IMPACT OF COVID-19 PANDEMIC ON SCIENCE LEARNING AT SECONDARY LEVEL

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Science is suffering from potential loss, and this is going to be very costly. Science learning is being compromised due to strict stay-at-home orders and school closures for Indian students. In this article, the researcher tried to investigate the effect of COVID-19 on the teaching and learning of science (particularly at the secondary level) in India's schools and educational institutions. The thought of online teaching and learning may sound exciting to many, but to science lovers, it is not! Students seem to dislike science with online classes because the essential elements of science classes are absent in online classes. Moreover, this may affect the future scientists of the nation. Additionally, access to technology, strict time tables, and teachers' inability to adapt to this online culture can be considered the main hurdles in teaching science in online mode. Further, the researcher has also elaborated on the point of online lectures and virtual labs. Somehow, this pandemic may end up helping us to address the improper science assessment policies too.

Keywords: Science learning, lockdown, school, students, COVID-19.

Introduction

Human life is approaching a new normal. The COVID-19 pandemic is staying longer than expected. The coronavirus pandemic is perhaps the most significant challenge faced by humans since Second World War. This virus is not looking for boundaries of the nations and states. When writing this article, the world's total coronavirus cases have crossed 14,78,84,279 cases, including 1,76,36,307 cases in India (Human Rights Watch; ISRC, 2020). All the countries of the world are racing to slow down the curve of infected patients. It includes testing and treating patients, contact tracing, restricting people's travel, and quarantining suspected patients. Since it is a communicable disease with no known effective drug treatment available, the best way is to close down everything and practice social distancing.

The COVID-19 pandemic has affected all the spheres of life, including education. This pandemic has resulted in the almost total closure of schools, colleges, and universities. All governments have temporarily closed all the schools and other educational institutes to contain this novel coronavirus, so has the Indian government. All the governments are increasing the vaccination drives in their respective nations. India has also given emergency approval to Oxford-AstraZeneca's COVISHIELD and Bharatbiotech's COVAXIN and has administered over twelve crore doses.

The COVID-19 is a communicable disease. World Health Organization (WHO) confirmed

its human-to-human transmission through nose, mouth, and eyes long ago; this disease is caused by SARS-CoV-2, which first appeared in Wuhan, China. It has resulted in a pandemic and was declared a health emergency. The first case of coronavirus in India was reported in Kerala, and then the cases started rising quickly. The Indian government imposed a lockdown on 24 March, 2020, for curbing the spread through human transmission. The lockdown measures and the stay-at-home orders led to the closure of all educational institutes and academies. Moreover, the learning of students from K-12 to higher education stopped.

Schools have to close down to adhere to public health measures. Today educators across the nation are worried about catering to the diverse needs of all the learners. The unequal access to technological tools and technology are significant hindrances. In order to sustain the interest of all learners in learning science, numerous efforts were made to run all the educational institutions online.

Experimentation and laboratory works are integral parts of science learning. According to NCF (2005),"scientific inquiry involves observation and experimentation to validate predictions made by theory (hypotheses), which instruments and controls may aid." However, experiments are not possible because of the shutdown. Science teaching and learning are critical because it is tough to continue this scientific learning (using scientific ways) through online mode in India.

This inspired the researcher to investigate the effect of COVID-19 on the teaching and learning of school science, particularly at the secondary level in India.

Methods and Procedures

The opinions from various teachers and students were taken online, mainly through emails and Google forms. Telephonic interviews were also conducted to know the different perspectives of all the stakeholders. The qualitative data collected were analysed and synthesised. Different policy documents were analysed to find their perspective about teaching and learning science. The inclusion of a lower economic section of society in the study was problematic because of lockdown and curfews; they did not have appropriate access to technology, which may be regarded as a limitation. However, various efforts were made to proportionate the share of students from all sections of the society. In addition to this, many research articles were analysed to observe the pandemic's global impact on school education and higher education in India.

Further, new concepts of virtual labs and virtual learning environments were also reviewed through open access literature available on the internet. In this article, the researcher explores the challenges regarding science learning through perception and opinion from various stakeholders. After gathering opinions from the field, the researcher reflected on all the aspects and put his thoughts together.

Results and Discussion

From the data collected through various means, students reported that they find science class annoying. Science has become a more robust and stricter subject. A child says, "I just cannot do science anymore." However, high scores said that they love

online lectures because they are in a good flow and good quality.

Teachers say that learning is being affected due to the closure of science labs. "We are not able to conduct experiments in laboratories due to this shutdown." A teacher from the rural area adds, "we have a tiny science lab in school with limited tools available; now the only means is also closed." Further, another teacher said, "I find these online classes as a burden because I am not aware of the appropriate use of technology; we have been given little to no training." He also said, "my complete focus in an online class is on the appropriate use of different technological tools rather on scientific concepts, and our students are not able to access these online classes due to various reasons."

Students and parents say that they do not have the appropriate tools. "We lack the internet and appropriate device for attending class online; many times, we cannot open documents in our phone due to different formats of the documents. We do not like learning science this way." "I have started hating science," a child added. Educational administrators add that "the budget for purchasing the latest technological tools is not available, but we are still focusing on teaching and learning online because it is the only way possible." The discussion on the data collected is discussed in the rest of the article.

Science Learning is Suffering in Shutdown

It just means that science is suffering from potential loss. This is going to be very costly for everyone. Science, which is considered one of the complex subjects, is already suffering from the stigma of 'meant for the intelligent', and the closing of all the essential places of scientific interest leads toward a new and drastic condition of 'hatred for science.' The students who are marginalized and were interested in science are losing their valuable time for sure. After this academic session is over, no one is looking for the deficiency in their understanding of scientific concepts (It is a general trend in India that we do not look at the concepts of previous sessions). This will deepen the gap in understanding, and we could lose the pure intentions of our potential scientists. This process is being explained in the different sections of this article.

Poor Quality of Science Learning During Pandemic

Many researchers repeatedly say that most Indian teachers are not prepared to teach online, and teachers have admitted it. The thought of online teaching and learning may sound exciting to many, but to science lovers, it is not! Merely replicating the regular science curriculum to learners through online platforms is harmful and unnecessary (Anderson, et al., 2020). They may end up disliking science. Teachers in India are not trained to teach science in online mode. They are ignoring the principles of science teaching because their working memory is already filled with the thoughts of technological tools. Further, all the universities and colleges are pretending to deliver the content online. It would be funny to imagine that all our students are studying online because the majority of the students belong to the lower middle class and poor class families and hence accessibility to technology is an issue

here (Government report as cited in *Hindustan Times*).

Following a demanding school day, timetable/schedules can hamper the learning. The unique materials that are commonly used in teaching and learning science are not available at home. Teachers have to take care of all these things while delivering instructions. The asynchronous mode is better than the synchronous mode because students will have more choice in attending classes.

Impact between Haves and Have-nots on Science Learning during Pandemic

The National Curriculum Framework (2005) says science "curriculum should engage the learner in acquiring the methods and processes that lead to the generation and validation of scientific knowledge." The closure of schools automatically meant the closure of all science experiments and the closure of all the science learning labs for most students. The lower income group of the society, having much potential for science learning, is out of the school's science class. They are not able to attend online classes or instructions. Additionally, merely attending online classes of science is not adequate until and unless some sorts of experiments supplement classroom learning. All these things are fictional now, which is why we may lose the charm. It is time for teachers to show their skills in making learners 'self-helped.' Teachers have to create some activities and must train students to prepare replicas of equipment through improvisation. Educators have to make sure that science lovers' learning is not limited by their access to technology. Science learning can be made with family members' help, e.g., how does your mother cook? (finding and locating science.) Creating the local pool for teaching and learning of science can be a good idea.

Senior students may be asked to prepare some models/tools/accessories of scientific interest as part of their science learning project, and these may be used by teachers or by senior students to popularize science interest among young ones. This crisis may be considered a good start in understanding the true nature of science, which is about life and not just book and curriculum. The books and curriculum are tools to learn science; they are not science in themselves. The syllabus is the complex mix-up of daily life phenomena. "To observe the physical and biological environment, look for any meaningful patterns and relations, make and use new tools to interact with nature, and build conceptual models to understand the world" (NCF, 2005); these wordings of the National Curriculum Framework-2005 may be realized now. Some ways may help in growing science learning in this pandemic situation. Some of these are explained in the discussion below.

Necessary Virtual Environment

The highly contagious novel coronavirus is responsible for the closure of all educational institutions. The norms and guidelines for this health emergency are responsible for the disturbance in a regular face-to-face classroom. These norms are inevitable to prevent the spread of this disease among other members of society. Like many other professional activities in the economy, the campus-based teaching and learning process has come to a halt. All the standard face-

to-face teaching strategies of education and science, in particular, are suspended indefinitely. This has suspended the dominant understanding of various main concepts in the minds of students. The concepts that require a demonstration of the skill/experiment are no longer accessible. All the laboratories and other experimental spaces of all the educational institutions are closed. This may lead to a more impoverished understanding of some essential concepts of science, and in a broader context, it may destroy the interest of students in the learning of science.

Nevertheless, the ICT or Information and Communication Technology advancements allow teachers and educators to connect with their students over the internet from their homes. Educational administrators are also trying to ensure that the learning should continue and should not come to a halt, no matter what the situation is. Many institutions and reputed schools have already been shifted to the virtual mode of transmission. They are creating an educational mission through a virtual environment. The remote learning strategies or distance learning strategies and television broadcasts are the most excellent examples of teaching and learning science in different ways. Teachers can teach, and students can study while staying at home and following the strict social distancing orders and stay-at-home.

"Online learning and virtual teaching are the recent development for popularizing science education; also, it has improved the spread of educational resources" (Hunter, 2015; Waldrop, 2013a, 2013b). According to Srivastava, et al. (2013), poor nations have a limited number of skilled teachers in science, and the number of students opting for science is much more than the resources available. Hence the use of distance and online learning is essential for these nations. Highly equipped educational schools and campuses are the need of the hour, but they are not accessible to all the interested students. It is the main reason why many students have to opt for non-science streams (despite having much interest in science). The Massive-Open-Online-Courses (MOOCs) is very popular in many countries across the world. However, the rates of completion of the courses are meagre.

Video lectures by experts and high-quality learning resources are, no doubt, beneficial for all students. Additionally, it may support the regular classroom learning of students in schools, colleges, and universities. The online streaming of the lectures is better because it may benefit most students, and students could ask their queries in the live classes. The use of platforms like Skype and Zoom for group discussion is better for enhancing the learning experience. The academic curriculum through a virtual environment is being followed even during this health emergency of COVID-19.

Popularising Virtual Labs

Digital learning is perhaps one of the biggest things for learning during this COVID-19 shutdown. One of the disadvantages of online classrooms and lectures is that they cannot provide adequate laboratory experiments, skills and expertise. The virtual lab—most popular thing for science learning in today's era can add this dimension. The virtual labs are a replica of real-life-laboratory in the virtual world. They are safer for students and newly appointed teachers. These provide some of the practical skills to students in

a virtual setting (Huang, 2004; Ray, et al., 2012, 2016; Ray and Srivastava, 2020). The main advantage of these labs is that it is helping learners in "obtaining the knowledge regarding real-life experiments in a risk-free environment devoid of any direct physical contact with any toxic chemical or pathogenic substances" (Jones, 2018) and significantly more helpful for underdeveloped countries having a low educational budget. Notably, different studies have shown that no significant difference exists in the students' learning outcomes of real laboratory and virtual laboratory (De Jong, et al., 2013; Ray, et al., 2016; Ray and Srivastava, 2020). Virtual labs provide learning spaces for students to enter the real laboratory with adequate skills because mistakes in the real laboratory are costly. The debate on completely replacing the real labs with virtual counterparts is on. However, the combination is always better than either of the choices.

The virtual labs facilitate the learning and teaching of science amid COVID-19. Virtual labs are better options for learning laboratory science experiments. The interested students are working in these virtual labs to gain some fruitful knowledge. This simulated experimental setup is, no doubt, a better option. The virtual labs are indeed a better option for learning some of the science experiments during this pandemic.

Experimental and Assignment Based Examinations

Returning to school campus again is still tricky for Indian students and teachers. The outbreak has not ended; in India, even the rate at which the virus is spreading is very high. It may result in a significant challenge in conducting the semester-end examinations for all schools and universities. They have to opt for another assessment strategy that can work in this COVID-19 pandemic, resulting in better assessment strategy development by educational administrators. It is more likely that the developed new assessment policy will undoubtedly be better than the term/semester end examinations because the term-end examinations cannot judge the understanding of the science skills and processes. Process validity is an essential criterion since it helps the student in learning to learn science (NCF, 2005). This pandemic is going to teach us better ways of assessing the outcomes of science learning. The virtual modes of assessment will also be strengthened and improved.

Conclusion

All Indian schools and colleges were closed to contain the spread of the novel coronavirus, which resulted in the total closure of face-to-face classes. To fill the deficit of knowledge, many schools started online classes with limited technological tools. This online culture leads to the discontinuation of hands-on experimentation and laboratory work, which is considered an integral part of science in schools. We investigated the effect of this pandemic on the teaching and learning of science at the secondary level in India.

In the online survey, we found that students with a high achievement level were comparatively more satisfied with online classes than their low scorer counterparts. In our talks with teachers, we found that Indian teachers are worried about science learning

by their students in the online mode because all hands-on experiments and laboratory works are entirely at a halt. Further, the teachers accepted their inability to use technological tools in teaching online. It is resulting in poor teaching quality of teaching and learning. Additionally, lack of access to technology and its tool to students is also a hurdle in attending classes online. In short, science learning is suffering in lockdown. This situation may increase the hatred for science among our learners.

Further, the researcher has elaborated on improving the quality of science teaching and learning during the lockdown. Online lectures by experts are one of the main recommendations. It will make learning lucid and exciting. It is time to shift to virtual labs and online laboratory for making science learning more effective. We have also suggested how new assignment and project-based examinations may increase love for science among all learners (even during shutdown).

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