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The Role of Faculty and ICT Factors in Shaping Online Learning Experience: A Study Among Engineering Students

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Abstract : The present study investigates the influence of faculty-related and ICT-related variables on the overall online learning experience of students. The study involved the participation of 348 engineering students, and data analysis was carried out using a Chi-square Automatic Interaction Detector (CHAID) decision tree. The results of this research highlight the significance of delivering superior quality content and providing a designated learning environment, which can enhance students' level of satisfaction and involvement in online education. A positive correlation was observed between the employment of virtual laboratories and enhanced academic performance among students. The present research provides evidence for the impact of faculty engagement, the provision of suitable virtual learning environments, and the incorporation of online laboratory simulations in enhancing students' virtual learning encounters. The findings have noteworthy implications for educational institutions that aim to enhance student satisfaction and optimise online learning environments.

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1. Introduction

The Covid-19 pandemic has profoundly impacted various aspects of human life, including the education sector. The global crisis has forced educational institutions to rethink their approaches to teaching and learning, with online education becoming the primary mode of instruction for millions of students worldwide (Almaiah et al., 2020; Dhawan, 2020; Gazi et al., 2023). As a result, there has been a significant shift in the educational system across the globe, with students, faculty, and institutions navigating the challenges and opportunities presented by this new mode of learning (Babbar & Gupta, 2021; King et al., 2022; Ryan et al., 2023). Online education has been widely adopted in various countries as an alternative to traditional face-to-face learning due to its flexibility and adaptability (Alzahrani, 2022; Yusuf & Al-Banawi, 2013). However, the rapid and unplanned shift to online education during the pandemic has exposed various challenges and shortcomings in the implementation of digital learning, especially in terms of access to information communication technology (ICT) infrastructure and effective faculty engagement (Alzahrani, 2022; Yusuf & Al-Banawi, 2013). Previous research has highlighted the importance of adequate ICT infrastructure and faculty engagement in ensuring a positive learning experience for students in online education (Buabeng-Andoh & Buabeng-

Andoh, 2012; Wastiau et al., 2013). Additionally, it has been established that the satisfaction of students in online courses is intimately tied to the availability and quality of technological resources, such as high-speed internet access, appropriate hardware and software, and a supportive learning atmosphere (Asamoah, 2020; Milakovich & Wise, 2019). Furthermore, effective faculty engagement, including content delivery, material availability, response to student inquiries, and assessment, has been found to be critical in determining students' overall learning experience and academic performance (Kuo et al., 2013)

In the Indian context, the challenges associated with the rapid transition to online education during the Covid-19 pandemic have been widely documented (Khan et al., 2021; Muthuprasad et al., 2021). The digital divide, characterized by limited access to ICT infrastructure and resources, has emerged as a significant barrier to effective online learning for many students in the country (Asadullah & Bhattacharjee, 2022; Kummitha et al., 2021). Moreover, several studies have pointed out the difficulties faced by Indian faculty in adapting to the new mode of teaching, including inadequate training in online teaching methodologies and a lack of familiarity with various digital tools and platforms (Mishra et al., 2020). Given the crucial role of ICT infrastructure and faculty engagement in shaping students' learning experiences in online education, it is essential to gain a better understanding of the factors that contribute to their satisfaction with this mode of learning(Kavitha & Anitha, 2023; Kavitha et al., 2024; Pandey et al., 2022). To this end, this study aims to examine the impact of ICT infrastructure and faculty engagement on the overall learning experience of Indian students during the Covid-19 pandemic. The Chi-square Automatic Interaction Detector (CHAID) technique is employed to analyze the data collected from a sample of Indian students.

The findings of this study contribute to the growing body of literature on online education during the Covid-19 pandemic, particularly in the Indian context. The insights gained from this research can inform educational policymakers and administrators, as well as faculty members, in developing strategies and interventions to enhance the quality of online education and address the challenges faced by students during these unprecedented times (Crawford et al., 2020). Moreover, this study adds to the understanding of the complex interplay between ICT infrastructure and faculty engagement in determining students' satisfaction with online learning, thereby providing a valuable foundation for future research in this area (Hung et al., 2010; Parkes et al., 2015).

The structure of this paper is as follows: Section two provides a review of the literature on online education during the Covid-19 pandemic, with a particular focus on the role of ICT infrastructure and faculty engagement in shaping students' learning experiences. Section three presents the methodology employed in this study, including the data collection procedures, the sample, and the CHAID analysis. Section four discusses the findings of the study, highlighting the key factors influencing students' satisfaction with online education in the Indian context during the pandemic. Finally, Section five offers conclusions and implications for educational policymakers, administrators, and faculty members, as well as directions for future research.

In conclusion, the Covid-19 pandemic has prompted a significant shift in the global educational landscape, with online education becoming the primary mode of instruction for millions of students. This study seeks to examine the impact of ICT infrastructure and faculty engagement on the overall learning experience of Indian students during this unprecedented period. By employing the CHAID technique to analyze the data collected from a sample of Indian students, this research contributes to the growing body of literature on online education during the pandemic and provides valuable insights for educational stakeholders in addressing the challenges and opportunities presented by this new mode of learning.

2. Literature Review

2.1 ICT Infrastructure

The significance of personal computing devices, such as computers or laptops, cannot be underestimated in the realm of online education. These devices function as a means of connectivity that links students to the wide variety of information accessible on the internet, thereby facilitating their engagement in the process of digital learning (Adedoyin & Soykan, 2020; Moran et al., 2010). The availability of these tools on a personal level has a profound impact that goes beyond basic connectivity. They act as crucial drivers for student involvement and achievement in the field of online education.

Research has indicated that the presence of a personal computer or laptop can significantly influence academic achievements. Access to such gadgets has been identified as a crucial factor in determining student achievement in the context of online learning environments (Adedoyin & Soykan, 2020). Furthermore, research has validated these findings, emphasising the positive association between the accessibility of laptops and elevated levels of student satisfaction, augmented engagement in online learning, and improved academic performance (Masa'Deh et al., 2023; Shanmugapriya et al., 2023)

Nevertheless, it is important to acknowledge that hardware alone is inadequate. A dependable and superior internet connectivity is of equal importance for the success of virtual learning. The establishment of an internet connection plays a crucial role in facilitating students' access to fundamental educational materials, enabling their participation in video conferencing, and promoting their active involvement in diverse online learning pursuits (Jafar et al., 2023; Yusuf & Al-Banawi, 2013). Several academic investigations have illustrated the notable influence that the availability of high-speed internet can exert on students' perceptions of web-based education, as well as their academic successes (Cajurao et al., 2023); Chopra & Chitranshi, 2022 and their likelihood to participate more actively in online discussions and activities (Violante & Vezzetti, 2015). The utilisation of webcams and microphones in online education is of great importance, as they are essential elements of the digital resources that augment the educational process. The incorporation of a vital layer of human interaction can enhance the personability and interactivity of online learning. The utilisation of tools, particularly those designed for video conferencing and virtual discussions, has been noted to considerably augment student engagement and participation in the realm of distance education (Themelis & Sime, 2020). Consistent with this viewpoint, a number of academic studies have observed the favourable influence of incorporating webcams and microphones in online education on students' contentment (Sekelová et al., 2023). Additionally, these tools have been found to promote active participation and foster efficient communication in the digital learning environment (Jafar et al., 2023).

Learning Management Systems (LMS) have emerged as indispensable resources in the field of digital learning tools. Prominent examples of LMS include Moodle, Canvas, and Blackboard. The aforementioned software applications serve to facilitate the task of educational institutions in organising and delivering online courses (Kant et al., 2021; Abburi et al., 2021). A multitude research studies confirmed the existence of a favourable association between the implementation of a Learning Management System (LMS) and enhancements in student engagement, participation, and academic achievement in the context of online education learning (Kant et al., 2021; Sekelová et al., 2023). In addition to Learning Management Systems (LMS), it has been noted that digital collaboration tools, such as Google Docs, Microsoft Teams, and Slack, significantly enhance the collaborative abilities of students. The utilisation of these instruments enables prompt cooperation among learners in team-based tasks and undertakings, thereby augmenting communication and fostering a shared outlook within the digital learning environment (Hyman et al., 2022). The integration of digital assessment tools, such as quizzes, tests, and assignments, provides a reliable method for instructors to evaluate students' comprehension of subject matter and provide valuable feedback(Yang & Wu, 2012). The application of these assessment tools associated with improved scholastic performance, motivation, and self-regulation within the realm of distance learning (Yang et al., 2020; Yang & Wu, 2012).

The integration of multimedia content - including videos, animations, and simulations - has indisputably transformed the presentation of course materials in online learning environments. This shift not only stimulates student engagement and motivation but also has been linked to enhanced student performance and overall learning outcomes (Darmayanti et al., 2022; Lacka & Wong, 2019). As such, the implementation of dynamic and engaging multimedia content has ascended to a position of indispensability in fostering an immersive and enriching online educational experience. In parallel with these developments, the advent of cloud storage services such as Google Drive, Dropbox, and OneDrive has fundamentally redefined the manner in which students engage with their academic materials. Empowered by the capability to store and retrieve educational resources from any location possessing an internet connection, students are now able to navigate their learning materials with unprecedented ease and flexibility (Hyman et al., 2022). This newfound accessibility has far-reaching implications, as several studies have underscored the positive effects arising

from the utilization of cloud storage services. Such benefits encompass improved student access to course materials, heightened learning experiences, and the facilitation of more efficient collaboration and communication within online learning environments (Moran et al., 2010)

Alongside these digital tools, the availability of technical support services by educational institutions plays a critical role in ensuring smooth online learning experiences. These services offer invaluable assistance in resolving any technical issues students might encounter in their learning journey, thereby minimizing disruptions and maintaining a steady learning pace(Landrum et al., 2020). The provision of technical support has been linked to improved student satisfaction, higher retention rates, and better engagement and performance in online (Landrum et al., 2020; Sekelová et al., 2023; Yang et al., 2020; Alamayrah et al., 2022). The presence of such support systems underscores the importance of a well-rounded, holistic approach to online education that accounts for both academic and technical needs. The significance of ICT infrastructure elements in students' online learning experiences was emphasized by several researchers. In order to ensure effectively access to high-quality online education, it is vital that students have access to fundamental resources such as a computer or laptop, reliable internet connectivity, a webcam and microphone, a learning management system, online collaboration tools, online assessment tools, multimedia content, cloud storage, and technical support. In order to enhance the quality of online education and provide every student an equal chance to learn, educational institutions need to invest in high-quality ICT infrastructure.

2.2 Faculty Engagement

Online education necessitates the strategic application of effective pedagogical strategies, which serve as a linchpin in driving student engagement and improving learning outcomes. Various research studies underscore the success of active learning approaches, encompassing group work and case studies, which act as catalysts for enhanced student engagement and performance (Müller & Mildenberger, 2021; Shi et al., 2019; Vedhathiri, 2022). Further reinforcing this perspective, it has been observed that problem-based learning (PBL) and inquiry-based learning (IBL) strategies have led to improved student engagement, honed critical thinking abilities, and elevated learning outcomes in online courses (Jafar et al., 2023). Transitioning to another essential facet of online education, the role of consistent instructor presence and communication emerges as pivotal in fostering a sense of community and fortifying student engagement (Stillman-Webb et al., 2023). Empirical evidence suggests a positive correlation between robust instructor presence, streamlined communication channels, and parameters such as student satisfaction and perceived learning outcomes (Prakasha et al., 2023; Stillman-Webb et al., 2023). The use of synchronous communication tools, including video conferencing and chat platforms, further enriches student engagement and in stills a stronger sense of community within online courses (Themelis & Sime, 2020).The role of timely instructor feedback and effective communication between students and instructors becomes increasingly apparent in influencing student engagement and learning outcomes (Gray & DiLoreto, 2016; Gupta et al., 2024). This underscores the importance of proactive instructor involvement and open communication channels in sculpting an enriching online learning environment. Moreover, the competency of instructors in navigating technology is a cornerstone for delivering effective online instruction. This proficiency is observed to be positively associated with student engagement and satisfaction (Magruder & Kumar, 2018; Martin et al., 2021). In particular, instructors' comfort with online tools and their prowess in incorporating multimedia content in teaching practices enhance student engagement and learning outcomes (Martin et al., 2021).

Inextricably linked to the aforementioned elements is the design and organization of online courses, which yield a considerable impact on student learning outcomes. Factors such as the clarity of online course content and its organization shown to resonate positively with student satisfaction and perceived learning (Waheed et al., 2016). Furthermore, the deployment of coherent course structures, clearly articulated learning objectives, and transparent assessment criteria have been linked to heightened student engagement and improved learning outcomes (Martin et al., 2021) The adoption of core course design principles such as alignment, interaction, and feedback significantly ameliorates student satisfaction and learning outcomes (Li et al., 2020). Finally, in the realm of online education, implementing effective feedback and assessment mechanisms is vital in fostering student learning and engagement. Numerous studies corroborate the

positive association between efficacious feedback and assessment methodologies and enhanced student engagement and performance (Li et al., 2020; Muthuprasad et al., 2021b). Incorporating strategies such as formative assessment, peer feedback, and regular engagement with students can substantially amplify student engagement, critical thinking abilities, and learning outcomes(Serrano et al., 2019).

3. Methodology

The research methodology of this study aimed to better understand the online learning and knowledge experiences of students in India during the COVID-19 pandemic, specifically focusing on the interaction between ICT infrastructure and teacher participation.

3.1Sampling strategy: A comprehensive online questionnaire was employed to collect data from 348 participants across India. The study used a convenience sampling approach, targeting students currently enrolled in online courses during the pandemic. The sample size provided a diverse representation of the student population experiencing the shift to online education. Despite the constraints on sample size for CHAID analysis, the method has been effectively applied in primary data analysis in various studies (Kabra & Bhichkar, 2011).

3.2 Participant demographics: The participants included students from various educational levels, age groups, genders, and geographical locations within India. This diverse sample allowed for a broader understanding of the challenges and successes experienced by students during the pandemic.

3.3 Interview process: In addition to the questionnaire, unstructured interviews were conducted with thirty students selected using a purposive sampling approach. These interviews were held via phone and video conferences and aimed to gather in-depth information about students' learning and knowledge experiences in online courses. The interviews were audio-recorded and transcribed for analysis. Thematic analysis was used to identify emerging patterns and themes in the data.

3.4 Questionnaire development: The questionnaire was developed based on students' comments and perceptions of online teaching. It was designed to gather information on various aspects of students' online learning experiences, including their satisfaction with course content, faculty engagement, and the availability of ICT resources. The content validity of the questionnaire was ensured through a review by experts in the field of online education, and a pilot test was conducted to establish its reliability.

3.5 Data analysis Strategy: The CHAID algorithm, a supervised machine learning technique, was selected for data analysis due to its ability to handle both quantitative and qualitative data simultaneously (Pedregosa et al., 2011). Unlike the CART algorithm, which necessitates a post-hoc pruning process (Breiman, 2017), CHAID is efficient as it requires no such step. Moreover, CHAID is particularly suited for our categorical data, unlike the QUEST algorithm that is tailored for binary splits and assumes a continuous outcome variable (Shih, 2004). CHAID's capability to generate nodes with multiple categories is critical for our analysis, providing a clear advantage over the binary-only splits of CART and QUEST. The algorithm was employed to identify relationships between categorical response variables and other categorical predictor factors, helping to reveal patterns in the data set (Kass, 1975). Prior to data analysis, any missing data were addressed through multiple imputation, and necessary assumptions were made and tested. The CHAID algorithm has been extensively used in educational research (Ramaswami & Bhaskaran, 2010; Tatli, 2018; Önder & Uyar, 2017; Firat, 2017), further supporting its suitability for the present study.

The CHAID (Chi-squared Automatic Interaction Detection) decision tree algorithm is a non-parametric method used to identify relationships between a categorical response variable and one or more categorical predictor variables. The algorithm builds a decision tree by iteratively splitting the data into subgroups based on the predictor variables that provide the most significant association with the response variable, as determined by the chi-square test of independence.

Outline of the CHAID algorithm:

The CHAID algorithm does not have a specific formula like regression models, as it is a tree-based algorithm that relies on iterative data partitioning

based on the chi-square test. The main statistical component in the algorithm is the chi-square test, which assesses the independence between predictor and response variables.

The chi-square test formula is:

$$\chi^2 = \sum_{i=1}^{k} \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

χ^2 is the chi-square test statistic,

O_{ij} is the observed frequency in each cell (i, j) of the contingency table,

E_{ij} is the expected frequency in each cell (i, j) of the contingency table,

calculated as E_{ij} = (row_i_total * column_j_total) / grand_total.

By employing this comprehensive research methodology, the study aimed to provide valuable insights into the online learning experiences of students during the COVID-19 pandemic, with a focus on the roles of ICT infrastructure and faculty engagement.

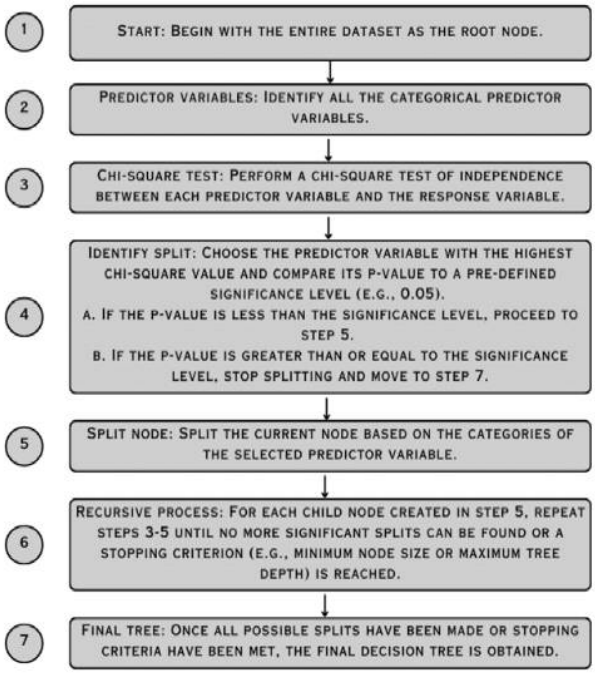

Fig. 1 : CHAID Algorithm Decision-Making Process

4. Results

4.1 Students overall online learning experience with ICT

The CHAID decision tree model was employed to gain a deeper understanding of the factors that contribute to students' overall online learning experience. A variety of input factors were considered, such as computer expertise, power backup, devices for attending online courses, personal computer availability, separate rooms, IT help, and virtual laboratories. The analysis generated a two-stage model, leading to the creation of two root nodes and three terminal nodes, which provided insights into the most significant factors affecting online learning experience. In the initial stage of the analysis, it was found that the availability of a separate room had the most substantial impact on students' overall online learning experience (χ2=43.524, df=2; p<.05). The first node revealed that, in the absence of a separate room, the online learning experience for 156 students was predominantly negative, with 82 students predicted to be dissatisfied, while only 14 satisfied and 60 neutral. This highlights the importance of having a dedicated space for online learning, as it appears to greatly influence students' satisfaction levels. Conversely, node two showed that when a separate room is available for attending online courses, the online learning experience for 192 students is more balanced, with 66 satisfied, 80 neutral, and 46 dissatisfied. This finding underscores the significance of a dedicated room for online learning, as it tends to foster a more neutral or satisfactory experience for the majority of students. Based on these findings, node two was promoted to the status of a root node, which subsequently generated two terminal nodes, identified as node three and node four.

In the second stage of the analysis, the availability of a virtual lab was identified as the most influential factor for overall online learning experience (χ2=18.713, df=2; p<.05). Node three displayed the classification results when a virtual lab is not available, predicting that students' overall online learning experiences would be classified as 36 satisfied, 68 neutral, and 37 dissatisfied. This indicates that, without access to a virtual lab, students' online learning experiences are characterized by a mixed response, with a tendency towards neutral outcomes. In contrast, node four demonstrated that when a virtual lab is provided during online courses,

students' overall online learning experiences improve considerably, with 30 students predicted to be satisfied, 12 neutral, and only 9 dissatisfied. These findings clearly emphasize the positive impact of virtual lab availability on students' online learning experiences, as it leads to increased satisfaction levels. In conclusion, the CHAID decision tree analysis revealed that the availability of separate rooms and virtual labs are crucial factors in determining students' overall online learning experience. Ensuring access to dedicated spaces for online learning and providing virtual labs can significantly enhance students' satisfaction with their online education.

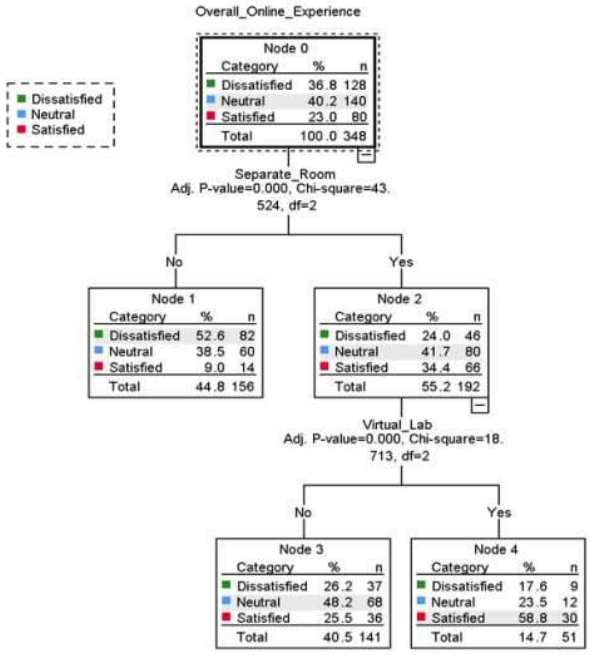

Fig. 2 : CHAID decision tree on overall student learning experience with ICT tools

4.2 Overall student learning experience with faculty engagement

In this study, researcher sought to investigate the overall student experience in relation to faculty-related factors within an online learning context. A CHAID (Chi-squared Automatic Interaction Detection) decision tree analysis was employed to explore the relationship between various faculty attributes and the overall student online learning experience. The independent variables under investigation included faculty content delivery, video quality, audio quality, response to students' queries, interaction with students, material availability, e-resource availability, learning management system, and availability of recorded class videos. Among these factors, faculty content delivery emerged as the sole significant predictor of total student online learning experience.

The CHAID decision tree analysis generated a single root node and three terminal nodes. The root node was identified as faculty content delivery, which effectively divided the entire student online learning experience into categories based on the quality of content delivery ($\chi 2$=94.47, df=4; p<.05). Node one, also known as a child node or terminal node, contained 128 responses. If faculty content delivery was rated as poor or fair, the responses were classified into Node one. Out of these 128 responses, 75 were predicted to be dissatisfied, 47 neutral, and 6 satisfied. This finding underscores the importance of high-quality faculty content delivery in online classes; if content delivery is subpar, a majority of students are likely to perceive their learning experience as unsatisfactory. Node two consisted of 82 responses, wherein faculty content delivery was classified as very good or excellent. In this node, 46 responses were predicted to be satisfied, 28 neutral, and 8 dissatisfied. This indicates that a positive student learning experience is strongly associated with the quality of faculty content delivery. It is evident that when faculty members deliver high-quality content, students find it easier to understand and learn, leading to a more satisfying online learning experience. This observation supports the commonly held notion that students' online learning experiences are significantly enhanced when faculty content delivery is of exceptional quality. Node three included responses where the quality of faculty content delivery was deemed good. In this node, a total of 138 responses were categorized, with 45 being dissatisfied, 65 neutral, and 28 satisfied. While the overall satisfaction rate in this node is not as high as in Node two, it still highlights the importance of good-quality content delivery in shaping students' online learning experiences.

The CHAID decision tree analysis revealed the critical role of faculty content delivery in determining the overall student online learning experience. The study supports the idea that effective content delivery contributes to higher student satisfaction levels in online classes. As online learning continues to grow in popularity, institutions and faculty members must focus on improving content delivery to enhance the quality of education and ensure a positive learning experience for all students. Other faculty-related

factors such as video and audio quality, interaction with students, and material availability, while important, were not found to be significant predictors in this analysis.

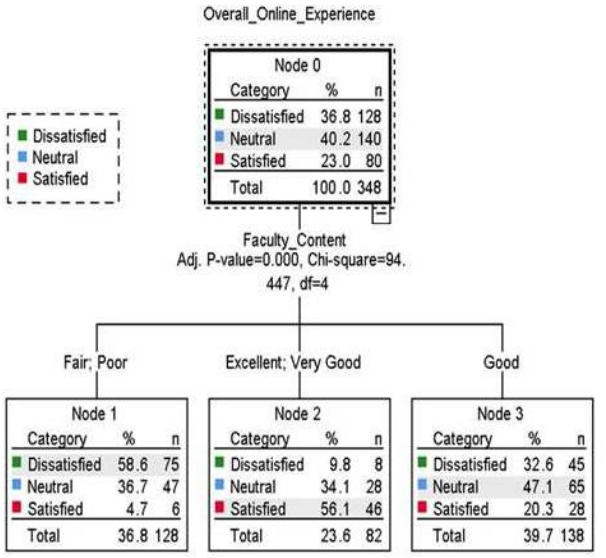

Fig. 3 : CHAID decision tree on overall student learning experience with faculty engagement

5. Discussion

The results of this study provide valuable insights into the role of faculty-related factors and ICT-related factors in shaping students' overall online learning experience. The findings are consistent with previous research that emphasizes the importance of faculty content delivery in determining students' learning outcomes (Martin Eberhard & Tarpenning, 2006; Martin et al., 2021; Sekelová et al., 2023). High-quality content delivery has been recognized as an essential element in elevating students' satisfaction levels in online education, substantiated by both the findings of this study and previous research conducted in the field of online education(Martin Eberhard & Tarpenning, 2006; Sekelová et al., 2023). To optimize this, educators should focus on interactive and multimedia content delivery methods, incorporating tools such as video lectures, interactive quizzes, and discussion forums to enhance engagement and understanding. In addition to highlighting the importance of high-quality content delivery, this study also underscores the significance of a dedicated room or learning space specifically designed for online education. Creating an optimal learning environment with a dedicated space can contribute to enhanced student engagement, focus, and overall satisfaction in online learning(Jayakumar et al., 2022; Kumar et al., 2021). Educational institutions should consider providing guidelines for students on setting up a conducive learning space at home or offering dedicated on-campus facilities for online learning. This finding is particularly relevant in the context of the rapid growth of online learning, as educational institutions need to ensure that students have access to appropriate learning environments in order to succeed.

Furthermore, study reveals a positive impact of incorporating virtual labs on students' online learning experience, which aligns with previous research findings. The correlation between the use of virtual labs and improved student outcomes strengthens the existing body of knowledge, emphasizing the value of integrating virtual labs in online education(Evstatiev et al., n.d.; Muslim et al., 2022; Desai et al., 2022; Fitriyana et al., 2024). It is recommended that institutions invest in developing or acquiring virtual lab resources, which provide hands-on learning experiences in disciplines where practical skills are essential. Additionally, training faculty to effectively use and integrate these virtual labs into their curriculum is crucial.

Conclusion

In conclusion, this study contributes to the understanding of factors that shape students' online learning experience. The findings highlight the significance of high-quality content delivery and the provision of dedicated learning spaces in online education. They reinforce previous research demonstrating the positive impact of faculty-related factors and ICT-related factors on student outcomes. To maximize the effectiveness of online learning, it is crucial for educators and institutions to focus on developing engaging, interactive content and to assist students in creating or accessing effective learning environments. Moreover, the study underscores the importance of incorporating virtual labs, as they enhance students' online learning experience. Educational institutions should prioritize the integration of virtual labs into the curriculum, particularly in subjects requiring practical skills, to provide a more comprehensive and hands-on learning experience.

These findings have practical implications for educational institutions aiming to optimize online learning environments and improve student satisfaction. By prioritizing high-quality content

delivery, creating dedicated learning spaces, and integrating virtual labs, institutions can enhance the overall online learning experience and facilitate student success in the rapidly growing field of online education. Furthermore, this study suggests a need for continued research in this area. Future studies could explore the implementation of these recommendations across different disciplines and learning styles, and investigate the long-term impacts on student engagement and academic success. This ongoing research will be vital in adapting online education to the evolving needs of students and the educational landscape.

Limitation of the study

The current study admits several methodological limitations that might be pursued for future research initiatives. The current sample size, although sufficient for preliminary investigations, is quite small and may impose constraints on the extent of CHAID decision tree analysis. A larger dataset would likely result in more robust and statistically significant stratifications. Moreover, the exclusive classification of students based on their academic year provides a possibility for future research into the effects of online education within several disciplines of engineering, perhaps revealing significant variations. Furthermore, although nominal data was adequate for the purposes of this research, future studies might benefit from the utilisation of ordinal or interval data. This would enable the application of a wider range of statistical techniques, hence improving the reliability and providing more detailed analysis of participant responses.

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