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India's Virtual Computer Science Education: Opportunities and Challenges

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Abstract

Following the COVID-19 outbreak, universities around the world including those in India were compelled to switch to entirely online instruction. India poses particular issues due to its low infrastructure and internet connectivity, along with its socioeconomic background. In this essay, we address the issues surrounding education in India, with a focus on Computer Science (CS), and we address the difficulties faced by researchers, educators, administrators, and students. Our story concerns the online transition of computer science courses at a well-known engineering college in India, which has three campuses and over 15,000 students. We also talk about solutions to the problems the digital divide has brought about. This article's primary goal is to spark thought-provoking conversations that might eventually result in improvements in ICTs specifically targeted at computer science education in underdeveloped nations.

Keywords: Migration to online classes; Limited Internet Connectivity; Challenges; Opportunities; experiences; Virtual; Computer Science; Online Education; Digital Divide

Introduction

In India, there are over 1.6 million undergraduate engineering students, of whom approximately 3.8 million study computer science (CS)-related subjects (All India Survey on Higher Education, 2019). Many nations, notably India, imposed multi-week lockdowns in reaction to the COVID-19 epidemic that began in early 2020. In the midst of the semester, residential colleges and universities moved their students out of the dorms and sent them home. In a few days, the manner of instruction and learning moved online. For their next fall semesters, the majority of these institutes continue to offer totally online courses. A developing nation like India provides significant hurdles, especially in CS education, under this "new normal," which affects these millions of students, even though numerous colleges throughout the world are also operating online and dealing with comparable issues.

These difficulties stem from how wide the digital gap is in poor nations. The disparity in information and communication technologies'

(ICTs) availability and use is known as the "digital divide." According to Van Dijk (2017), the primary cause of the digital divide is limited access to technology. The availability of technology varies even within a single nation; developing nations do not have the same level of access to ICTs as wealthy nations. Cruz-Jesus et al. (2016) state that they observed a digital gap in Finland, a nation with highly developed digital infrastructure. Due to inadequate ICT access, Lembani et al. (2020) discovered that urban students' educational experiences differed greatly from those of their rural counterparts. More over two-thirds of urban students used ICTs for learning, but only roughly one-fifth of students from rural areas could do the same, according to research by Kumar and Kumara (2018). These issues—regularly interrupted electricity supplies and a dearth of high-speed internet—are severe in many parts of India. Rao (2005) points out that there are differences in infrastructure between Indian states; that there are differences between urban and rural areas within a state; that there is a digital divide between rich and poor people at the same education level; and that there are differences in education between geographic groups.

The general availability of ICTs has increased recently due to infrastructure measures. For example, according to the National Digital Communications Policy of 2018, there are currently over half a billion Internet users in India. However, the next level of the digital divide stems from the disparity in the digital skills needed to use the technology efficiently (Scheerder, van Deursen, and van Dijk, 2017). These are not always the talents of an undergraduate CSIS student. Furthermore, well-known social and cultural problems, such prejudice based on gender, persist in the digital sphere (Mihelj et al., 2019; Prinsen et al., 2007).

Our observations, which come from Birla Institute of Technology Mesra, are likely applicable to most Indian colleges as well as those in other developing nations. We saw numerous issues that impacted teaching and learning in a number of ways as the curriculum shifted to an online format, including presenting lectures, running labs, carrying out ongoing research, and evaluating student progress. Better evaluation tools, a wider use of ICT in education, conferences with larger attendance, etc., are some of the ways we think these conditions present chances to enhance the way we approach teaching and learning. In this study, we address these issues and provide some possible solutions.

Decisions Made by the Administration

With the safety and well-being of the campus community as their top priority, universities were forced to make some difficult decisions quickly after the lockdown was declared. Across all three of its campuses, BITS Pilani's Council of Student Affairs polled the student body. Questions regarding grading, teaching methods, and other aspects of student life received responses from over 9,000 students. In order to lessen the negative effects of incomplete coursework on graduates' grades and job placements, the institute chose to give them a

Pass/Fail grade rather than a letter grade that would have an influence on their grade point averages based on the survey results. About 75% of continuing students (first, second, and third years) disagreed with the use of online tests that would account for a sizable amount of their final grade when asked another question. They stated that when they return to the campuses, they would rather take their final exam on paper. For the most part, students chose this over an online exam due to concerns about lack of transparency, ease of cheating by other students leading to unfairness, and unreliable Internet availability.

Some colleges that held their final exams online received harsh criticism for placing students at a disadvantage against those who have access to computers at home or high-speed Internet. Ensuring student integrity presents another difficulty when administering online tests. Even for somewhat big classrooms, proctoring exams via screen sharing and webcam is not scalable, especially when there are network problems.

Online Courses

Presenting a live lecture through videoconferencing was difficult because some students had limited Internet speed. As a result, the online lecture became a one-way webinar, making it even harder for the lecturer to engage with the class and assess their understanding because they could not see the students. For communication in these situations, the teachers were forced to use the chat box, which presents its own problems for pupils who are not fluent in English. In order to assist students who might be unable to attend the scheduled lecture for a variety of reasons, lecture recordings were made available for download and viewing whenever it would be convenient for them. However, the experience of attending a live lecture and engaging with the teacher is still diminished by this. Furthermore, the availability of lecture recordings unintentionally resulted in a decline in student attendance and focus. Furthermore, auto captioning programmes do not perform well with several languages and accents, which is a significant issue for students with certain disabilities. Captioning lecture films is also not an easy task.

Virtual Evaluations

With the assistance of numerous teaching assistants (TAs), BIT Mesra's introductory programming course is attended by more than 900 students. At this magnitude, it is difficult to provide significant feedback via the Internet. According to Malmi et al. (2019), taking such massive courses won't allow you to build on pedagogical elements that call for face-to-face interaction. Although testing frameworks such as JUnit can be used for the summative evaluation in these types of courses, formative assessments in the areas of algorithm design, code quality, and programme correctness need to be evaluated using scalable, reasonably priced, and easily available tools.

Sessions in the Laboratory

Although most computer science lab courses can be offered remotely, they present their own set of difficulties, in contrast to

mechanical or chemical engineering labs that call for large apparatus or chemical reagents. In comparison to other computing disciplines, introductory programming courses demand higher level cognitive abilities (Oliver et al., 2004). Students also require as much assistance as possible from TAs and instructors. In laboratory sessions for these kinds of courses, several teaching assistants (TAs) assist students in solving the exercise problems that are set for that particular session. Many students lose motivation to keep learning programming when they are unable to attain the learning they would with the assistance of a teaching assistant.

However, without constant supervision from the TAs and without Internet access restrictions (which are usually enforced in the laboratories through IP whitelisting), some students may find themselves tempted to search for and copy code snippets from online resources. This kind of plagiarism is more difficult to identify (Lancaster et al., 2019) and will be more difficult to prevent in a virtual environment.

It is also more difficult to transfer lab sessions from a traditional classroom setting to an online one when specific computer science courses demand specialised infrastructure. For instance, the absence of a virtual lab infrastructure supporting high-performance computing led to the cancellation of a Parallel Computing course at BITS Pilani.

Analytical Studies

Numerous research initiatives came to an end as students departed the university. The majority of computer science projects that don't need specialised hardware have restarted, and researchers are using a combination of collaborative platforms including Overleaf (for group editing of LaTeX documents), GitHub (for code sharing and repository creation), and Slack (for group messaging). Still, computer science research projects that need specialised hardware—like GPUs with top specs for simulation or FPGAs, which are only available in university laboratories—are coming up with creative ways to involve students who aren't on campus. Using the desktop-sharing programme TeamViewer, one of our colleagues has remotely configured workstations on lab computers for every student researcher and linked the gear to those devices. The sophisticated gear is accessed by students who remotely log in from their homes. Of course, in addition to the previously mentioned issues with the digital divide, this workaround is obviously not scalable.

Conclusion

Universities all throughout the world switched to online learning in order to lessen the negative effects of lockdowns on instruction. Even while ICT has made it feasible to conduct research and instruction online over the past few decades, the digital divide creates a gap in the experiences of teachers and students who are less fortunate.

While governments in underdeveloped nations are responsible for addressing several variables (such as infrastructure development), there are chances to investigate within the constraints of current technology in the context of higher education. Modern platforms streamline virtual interactions and strive to replicate the in-person experience as closely as possible. In particular, scalable proctoring techniques that can manage fluctuating bandwidths and technological challenges should be the primary emphasis of platform builders. Teachers must come up with innovative strategies to hold students' attention during in-person lectures. In order to promote online learning and interaction with students for feedback, faculty members should support the utilisation of holistic discussions.

India and other nations where the English language is not widely spoken should provide teaching resources and methods that are not limited by language, particularly in online learning environments when body language and other nonverbal clues are absent. It is possible to create tools in CS that will aid in assessment, increase engagement, and facilitate greater conceptual learning. Zybooks and other interactive e-books are useful for teaching beginning computer courses (Allen et al., 2018), however these technologies are expensive for developing nations and mostly cater to rich nations. Furthermore, if the technology depends on a continuous Internet connection, it can experience the problems already mentioned.

In 2018, Hillier proposed the modular offline learning education assessment platform (MOLEAP), which leverages Moodle's learning management system features and adds office suite-like tools for offline use. It also combines these features with the ability to enable two-way communication and updates when the network is available. These hybrid solutions have the potential to partially close the digital divide and give kids from different backgrounds equal access to opportunities.

Finally, a paradigm shift in the education landscape has been compelled by the COVID-19 pandemic. The difficulties posed by this abrupt change to virtual education—which is unique to India and is made worse by the digital divide—were covered in this study. The education technology sector has a lot of chances to create resources that are appropriate for CSIS education in developing nations like India, thanks to many of these problems. A truly global solution that promises to mitigate the impacts of the digital divide should be proposed in response to this global issue.

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