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Challenges and Opportunities in Online Computer Science & Engineering Education: A Study in Velammal College of Engineering & Technology, Madurai

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Abstract: Owing to the entry of COVID-19, starting from the year 2000, India managed online education well for more than a year and a half. Now, the question is to understand whether the online mode of education is as effective as the face-to-face classes. This study intends to focus on identifying the challenges and finding the opportunities to enhance the quality of online engineering education with respect to Computer Science and Engineering (CSE) branch. A survey was conducted using a questionnaire involving the chosen 2nd year, 3rd year, and 4th year students of CSE department, Velammal College of Engineering & Technology, Madurai (VCET), who have had the experience of acquiring knowledge through both offline and online modes. The spreadsheet software was used to filter, organize as well as visualize quantitative data, and descriptive methodology was adopted for the data analysis. The result of the study will lay a scope to understand the existing gaps in online CSE education and the proposed ideas to fill the same enhancing the resources. Further, this study may play a pivotal role in making effective online CSE education at par with face-to-face classes completely possible and preferable.

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1. Introduction

With the emergence of Corona Virus (COVID-19) at the end of 2019 in China and its gradual encroachment into India in the year 2000, there were quite a lot of lifestyle changes worldwide. The sudden closure of educational institutions resulted in abrupt stoppage of flow of knowledge. To compensate this, the online education came into picture with a lot of challenges (Garcia-Morales et al., 2021; Pilav-Velic et al., 2021). The students were not mentally prepared and the faculty members were not completely trained (Jain & Sharma, 2022). In addition, the educationists were in a state of flux as to whether to invest in online resources or not (Asfour & Alkharoubi, 2023). In course of time, with COVID-19, not being completely controlled, the education was rendered to the students through online mode (Wong, 2023).

Velammal College of Engineering & Technology (VCET), Madurai, offers undergraduate programmes in the following streams namely Civil Engineering, Computer Science and Engineering, Electrical and Electronics Engineering, Electronics and Communication Engineering, Information Technology and Mechanical Engineering; also, it offers post graduate programmes in the above-mentioned disciplines except the Civil Engineering. VCET became the forerunner to start the online

classes using Google Meet efficiently. With a simple demonstrative session by the IT personnel and with limited resources and intermittent network connection, the members of VCET started to manage the flow of knowledge using the smart devices. Thus, VCET assured business continuity, flow of communication, and undisrupted knowledge transfer. The paper intends to analyze the challenges and drawbacks faced by the students with respect to online computer science and engineering education so that strategies could be devised towards addressing the identified problems to enhance the teaching learning process.

2. Literature Review

With the intervention of Corona Virus (COVID-19) in the end of 2019 in Wuhan, China (Sansa, 2020), the scare of being infected by the same has started getting into the nerves of each of the countries across the world. The World Health Organization proclaimed COVID-19 to be a Public Health Emergency of International Concern on 30 January 2020 (Wee et al., 2020). Gradually the widespread of COVID-19 in various countries was witnessed. India is not an exception to this, as in course of time, it witnessed the entry of COVID-19 in Kerala on 30 January 2020 (Jayesh & Sreedharan, 2020). As a course of action, travel ban, the immediate closure of educational institutions, recreation centres, malls, etc., came into picture followed by a series of lock down which disturbed the normal routine of the people. Initiatives were taken by the government to educate people about the spread of the pandemic through print and audio as well as video messages (Shaanxi Normal University, 2020). This pandemic situation affected every aspect of life including education.

As urged by (Hodges et al., 2020) and endorsed by (COL, 2020; OECD, 2020), Emergency Remote Teaching (ERT) is a quick alternate arrangement to manage the pandemic situation (Bozkurt & Sharma, 2020) to ensure the consistent flow of education by redefining the teaching methods which (Millman, 2020) calls as "pandemic pedagogy." As a measure to cope with the pandemic situation, distance learning was adopted by the educational institutions (Wu, 2020; CDC, 2020) so that social distancing could be guaranteed. Though it was initially a challenging task to manage education during the lock down situation (Wang, 2020), things started falling in place gradually. In course of time, the world witnessed many educational institutes adopting online education and continuously putting efforts to assure better learning environment (Murphy, 2020). The burning issue during the pandemic with respect to online classes was the drive amidst the faculty and students to adopt it as an alternative. Teachers with 'work from home' (Hubbard, 2020) option found it hard to handle the task (Luo et al., 2020).

Meanwhile, the limitations and the challenges that were brought by COVID-19 on educationists with respect to education occupied the majority of the literature (Huber & Helm, 2020; Judd et al., 2020; NFER, 2020) out of which some came up with meticulous action plans to handle remote teaching commendably (Ferdig et al., 2020) and the rest appreciated the transformation of mindset of the stakeholders in this regard (Moorhouse, 2020; Zhang et al., 2020). UNESCO Director-General Audrey Azoulay observes this globe-wide educational disruption as an education crisis (Education International, 2020) and (UNESCO, 2020) acknowledges that the online education is the only way to cater to the knowledge transfer. Online education promises and provides study materials anytime, anywhere which contributes to learning at their own pace and convenience (Gewin, 2020). Due to this and advancement of digitalization, noted universities like Tsinghua, Peking, Harvard, MIT, Yale, Oxford and Cambridge had already brought online education in place in the last decade (Bao, 2020) itself.

Online platforms like MS Teams facilitates the effective transfer of AV materials instantly (Barteit et al., 2020) and this helps in commanding students' enthusiasm and contribution resulting in meaningful learning (König, 2020). Broadcasting of audio files, telecasting of video lectures, relay of MOOCs (courses), and NPTEL courses also facilitate distant learning (University of British Columbia, 2020). Blended learning which is a combination of online and offline classes facilitate connectivity through Google form, Learning Management System like Moodle, Blackboard, Canvas etc., for assigning tasks and evaluating the performance of the students. Active learning helps students in knowledge acquisition much faster than any other way. The interaction between faculty and students are supported by LMS as instant messaging could be tiring.

With the emergence of online assignment submission and online tests, the genuineness of the person submitting the assessment and the originality

of the submission are questionable (Borge & Mercier, 2019). Monitoring of students during assessments is still a challenge as there has been hesitation and reluctance sensed amidst the students especially girls (Sanderson, 2020). In addition, the study by (Flores et al., 2020) pinpoints that despite spending more time in making online teaching effective, there was hardly any creditable student participation or engagement. The need for the inculcation of artificial intelligence (Lim, 2020) to impart education in online mode more effectively has become the need of the hour (World Bank, 2020). Online education (McKimm et al., 2020; Goh & Sanders, 2020) has become indispensable and so in the post pandemic era, one should be prepared for a mix of online and offline classes for the same syllabus (Zhu, 2020). Hence, it calls for an attention to update advancements in the digital literacy and the education tools to bring in an effective teaching learning process (Jandrić, 2020). This aspect forms the crux of the study that was conducted on CSE students of Velammal College of Engineering & Technology (VCET), Madurai.

3. Methodology

Keeping in mind to identify the opportunities and challenges with respect to information acquisition pertaining to Computer Science and Engineering branch of study, a questionnaire consisting of 20 MCQs was made (Littlefield, 2018). It was based on multiple choice questions with varied number of options depending on the context. Convenient sampling method was adopted. The students of CSE branch who had the experience of online education were chosen to be the samples for the study. Formal permission was acquired from the head of the institution as well as the CSE department to conduct the survey. The purpose of the study and the questions were explained to the students. The students were given the choice to agree or disagree to be the part of the survey. In addition, to assure confidentiality, the identities of the students are not revealed to anyone. The survey was conducted employing a Google Form shared through their respective class WhatsApp groups. 100 students filled up the questionnaire, however, only 81 responses were considered for the study. The other 19 were incomplete and distorted. The result of Cronbach Alpha reliability test considering all the items present in the questionnaire was 0.834 which is highly significant in terms of reliability. After confirming the validity, the MS Excel Spreadsheet software tool was used to filter, organize as well as visualize quantitative data, and descriptive methodology was adopted for the data analysis.

4. Data Analysis

Out of 81 total respondents of 2nd, 3rd, and 4th year students of CSE branch, 48 were female students and 33 were male students; 25.9% from 2nd year, 58% from 3rd year, and 16.1% from 4th year of study. 96.3% of the respondents claimed to have the experience of both online and face-to-face learning experiences with respect to online CSE education; 93.8% asserted to have got the basic digital literacy to access online classes before taking them up. It can be interpreted that online education was not a new phenomenon before the pandemic period very specifically in Madurai region. The youngsters of today have got exposed to the basic digitals skills as they are more familiar with social media applications, webinars, Skype calls etc. which is acknowledged by (Suharto & Ambarwangi, 2021) as well. This has enriched their digital experience and so adopting to online education and tools became an easy task.

When asked about the items they enjoyed in online classes, 45.7% mentioned that online classes facilitate them to study at their own pace; 30.9% felt relieved that there wasn't any need for commuting to college; 11.1% felt listening to recorded lectures recurrently made them learn better; 6% felt good about the lack of need to dress up and be appealing whereas 5% enjoyed online assessments, and 1.3% considered flexible submission of assignments to be enjoyable. It is very significant to note that most students like to study at their own pace without any peer pressure or the regulations imposed by the instructors which is in line with the findings of (Gewin, 2020). However, whether the students opting for this will be able to learn time management remains a question that needs further probing.

When enquired about the methods that engaged them personally to learn digitally, 33.3% mentioned small group work, 29.6% voted for project-based learning, 27.2% opted for individual assignment, and 9.9% liked the large group tasks. This clearly suggests that small group tasks are considered more effective with the complementary skills helping each other. The small group also facilitates easy and effective coordination which may not be possible effectively in large group coordination and communication. Task based learning is almost equally preferred because division of the work, following up of the same, and consolidating of the results happen instantly and aptly

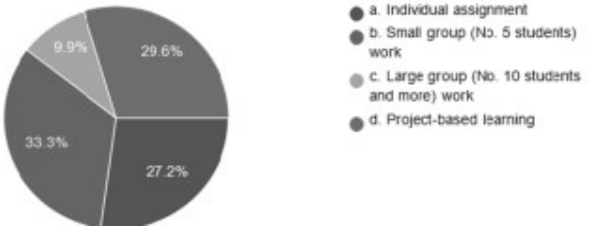

Fig.1: The methods engage personally to learn digitally

(Lambert et al., 2023). When a specific task is assigned, 56.8% preferred working in a small group, 33.3% opted for working in pairs and 9.9% wanted to work individually.

When questioned about the digital approaches that motivated them to learn, 32.1% mentioned that animations really make them stay tuned and this is confirmed by (Maisaroh & Endahati, 2022; Mansor et al., 2020; Schneider et al., 2023), 28.4% mentioned that PPT presentations are good to learn from, 14.8% were enthusiastic about online exercises, 9.9% liked all kinds of audio-visual materials, 8.6% were thrilled about using digital pen and slate whereas 6.2% preferred the white board and pen. It is worthy to note that the art of writing is losing its momentum be it using digital pen and slate or white board and pen. The students of today are ready to type out and feel reluctant to write. This may be due to their mobile addiction where they communicate via social media in the form of texting, voice messaging, and voice or video calling. Added to this, with their mobile phones, they are quite used to prediction of words or text as well.

When asked about their experience with online learning from home digitally, 67.9% mentioned that they are comfortable learning at their own pace at home whereas 21% mentioned that they get distracted with various activities like people chatting, watching tv, visitors, external noise etc. 8.6% mentioned the difficulties they faced with respect to inconsistent flow of Internet and how they had to suffer carrying the device from a place to another place looking for strong signal strength of the network, and 2.5% complained that the home situation is only challenging and it is not at all favorable for learning. This calls for an attention of providing equally a conducive atmosphere at home also to facilitate effective learning as reflected by (Barai, 2020; Keser Aschenberger, 2023).

When commenting about the type of video lectures that made their learning effective, 61.7% mentioned that the video lectures delivered by their faculty to be more effective following the video lectures delivered by unknown experts, video lectures delivered by reputed overseas universities, and lastly NPTEL video lectures which is contrary to the findings of (University of British Columbia, 2020). This calls for an attention with respect to analyzing the effectiveness of NPTEL lectures as these are considered to be one of the major development programmes to upskill oneself. We need to understand the reasons behind the least preference of NPTEL lectures and motivate students to overcome those and to actively learn from those. Students' preference for the video lectures delivered by their faculty encapsulates that they are designed in accordance with the students' frame of reference and meant for getting better grades in their exams.

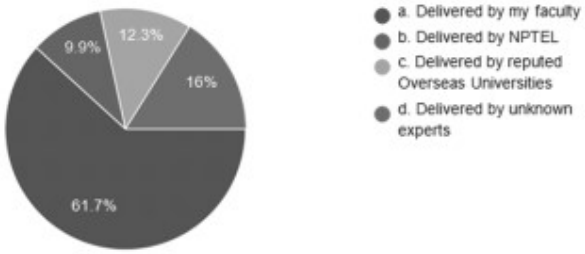

Fig.2: Video lecture effective for learning

When given a choice about the most preferred method for clearing doubts, 45.7% wanted to ask the instructor and clarify their doubts directly whereas 32.1% preferred to go through the online material providing additional explanation, and 22.2% preferred to post the query in the discussion forum to get inputs from the instructor as well as peers. Despite various means, asking the instructors directly and clarifying the doubts stands the most popular and preferred as the instructor can provide explanation keeping in mind the level of understanding of the student/students. Secondly, the instructor may give relevant examples and additional information with respect to the issue which may not be possible when you look for information online. Hence, when they post a query and when the peers respond, there is still a

Fig. 3: Methods for clearing doubts in online learning

lack of confirmation till the instructor intervenes. This acknowledges the indispensable role of instructor support be it online or offline which is in line with the study by (Mohd Basar et al., 2021; Nagi & Bojiah, 2020).

When clarified about the sense of being comfortable using a cell phone or computer camera to show their face only for the purpose of identification during demos, presentations, or exams, 69.2% agreed without any hesitation and mentioned that there wasn't any problem about it which is contrary to the findings of (Sanderson, 2020). However, 18.5% felt awkward and found it to be objectionable whereas 12.3% remained in a state of confusion as to what to say. Most students agreeing for the motion is a good sign of understanding the importance of academic integrity as we do not have an option to confirm who is carrying out the assessment. If the instructor does not check, he or she may end up assessing someone else instead of the specified student.

When examined about the challenges they faced when taking classes in a fully online environment, 42% mentioned that inconsistent flow of Internet is the major challenge. The students suffer attendance issues owing to this and at times they may have to shuttle in and out of the online class due to intermittent network which will affect the smooth transfer of knowledge. This may hamper the building up of rapport with the instructor and the peers as well. Following this, 34.6% mentioned that they have sensed a lack of concentration during online classes, 12.3% complained about the unavailability of smart devices that makes online classes more effective and lastly, 11.1% did not have enough private space to do their online classes peacefully. This again stresses the importance of having a peaceful and conducive atmosphere to facilitate learning at home.

When commenting on the online class platforms like Zoom or Google Meet, 39.5% mentioned that they felt socially disconnected with their peers as they did not have the opportunity to share and care for each other in person which reflects the results of the study conducted by (Hehir, 2021). They missed the real time discussion and clarification that contribute towards learning. 38.3% mentioned that they could not focus and follow lectures, 12.3% felt online classes to be ineffective, and 9.9% felt no inclination to acquire knowledge from online classes. Being socially disconnected with peers and instructor drastically affect the mental make-up of the students. This could be the major reason for finding online classes to be ineffective and lacking in commanding student engagement and participation.

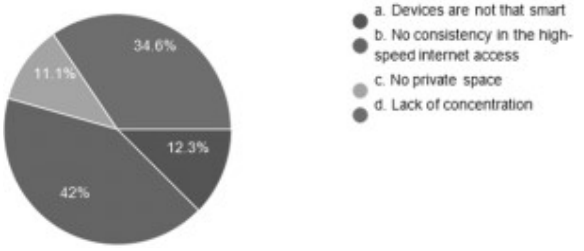

Fig. 4: Challenges of online environment

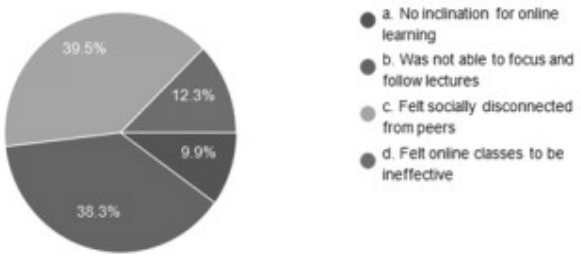

Fig. 5: Challenges in Zoom/Google Meet classes

In terms of instructional mode and materials, 45.7% felt that there was a much-pronounced lack of communication, 19.8% had issues using software, 18.5% faced issues pertaining to accessing and submitting assessments, 8.6% could not access course materials with ease, and 7.4% could not understand the instructions completely. This may be due to the unpreparedness from both the faculty and the students' side. Online education was adopted as a matter of emergency service (COL 2020; Hodges et al., 2020; OECD 2020) and so neither faculty nor students had ample formal training to equip themselves for this mode of education. The faculty members tended to use the same instructional materials and assessments for the course (Dayal, 2023) which is a matter of serious concern as to how they will fit in when there is a change in the mode of delivery.

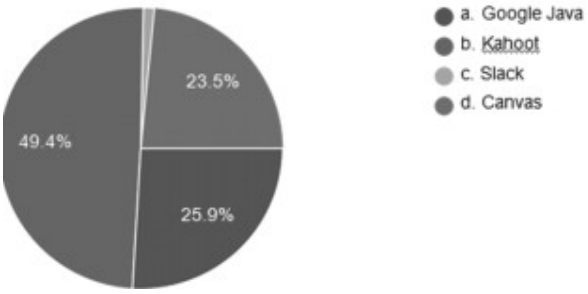

Fig. 6 : Tools for assignment submission

With respect to online mode of instruction, the overall experience was rated to be 43.2% of satisfied level and 18% of very satisfied level. This clearly indicates that the students are ready for online education as the dissatisfied level and very dissatisfied level stand at 3.5% and 2%. However, 33.3% stands neutral as to what to decide calls for a redressal of equipping the faculty and students to be trained enough to involve in online classes and developing of the course content and instructional materials that suit the purpose of education in online mode. Nevertheless, 46.9% stated that the online mode is good for semi-theoretical courses, 42% recommended online mode for theoretical courses, and 11.1% insisted that it fits in for lab courses as well. More than 10% suggesting that online mode is good for lab courses is a good sign because with no big technical support, lab courses were conducted online to keep up with the knowledge transfer flow during pandemic. This recommendation from students suggests that with proper training and resources, effective teaching of lab courses through online is possible.

When asked about their suggestions to make lab courses effective through online mode, 33.3% voted for 3D enhanced practical sessions, 16.1% suggested to enhance IT infrastructure, 14.8% recommended a Learning Management System (LMS) to be in place, 13.6% voted for hybrid or blended mode of learning, 11.1% recommended digitalizing scientific materials, and safeguarding educational platforms. It is very clear to comprehend that the IT infrastructure should be enhanced to accommodate LMS to impart 3D sessions using digitalized instructional materials and education tools to make the user experience a fruitful one.

For the submission of assignment, 49.4% preferred Kahoot!, 25.9% preferred Google Java, 23.5% preferred Canvas, and 1.2% preferred Slack. Kahoot! is a social learning platform, with users of the game gathered around a common screen such as an interactive whiteboard, projector or a computer monitor. The site can also be used through screen-sharing tools, like Zoom or Google Classroom. Students find it easy to comprehend through Kahoot! be it a short answer or writing the answer in detail. Hence, the students prefer to use this platform for assignment submission. As Kahoot! is user-friendly, game-based, and simple process of accessing, it is proved to have more liking from the students (Altawalbeh & Irwanto, 2023; Sinnivasagam & Hua, 202

Second preference is given to Google Java as it ensures that every assignment or work given to the students is done in the right way (Baharum et al., 2020; Skalka et al., 2020). Students get automatic evaluation after submitting their assignment and it makes sure that the student gets marks after satisfying all the requirements of the project assigned. For this reason, Google Java may be considered easy to handle from the instructors' points of view whereas it is said to be hard to handle as evident from the students' responses. These are not so familiar to students owing to its complexities and the lack of training. The studies by (Marachi & Quill, 2020; Ragupathi & Pinto, 2022) explain the varied features of Canvas and their effectiveness in enhancing the learning experience in detail. Though Canvas is also preferred as equal as Google Java, it does not seem to be very popular amidst the samples; Slack is the least preferred and it is quite possible that the tool is unexplored. Hence, it is important to train the people involved and use a variety of tools for the enrichment of learning experience.

When they are asked to suggest innovative teaching methodologies for online mode of teaching, 61.7% suggested game-based learning, 19.8% wanted pre-recorded video lectures, 11.1% recommended mind map, and 7.4% wanted class blog. Though, game-based learning cannot be suitable for all the courses, it seems to command more student engagement. Pre-recorded lectures have its own flavour of favouring students with the recurrent use for more clarity as these are demonstrative in nature. The preference for mind map and class blog are least rated as these may command some participation at the students' end. This clearly suggests that the students want something readymade and easy to access to manage their study.

51.9% suggested that the complete online engineering education was not effective whereas 48.1% felt that it is effective. Amongst this, a greater number of boys and a smaller number of girls have found online education to be very effective. 54.3% disagreed to enroll for an online postgraduate course but 45.7% agreed to get admitted. Amongst this, a greater number of boys and a smaller number of girls agreed to take up their post graduate degree programme completely online.

5. Conclusion

It is concluded that there are many niceties abiding

online learning. Studying at our own pace of time and convenience, exploring novel education tools for online mode of education, engaging in small group works for performing tasks, watching animations, listening to recorded lectures by the faculty, clarifying doubts instantly through the learning platform, game-based learning, and online submissions through Kahoot! to name a few. However, the overall responses suggest that a completely online CSE education will not be effective and majority disagreeing to enroll into a completely online post graduate course highlights the need to address the gap. The suggestions to include 3D sessions with digitally modified instructional materials, arrange for proper training of the faculty members and students, incorporate more game-based assessments, employ varied education tools, invest in high-speed Internet connectivity, and other IT infrastructure are to be taken seriously to embark onto this journey.

6. Recommendations

- Hand written assessments are losing its charm owing to the emerging technologies. Hence, this study intends to recommend typing of the answers from the beginning of the college level education. These days there is no concern for any hand written manuscript and in the college level education, checking the knowledge of spelling is also not the priority. Moreover, the similarity index will significantly find out and report the originality of the submission. It is recommended to have the plagiarism software to be embedded in the LMS platforms that is provided for task submission. The students also can check and verify at their ends which will help them work further and submit again.

- For online education to be more effective, counselling sessions should be arranged for family members of the wards stressing the importance of maintaining a quiet private space which is conducive for online learning.

- It is recommended to identify the challenges pertaining to NPTEL courses so that these could be improved to make the students attend them willingly.

- It is recommended to recognize the changing role of the faculty from instructor to facilitator so as to train him or her in the light of digital literacy to equip them to make the teaching learning process more striking.

- It is recommended to find out ways and means to monitor students during examinations using recognition of facial expressions, movement of eye balls, gestures, and postures.

- It is recommended to develop smart devices meant ideally for educational purposes so that there are no distractions to the learners in any manner.

- Online education comes with a lot of issues pertaining to the social disconnection. It is recommended for the instructors to incorporate a lot of interactive tools with respect to group work to let the students collaborate and learn better.

- It is recommended to have a mix of online and offline modes of education when imparting engineering courses as this will help in social interaction and hands-on learning. For these reasons, students enjoy blended or hybrid models to realize the ease of learning at their own convenient pace as well as learning practically interacting with peers and instructors.

- The LMS platforms like Kahoot! needs intense promotion amidst students. More LMS platforms should be introduced to the students for the ease and engagement of the students with the content and the instructional materials.

- Game-based learning proves to be commanding more attention and interest. It is time to explore the concept of the Metaverse which is undeniably becoming a part of every technology that makes our lives easier. It is recommended to bring in 3D technology, establish virtual learning environment embedding artificial intelligence, augmented reality, mixed reality etc., to make the learning experience vivid and participatory. However, it is also suggested that one should know that the self in the real world and the self in the virtual world are two different identities. Nevertheless, the self in the virtual world could be an alter ego of the real identity. It becomes compulsory for the instructors to clarify all these to the students before they expose the students to this kind of environment to avoid the student's tendency to suffer identity crisis.

7. Future Research

The correlation between studying at their own pace and time management should be analyzed. In addition to the effectiveness of online delivery and digital

instructional materials, the need for a peaceful ambience at home is still stressed by a considerable number of students. Further probing in this regard should be carried out in the Indian context in general and Madurai context to be specific. Game-based learning seems to be promising in commanding student engagement however, whether it contributes towards academic performance remains a query. The effectiveness of 3D materials, education tools, formal training on online education, peer learning, and online lab courses still need in-depth analysis with respect to Madurai context.

8. Limitations

The study is based on the responses from the sample size of 81 from an institute. Hence, the findings cannot be generalized. Further, the study was conducted only on the students of CSE major which further restricts itself to idealize the findings with respect to CSE education as a whole.

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