Education Research International

Competencies for Complex Reasoning in the Framework of Education 4.0 and Open Science

Lead Guest Editor: Maria Soledad Ramirez-Montoya
Guest Editors: Francisco J. García-Peñalvo and Glenda Cox

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Research Article

Transforming Learning to Online Education 4.0 during COVID-19: Stakeholder Perception, Attitude, and Experiences in Higher Education Institutions at a Tier-III City in India

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Higher education institutions worldwide had to quickly pivot to delivering online classes as the COVID-19 pandemic set in. This disruption brought into focus institutional preparedness to ensure academic continuity, faculty proficiency in the use of ICT, and student readiness to adapt to an online-only model suggested in Education 4.0 framework. The Education 4.0 framework emphases to use advance technology and tools to transform education system. It was initially envisaged that the online-only model of education will at best be a stop-gap arrangement. However, as the pandemic continues unabated across India, the education community needs actionable data to fine-tune its online delivery model, to ensure its effectiveness, and retain its value perception in the eyes of the stakeholders. This is a critical aspect as evidence suggests that the initial high level of online engagement is petering out due to overexposure, mental saturation, and fatigue among both the students and faculty members. This research paper examines the perceptions, attitudes, and experiences of stakeholders involved in online education from Jammu, a Tier-III city in India. The study asserts that real "value creation" in an online mode can happen when all the stakeholders are equally motivated and working together. Institutions need to prioritize value delivery, support faculty members, provide the needed resources, and set clear expectations.

1. Introduction

On the January 30, 2020, the World Health Organization declared the coronavirus outbreak as a global public health emergency. Due to the pandemic educational institutions all over the world, including India were shut down. As per date released by the UNESCO, over 800 million students are facing disruptions in their education ranging from full school closures to part-time academic schedules [1]. The pandemic, therefore, significantly disrupted the system of education, which was largely built around a face-to-face model of instruction and peer interaction in a classroom setting.

This necessitated exigent use of technology by institutions and educators worldwide to ensure the continuity of the teaching–learning process at all levels. Institutions which were early adopters of technology and led by proactive leadership teams made a smooth transition to an online-only mode of educational delivery, while other institutions struggled with choosing the right platform and training their faculty in its effective use. However, to the credit of all institutions, new competencies and capabilities were developed in record time and online classes, though not perfect, were delivered in some form or the other. This widespread adoption of technology in education has led to an unprecedented shift from a teacher-centric model toward a student-centric model, where the teacher's role has become more of a facilitator [2].

The higher education sector has witnessed an unprecedented adoption of learning management systems, video-conferencing platforms, and access to repositories of digital content. In many ways, learning has been democratized with the students exploring new material and online resources on their own. Education 4.0 is a desired learning strategy that coincides with the emergence of the fourth industrial

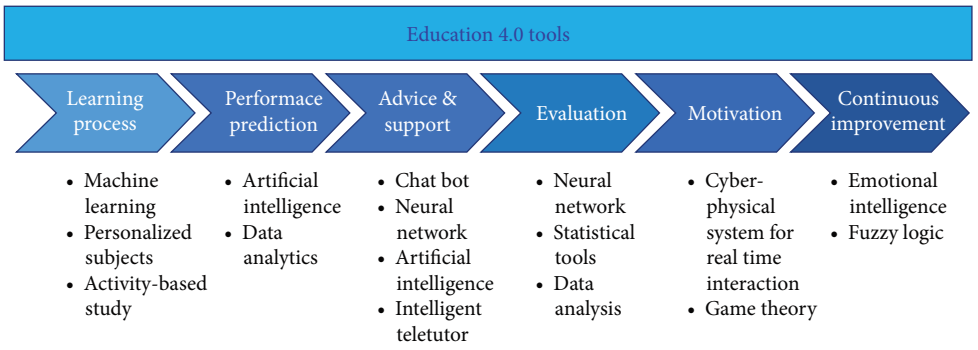

Figure 1: Education 4.0 tools for skill enhancement.

revolution. Smart tools/technology, artificial intelligence, ICTs, and robotics are all part of this industrial revolution, and they all have an impact on our education system as shown in Figure 1. Faculty members too have become technology savvy and are better placed to leverage digital content than before. Thus, some significant positives have come out of a challenging situation.

It is now clear that the situation remains far from normal, with the second wave of COVID at its peak and a third wave widely anticipated, and the online education model shall persist for the foreseeable future. Many parents are reluctant to send their wards to schools or colleges till a large percentage of the population has been vaccinated, which could be till the middle of 2022. It is therefore imperative to research all aspects of the online-only model of education and examine stakeholder perspectives to ensure value-creation for the students based on meaningful engagement. Such studies would need to be conducted in diverse environments so that locally customized models can be formulated to meet and exceed stakeholder expectations.

This paper presents a study of stakeholder perceptions, attitudes, and experiences with the online education model. Key learnings, best practices, and some strategies to strengthen the value articulation in an online-only delivery model are presented which can be replicated in similar settings.

2. Review of Literature

As all education moved online at the onset of the pandemic, proponents of online education were quick to predict the end of the traditional education model owing to this massive disruption. On the other hand, large universities felt that online delivery was a temporary phase and that students would always pay a premium for an in-person, on-campus learning experience. The truth might lie somewhere in the middle and a blended model might take shape in future. Nonetheless, it is safe to conclude that institutions will be inclined to use the online delivery model honed during the pandemic to continue to deliver additional value to students even when physical classes resume. Institutions which dismissed online education as a fad or considered it as a stop-gap arrangement are racing against time to equip their organizations to deliver value. Beyond the obvious research into the merits and demerits of online delivery, it is important to look at stakeholder experiences and perspectives in a completely online delivery model during the pandemic, a time of great uncertainty and anxiety. Insights gained from such studies across diverse environments shall help institutions cater more effectively to the needs of the faculty and students. The characteristic of Education 4.0 is shown in Figure 2. It states that it focuses on individual goal through upgrading the skill of the students taking into student interests. With the education sector not likely to open in India anytime soon, institutions would need actionable insights on enhancing their value perception in a purely online engagement model.

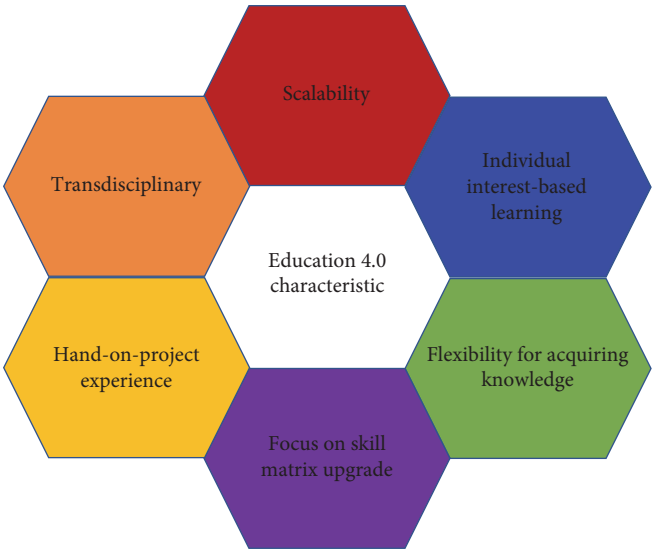

Figure 2: Characteristics of Education 4.0.

Several studies have been conducted during the pandemic time to analyze the impact of online education and captured the insights of various stakeholders. A study by Chen et al. [3] has tried to study the satisfaction level of the Chinese students toward the online education platforms. It was concluded in the study that personal factors of the user have no direct influence on user satisfaction, while the availability of the platform seems to have the greatest influence on satisfaction of the user. The study also highlighted some of the key challenges faced during the conduct of online classes

like internet congestion, lag in the video during live interactions, etc.

Some research studies in the developed countries which examined positive student experiences with pure online delivery concluded that institutions which proactively adopted technology and invested in technology platforms, content, and virtual labs, etc. fared a lot better than other institutions [4, 5]. A study by Long et al. [6] provides important insights on how the pandemic provided opportunity for course instructors to improve their online teaching style, develop new content and engagement strategies and adapt to a completely online teaching environment. There was actually a need for value delivery and innovative ways of engaging and motivating the students had to be taken up [7]. Amid the various challenges, the pandemic situation has also opened up various opportunities for the education sector and there is definitely a need to rethink the strategies outside the four walls of the classrooms [3].

A study by Olszewska [8] has tried to express the opinions of Polish university students on the effectiveness of online learning during the COVID pandemic and forced distance learning. It was found that students prefer the traditional mode of classroom teaching and perform better in the class environment. The students although appreciate the online learning benefits but there is lack preparedness and willingness to switch to purely online learning. Similarly, in another study by Blizak et al. [9], the researchers investigated the perceptions of the Algerian students when they had to make an abrupt transition to the online mode of teaching–learning due to the pandemic. The results of the study have indicated that students have a negative perception of the online learning with resistance to online teaching citing low satisfaction.

Several studies have examined the stakeholder experiences in the Indian context during the pandemic. They have brought out the key challenges faced by the stakeholders, including the faculty, students, parents, as well as institutional leaders. Dhawan [10] highlighted the challenges associated with online learning in India, primary being that faculty was ill-equipped to be effective online educators. This major gap has led to the growth of Ed-Tech Companies providing quality content, packaged in small snippets, and continuous assessment to check comprehension. Muthuprasad et al. [11] studied the perceptions of the students toward the online learning during the pandemic. The results indicate that students mostly make use of the mobile phones to attend the online classes which inhibits their level of comprehension due to low attention levels. Students were also very reluctant to switch on their cameras during online classes. Mishra et al. [12] have studied user preferences toward tools and platforms for delivering/consuming online education. Zoom, Cisco Webex, and Google meet were the most widely used online platforms in India during the pandemic. For smooth facilitation of the online teaching–learning massive use of social media apps like WhatsApp group was extensively used. The findings of the study indicate that proficiency in computer literacy, domain knowledge, self-motivation, empathy with the students, and access to digital material and resources were some of the winning strategies during these difficult times from the teachers' perceptions. Arora and Srinivasan [13] in their study have indicated that for students the experience has been of mixed nature. They believed that the online learning experience provided them an exposure outside the classroom but many of them showed a lack of interest in the online classes, faced distractions, and expected major concessions, including mass promotions to next classes/semesters as a matter of right. In India, the pandemic also threw up existential concerns for nonproactive institutions, especially in smaller towns and cities leading to further consolidation in the sector. By and large the pandemic has not been kind to the student community resulting in significant academic loss and a perception of low value creation via a purely online mode of education.

Thus, researchers have focused on several aspects of online education during the pandemic from issues, perceptions, and challenges from the perspective of students and teachers to interventions or lack thereof by educational institutions. The experiences of a purely online teaching–learning environment have varied significantly from developed countries to developing countries showing that the context and environment of each study are relevant and significant [14]. Socioeconomic and cultural factors have also impacted the perceived effectiveness of online teaching during the pandemic. While studies in developed countries have focussed on online teaching pedagogy improvements, student engagement, and experiences, the developing countries had to contend with access, training, motivation, and adoption issues. In India too the focus of research studies has been on the challenges and opportunities while strategies, best-practices which worked have not been researched and articulated for the benefit of the teaching community and institutional leaders. Such insights shall be crucial to deliver significant value to the millions of learners across India if the pandemic persists in the near future.

2.1. Purpose of the Study. The purpose of the study was to investigate the attitudes and perceptions of the primary stakeholders, i.e., faculty members and students in the higher education institutions at a Tier-III city in India. The study intended to consolidate key learnings, faculty experiences with technology and content, student attitudes, perceptions, and expectations during this time. The viewpoint of the institutional leaders was also examined to articulate strategies for institutions and educators in building deeper engagement with students to build a favorable stakeholder perception.

2.2. Research Design. The study was designed as a qualitative study based on interviewing different stakeholders across 10 higher education institutions in the region. The primary questions addressed by the study are:

(1) What are the attitudes and perceptions of faculty and students toward the online education model in the higher education sector in Jammu city?

Table 1: Sample interview questions.

Students	Faculty	Leadership team
Were you satisfied with the quality of the online classes and content delivery by your teachers?	How would you rate your ICT readiness at the start of the pandemic and comfort level in delivering online classes?	How did you monitor the effectiveness of the online classes?
Would you prefer online classes over face-to-face learning?	Were you provided any training by your institution in delivering online classes or in the use of online platforms?	Do you think there was a need for formal training and certification for conducting the online classes?
How were labs conducted by your institution? Were you satisfied with the quality and experience of attending these lab sessions, if at all?	How would you rate the student engagement levels during online classes?	Do you think that the google form assessment was an effective way of assessment?
What challenges did you face while attending online classes?	What challenges did you face in delivering online classes?	During these challenging times did you provide some kind of flexibility in policies?
Did you experience any stress during the lockdown with regard to your studies?	Did you receive adequate institutional support during the pandemic? Could the institution have taken additional measures to support you better?	What do you think was an effective media for communication between the faculty and the students?
Were you satisfied with the online evaluation and assessment process adopted by your institution?	How would you compare the workload while delivering online classes working from home to the normal workload at your institution?	If you had advance knowledge of the pandemic, what additional measures would you have taken to improve student and faculty experiences?
If you had to attend online classes for the next 1-year, what suggestions would you give to improve the overall experience and value for you?	Did you experience stress during the pandemic? Did you feel that the students were stressed too?	Have you enhanced your IT/ICT budget post the pandemic?

(2) What strategies work at the level of the institution and the individual educator in creating a favorable stakeholder perception?

3. Data and Methods

3.1. Data Collection. The data for the study was collected through semistructured personal interviews [15] conducted with the students and faculty members, and institutional leaders. The interviews of all the respondents mentioned above were conducted virtually and audio-recorded. The number of participants in the study included 100 students, 40 faculty members, and 10 institutional leaders. The age range of the students varied between 18 and 25 years and the average age was 20 years. The age range of the faculty members varied from 26 to 65 years, the average being 34 years. The study was carried out after 6 months had elapsed since the lockdown in March 2020. The faculty members belonged to seven different institutions who were teaching undergraduate and postgraduate courses in engineering, teacher education, management, commerce, and psychology.

Initially, informal conversational interviews were conducted with the participants, and then the standardized open-ended interview was conducted with respondents who were inclined to provide detailed insights into their experiences. Some of the questions asked to the faculty, students, and leadership teams are mentioned in Table 1.

Standard templates for determining the effectiveness of online teaching–learning were not used due to context mismatch. Here, the entire delivery had shifted from offline to online mode and for a majority of the students and faculty this was their first experience with online learning. The questions were directed yet open-ended by design to elicit diverse responses from participants. These were face-validated by subject experts from a teacher education and online education background. Sample interviews were conducted and the interview questions refined over two iterations.

3.2. Data Analysis

3.2.1. Sentiment Analysis. The analysis of the transcript text files was carried out using automated sentiment analysis [16] to figure out the overall attitude perception of the students, faculty, and the leadership team. The analysis cross-referenced the words in each of the transcripts with an opinion lexicon of both positive and negative words [17]. Using this method, we calculated the sentiment score for each sentence in the interview transcript using the following formula:

$$\text{Score} = \text{number of positive words} - \text{number of negative words}$$

If Score > 0, the sentence is considered to have an overall "positive" opinion

If Score < 0, the sentence is considered to have an overall "negative" opinion

If Score $= 0$, the sentence is considered to have an overall "neutral" opinion

A breakdown and quantitative analysis of sentiment scores by individual properties was performed to understand the overall attitude of different groupings of people who were interviewed.

3.2.2. Qualitative Analysis. We also analyzed all interview transcripts through a manual text coding process using a framework method with emerging thematic analysis via NVivo, a qualitative data analysis software program. Prior to the coding, interviewee names were replaced with unique identifiers following the procedure outlined in the approved IRB protocol to protect individual privacy.

4. Results and Discussion

There were two research questions. The results and discussion for each research question are presented below:

Research Question 1: What are the attitudes and perceptions of students and faculty in higher education toward the online delivery of education during the pandemic?

4.1. Sentiment Analysis. The sentiment analysis extracted 957 total interviewee statements: 623 from students, 262 from faculty members, and 72 from the leadership teams. The analysis of the students' transcripts showed that about 54% of the comments were neutral with positive and negative phrases in equal measure. Overall, the average sentiment score was about 0.162, which means that the comments had a slightly positive skew. Of the 46% statements that had extreme sentiment scores (i.e., above +2 for positive and less than −2 for negative), 70% of the statements were positive while the rest were negative. This indicates that students had mixed feelings toward the purely online delivery mode during the pandemic. Most of the extreme negative sentiments revolved around the lack of access to the institutional infrastructure and the institutions demanding full fees during the period. A similar trend of mixed sentiments trend was observed for faculty members as well. However, the areas of concern were varied for faculty belonging to different institutions. Overall, 65% of the women faculty responses (90% for married women faculty) indicated a negative sentiment due to increased stress on working from home. Overall, 44% of the faculty respondents expressed extremely negative sentiments around deduction in salaries paid by their respective institutions.

Discussions with the respondents were recorded, transcribed, and content analysis carried out. Meaningful sentences were coded and those belonging to the same code were organized into subthemes. Finally, similar subthemes were grouped together under a main theme. The coding mechanism and the emergent themes were reviewed and cross-checked for correctness. Five major themes emerged as depicted in Table 2.

4.2. Faculty Interview Themes

4.2.1. ICT Readiness. The theme *ICT Readiness* refers to the preparedness of the faculty members in effectively delivering online classes at the beginning of the lockdown. Some of the key findings on ICT Readiness were:

(a) ICT readiness of faculty members can be characterized as average. Only two institutions out of 10 had subscribed to online collaboration platforms prior to the pandemic (free for education accounts) and very few faculty members had prior exposure to such platforms or teaching online.

(b) Google Meet emerged as the platform of choice for delivering online classes during the pandemic followed by Zoom and Microsoft Teams. The faculty members found it challenging to replicate the effectiveness of physical classroom teaching.

4.2.2. Training Needs. "Training" emerged as a major theme during the interviews. While faculty members were able to deliver lectures after taking remote help from colleagues and their institution's IT team, several faculty members had issues in setting up their online classes and delivering a seamless experience to their students during the first month. Some of the key findings related to the training needs of the faculty members were:

(a) Most of the faculty members felt that formal training for conducting online classes was needed, while a few felt it was not necessary and it was as easy as learning to use a mobile application.

(b) Faculty members wanted their institutions to subscribe to premium versions of online teaching platforms as free versions offered restricted features.

(c) Most of them also mentioned that a focussed training on conducting online assessment and evaluation was required.

(d) Some of them felt that they must be trained on enhancing engagement levels in the online teaching through the introduction of new collaborative tools or mobile applications.

4.2.3. Workload and Stress. Enhanced workload and stress during the lockdown were another theme which emerged from faculty interviews. Many faculty members had to create digital content (compared to a chalk and talk methodology earlier), set up classes, coordinate with the students on a daily basis, evaluate assignments in an online mode, conduct online examinations. Thus, a significant increase in screen time was reported. The key findings are summarized below:

(a) An overwhelming majority of the faculty members felt that the online mode of teaching–learning increased their workload significantly.

(b) Several faculty members indicated that they felt increased levels of stress during the lockdown. Primary reasons cited were fears of loss of job and salary cuts (private sector), health concerns of self and family members, and additional work at home. Women faculty members indicated that their daily domestic workload increased significantly during the lockdown due to nonavailability of domestic help.

4.2.4. Recognition. Majority of the faculty interviewed felt that during the pandemic they were not appreciated enough by the management of their institute for putting extra efforts

Table 2: Thematic analysis of faculty discussions.

Themes	Subthemes	Description	Instances
1	ICT readiness	Resource/ tools/platform availability	"Our college had no clear strategy or subscription to platforms for online delivery of classes. We wasted a lot of the initial time in figuring out how to ensure academic continuity for students."
			"It was very difficult to coordinate with students on a daily basis. I used WhatsApp groups for coordination and Google Meet for online classes. It took me 2–3 days to get comfortable with taking classes online."
		Resource/ tools/platform familiarity	"I had never conducted an online class before the pandemic. I found it difficult to set up the classes on my own. There was no technical support available during the initial days. I felt I was going through the motions."
			"I am a mathematics teacher and use to whiteboard a lot during my classes. When I moved to online mode I found it very difficult to do justice to my subject. My college advised me to procure a pen-tablet, which I did. It took some time to get used to, but I could then write and solve maths questions for the class."
2	Training needs	Technology training	"While power point slides were easy to run, writing and solving problems was a major challenge. It took me some time to figure out using the pen-tablet to write and explain concepts to the students."
			"I did not have any experience on how to use any kind of platform for online classes. This training should be provided for at least one week days by the institutions. Only then can they expect faculty members to deliver quality."
			"My institution does not place emphasis on the use of ICT and hence we could not deliver good classes to students during the first two months. Initially we only shared handmade notes over whatsapp."
		Pedagogy training	"Conducting online evaluation was very challenging. We used Google Forms, but the examination was too easy and MCQ based. I don't think the teachers were trained properly on conducting online assessments. It is definitely needed."
			"My institution is very progressive in terms of ICT adoption and we had all the systems in place at the time of the lockdown. Within the first week we received instructions to deliver online classes, and everything was handled smoothly. Now we are talking about experimenting with pedagogy and virtual labs to deliver enhanced experience to our students."
			"Online teaching is very different, there is no real-time feedback. I need training on how to conduct classes effectively and build engagement with the students."
3	Workload and stress	Work–life balance	"It was difficult to work from home. I had to cook, clean, manage the kids and the family. It was difficult to focus professionally with everyone around. I did not have a private space to myself to deliver classes effectively."
			"I definitely felt overloaded with work during the first month with the purely online model of delivery. There were things to be learnt, new processes to be adopted and preparation time for lectures increased quite a lot."
			"While I used ICT in my face-to-face classes, I had to prepare slide decks as per my lesson plans for all my classes which took a lot of time."
		Fear and anxiety	"I was down with Covid and had to take leave for 3 weeks. The post covid recovery was also slow and I was very anxious about my health. I probably did not do justice to my teaching assignment during this period and contemplated quitting my job."
		Uncertainty	"The lockdown period was very stressful. We were hearing bad news all round. Several of my friends reported job losses and salary cuts which weighed heavily on us. I felt I was under pressure throughout this period."
			"I was surprised at the reaction of the students and parents when they refused to pay the fees to the institution for delivering online classes. We were not sure whether the institution would be able to pay the salaries on time."
4	Support and recognition	Assistance received from the institution in delivering online classes	"I felt that there were too many instructions issued by the management without realising the tough environment and pressures on the faculty. I think the empathy was missing."
			"All the faculty did a fabulous job, but the management felt that working from home is not equivalent to a full-time office job."
			"Our management reduced the salaries by 40%–50% during the pandemic citing lack of payment of fees by the students. I felt cheated and felt it was morally wrong to reduce salaries in an already tough environment."
			"Our work was getting recognized through the internal stakeholder communication platform created to disseminate information. All the lectures recordings along with lecture content was being shared which helped us in sharing best practices. Overall the morale was good."

Table 2: Continued.

Themes	Subthemes	Description	Instances
5	Teaching–learning effectiveness	Quality of the classroom teaching	"I am not very satisfied with the quality of classes I have conducted. I believe that online classes should be of shorter duration with more assignment-based learning for the students." "I think I completed only 65% of the curriculum during online classes, so the students have learnt less during this time. They were also not very serious during online classes." "Students didn't respond much during the online classes. This may be due to their lack of interest or engagement in other activities simultaneously. Many a times I found students switching off their cameras and not being around." "Online examinations were a sham. The multiple-choice questions were too easy with very high student scores. The system was severely compromised."

in switching to the online mode and coping well in the virtual mode. Some faculty members were further of the opinion that they had to work extra from home with extended hours of work and managing both the family as well as online work was a very tedious task. A few faculty members said that they preferred the online mode and would be happy to permanently teach from home due to the additional time savings.

4.2.5. Online Class Effectiveness. While online delivery of classes was hailed as a positive indicator for technology adoption by the institutions, faculty perception during interviews indicated mixed reviews. Initially, faculty members felt that it was a novel experience for them. Then they started experiencing fatigue and lack of motivation due to muted student feedback and engagement. They felt that they were not able to connect well with all the students. Finally, some faculty members felt that online classes were a nuisance and reported instances of student misbehavior and background noise as major irritants. Some major findings on online classes' effectiveness are summarized below:

(a) Student disengagement was evident
(b) Online evaluation was not effective
(c) Teaching–learning lacked academic rigor
(d) Small class sizes of 20–25 were the most effective with cameras of all students switched on
(e) Frequent engagement through polls, quizzes, and use of pen-tablets boosted class engagement

4.2.6. Challenges. From the interviews conducted with the faculty members of various institutes in higher education several challenges emerged, which are described below:

(a) **Conducting Labs:** Faculty members identified conducting labs as another major challenge. The computer science faculty members were able to conduct their labs online by accessing online coding tools or sharing screens and executing programs. Faculty members from other departments such as civil and electrical expressed their inability in conducting labs effectively. Conceptually some concepts could be explained using virtual labs, but the physicality of the labs was found to be irreplaceable. As a result, practical learning was a major causality of online teaching during the pandemic.
(b) **Evaluation and Assessment:** Evaluation and assessment part was a major challenge for the faculty. They felt that the assessment options were limited to quizzes and MCQs. Subjective questions and those requiring mathematical formulae to be written could not be given as part of the online tests unless paid online assessment tools were used. Monitoring students and ensuring fairness in the online exams was a major limitation. Institutions did not adopt online proctored frameworks for online examination. Faculty felt that the sanctity of the evaluation process was significantly diluted and the process was unfair to the top students.
(c) **Accessing and Leveraging Digital Resources:** While faculty agreed that there were a lot of digital resources on offer for free, they were not able to leverage all resources effectively. Most of the time was spent in exploring digital resources and examining its suitability in their respective courses. However, many institutions in the region lacked awareness about the digital resources on offer and were not able to utilize them to enhance student learning. Many institutions lacked a coherent plan of engaging students in an online mode. The faculty felt that the students did a better job in self-paced learning with a majority of students completing multiple courses on Coursera, NPTEL, etc. Faculty members also attended several webinars and completed online courses including industry certifications.
(d) **Online Classroom Effectiveness:** Faculty members felt that online classes should not be more than 30 min as students tended to lose focus and attention. Further, it was very tough to gauge student interest in real-time, especially for large class sizes. The teachers felt exhausted themselves and found it tough to keep themselves motivated. Some faculty members who adapted to online teaching and reported using online polls and quizzes and engaging students in discussion, etc. reported better engagement. Hence, teacher training for delivering effective online classes emerged as a major theme during the interviews. A significant majority of the faculty still felt that online-only classes are not sustainable in the long run.

4.2.7. Student Interview Themes. Five themes emerged in student interviews which were labeled as "ICT Readiness," "Online Learning," "Exam Readiness," "Value Perception," and "Stress and Mental Fatigue." These themes were

Table 3: Thematic analysis of student discussions.

Themes	Subthemes	Description	Instances
1	ICT readiness	Device and connectivity	"I wish I had invested in a good quality laptop and a broadband internet connection. During the stringent lockdown I could not access high quality content and effectively attend classes. It is absolutely essential during these times." "I had to go to a friend's house during the lockdown to take my exams. The internet service provider did not serve my area and I faced repeated disconnections over mobile internet."
2	Online learning	Self-paced learning vs. online classes	"I really enjoyed exploring the latest courses from coursera, the lessons were short and to the point and I could complete four courses online during the pandemic. Our institution provided free access to Coursera during the lockdown, which was very useful." "The online classes seemed novel at first, but quickly became boring. It was tough to sit through looking at slides and hearing the faculty members for extended periods of time. Only few faculty members could make classes interesting." "I completed 2 industry certifications during the lockdown. There are so many interesting channels to learn online based on your learning level and interest."
3	Exam readiness	Work–life balance	"There is no need for final examinations as the entire syllabus was not completed. Why is the college insisting on exams during such a crisis? All students should be promoted to higher semesters without exams." "The University is planning to conduct exams for final semester after so much delay. It is not possible to prepare well under such stress. We are not sure whether we can appear in online exams without problems."
4	Value perception	Quality of instructional delivery, engagement and perceived value	"Colleges have no right to demand fees when students did not attend classes, labs or use the college facilities." "I personally feel that colleges should reduce their fees and understand that everyone faced loss of income during the pandemic. Online classes are not the same as physical classes." "Online classes were just an eyewash. We did not gain much during the period." "Our college did not even deliver online classes during the period. There was no schedule and faculty would send out a WhatsApp message to a few students for conducting classes on short notice. The classes did not add any value and hence the college should also not charge fees." "The faculty worked hard to deliver classes and the institution organized several workshops, trainings and value-added courses. I got a lot of time to build my skills."
5	Stress and mental fatigue	Uncertainty, anxiety, excessive screen-time and boredom	"My eyes started to hurt with increased screen time. Online classes are not sustainable." "It is difficult to concentrate with so much uncertainty around examinations. Even the teachers are not sure what will happen." "I am bored of online classes, I switch off my camera and carry on with my tasks." "My entire family got infected, we saw some very anxious times, I did not attend classes for a month."

interrelated and interdependent and not entirely independent of each other. The thematic analysis is presented in Table 3.

4.2.8. ICT Readiness. During student interviews, it emerged that 64% of students had laptops/desktops at home with wi-fi connections. Others used mobile phones over mobile internet to attend classes. The socioeconomic constraints in J&K are real. The lack of availability of a laptop/computer and good internet connectivity emerged as a major hindrance in effective teaching–learning. The reluctance of some students to invest in a computer and internet for their own benefit was quite surprising. The situation was also exploited by the students. Initially, the students were opposing online examinations. Once they realized that the online examinations were much easier they reversed their stand and protested across several institutions to conduct examinations in an online mode only. The students were indeed very complacent during this period and expected major concessions from the system. Thus, the academic loss for the students has been real during the past year, especially in institutions where student disinterest was matched by lack of energy by the institutions and faculty members.

4.2.9. Online Classes vs. Self-Paced Learning. Students indicated mental fatigue with online classes after a while with many indicating that they just join the class and do not pay attention during it. Further, the students indicated that they enjoyed undertaking self-paced courses on online platforms and took to such platforms very enthusiastically. In one of the institutions, students had undertaken over 250 different courses on Coursera with over 10,000 h of lessons. This is a worrying trend for institutions as students indicated fatigue with online classes, but enthusiasm for self-paced learning. Clearly quality and pedagogy for online delivery of classes need to be revisited by the faculty and the institutions. Further, the gamification used by online platforms attracted the students in enrolling for courses and completing them. Students believed that such online courses added value to their resumes. The institution which enrolled for the Coursera initiative and provided access to the students, generated significantly positive student sentiment as evident from student comments on social media. Further, institutions which rapidly adopted online platforms and provided academic continuity to the students were much appreciated by the students

Table 4: Summary of responses from educators and institutional leaders.

Educators		Institutional leaders	
What did not work	What worked	What did not work	What worked
(i) Recorded lectures (ii) Whatsapp groups and material sharing (iii) Self-paced learning of course material shared with students (iv) Online lectures of 1 hr duration with slides (v) Using only slides to deliver content (vi) Students not switching on their cameras during classes (vii) Lack of communication from institutional leadership (viii) MCQ-based assessment using Google Forms leading to unfair means (ix) Free online tools with basic features (x) No physical laboratory access and experimental work (xi) Working with the whole class always (xii) Group interactions and communication	(i) Live classes (ii) Structured and formal online classes (iii) Learning through MooCs, especially Coursera (iv) 30–40-min lectures with frequent polls and quizzes (v) Using pen tablets for writing/drawing (vi) Students switching on their cameras during classes (vii) Clear institutional vision, communication, and directions (viii) Online proctoring-based tools, oral exams, open book exams, assignments (ix) Paid subscriptions with premium features (x) Use of V Labs, videos by faculty while using actual labs (xi) Working with small breakout groups (xii) Individualized mentoring, counseling sessions	(i) Individual faculty tool usage (Whatsapp, Zoom, Gmeet, etc.) (ii) Faculty communicating with students through Whatsapp groups etc (iii) Effective tool usage by faculty on their own (iv) Informal training on teaching online (v) Pedagogy innovation by faculty (vi) Monitoring of quality of online lectures (vii) Google forms-based assessment (viii) Lack of engagement with student groups/faculty by institutional leadership leading to communication gaps (ix) Use of free online tools and treating the pandemic as a temporary phase (x) Rigid control and strict monitoring (xi) Traditional management and planning (xii) Outsourced IT teams and reliance on outside training agencies (xiii) Long-decision-making cycles	(i) Central unified strategy and platform usage at institution level (ii) Clear unambiguous communication through formal channels like emails (iii) Centralized online training for faculty (iv) Formal training and certification (v) Training for faculty on building engagement (vi) Enabling recording of lectures for review (vii) Online proctoring-based assessment (viii) Institutional leadership frequently engaging with and addressing concerns of student groups and faculty members (ix) Investment in building online delivery capability as a strategic investment (x) Flexible policies and understanding empathy (xi) Strategic planning, management, and execution (xii) Inhouse IT and ICT expertise with training capabilities (xiii) Agile decision-making and responsiveness

generating significant brand differentiation compared to institutions which did not.

4.2.10. Exam Readiness. There was a lot of resistance from students across institutions to appearing in final examinations. Students felt that mass promotions should be the norm under such exigent circumstances and were quick to point out the inadequacy of online classes.

4.2.11. Value Perception. A majority of the students felt that colleges did not deliver full value during the pandemic. Many felt that since they could not use the college facilities and the colleges did not incur any expenditure during the period, the fee should be waived off. Students strongly felt that the colleges should not charge any fees during the period of the lockdown. There was a lot of resentment among the students when the colleges raised the demand for fees during July–August at the time of starting of the next semester.

This feedback correlated with colleges reporting reduced fee realization from students during the period resulting in delays in paying staff salaries. A majority of the students paid their fees after delays and multiple follow-ups. It was interesting to note that while students felt that online classes were of not much value; however, the absence of online classes was in fact considered a deficient service by students. Hence, the absence of online classes was viewed very negatively by the students. Colleges which did not provide online classes received student backlash and subsequently poor admissions in the next cycle of admissions. Colleges which delivered online classes effectively and conducted examinations on time reported higher admissions and increased brand/value perception.

4.2.12. Stress and Mental Fatigue. Toward the end of the second wave, students reported mental fatigue with online classes, webinars, meetings, etc. Many reported excessive screen times and lack of concentration. This represents a major challenge for online-only delivery models. It is intuitive here that an online only model works well when the learning is self-driven and self-paced. Running scheduled classes throughout the day and for extended periods has resulted in mental fatigue setting in for the students.

Research Question 2: What strategies work at the level of the institution and the individual educator in creating a favorable stakeholder perception?

To answer research question 2, interviews were conducted with 15 senior educators and 10 institutional leaders to determine which strategies/interventions worked and which did not work while delivering online education during the pandemic. The responses are summarized and tabulated in Table 4.

Some of the themes that emerged from the interviews with institutional leaders included adoption of formal strategic planning, investment in IT/ICT, setting up formal and informal communication channels with stakeholders and communicating frequently, agile decision-making and responsiveness to stakeholder concerns, supporting faculty through formal trainings, equipping them with required resources, and treating the online model/blended delivery model as a long-term trend in education. The educators surmised that short lectures, frequent polls, use of multimedia content, quizzes, use of pen tablets, oral examinations, and working in small groups increased the effectiveness of online learning. These outcomes clearly indicated the need for deep engagement model going forward as a blended online delivery model may be new normal in the education industry.

5. Conclusions

The present study has revealed some interesting insights into the perceptions, attitudes, and experiences of faculty and students at higher education institutions in the Jammu region related to online classes during the lockdown.

Empathetic leadership is also the need of the hour to navigate through uncertainty and stressful times. Our research shows that leadership intent, resource provisioning, faculty support, intensive faculty training, student orientation, easing out assessment and evaluation and working in small groups can help institutions deliver value to students in these challenging times while enhancing institutional brand value. Faculty members need to invest in themselves and assume responsibility for generating the needed energy and interest in online learning through the use of modern tools, animation, videos, quizzes, polls and individual student engagement. Students need to be primed to receive the benefits from the online delivery model and exerting the required pressure on faculty and institutions to deliver value. This is a great time for proactive institutions to innovate and use digital technology to expose students to world-class content and resources. Such institutions have benefitted by creating a value differentiation while the decline of laggard institutions has been hastened. Technology in education has its own set of advantages and disadvantages, but with effective implementation, the disadvantages can be minimized. A better plan is required. In order to be one of the world's most competitive countries, schools/colleges must expand and develop their educational systems in accordance with Industry 4.0. When opposed to the previous technique, Education 4.0 allows a learner to better understand the learning settings [18–23].

Data Availability

The data available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there is no conflict of interest.

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Research Article

A Pedagogical Framework for Advanced Learners during COVID-19 for Engineering Students

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The COVID-19 pandemic has raised unprecedented challenges for the progressive education community universally. One crucial challenge is the engagement of advanced learners in pandemic times. Their academic interest is retained, their performance does not decline, and they get access to appropriate resources in time. This article will elaborate on the identification mechanism and the categorization of the students grounded on their comforts and performance. The pedagogical framework is developed for advanced learners by focused interventions such as providing exposure to industry-oriented problems, international virtual events, online courses and software, career counseling by industry leaders, and preparation for higher education. In this article, we are discussing obligatory interventions and their outcomes. Adopting blended learning is becoming a boon to learners by effectively using online resources. Working with these advanced learners, the teacher can directly converse the precise space where the scholar needs the support. In this research, student-centric methods are used. A pedagogical framework is proposed for aerospace engineering students. Advanced learners are categorized into specializations based on real-time data analysis such as aerodynamics, propulsion, space technology, and avionics. Analysis suggests that the categorization and targeted pedagogical intervention yields better student performance outcomes. Based on this study, we started offering specialization-based courses at the undergraduate level in coming batches.

1. Introduction

COVID-19 brings many challenges to the life of human beings. Since January 2020, the impact of coronavirus has gradually risen and brought a challenge to society. It encounters rapid fall in the economy for all the countries globally. All the nations are struggling to work on the impact of pandemics. Due to the rise in the COVID-19 cases, all educational institutions have to close their face-to-face interactions. COVID-19 brings enormous challenges for all educational professionals [1]. It impacts the teaching and learning process globally. It made us adopt online teaching as a traditional way of learning. Because of this high anxiety and negativity, it was a great challenge for students to cope with the new methodology.

A traditional engineering education emphasizes content, craft, and design while developing critical thinking and problem-solving skills [2]. Active learning [3], flip classes, and project-based learning are common pedagogical approaches to improving engineering education. Over the past decade, online education has become a viable component of higher education in technical fields such as electrical and computer engineering, computer science, and information technology, especially at the graduate level [4]. While online education is not a new concept for educators, the COVID-19 pandemic has presented an unprecedented global need to explore online teaching/learning opportunities online at various educational and professional levels. More than 1.5 billion students worldwide (90.1% of all enrolled students) have been affected by the closure of educational institutions and subsequent changes in education due to COVID-19 [5]. The sudden closure of most educational institutions worldwide has forced the transition from full-time education

to entirely online (or blended) in a short transition period [6]. As a result, institutions that focus primarily on traditional face-to-face education face several challenges during this transition period [7]. Mitigating the impact of the pandemic on technical education, especially for vulnerable, disadvantaged, and skilled students, requires urgent, careful, and evidence-based planning, symptoms, and underemployment [8]. Additional efforts are needed to ensure that online engineering courses meet stringent program accreditation requirements, such as the NAAC (National Assessment and Accreditation Council) and NBA (National Board of Accreditation) in India. While the available literature on online technical education is, to our knowledge, a comprehensive analysis (quantitative and qualitative) of the issues and factors influencing the pandemic, online engineering education in universities mainly offers immediate pandemic face-to-face training. The Sloan Online Learning Consortium has identified five pillars of high-quality online education: learning effectiveness, student satisfaction, teacher satisfaction, accessibility, size, and cost [2]. Mobile learning identified various advancement types [9, 10]. It impacts both (teachers and students) the stakeholders in the education industry [11]. UPES is one of the most diverse universities in India in terms of race/ethnicity, gender, finance, and culture (for example, with a large percentage of students from different states). It helps organizations with similar demographic groups improve their online engineering education during and after the pandemic, especially for advanced learners.

Experiential Learning (EL) and Deep Learning (DL) tactics are primarily proposed and developed. The following are the most recently promoted and discussed in teaching technology [12].

Traditional face-to-face (f2f) publications supplemented with the virtual era and tools (e.g., PowerPoint or Prezi presentations, online tests, and quizzes). In practice, this method is very conservative, with a low degree of lively college students' dedication and nonconventional sports implementation for the duration of lectures and classes. Thai et al. [13] explained that blended learning includes online [14] and conventional getting-to-know environments, technology, and virtual media for getting-to-know content material delivery, considering numerous coaching and getting-to-know methods (each online and conventional).

In hybrid publications and blended learning, teacher and students combine exclusive online getting-to-know subjects and conventional publications, presenting a few digital periods and games accessed remotely via the student. That method allows the construction of many frameworks and systems for publications, with the excessive dedication to college students and lively mentoring positions of instructors and lecturers.

Flipped study room (FC) may be considered a type or a part of blended learning. Substances and technical contents are available for college students outside of the classroom via digital platforms, cloud sharing, and online Learning Management Systems (LMS) [15]. The study room conferences are planned instead of conventional lectures for brainstorming and problem-fixing discussions within the presence of the teacher/mentor.

With this in mind, we demonstrated the case study on aerospace engineering students. Identifying the advanced learner was the task of providing the proper intervention at this challenging time. Advanced learners are always the flag bearer of the institute. In engineering education, advanced learner identification is crucial. These industrial-oriented courses seem to have their direct importance in society. For the societal development of the country, we always need to work with this advanced learner

The term advanced learner in this article refers to the students that are involved in learning events faster than the other students in the course, achieve prodigious scores, and mark significant achievements in their life. They are more skilled with comprehension, retention, reminiscence, intellectual, creativity, and contextualization practices. These scholars can take up advanced level learning and academic tasks, and they can bring some new concepts and strategies and take leadership roles in the teaching-learning actions.

Engineering education requires practical expertise. Performance in the core subjects can help in the identification of advanced learners. Primarily when we cover the aspects of aerospace engineering, this stream requires diverse expertise per the industry requirements. In this article, our primary objectives are as follows:

(a) Identification of advanced learners.

(b) Providing the obligatory interventions required for advanced learners during COVID-19

(c) Accessing the outcomes of pedagogical interventions for aerospace engineering students

These pedagogical interventions are accessed for aerospace engineering students of the University of Petroleum and Energy Studies (UPES), Dehradun.

2. Significant Challenges with Advanced Learners

In any teaching, we tend to begin with what the students bring around the classroom: their level of ability and knowledge, skills and talents, deficits, learning styles, and interests. Advanced learners have several requirements. They can accelerate, so they will progress through the syllabus at their learning pace, which is considerably quicker than those at their grade level. They have a minimum of some inventive experiences to experiment, invent, and apply what they have learned. They have materials to work on their concepts and explore new lines of inquiry. Several conjointly want sensitive handling, as they might feel socially isolated due to their learning passion. Teachers cite numerous challenges to knowing and responding to the wants of advanced students. However, the subsequent are among the foremost common.

2.1. Time Spent on Testing. The high-stakes testing in several districts implies that teachers usually feel they cannot breathe a lot of till when administering the tests. Since advanced learners typically attain higher scores, they appear at an advantage over people who do not.

2.2. A Course of Study Restrictions. Academics add prescribed content with benchmarks already established for moving students through the curriculum. Most teachers are specialists at adjusting things as they go along. However, each teacher feels the pressure to bring students to the equivalent level of mastery altogether needed content areas. Hence, they enter successive grades with the abilities and information they want. This pressure usually restrains alternatives: artistic processes, freelance or small-group projects, and cluster groups.

2.3. Knowledge. Another challenge academics face is a lack of experience providing the quiet advanced students require. Providing opportunities for them to experience real challenges and advance at their ability level may be a matter of coming up with selections that yield much-accelerated learning, creative thinking, and interest-based comes. To some extent, several academics do this by identifying areas in their course of study where they can increase the number of problems for many advanced students..

2.4. Learners. Others prepare for college kids with specific talents to review an issue during a higher grade or find parents willing to figure out freelance study projects involving the curriculum with students.

2.5. Resources. The fabric and human resources are frequently lacking or appear to be so. High-ability learners would like completely different sorts and levels of the source to expand their imagination and hunger for knowledge. Human resources are equally important. Academics, parents, community members, artists, scientists, writers, and alternatives can give enrichment, project ideas, guidance, and sensible help in the classroom, benefiting advanced students.

2.6. Attitude. All students should learn, whoever they are, no matter their challenges or talents. Teachers who need to assist advanced students mostly face resistance from peers or directors due to a bias against advanced education. Advanced students spend plenty of time continuing what they have already learned or waiting for others to catch up, a state of affairs that may cause real hurt over time [3].

Many teachers can easily spot advanced learners through academic performance and test scores. One helpful way to expand our understanding of whom the advanced students are in our classrooms is to explore their thinking, learning, and behavior patterns in three broad categories.

Academically able children can absorb, synthesize, and analyze information quickly. They may be advanced readers with precise and detailed memories, able to digest new concepts quickly, comprehend meaning and application, and use logic and critical thinking in complex ways. Advanced intellectual ability also embraces a range of skills and thinking processes that some may consider less intellectual such as intuition, experimentation, instinct, or inspiration.

2.7. The High Degree of Creativity. Educators and parents have long seen creativity in their children. However, creative ability is difficult to measure. In schools that rely on standardized tests to identify advanced learners for special programs, the imaginative student with a quirky sense of humor may not qualify. Creative children apply logic to problems, explore solutions, and synthesize relevant information. The creative way they do all of these things is where they differ.

2.8. Heightened Sensibilities. When advanced students learn, they connect to the process profoundly, internally, absorbing the world through every pore [16]. Life provides them with multiple and complex sensations.

During this pandemic, advanced learners suffered due to a lack of unacquainted resources with online teaching, limited lab access, and negativity. So keeping their performance through various pedagogical interventions is the requirement of the present time.

3. Requirement of Pedagogical Intervention for Advanced Learners

The higher education sector requires the student to be skilled in the ever-changing industry requirements. The basic skill requirements are expertise in problem-solving, critical thinking, innovation, collaborative skills, digital literacy, and adaptability. We need to develop those skills by facilitating or enabling complex skills development in our teaching and learning pedagogy. This development requires additional mental and technical preparation from teachers and students. The COVID-19 lockdown announced in March 2020, with all its restrictions in f2f interactions [17], led to the need to transition to fully remote work with students in the learning process.

In contrast, it is possible to change the blended learning approach into the framework with online meetings and labs. Additionally, this condition was astonishing for both mentioned parties. At the same time, each was aware of the necessity to continue the courses and activities, especially the laboratory ones.

We keep the philosophy and the spirit of outcome-based education implemented by our university in the aerospace engineering program. The course curriculum for the program will remain the same as that approved by the Board of Studies (BoS) of the university and committees of the respective department and prescribed in the course booklets. Online classes and meetings are through UPES Learning Management Software "Blackboard."

Scheduled classes were conducted through virtual classrooms, and the students had to enter the virtual classrooms through their Blackboard IDs and passwords to attend the class. We had made provisions for recording all virtual sessions on Blackboard for future reference.

In order to minimize the impact on the predefined learning outcomes of a course due to the conversion of the actual classrooms to virtual classrooms, this action plan recommends having online discussions with the students

over Blackboard and focusing on take-home assignments and tutorial sheets a pedagogy. Students were provided with materials for observation, e.g., video recordings of activities in the identified field. This action plan was followed to minimize the impact on learning outcomes for all programs.

During this crisis, and in keeping with global trends, UPES has collaborated with "Coursera" to offer a unique learning experience for students. It is a valuable addition to the regular core courses to augment learning outcomes, equipping students with the right skill sets to enhance their career prospects. It is an excellent opportunity for the students to acquire new-age skills, enhance subject knowledge, and build personal branding. There are about 3800+ courses available with nearly 400 specializations. Upon completion of each course, students acquire verified, university-branded certificates. During the COVID-19, Coursera has launched a global effort to assist universities and colleges by providing additional 5000 licenses for an uninterrupted learning experience.

In 2006, UPES started one of the bachelor's courses in aerospace engineering. This domain covers the studies related to aviation technology and space technology. We surveyed the four specializations for aerospace engineering students: aerodynamics, propulsion, flight mechanics, and structures. We had taken a few initiatives for our advanced learners to provide the right interventions during this crisis. We are going to discuss all these interventions in detail further. All the data for this analysis are considered from IQAC (Internal Quality Assurance Cell) of UPES.

4. Best Practices for Advanced Learners

Higher education plays a vital role in nation-building. Higher education contributes to advancing civic conduct, nation-building, and social cohesion by transmitting democratic values and cultural norms. NAAC is the council in India that looks after teaching-learning requirements for various institutions. NAAC always motivates institutions to support their advanced learners by offering various scholarships, placements, lab support, etc. NAAC (https://naac.gov.in/docs) has suggested various best practices.

Choice-Based Credit System

To make higher education student-focused and promote academic excellence in student-centered areas, CBCS is a boon to students. It provides suitable flexibility in the selection of subjects for students. CBCS allows students to choose interdisciplinary, intradisciplinary courses and skill-oriented papers. We have adopted core courses, program elective courses, and ability enhancement courses. We have been following this system from 2016 onwards in our institution with the help of experts in various committees.

Curriculum for Experimental Learning

We have developed the curriculum to cater to allied industries' requirements. It brought horizontal mobility into practice and introduced job-oriented and skill-based courses. Interdisciplinary courses help students to widen their areas of learning. At our university, we have introduced skill courses to cater to the diverse need of the nation.

Curriculum to Cater to Diverse Needs

We have introduced the flagship projects for all the teachers and students. These flagship projects cater to a vast area of expertise, namely, flying cars, rural technologies, smart cities, and disaster management. It helps the student support the country in attaining its vision. It develops the research ability that helps them to achieve their life goals. Young minds can continuously innovate new things [18]. We support our students by providing various financial grants to pursue innovation [19].

Research: Integral Part of Curriculum

5. Methodology

5.1. Pedagogical Framework Development. We have developed the framework by characterizing the students' areas of interest. In aerospace engineering, four areas are more prominent: aerodynamics, propulsion, flight mechanics, and structures. We floated this request to all the students and collected their choices. We have provided the right interventions to them as per their choice. It was found that the performance of these students increased by 15% from the previous batch, even in COVID-19 pandemics [20]. This modified pedagogical framework is divided into five steps. We are going to analyze each of them further.

5.2. Identification. Identification of advanced learners was conducted in the following criteria.

5.2.1. Creativity in Aeromodelling. In our curriculum, the aeromodelling lab is introduced as a regular subject. Students prepare their aircraft models by applying the basic principles of aerodynamics, propulsion, flight mechanics, and structures. In this lab, it was observed that few students had shown their creativity in all the respective specializations. Few students have done the modification in wings by showing their creativity and interest in aerodynamics. Some students develop new concepts for aircraft engines that can carry more load. Many students modified their model's aircraft systems and controlled them efficiently and economically. Few of them identified the load distribution and strength of the aircraft efficiently. This Aeromodelling lab helped us identify these students in their respective areas of specialization, and we provided them with the proper intervention.

5.2.2. Performance in Core Subjects. The Aerospace Engineering Program is a four-year course segregated into eight semesters. In aerospace, we have four core specializations and subjects. In Table 1, we have shown the core subjects with their respective specialization. The performance of all the students in their respective subjects is identified.

Table 1: Semester-wise specialization for aerospace engineering.

Semester	Specializations			
	Aerodynamics	Propulsion	Flight mechanics	Structures
III	Fluid mechanics	Thermodynamics and heat transfer	Engineering mechanics	Strength of materials
V	Aerodynamics	Aircraft propulsion	Flight mechanics	Aircraft manufacturing and materials
VII	Supersonic aerodynamics	Gas dynamics	Aircraft systems and control	Aircraft structures
VIII	Hypersonic aerodynamics	Rocket propulsion	Orbital mechanics and space dynamics	Aeroelasticity/Aeroacoustics
	Major projects			

Students scoring 70% and above are considered advanced learners in their respective specializations. In this broad classification, each student has the equal opportunity to be an advanced learner and be provided with the proper intervention.

5.2.3. Major Projects. A faculty mentor was provided based on their performance in their respective specialization. Specialization of faculty mentor matches with mentee's interest. Both will plan for a project to help us identify their interest. They spend time with their faculty mentor in the domain discussion for a year of work in their respective specialization. These projects help an advanced learner participate in external events like competitions and conferences. These interventions are planned in virtual mode during this pandemic, and advanced learners are guided to avoid losing interest.

5.3. Student-Centered Classification. In engineering education, the student-centered approach is essential. We always have to conduct one-to-one interactions with our students. In these discussions, we will learn about their area of interest. Later, we need to provide the right interventions that improve their performance in life. In our university, recently, we have adopted for school for life. In this, all the students are prepared to face life's challenges and make the world beautiful for society. A student-centered approach helps students choose their specialization and perform best in the domain. Advanced learners are identified after they have chosen their area for their starting of graduation. Student clubs are where these ordinary students transform themselves into advanced learners. Students make these clubs, and they also felicitate various activities. In aerospace engineering, we have always offered the proper intervention based on student interest. We have two student technical clubs, Infinity Space Club and Aerospace Club. These clubs help students develop leadership and communication skills away from the class. Based on the identification mechanism mentioned above, Table 2 represents students' classification in the respective domain.

5.4. Design of Framework. We have followed the framework for each specialization in aerospace engineering. These pedagogical interventions by most faculties help the advanced learners grow in their respective domains. Pedagogical framework development for advanced learners is the present-day requirement. The following interventions were proposed for advanced learners.

5.4.1. Case Studies. Aerospace Engineering is the domain of engineering that evolves every day. In this volatile domain, it is mandatory to adopt the pedagogy of case studies in our teaching and learning practices. These case-based studies help advanced learners adopt the techniques that prepare them for industry and research jobs. We have adopted the industry-based problems in our classrooms.

We adopted the case base study for our Rocket Propulsion class [21]. It is a high-level core subject, and most advanced learners choose this subject in their final semester. We used our industrial experience with Vikram Sarabhai Space Centre (VSSC), ISRO, to frame the problem based on the propulsion systems of the satellite.

The response was overwhelming from most of the students during our f2f interactions before the pandemic. However, we were challenged to conduct a similar exercise during the pandemic. We modified our case using open-source software online. This time we had 25% more participants in the process. We will have positive results if we provide the right interventions during the pandemic. Later, few students have adopted similar case studies in their major projects [22, 23]. They virtually developed the thrust stand for testing the rockets in labs. This work got international recognition and was presented at various forums. COVID-19 does not affect the performance of our advanced learners, but it helps them explore more possibilities in open source.

Similarly, we have various case studies related to aerodynamics, propulsion, flight mechanics, and structures. Significant improvement is observed by adopting the case-based study, especially for the advanced learner. We have observed this while interacting with other teachers in the department.

5.4.2. Technical Competitions. Technical competitions are framed based on the problem statement of the industry or society. Advanced learners from aerospace engineering regularly participate in various technical competitions. SAE Aero Design Challenge, NASA Design Challenge, and UAS Challenge are a few in the domain. We participate in these events and regularly bring laurels to the university along

Table 2: Classification of advanced learners.

Batch	Total students	Identified advanced learners			
		Aerodynamics	Propulsion	Flight mechanics	Structures
2015–2019	100	20	15	10	15
2016–2020	120	15	20	10	20
2017–2021	100	15	15	15	15

The 2015–2019 batch is before the pandemic, and from the 2016–2020 batch onwards, we have a pandemic effect on our education sector. We had planned all identification and interventions in online mode.

with our students. These competitions help the student to build their design for the desired application. These challenges help them apply their engineering knowledge practically and complete the problem statement. While participating in these events, they learn various design software and concepts. Our Aeromodelling lab helps them to develop their aircraft model.

We want to share our student's experience, Ms. Ishika Jain, winner of the SAE Aero Design competition 2021. We are part of Team Aztec from the Department of Aerospace, who participated in the AeroTHON, Air Vehicle Design Contest, organized by SAE India. This time the competition was organized virtually because of a pandemic. In this competition, we have to design an aircraft that can carry a maximum load under a given constrain, so we have formed a team from all the specializations in our department. The contest started in April and ended in June 2021 and comprised two rounds. Students were given a problem statement for developing the aircraft that carried the maximum payload for one month in the preliminary round. They had to develop an innovative and original UAV design, satisfying all the design requirements. We are qualified for the final round and stood in the top 5 teams. The final round was successfully held in June problem statement was handed over and had to finish within 24 hours through a presentation. This competition taught us more about team building, working under pressure, and applying our technical specialization. During this pandemic, also we learned a lot and participated with full enthusiasm.

5.4.3. Job-Oriented Training. All the students at university need to go for industrial visits and industrial training during their summer break. We in the Department of Aerospace Engineering always focus on our advanced learners by providing them an internship in the organization that works in their specialization area. Our advanced learners from aerodynamics specialization joins industry like Airbus, National Aerospace Laboratory, Birla Institute of Technology (BIT), and Indian Air Force (IAF), to name a few. These organizations work on an industrial project related to aerodynamics with an additional mentor from university. Advanced learners emphasize propulsion, provided by companies like Axiom Research Labs, ISRO, and Rolls Royce. A similar pattern is followed for other specializations, and these advanced learners reach the proper organization from the 3rd year onwards. It helps the university showcase its best students to the industry, positively impacting our placement scenario.

5.4.4. Motivation and Guidance. Motivation is the fuel for students and teachers, which makes them feel excited during this pandemic. Motivation comes when we listen to or read about industry leaders. Each advanced learner has a mentor, but sometimes it is vital to know the skills and mindset required for the industry and research jobs. We used to conduct various invited lectures from industry leaders and wellness coaches. This pandemic brings a lot of anxiety and negativity to advanced learners. So, we have increased the intensity of these motivational and technical talks for our students. Along with this, we have a few international collaborations where our advanced learners pursue their research. It helps them to plan for higher studies and jobs overseas.

5.5. Applying Pedagogical Interventions. We applied this pedagogical framework to our students. The response is very promising for employability. In most of the top aerospace companies, we have our alumni working in good positions. We have analyzed the data from the National Institutional Ranking Framework (NIRF), the Ministry of Education (MoE), Government of India (GoI).

The strength of the department lies in our students and facilities. We used to guide them from 2nd year onwards for technical competitions and later they directly participate in these events at the international level. During this COVID-19 era, we won more technical challenges than f2f. Table 3 presents the interventions for technical competitions showing promising results.

We have arranged an online internship for all our students during this pandemic, mainly focusing on our advanced learners. We have provided them with a domain-specific organization where they can work on their specialization. Table 4 presents the data of recent years for all of our students.

Table 5 shows the continued increment in our students' guest lectures and other motivational activities. It shows that we have invited most of the prime leaders of the aerospace industry to motivate our students. During the pandemic, we have conducted master classes by these experts in our regular teaching sessions. These sessions help our advanced learners to pursue research in their respective verticals.

5.6. Accessing the Pedagogical Interventions. Advanced learners are the flag raiser of the institute. We have to plan and analyze the interventions that we took for them. The proper intervention increases their performance and employability. In Figure 1, it is clear that involving more

Table 3: Technical competitions.

Year	National/international completion	Club activities	Awards	No. of the students involved
2016	2	5	Team ASTRAL participated in the CanSAT-2016 award by NASA, Winner of the Singapore Space Challenge	16
2017	1	4	Team ASTRAL won the CanSAT-2017 award from NASA	17
2018	2	13	2nd position in SAE Aero Design Challenge, National Aerospace Conceptual Design Competition	25
2019	2	10	AIAA Engine Design Competition	28
2020	2	10	NASA Design & Build Challenge	30
2021	3	10	Winner of UAS Challenge 2021 VIRTUAL Award and SAE Aero Design	37

Table 4: Internship data.

Year	No. of organizations	Name of a few renowned organizations	No. of the students involved in the internship
2016	5	NAL, HAL, IAF	80
2017	7	Mahindra Aerospace, Axiom Labs	80
2018	8	ISRO, Genesor	100
2019	14	CII, BIT, IISc, DRDL	130
2020	15	Wingbotics, IAF	120
2021	18	Airbus, Rolls Royce	117

Table 5: Industry guest speakers.

Year	Industry expert lectures	Alumni talks	Renowned speaker/organization
2016	3	1	Director DRDO
2017	3	3	Member Niti Aayog
2018	1	1	ASL, DRDO
2019	2	7	CEO, Geneser Aerospace
2020	18	8	Scientist, NASA
2021	15	9	Chairman ISRO

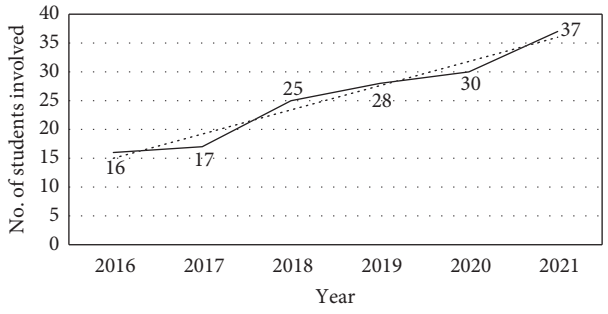

Figure 1: Impact of technical competition.

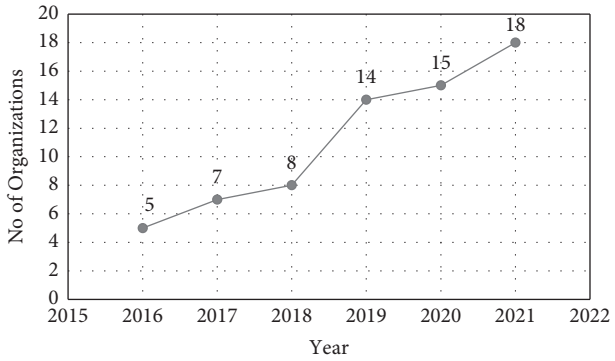

Figure 2: Analysis of industrial involvement.

students in technical competition brings more awards to advanced learners.

These competitions are organized regularly by various organizations like NASA and SAE. During the pandemic, our advanced learners in all specializations came together and participated in SAE Aero Design and UAS challenges. It helps them to develop their communication skills while presenting their concepts. These competitions prepare them to face challenges in the coming future. They bring laurels through their performance.

Team building and collaborative work help students advance in life. Tremendous possibilities help our advanced learners to work smartly even during the pandemic. Figure 2 suggests the continued improvement in the industrial involvement training for our students. Few of our advanced learners secured an internship in companies like Airbus during this pandemic. Receiving such a response from the big giant companies in this challenging time is excellent

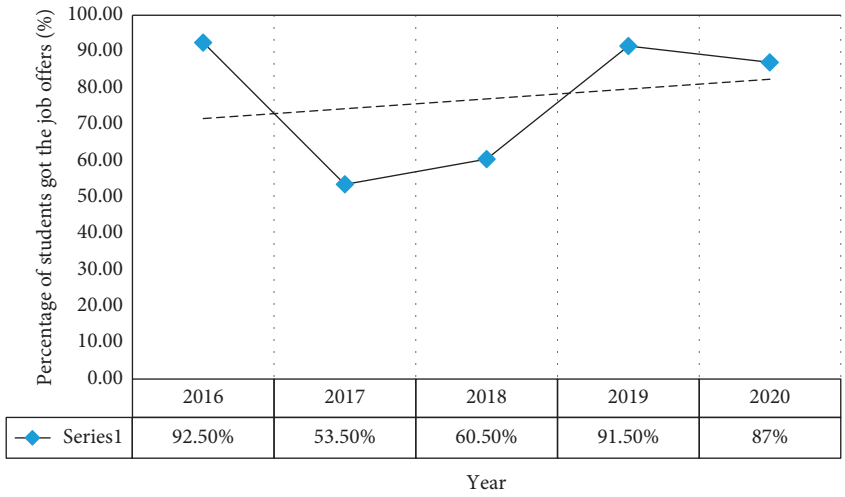

Figure 3: Placement scenario for advanced learners.

Table 6: Summary of pedagogical interventions concerning the academic year.

Batch (academic year)	Total No. of students	Percentage of advanced learners (%)
2015–2019	73	34
2016–2020	78	39
2017–2021	72	41
2018–2022	76	48

support for our students. It is possible only by providing the right interventions from the beginning of their course.

We analyzed the performance of prepandemic and during the pandemic of advanced learners. We found that our advanced learner participation and performance increased during a pandemic.

We used to prepare our advanced learners for industry requirements by getting exposure from various organizations during industrial visits and internships. A large number of companies visit our campus regularly and recruit our students. In Figure 3, consistent growth in the jobs is observed for our advanced learners. It is the outcome of our various interventions in the framework. During the pandemic, various companies conducted the online recruitment process, and we achieved the mark of 87% of our advanced learners receiving job offers. It suggests that consistently our right interventions were positively affecting their employability.

Authors may summarize the assessment of pedagogical interventions from Table 6. It is clear that providing job-oriented training, exposure to real-world technical issues, and bringing industry to the classroom transform more students into advanced learners. In this crucial challenging time of COVID-19, we have significantly increased the number of advanced learners.

6. Conclusion and Future Work

Engineering education requires various pedagogical implementations. In this article, we have emphasized the new framework for advanced learners. We have analyzed the interventions for aerospace engineering students and found that providing the right interventions to advanced learners improves performance even in a pandemic. Identifying the advanced learner based on specialization and performance helps provide the proper intervention. We followed a student-centered approach by involving students in technical competitions, internships, industrial visits, and projects. The framework discussed in this article for advanced learners provided around 90% employability during the pandemic. All the pedagogical changes we adopted during this pandemic improved employability for our advanced learners. Students receive a specialization-oriented job profile that helps them to grow further. This article justifies providing a specialization-based pedagogical approach to the advanced learner to make them more productive in their career. We accessed the impact of participation in technical competitions and industrial involvement during their engineering education. We propose the idea of a specialization-based approach in higher education. We had accessed the pedagogical interventions for a short duration during students' course of study in the institution.

With these pedagogical interventions, at the university, we started offering specialization to students from 1st year onwards to be a part of the advanced learner community. Critical analysis of suggested pedagogical interventions will be accessed in the coming years. Shortly, we will assess the long-term impact of our interventions on our advanced learners through the various survey.

6.1. Limitations. All the pedagogical interventions suggested in this article were confined to batches of the Aerospace Engineering Program from UPES. The article is restricted to the technical education system.

Data Availability

The data used to support the findings of the study can be obtained from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

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