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Evaluating Synchronous And Asynchronous Online Learning In India's GAFBE System During COVID-19

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Abstract

Over 1.6 billion students worldwide were momentarily displaced due to the COVID-19 pandemic, which caused an unprecedented disruption in education. Officials responded by providing online learning in two ways: synchronous (live video classes) and asynchronous (self-paced digital content, such as the DIKSHA app) in India's Government-Aided Free Basic Education (GAFBE) system. While synchronous learning offers a real-time classroom experience, asynchronous learning "gives a flexible approach" to students. This study thoroughly assesses these modalities for basic education using the Cognitive Analytics Management (CAM) framework.

We used Value-Focused Thinking (VFT) with stakeholders (students, parents, teachers, principals, and administrators) to extract their primary educational objectives and concerns for synchronous online instruction using CAM's cognitive dimension. In order to identify recurring themes in asynchronous learning feedback, we extracted 47,707 user reviews (≥5 words) from the DIKSHA app and performed Latent Dirichlet Allocation (LDA) topic modeling.

Important conclusions include:

- ***VFT analysis of strategic objectives**: Stakeholders emphasized five key areas: governance, social equity issues, technical/infrastructure support, healthcare/safety measures, and the quality of instruction and training.*
- ***DIKSHA review themes (analysis using LDA)**: Content quality, learning impact, app experience/usability, content/course management, technical issues, teaching quality, and content assessment were among the eight main topics that surfaced.*

These findings highlight each mode's strengths (such as excellent curriculum content and active teaching methods) as well as common problems (such as device and connectivity issues, content updates, and a lack of real-time support). The recommendations from this integrated CAM analysis are practical and include strengthening digital infrastructure and access, improving teacher preparation for online pedagogy, optimizing learning platforms (particularly for content delivery and updates), and addressing socioeconomic barriers to ensure that all students have access to education. These observations can help educators and legislators improve their approaches to education technology in the event of a crisis.

***Keywords:** Right to Education, Cognitive Analytics Management (CAM) framework, Value-Focussed Thinking (VFT), Topic Modeling, Government aid free basic education (GAFBE)*

1. INTRODUCTION

Education was recognized as a fundamental right by the Universal Declaration of Human Rights (1948), and India upheld this by implementing programs like the Right to Education Act (2010) and Sarva Shiksha Abhiyan (2002), which guarantee free education for children ages 6 to 14 through public schools in the Indian context [1]. But these efforts were severely hampered by the COVID-19 pandemic, which affected more than 1.6 billion students worldwide. In March 2020, India imposed a nationwide lockdown.

To maintain education in the GAFBE system, the Indian government responded by implementing online learning via synchronous (like Zoom and Google Meet) and asynchronous, like the DIKSHA app which makes online learning easier by mapping a set of learning paradigms as offered by the synchronous mechanism through content and support for skill development, but in a flexible way that allows them to use their time whenever they want. DIKSHA app has also played a major role in bridging the learning gap in rural areas [2]. Assessing these modes' efficacy is essential for well-informed policymaking.

Both ways are evaluated in this study using the Cognitive Analytics Management (CAM) framework. The Value-Focused Thinking (VFT) method is used to assess synchronous learning through stakeholder insights, and topic modeling of DIKSHA app reviews is used to analyze asynchronous learning. An efficient and successful substitute for using students to understand teaching and learning experiences is topic modelling [3]. Combining topic modeling with qualitative research can be very helpful for education researchers because it helps them better understand and improve asynchronous online learning environments [4]. A thorough and innovative assessment of online learning within the GAFBE system is provided by the combined analysis.

2. LITERATURE REVIEW

a. COVID-19 and the Right to Education

The right to education was seriously disrupted by the COVID-19 pandemic, particularly in India's GAFBE system. Around 247 million students were affected by August 2020, and 71% of Class 2 students had difficulty with basic reading skills [5]. This resulted in significant learning loss. Lack of digital devices, poor internet access, and low motivation were major obstacles that made it hard to continue education [6].

b. Online Learning: Synchronous and Asynchronous

By removing the requirement for physical presence, online modalities have greatly benefited the educational paradigm by making education more accessible [7]. In the context of educational stakeholders who have historically had limited access for social and economic reasons, online modalities are even more crucial. Thus, in all forms of education, online modalities are still becoming more and more popular [8]. Online learning, on the other hand, is a "complex function of doing, communicating, thinking, feeling, and belonging, which is a common mechanism in both online and offline" [9,10]. Following the onset of COVID-19, online modalities also proved helpful in the Right to Education for GAFBE systems case. The Indian government introduced synchronous and asynchronous bi-directional online modalities to help students create an independent learning environment [11–13]. In the synchronous configuration of online modalities, students participate in live classes using well-known platforms such as Zoom and Google Meet, among others (usually with free or default services offered), and they communicate with the instructor and other students in real time [14]. This creates a face-to-face equivalent of in-person or physical classes [13]. Additionally, these classes can be recorded for a flexible post-learning opportunity [15,16]. Existing research has also shown that students who may be shy in a traditional classroom setting are more likely to open up in an online environment [17]. In order to guarantee a positive learning environment, the Indian government, acting through the Ministry of Education, launched the DIKSHA app, which allowed students in GAFBE systems to learn asynchronously [6,18]. Here, the app included tutorials, tests, and lessons to help students learn the same or related material that had previously been taught to them in a synchronous setting. This made it easier for students who had time, resource, or availability constraints to get an education whenever it was most convenient for them. Current studies have examined how asynchronous modalities can improve deep learning, lessen resource anxiety, and help students develop their response mechanisms [12,13,19].

c. The Framework for Cognitive Analytics Management (CAM)

To direct technology interventions for the benefit of stakeholders, the CAM framework combines the dimensions of management, analytics, and cognition [20].

- **Cognitive**: Determines the values, difficulties, and objectives of stakeholders.
- **Analytics**: Supports decision-making through data-driven techniques (such as modeling, simulation, and optimization).
- **Management**: Converts observations into tactical suggestions for digital transformation, change management, and policy.

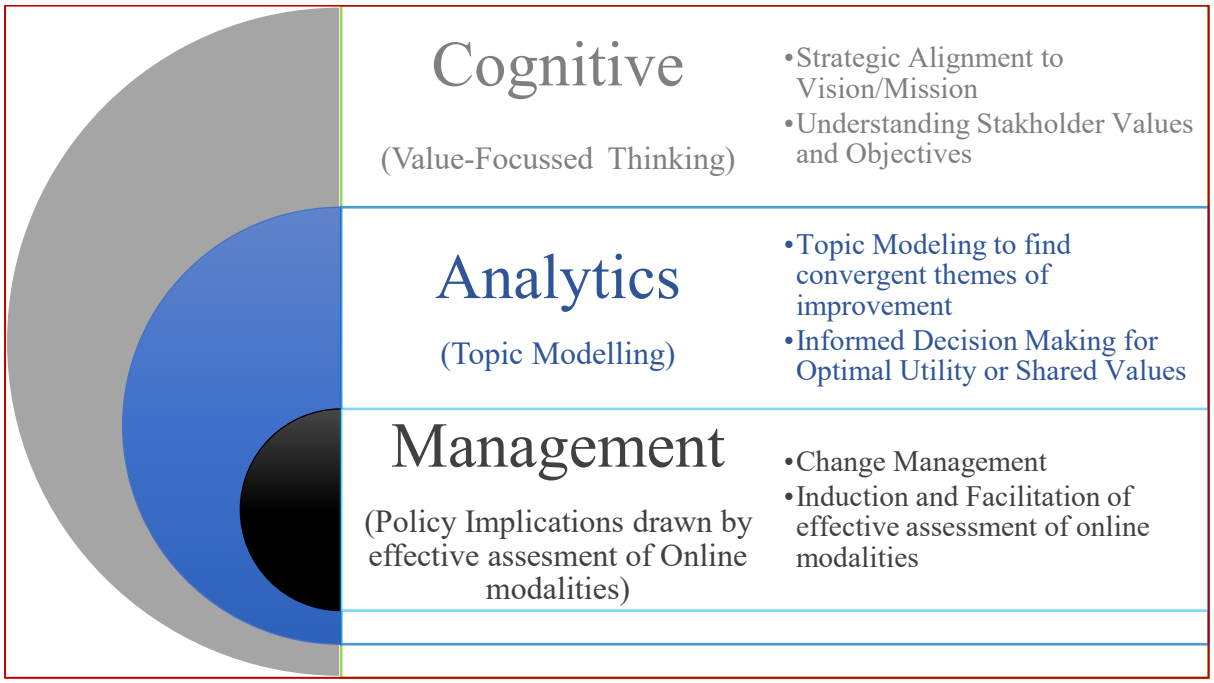

Figure 1: A representation of Cognitive Analytics Management (CAM) Framework with key tenets of the research premise

With its roots in theories like Big Data Analytics and Social Cognition, CAM prioritizes the creation of shared value and puts the human element at the center of assessing technology-driven educational solutions.

3. METHODOLOGY

In this paper, we have used CAM framework created by Osman et al [20] and using this framework, we applied Value Focused Thinking (VFT) [21,22]for synchronous online part in the Cognitive aspect and asynchronous part by evaluating the DIKSHA app's review data using Topic Modeling [23,24]in the Analytics aspect. We lastly built convergence on the evaluation of Cognitive and Analytics dimension findings [25]. The process flow of methodology is shown in Figure 2 below:

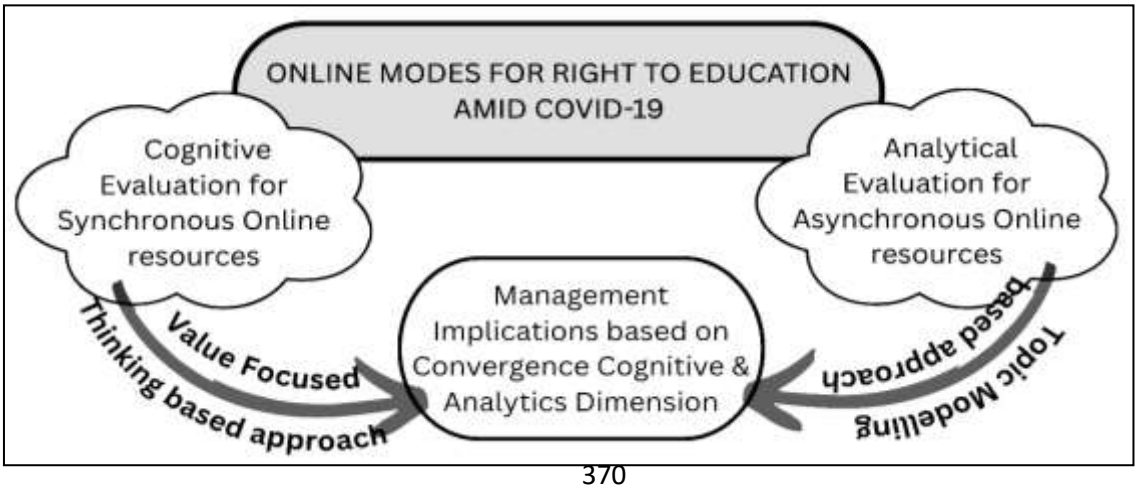

Figure 2: A representation of Cognitive Analytics Management (CAM) Framework with key tenets of the research premise

a. Cognitive structuring using VFT

Over the past 30 years, Value-Focused Thinking (VFT) has been used a lot to figure out what stakeholders need and come up with the best solutions in a wide range of situations, including strategic planning, sustainability, and cybersecurity [21,26,27]. VFT finds out what stakeholders value, turns those values into basic goals, and makes sure they are in line with strategic goals. Using the CAM framework, this study's main goal is to look at how synchronous online modalities for the Right to Education work in GAFBE systems during the COVID-19 pandemic. Structured questions were used to get input from a wide range of stakeholders, including parents, students, teachers, principals, and education administrators, in order to figure out basic and strategic goals. These insights show important problems, chances, and points of view from stakeholders that are important for making online education better.

The breakdown of key stakeholders consulted during this study is shown in Table 1:

Table 1: A detail on stakeholder interaction

S. No.	Stakeholder	Number of stakeholders interviewed	Duration of each interview
1	Parents/Guardians	14	~15-30 minutes
2	Students	21	~10-30 minutes
3	Teachers or Faculty Members	16	~15-30 minutes
4	Principals	7	~15 minutes
5	Administrative Authorities	5	~15 minutes

We reached out to primary schools or nearby locations to interact with guardians or schools, which are our above mentioned key stakeholders. The discussions with other stakeholders, like authorities, also involve the use of online tools like Zoom, based upon their availability.

The VFT process collected data in five steps. First, stakeholder baseline values were found and turned into goal-oriented fundamental objectives. These were then put together into bigger strategic goals that all worked toward the main goal of effectively evaluating synchronous resources for the Right to Education in GAFBE systems during the COVID-19 pandemic.

Defining the Objectives ➡ Structuring Objectives ➡ Hierarchical visual of Objectives

Develop Solution/alternative with policy implications ⬅ Strategic Goal function

b. Analytical structuring using Topic Modeling

Researchers are using text mining techniques to find useful information in the growing amount of text data on digital platforms like blogs, apps, and reviews [28]. Text mining is when computers look at a lot of unstructured text [29,30]. You can find patterns in this text easily with topic modeling. Topic modeling, especially probabilistic methods like Latent Dirichlet Allocation (LDA), is very popular in both research and practice [24,31]. People think of it as a scalable alternative to traditional content analysis [32].,

The distributional hypothesis says that words that are used in similar situations usually mean the same thing. This is how LDA works [30]. It thinks of documents as groups of topics and topics as groups of words. This means that themes can be found in more than one text. For example, "moonlight," "sunshine," and "temperature" could all have something to do with the weather. LDA can pick up on small differences, like polysemy, which is when a word like "Ford" can mean a president, a car, or a businessman. It does

this by giving each topic a word probability (β) and each document a topic probability (γ). These numbers show how complicated natural language is.

Researchers from many fields are using text mining techniques to look at the growing body of written information on the internet and related digital artifacts like apps, blogs, reviews, and more [28]. Text mining is the use of computer methods to find useful information in a large collection of text data [29,30]. Topic modeling is a specific method used in text mining to find patterns in a text corpus that are called topics. Topic modeling is a new but powerful way to look at a lot of unstructured text data in a very efficient and scalable way [30]. Existing research also looks at topic modeling as an automated way to do content analysis, which is based on traditional qualitative analysis methods [32].

In the last ten years or so, researchers and practitioners have paid a lot of attention to the probabilistic topic modeling approach as a way to mine large amounts of text data [31]. The Latent Dirichlet Allocation (LDA) model is an example of a probabilistic topic modeling approach that can find topics in a large number of documents and assign each document to a specific topic [24,33]. The main idea behind these algorithms comes from the distributional hypothesis of linguistics, which says that "words that occur in the same context tend to have the same meaning or essence" [30]. For example, if a group of newspaper articles all use the same words like moonlight, wind, pleasant, sunshine, temperature, and so on, this could mean that they are all talking about the same thing, which could be the weather. So, topic models use a relational approach to figure out what topics are and how they relate to each other. The focus on relationships also helps topic models find polysemy, which is when the same word is used in different ways to mean two different things. For example, the word "Ford" can mean a US president, a car, or the name of a famous businessman.

LDA is a way of looking at each document as a mix of topics and each topic as a mix of words. So, the topics don't stand alone; they usually overlap, which is how natural language is used. Every document is a mix of words that show that Document 1 can have x% of Topic A and y% of Topic B. Words in each document can also come from both entertainment and education. The topic model defines certain probabilities, such as β probabilities, which are the chances of a word being a US president or a car. For example, the word "Ford" can have a 50% chance of being a US president and a 50% chance of being a car. The LDA model also defines γ probabilities, which tell you the probability of each document being about a certain topic. Figure 3 below shows a schematic chart of the LDA model to help you understand the method better:

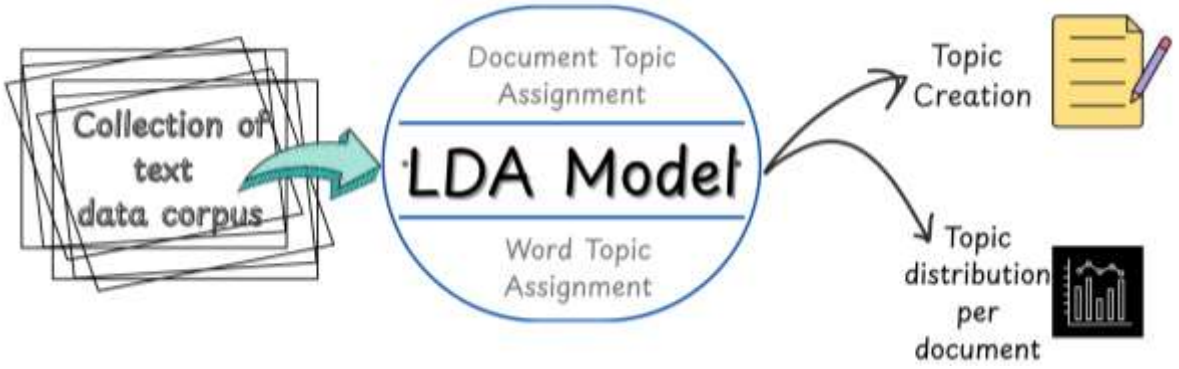

Figure 3: Schematic view of LDA based topic modeling approach

For the topic modeling process, we have scraped the review data from DIKSHA app which is a source of asynchronous mode with 141857 review data points. For making our research more practical and realistic, we considered the reviews only with length >= 5 words. This left us with a total of 47707 review data points, through which we recognized 8 topics that are identified through the automated topic modeling approach of LDA.

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RESULTS

We present results from the CAM framework's analytics and cognitive dimensions. The GAFBE system's assessment of synchronous online resources was organized by the cognitive analysis, which was founded on Value-Focused Thinking (VFT). VFT assisted in identifying the core goals that stakeholders value most. Subsequently, these were categorized into strategic goals that correspond with the overall strategic objective.

Based on the identified fundamental objectives through the stakeholder interaction using the VFT process, we can further classify these fundamental objectives under 5 broad categories of strategic objectives. These strategic objectives are - Teaching and Training, Technical and Infrastructure, Social, Governance and Healthcare.

Figure 4 presented below gives the hierarchical structure of fundamental objectives aligned to the strategic objectives and the strategic objectives aligned to the strategic goal of effective evaluation of synchronous online resources for teaching in GAFBE systems during the COVID-19.

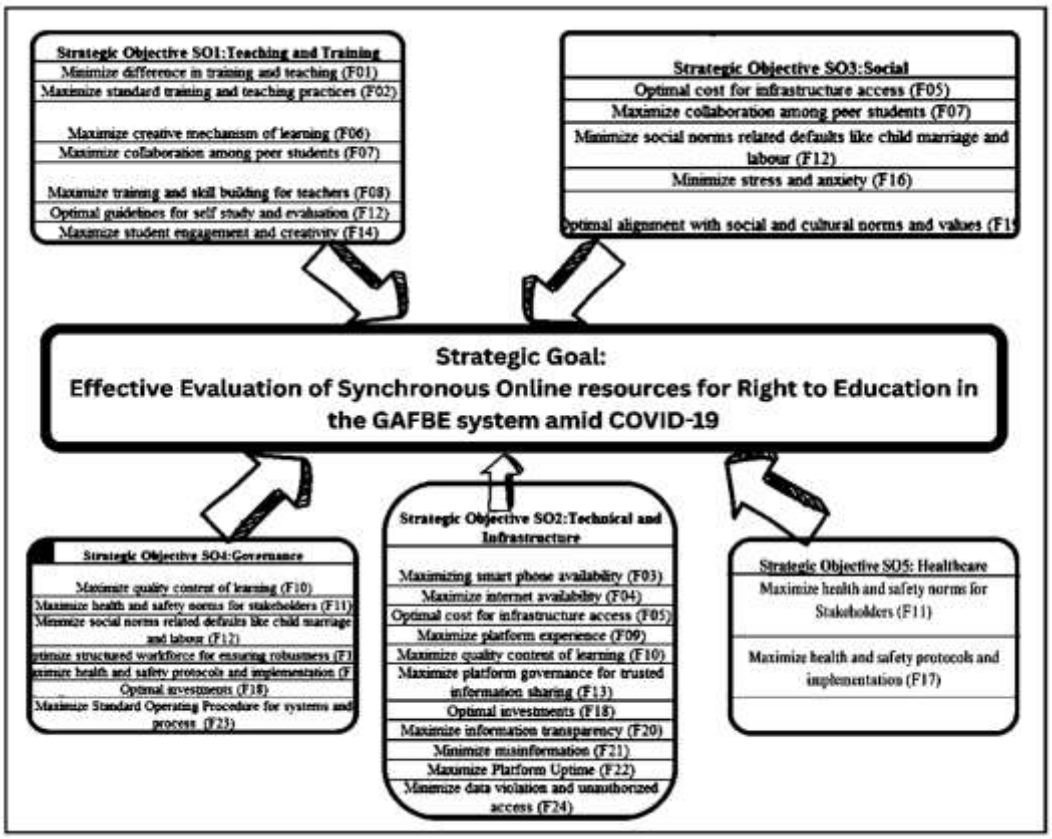

Figure 4: Schema of fundamental and strategic objectives aligned to strategic goal through VFT

Once a qualitative assessment of synchronous online resources is done using the VFT based approach, we are now good to go with topic modeling for the Analytics dimension of the CAM framework for effective evaluation of the asynchronous online resources primarily through the review data generated by the DIKSHA app.

The first thing to do is to go through the topics that were made and rank them based on how well they fit together. The coherence score shows how easy it is for people to understand a certain topic. Some keywords are found along with their chances of being related to the topic, which adds to the coherence score. One tries to get the coherence score value as high as possible. Figure 5 shows that maximum coherence value is reached with 8 topics in this case.

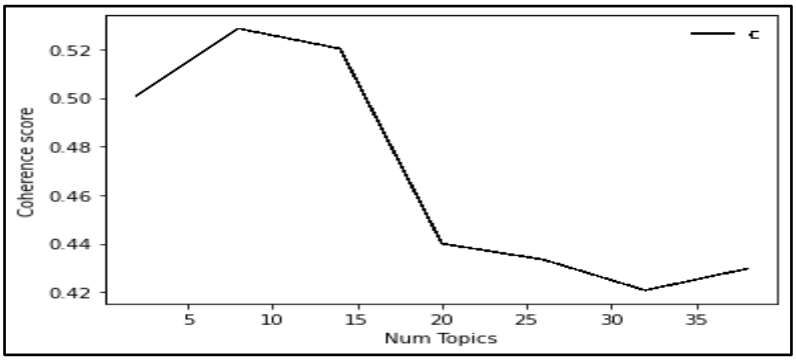

Figure 5: Coherence score graph of variation in number of topics

To find the suitable topics, let us iterate from 2 to 38 to find the maximum coherence score at 8 no. of topics as shown in the Table 2.

Table 2: Coherence value for various number of topics

Topic Number	Coherence Value		Topic Number	Coherence Value
2	0.501		26	0.433
8	0.528		32	0.421
14	0.52		38	0.429
20	0.44			

The visualization of topics generated by the LDA model are given in Figure 6 which shows the overlapping or non-overlapping of each of the 8 topics. Topic 2, 3 and 7 are completely unique, formative and non-overlapping, whereas the other six topics viz.1,4,5,6,8 have overlapping components in terms of common words and interpretations.

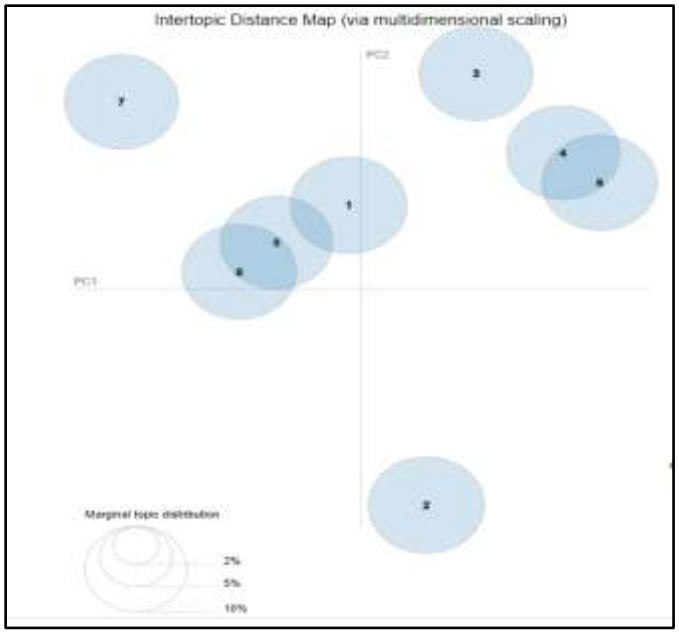

Figure 6: Inter-topic distance mapping through LDA model

The LDA model found key words for each topic, which are shown in Figure 7 below. These keywords help you find important information about the hidden artefacts in the DIKSHA app's review data.

Topic 1 (content management on app)	Topic 2 (technical artefacts)	Topic 3 (teaching and learning quality)	Topic 4 (content assessment)	Topic 5 (content curation and quality)	Topic 6 (content)	Topic 7 (learning impact)	Topic 8 (App experience)
complete	problem	teacher	good	good	video	nice	app
show	work	student	teacher	study	content	give	bad
certificate	open	learn	learning	student	book	learn	time
training	properly	easy	education	class	subject	make	full
download	time	understand	teaching	helpful	lesson	application	slow
issue	fix	helpful	platform	important	question	excellent	experience
unable	option	child	knowledge	online	add	great	lot
update	phone	school	experience	teacher	find	thing	poor
day	solve	teach	improve	amazing	chapter	good	super
module	update	interesting	provide	material	answer	lot	install

Figure 7: Top Keywords of each topic

4. DISCUSSION

The management dimension of the CAM framework is informed by insights from both the cognitive (VFT) and analytical (LDA) analyses. VFT identified five key strategic objectives for synchronous learning in GAFBE: teaching and training, technical infrastructure, social challenges, governance, and healthcare. These highlight core issues such as inadequate SOPs, infrastructure gaps, social concerns, and the need for clear governance and health protocols. LDA-based topic modeling of DIKSHA app reviews revealed eight main themes for asynchronous learning: content quality, learning impact, app experience, content management, technical issues, teaching quality, and content assessment. Challenges include update/download problems, lack of real-time responsiveness, and technical limitations, although teaching quality and curated content were generally well-received.

Some important principles are outlined below, which are based on the convergent understanding that was created during the COVID-19 pandemic by the synchronous and asynchronous online modalities of the GAFBE systems:

- The availability of infrastructure and technical support to a diverse range of stakeholders from various economic backgrounds is the most significant dubious assumption. Online modalities won't succeed until the government adopts an ideal investment narrative and provides assistance to the relevant stakeholders.
- Although asynchronous content curation appears to be standardized and of high quality, it is difficult to overcome this factor by providing teachers with appropriate training for synchronous online modalities, which is necessary to guarantee the overall success of online modalities.
- The technical platform needs to be optimized for asynchronous learning in particular because there are a lot of issues with course management, such as downloads and updates to the course status, which cause confusion and problems for the stakeholders. GAFBE systems should improve the quality of the apps while also attempting to improve teacher proficiency in order to engage students in the most creative way possible when using synchronous tools like Zoom, Google Meet, etc.
- Some specific causes of concern include the social ramifications of child labor (students working for daily wages because schools are closed) and even early marriage, which should be prevented by appropriate governance measures. GAFBE systems should offer a platform-driven mechanism for reporting these incidents.
- Lastly, in order to guarantee the safety of all GAFBE stakeholders, including instructors, students, and others, there should be ongoing guidelines, support, and assistance for both forms of online modalities that have emerged as a result of the COVID-19 situation. A core group of GAFBE systems should be available to develop a dynamic change management plan to combat particular emerging circumstances.

5. LIMITATIONS AND FUTURE WORK

By assessing online modalities within GAFBE systems, this study significantly advances the field. It does have some restrictions, though. A smaller and more specialized group of stakeholders served as the basis for the VFT analysis; increasing the number and diversity of these stakeholders could improve the results. VFT provides a representative understanding of the research context, but it is not all-inclusive. Assumptions like a minimum word count in reviews may have an impact on topic generation for LDA-based topic modeling. Future research could incorporate data from other platforms to enhance insights, but this study only looks at the DIKSHA app. A larger text corpus, more diverse stakeholders, and the application of different qualitative or problem-structuring techniques to confirm and expand the findings could all be future enhancements.

6. CONCLUSION

This study adds to what we already know by looking at both synchronous and asynchronous online modes in GAFBE systems together. There hasn't been much research on this topic before. We used VFT within the CAM framework to get feedback from stakeholders on what they thought were the most important parts of synchronous learning. Using LDA to model topics in DIKSHA app reviews gave us information about asynchronous modes. The study ends with useful suggestions for policymakers and practitioners that focus on important areas like social issues, infrastructure, platform and general governance, and healthcare protocols to make online education more effective.

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