeks to disrupt the learner’s alternative or naïve ideas and replace them with western science ideas (Posner et al., 1982). Critics of the conceptual change model have equated it to a type of violence perpetrated on the learner, noting its ineffectiveness when teaching science in certain populations (Aikenhead & Jegede, 1999). In response, supporters of the conceptual change model argue that certain alternative concepts are incompatible with accepted Western science; that allowing students to hold on to alternative ideas is a disservice to them, because it limits their progress in acquiring deep knowledge about how the physical world actually works (Treagust & Duit, 2008).

My observations during the COVID-19 pandemic confirm that T&T learners possess strongly held alternative ideas which have not been replaced by existing science education methods. Local science educators should explicitly reconsider how they address this situation, and perhaps include the border crossing approach to science education in the T&T context.

Public Perceptions about the Nature of Science

Derek Hodson (2008) insists that in addition to knowing the ideas, theories, and laws of science, learners need to know about the nature of science (NOS). Understanding the NOS requires exploration of the history, philosophy, and sociology of science. It means understanding what distinguishes science as a discipline from other endeavours; the work of scientists; and how the scientific enterprise works in a realistic way (among other things). According to many science education scholars (see for example, Akerson et al., 2011, Jenkins, 1996, and Lederman, 2007), this is important because it is only through a thorough understanding of the NOS that learners can be fully motivated to pursue science careers, sustain the scientific enterprise, and understand living in a world that is increasingly mediated by science and technology.

During the pandemic a number of opportunities arose for public discussion of the science associated with COVID-19. In addition to providing much insight into the level of scientific knowledge possessed by citizens, these forums also provided insights into public perceptions about the nature of science. As with scientific knowledge, a limited understanding of NOS was revealed. For example, persons seemed largely unaware of the complexity of scientific work conducted on the disease. Many seemed to think that the pandemic would be a relatively short-lived phenomenon that the medical fraternity would quickly bring under control through the development of effective treatments and a vaccine. The public seemed totally unaware of the vaccination development process. Indeed, there was initial disbelief that a vaccine could take years to develop. The need for trials, and extensive testing of experimental vaccines and new drugs was met with incredulity. Many also wondered why there were so many different teams of scientists working in separate locations across the world. That scientists could be working in competitive teams driven by different political and economic interests seemed anathema to many.

Another issue that indicated poor public understanding of the true NOS was mask-wearing. From the very start of the pandemic, expert opinion varied on whether mask wearing would provide personal protection and diminish the spread of the virus. While factors like the type of mask and the proper use of masks were debated by some, perhaps the main thing that seemed to dismay the public altogether was the lack of unified advice among experts. Claims (often backed by reasonable sounding evidence) seemed to be coming on a regular basis from various reputable groups, some claiming that mask wearing was ineffective while others claimed that it was effective. That science could provide no firm knowledge because evidence could be interpreted in various ways, was a source of confusion to the public.

These are just two examples that occurred during the first phase of the pandemic which indicated that many citizens in T&T still held a naïve image of the NOS. The latter characterisation is not an indictment of the T&T public. Indeed, this finding is congruent with what international researchers of science education have been finding for over the past two decades in many societies (see for example, Miller et al., 1997; Irwin & Wynn, 2003). According to these researchers, many people, despite evidence to the contrary, continue to believe that:

- Most science facts and theories have already been discovered, new science consists mostly of the application of these known ideas.
- Science is a relatively straightforward and quick process.
- Science produces sure knowledge that once discovered changes little over time.
- Science is the idealistic search for truth unimpeded by political, cultural, or economic interests; or the petty moral failings of scientists.
- The media accurately reports science.

In response to such findings, scholars have suggested that part of science education throughout the school years, should be the explicit teaching of the true nature of science. William McComas (1998), for example, has identified 8 aspects of the NOS that he considers essential for a comprehensive science programme. They include teaching that: scientific ideas are tentative but durable; scientists work within a socioeconomic milieu; and scientists' work is mediated by their cultural and personal biases. He also recommends providing students with a true sense of the relationship between science, empirical evidence, and inquiry. Most recently, with the explosion in communication technologies and the evolution of fake news, Hottecke and Allchin (2020) have further suggested that the process of science communication is another aspect of NOS that school science needs to embrace. What is occurring during the pandemic reiterates the need for science education to urgently reorient itself towards understanding the NOS.

Public Trust in Science

Based on its methodology and the knowledge it generated, science was established as a subject of power (Cassirer, 1951) during the 18th century Age of Enlightenment. A scientific methodology emphasises the gathering of empirical evidence and the use of reason and logical thinking to investigate the world. So powerful has this methodology proved to be, that it has been applied over the past 200 years to many other areas of human life, such as education (Dewey, 1938), economic activity (Mirowski & Plehwe, 2009), and societal development (Becker, 1994). Indeed, a scientific approach to any problem garners such an air of respect, that it forms the basis of scholarship in many other academic areas. Science also produces knowledge which is used to generate technologies and artefacts that impact everyday life in unimaginable ways. Most of the changes in health, communication, energy use, transport, sport, agriculture, construction, and recreation that have taken place since the 18th century were as a result of science, technology, and engineering working in tandem. For the foreseeable future, science is expected to continue to be a major moderator of the way we live.

It is no surprise then, that at the onset of the COVID-19 pandemic, the world looked to science for immediate guidance and solutions. The WHO, in announcing the pandemic, took a scientific stance in doing so. Dr. Tedros Adhanom Ghebreyesus, Director General of the WHO, backed his announcement with empirical evidence that the organisation had been collecting since the outbreak of the disease in China in late 2019, suggesting an initial set of response guidelines based on the existing research and best available advice of its various science experts (WHO, 2020). In response, some countries chose to ignore the WHO's advisories. Most notably, in the United States, President Trump initially refused to acknowledge the existence of the pandemic, and later accused the WHO of making the wrong decision (Plett-Usher, 2020). In the face of the growing crisis in the United States, Mr. Trump persistently continued to question the truthfulness of scientists; promoted hydroxychloroquine as a cure-all for COVID-19; suggested that injecting disinfectant could cure the illness; ridiculed the wearing of face masks; and encouraged his supporters to defy stay-at-home orders. While some have interpreted these actions as being determined by the president's focus on economic and political factors (Kim, 2020), others (for example, Yamey & Wenham, 2020) suggest these actions represented a direct denigration of science by the President of the United States.

Unlike the United States, many countries chose to accept the advice of the WHO and set up science-based teams to adapt WHO guidelines to their local contexts. T&T was one of these. The details of the local response, described earlier in this paper, seemed to work well until June 2020, and led at that time to T&T being praised as one of the most successful jurisdictions to have a handle on the COVID-19 pandemic (Hunte et al., 2020). Throughout these first months, March 2020-August 2020, the government stated that they would follow the science, and because of the low incidence of disease this approach seemed to be accepted by the majority of the public. The government's continuing trust in science to deal with the pandemic is evidenced by the words of the T&T Prime Minister, Dr. Keith Rowley, in a newspaper story on August 18, 2020, "…the use of the scientific data in risk management gives all people the best chance to get the best available results in a dangerous situation" (Daily Express News Extra, 2020). However, during the latter part of August 2020, a second wave of the disease was being experienced. Local spread was underway and public opinion seemed to be changing. Media reports indicated that the country was witnessing an increasing resistance by the public to continue with science-based public health measures, especially mask wearing and limited congregation. On August 18, 2020, 32 people were arrested for breaching health protocols (Loop News, 2020). On social media and other public forums, people began questioning the validity of the science-based response. It seemed that public trust in science was diminishing.

The beginning of this section established science as an entity of power that has been a driving force in almost every area of human life. But while this is true, the extent of the power accorded to science has also been questioned from the beginning of the scientific era. Some critics argue that science is one form of knowledge limited to the physical world and thus provides incomplete information about all aspects of reality (Midgley, 1992). Others cite numerous examples of science being used for negative purposes—for example, as a hegemonic tool to denigrate various groups of peoples and cultures (Gould, 1981). For these critics, science lacks the epistemological, ethical, and emotional bases required to provide the sole guidance for human decisions on complex issues. While we have seen the effects of anti-science views at work in society, for example in the anti-vaxxer movement (Capurro et al., 2018), the pandemic has demonstrated the fickleness of public trust in science. It would seem that people worldwide are willing to follow science as long as it creates immediate positive outcomes. However, that trust can be quickly eroded by charismatic anti-science speakers; political and economic considerations; and the limited capacity of science itself to speak with the certainty that people seem to long for in times of crisis.

The issue of public trust in science has implications for science education. For some time now, science educators have recognised that the criticisms of science noted above also act as barriers to the teaching and learning of science. In traditional classrooms, science is usually taught in a monolithic, imperialistic fashion. Students are expected to unerringly trust science knowledge and its methods as superior (Cobern, 1996). Researchers have noted various ways in which learners reject these underpinning assumptions of science education, including dropping out of science classes and rejecting the use of science knowledge in their everyday lives (Calabrese Barton, 2003). As such, a growing fraternity of science educators have been suggesting that science should be taught in a way that takes into account these criticisms of science and honours the complexity of the lived world. Several such contextually relevant approaches have been suggested, such as teaching through socially acute questioning (SAQ), socioscientific issues (SSI), and science technology societies and environments (STSE) (Bencze et al., 2020). Pedretti & Nazir (2011), for example, suggest that science teaching must examine the interfaces between science and the social world and suggest six different possibilities for science educators to do this in schools.

In the T&T context, a realisation of the fickleness of the public trust in science illustrated by the recent pandemic should encourage local science educators to reconsider the underpinning assumptions in their own classrooms and the impacts of these on effective science education. Educators cannot continue to assume that the mythical power of science will provide enough motivation for students to learn it, or that students will unresistingly believe the science they are taught. Science teachers should actively work to build public trust in science, perhaps through some of the alternative approaches to science education suggested above, especially if the goal is for the average citizen to incorporate science in their everyday lives.

Digital Teaching of Science

Throughout this article certain ideas about effective pedagogy for science have been indicated, that is, science should be taught in ways that take into account students' alternative knowledges, contexts and the complexity of real-world experiences. Two other ideas that have dominated science education literature recently are: (i) the need for concrete hands-on experience with physical phenomena, and (ii) student engagement in inquiry when learning science (Flick & Lederman, 2006). Science is the study of the physical world. If students are to meaningfully understand abstract scientific concepts and the connections among them, they require hands-on experience with concrete materials and phenomena. Furthermore, inquiry is the methodology that scientists use to produce science knowledge and many suggest that it is an ideal way for students to learn science.

The process of teaching science through inquiry requires learners to ask questions and try to answer those questions through their own efforts—by doing investigations, making observations, gathering and interpreting data, making logical conclusions, and communicating their findings to others. For example, if students are learning about levers, it is expected that they will observe real world examples of levers, try to figure out how different types of levers work, perhaps apply the use of a lever to solve a problematic situation, and be able to discuss the scientific working of levers confidently and competently.

The COVID-19 pandemic has caused a shift from face-to-face teaching to remote and online education. In Trinidad and Tobago, the local ministry of education activated alternative educational options accessible through local television stations and the internet. The television option consisted of classes conducted by teachers for various subjects aired on a daily schedule on local stations. The internet option consisted of an online learning platform called the School Learning Management System (SLMS), with embedded conferencing software for live classes. From June-July of 2020, I examined the science education arrangements made by the Ministry of Education. I observed several of the science classes aired on Tobago Channel 5 and Trinidad and Tobago Television (TTT) (The Government of Trinidad and Tobago, Division of Education Innovation and Energy, 2020). I also investigated the premade science courses that were provided by the Ministry of Education on the SLMS (The Government of Trinidad and Tobago, Ministry of Education, 2020), that students could access on their own and teachers could use in their individual virtual classrooms.

My examination of these pointed to several significant trends. Firstly, in addition to teacher talk, many of the television classes and SLMS offerings used PowerPoint presentations with links to digital animations, pictures, and videos to supplement teaching. For example, a session about atoms for Form 4 Chemistry, consisted of Powerpoint slides describing knowledge about atoms which included several relevant images and a link to an animated video showing the 3D structure of the atom. These multimedia contributions were meant to act as supplements to the traditional teacher explanations. However, while the use of multimedia was prominent, and provided students with multiple ways to interact with concepts, it was conspicuous that most of these items were derived from non-local sources. Pictures and videos for many topics were culled from the sites of popular search engines like Google and free video hosting sites like Youtube. While examples taken from international sources can be of relevance to Caribbean students, many of the examples used appeared to have questionable contextual relevance to T&T students.

Another characteristic of these alternative educational arrangements, was the lack of opportunity presented for interactivity. Sessions were mostly designed for teachers to present information, and students were expected to passively listen and absorb. There were very few opportunities for students' hands-on interaction with concrete materials or the genuine inquiry necessary for effective science learning. Where student-centred practical exercises were suggested, instructions were not clear, and instructors seemed limited in their knowledge on how to bridge the digital divide to provide support or encouragement for engaged inquiry. For example, in a Standard Two class about food chains outlined on the SLMS, an activity was suggested for students to go out to their backyards or local greenspaces to discover food chains. However, neither a supporting worksheet nor appropriate ways to foster student engagement to complete the activity were provided.

For the past three decades, digital and online education have been on the rise (Davis & Niederhauser, 2007; Hodges et al., 2020; Kebritchi et al., 2017). However, having to suddenly move to remote/online education because of the COVID-19 pandemic highlighted the lack of comprehensive face-to-face pedagogical options for science education in T&T and clearly showed the low level of teacher knowledge in the field. While, teachers seemed comfortable supplementing their teaching with multimodal resources such as Powerpoint presentations, animations, pictures, and videos the predominance of non-local materials in these new resources is a clear indicator of teachers' lack of appreciation for contextually relevant materials in their own teaching. This is at odds with current thinking in science education which emphasises that for science education to be truly effective, local examples, indigenous knowledge, and local applications must be included (Bencze et al., 2020).

The pandemic experience also highlighted the lack of easily available remote/online options for inquiry and hands-on experience with concrete materials when learning science. While there is some promise internationally for digital inquiry in the form of virtual labs (Hernández-de-Menéndez et al., 2019; Keller & Keller, 2005; Lynch & Ghergulescu, 2017), an intensive internet search revealed a dearth of economically viable options for school science in the T&T context. As such the pandemic also indicated that science cannot be taught in the local context without some face-to-face interaction with competent science teachers until appropriate digital resources that celebrate local culture, inquiry, and concrete experience with phenomena are developed.

Conclusion

The COVID-19 pandemic came like an unexpected hurricane. It has turned our lives upside down. Education systems internationally have been disrupted and educators are still scrambling to cope. Like others, the government and educators of T&T responded in the best way they could, based on local existing structures. Teaching and learning have continued in some ways, but the impact of these efforts still needs to be evaluated. However, we in the Caribbean are no strangers to adversity. In being resilient, we know that negative phenomena can have advantages. In this paper I interrogated my experiences as a science educator/researcher in T&T during the early part of the COVID-19 pandemic, to show how this event can act as a lens to more clearly elucidate some of the issues troubling science education in the country.

While it is not my intention to denigrate the local efforts of current or past science educators, my analyses revealed certain characteristics of science education in the local context including: the poor state of public scientific literacy; a poor public understanding of the nature of science; an antagonistic dynamic with respect to public trust in science; and the lack of comprehensive remote/online pedagogical options for science. These issues have implications for the teaching and learning of science in T&T, especially since effective science education is increasingly being named as a key to sustainable development regionally (Warde & Sah, 2019) In particular, I suggest that science educators: interrogate their approaches to teaching science, especially the ramifications of a conceptual change model versus a border crossing approach; explicitly teach the nature of science to differentiate scientific knowledge from other ways of knowing; adopt a science-in-context approach to science education to make science more relevant and interesting for local students; and work on developing digital pedagogies for teaching science that celebrate local culture, inquiry, and concrete experience with phenomena. In other words, instead of teaching science in a very formalised, rote and abstract manner, science teaching should utilise items; objects; foods; natural phenomena; and cultural events that we regularly experience in the Caribbean. In T&T, for example, steel pans and steel pan music could be used to teach a lot of physics concepts (sound energy; mechanical wave transmission; frequency; amplitude; wavelength; etc.) These suggestions are in agreement with Reiss (2020), who notes that "there is not much use in grumbling about historic changes…and school science education" (p. 1080). Rather, educators should focus on how the COVID-19 pandemic can be used as an opportunity to improve science education globally for all.

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