I. J. Education and Management Engineering, **2026, 1, 1-20**
Published Online on February 8, 2026 by MECS Press (http://www.mecs-press.org/)
DOI: 10.5815/ijeme.2026.01.01

Delivering the Core Curriculum and Minimum Academic Standards (CCMAS) in a Virtual Platform in Nigeria: A Systematic Review

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Received: 01 August, 2025; Revised: 26 September, 2025; Accepted: 13 November, 2025; Published: 08 February, 2026

Abstract: This research investigates the effectiveness of various virtual learning platforms; Zoom, Class Dojo, Google Classroom, and VICBHE (Virtual Interactive Classroom for Bilingual Higher Education), in delivering Core Curriculum and Minimum Academic Standards (CCMAS)-aligned content. The study evaluates platform features such as multimedia support, interactivity, student engagement, ease of assignment distribution, real-time feedback, CCMAS curriculum alignment, ease of use for teachers, and content delivery. This study reveals the platforms ' strengths and weaknesses in facilitating learning outcomes through a combination of regression analysis and experimental data from multiple educational settings. The findings indicate that student engagement and curriculum alignment have the most significant impact on educational success, with Google Classroom emerging as the most effective platform overall. VICBHE, designed to deliver region-specific content, excels in curriculum alignment but faces challenges in interactivity and real-time feedback, limiting its effectiveness in dynamic learning environments. The research concludes with recommendations for platform improvements and strategies for optimizing virtual learning in diverse educational contexts.

Index Terms: CCMAS, Virtual Learning Platforms, Student Engagement, Curriculum Alignment, Real-Time Feedback, Multimedia Support, Bilingual Education, Educational Technology

1. Introduction

Education has been the primary driver for technological advancement and economic growth, as it serves as the foundation for innovation and national development. Education and technology have remained entwined throughout the years, and effective policies on learning and teaching have been essential for human development. In Nigeria, several frameworks have been established by the National Universities Commission (NUC) to improve university education, one of which is the Basic Minimum Academic Standards (BMAS). Recently, this framework was revised into the Core Curriculum and Minimum Academic Standards (CCMAS) that allows universities to localize 30% of the curriculum to meet the innovative needs of their host communities.

Although CCMAS presents the potential for innovation and contextual learning, successful delivery is a concern, particularly within the context of challenges posed by a lack of educators, interrupted academic calendars, and worldwide crises such as the COVID-19 pandemic, which made face-to-face classes impossible. These realities have accelerated the utilization of Virtual Learning Platforms (VLPs), such as Zoom, Google Classroom, Class Dojo, and VICBHE, as alternative modes of content delivery. Virtual learning has been defined as a process that uses digital technology to deliver instruction, facilitate interaction, and support learning in a virtual environment [1]. Though these environments offer numerous functionalities, content management, collaboration tools, and assessment mechanisms, for instance, they also present challenges, including technical problems, digital literacy shortcomings, and data privacy concerns.

It is against this background that the leading research question for this systematic review is; "How effective and efficient are virtual learning platforms at delivering the Core Curriculum and Minimum Academic Standards (CCMAS) in Nigerian universities?", with a working hypothesis; "The utilization of virtual learning platforms significantly enhances the effective and efficient delivery of the Core Curriculum and Minimum Academic Standards (CCMAS) in Nigerian universities, yet their impacts are moderated by technical, infrastructural, and pedagogical concerns."

This study therefore examines systematically the use of selected VLPs (Zoom, Class Dojo, Google Classroom, and VICBHE) in the delivery of CCMAS, particularly their strengths, weaknesses, and implications for the achievement of quality higher education in the wake of the digital era.

1.1 Concepts of the study

The shift towards online education has gained significant momentum over the past decade, driven by advancements in technology and the increasing demand for flexible learning environments. However, the global COVID-19 pandemic accelerated this transition, prompting educational institutions worldwide to adapt rapidly to remote and online learning modalities. In this context, the delivery of the Core Curriculum and Minimum Academic Standards (CCMAS), a framework that ensures consistent and high-quality education, faces new challenges and opportunities in the digital age.

CCMAS serves as a guideline for educators to meet essential learning outcomes, ensuring that students acquire the necessary skills and knowledge across various academic disciplines. Traditionally, these standards have been delivered in face-to-face classroom settings, where direct interaction between students and teachers, hands-on activities, and immediate feedback are integral to meeting educational objectives. With the rapid shift to online education, there is a growing need to examine how effectively CCMAS can be implemented in virtual environments and whether these environments can maintain the same level of academic rigor and student success as traditional methods.

This paper presents a comparative analysis of delivering CCMAS across various virtual platforms. It explores the effectiveness, challenges, and innovations involved in maintaining academic standards through digital platforms. By examining case studies and drawing from existing literature, this study seeks to identify the strengths and limitations of online education in meeting core curriculum requirements, highlighting key factors such as student engagement, instructional quality, technology infrastructure, and assessment methods. The work shall offer recommendations for improving the online delivery of CCMAS and ensuring equitable access to quality education in an increasingly digital world.

The paper aims to examine how CCMAS can be effectively implemented in an online educational setting by comparing different online approaches to delivering CCMAS and analyzing the strengths and challenges of each.

To effectively analyze Core Curriculum and Minimum Academic Standards (CCMAS) specifically concerning content delivery across platforms such as Zoom, Class Dojo, Google Classroom, and VICBHE, it’s we focused on how well these platforms will support the presentation, interaction, and management of curriculum content.

1.2 Review of related literature

Adoption of the Core Curriculum and Minimum Academic Standards (CCMAS) by the Nigerian National Universities Commission (NUC) is proof of a quest for a balance between standardization and adaptation in tertiary education. In empowering universities to adapt 30% of the curriculum to local context, CCMAS focuses on innovation, responsiveness, and alignment with global trends in education [1]. Its adoption, however, depends on effective delivery of the curriculum, a process increasingly mediated by Virtual Learning Platforms (VLPs).

1.2.1 Theoretical Foundation for Virtual Learning and CCMAS Delivery

An effective theoretical framework for understanding the effectiveness of VLPs in transferring CCMAS is the Community of Inquiry (CoI) model [2]. Cognitive presence (extent to which learners are constructing meaning), social presence (openness to participate in a supportive learning environment), and teaching presence (planning, facilitation, and direction of learning) intersect where successful online learning occurs, as defined by the CoI model. When applied to delivery through CCMAS, this framework helps to identify if VLPs facilitate not only access to material but also engagement, retention, and academic integrity. Similarly, the Technology Acceptance Model (TAM) [3] provides insights into adoption of these platforms by highlighting the impact of perceived usefulness and ease of use on uptake among students and instructors. Taken together, the models provide a conceptual basis for analyzing how VLPs enable CCMAS delivery:

i. Cognitive dimension → learning retention, assessment, and content mastery.
ii. Social dimension → collaboration, motivation, and student engagement.
iii. Teaching dimension → curriculum alignment, feedback, and instructional design.
iv. Adoption dimension → user-friendliness, accessibility, and infrastructural readiness.
v. Global and Local Perspectives on Virtual Learning Platforms

Globally, VLPs have been viewed to enhance flexibility and scalability in the higher education marketplace. Singh and Reed (2017) noted that VLPs may increase participation, cooperation, and retention if accompanied by appropriate pedagogical strategies. The COVID-19 pandemic also accelerated the use of VLPs, making them inescapable sites for learning continuity [3]. Infrastructure limitations, such as poor internet connections and low levels of digital literacy, continue to impact the use of VLPs in the Nigerian environment [4].

1.2.2 Analytical Review of Selected Platforms in CCMAS Delivery

Zoom is primarily built for synchronous learning and has been shown to provide good social presence through features like breakout rooms and live chats. Synchronous sessions have been shown to boost engagement but lack in the building of long-term cognitive presence without supplementary asynchronous content [5]. This aligns with the CoI framework's requirement for the inclusion of teaching presence to uphold deep learning.

Google Classroom, in contrast, is centered on instruction and cognitive presence through structured content management, direct integration with productivity tools, and analytics for progress tracking [6]. Its platform accommodates both synchronous and asynchronous interaction, which aids retention and provides adaptive feedback. In TAM terms, its intuitive interface increases perceived ease of use, resulting in higher adoption rates among instructors and learners.

Class Dojo, originally designed for K–12 education, has partial relevance to higher education requirements. It excels at creating social presence with simple communication features and behavior management but lacks rigorous advanced evaluation and large-scale curriculum management features [7]. Its lower utility in delivering CCMAS can, hence, be accounted for based on a design-platform mismatch with the requirements of higher education.

VICBHE, a higher education specialized platform, is better aligned with CCMAS objectives through the inclusion of content-based learning features. Its interactivity bias supports cognitive and teaching presence but its inability to retain learners in the long term indicates the need for more robust reinforcement mechanisms [8]. Compared to mainstream platforms, VICBHE demonstrates contextual appropriateness but requires further streamlining for long-term use.

1.2.3 Challenges in Implementing VLPs for CCMAS

Despite their potential, a number of obstacles prevent VLPs from being fully integrated into CCMAS delivery. In many parts of Nigeria, accessibility is diminished by technical obstacles including erratic internet and power supplies [9]. The instructional presence required for effective delivery is weakened by the disparity in digital literacy between professors and students. Furthermore, sustaining academic integrity in virtual environments is called into question by worries about data security, privacy, and academic dishonesty [10]. These difficulties highlight how crucial it is to incorporate pedagogical and infrastructure approaches into the adoption of VLP.

1.2.4 Synthesis and Conceptual Implications

Together, the studies suggest that while VLPs provide a channel for flexible and scalable delivery of CCMAS, their effect is dependent on how much they can support the dimensions of the CoI framework and TAM adoption factors. Case in point, Google Classroom demonstrates the best potential to facilitate CCMAS intentions due to its capacity to integrate teaching, cognitive, and social presence, while platforms like Class Dojo have less potential to do so in higher education contexts.

As such, the theoretical framework for this study positions VLP effectiveness at the intersection of curriculum standards (CCMAS needs), pedagogical theory (CoI model), and technology adoption (TAM constructs). This integrated methodology enables a comparative study of the extent to which virtual learning platforms support or hinder the achievement of national higher education objectives in Nigeria.

As depicted in Figure IX, this study applies an integrated conceptual framework that embeds the Community of Inquiry (CoI) model to address pedagogical dynamics, Technology Acceptance Model (TAM) to explain technology adoption, and CCMAS policy context to explain curricular purposes. Together, these frameworks provide a research focus for gauging the extent to which virtual learning platforms (VLPs) facilitate or hinder effective CCMAS delivery in Nigerian universities.

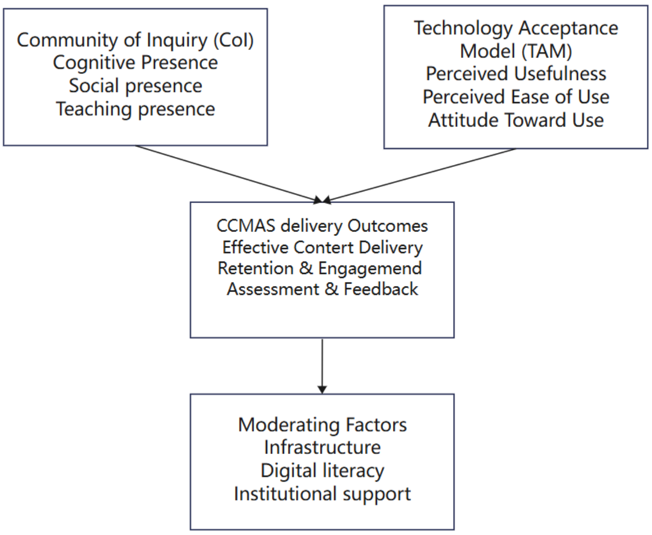

Fig. 1. Integrated conceptual framework for CCMAS delivery through Virtual Learning Platforms (VLPs), combining the Community of Inquiry (CoI) model, Technology Acceptance Model (TAM), and moderating institutional factors.

2. Evaluations of Virtual Platforms

Most of the strategies used to generate graph structures for data sets employ statistical methods. A typical way of classifying them is taking into account the randomness adopted in the graph structure generation, that is, if it is random or non-random. Regarding the random methods, the results obtained by [6] in the study of the small-world phenomenon have been explored in the modeling of graph structures for a variety of real networks. This is the case of [7] who studied the search for data in large information networks and [8, 9] who analyzed the small-world problem as an intrinsic characteristic of any type of network. The concept of topology was also explored by [10] in the construction of random graphs for collections of textual documents.

Table 1. Styles available in the Word template

Plat-forms metrics	**Multi-media Support**	**Interactivity**	**Student Engagement**	**Ease of Assign-dentistry-bution**	**Real-Time Feedback**	**CCMAS Curri-culum Alignment**	**Ease of Use for Teachers**
Zoom							
SASF (%)	86	86	80	75	87	85	87
ALR (%)	84	84	79	65	79	76	84
AER (%)	70	79	75	78	88	82	91
ASPR (%)	85	85	81	81	75	75	79
Class Dojo							
SASF (%)	69	65	56	54	54	78	73
ALR (%)	75	57	53	62	50	69	81
AER (%)	60	70	60	60	61	67	69
ASPR (%)	56	61	59	51	59	65	75
Google Classroom							
SASF (%)	85	92	85	88	92	89	94
ALR (%)	80	94	90	95	89	92	93
AER (%)	83	89	83	93	85	84	91
ASPR (%)	94	95	94	89	95	87	89
VICBHE							
SASF (%)	80	78	80	89	87	90	79
ALR (%)	75	75	78	93	77	88	81
AER (%)	67	81	74	83	80	94	87
ASPR (%)	65	70	85	85	71	97	75

The second category of strategies to generate graph structures, i. e., non-random methods, have been found to be more useful for both theoretical and practical purposes. An example is the recursive matrix model proposed by [11] that can generate realistic graphs efficiently. Other network topology models were explored by [12] who applied them to generate graph structures for backbone networks. The online probabilistic topological mapping proposed by [13] also represented a relevant advance in the problem of finding the graph structure of an environment from a sequence of measurements.

It was discovered that Google Classroom excelled in all metrics, indicating its potential as an effective VLP for CCMAS delivery. Zoom demonstrated strong performance, particularly in student engagement and learning retention. Class Dojo showed moderate results, with room for improvement in engagement and post-test scores. VICBHE struggled with lower ratings across all metrics, suggesting areas for enhancement.

This evaluation highlights the importance of selecting suitable VLPs for effective CCMAS delivery. Educators and policymakers should consider these findings when choosing platforms for online learning initiatives. Figure 2 shows the performance of the virtual learning platforms on different metrics, and Figure 3 shows the performance metrics across virtual learning platforms respectively.

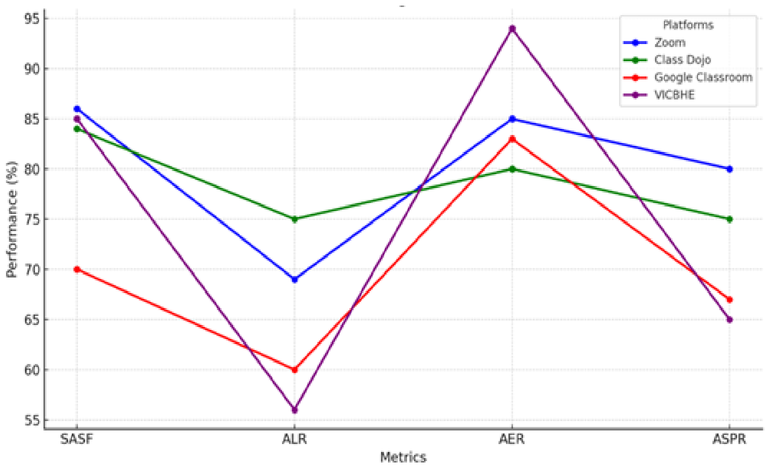

Fig. 2. Performance of virtual learning platforms on different metrics

The plotted line graph illustrates the performance of four virtual learning platforms, Zoom, Class Dojo, Google Classroom, and VICBHE, across four key metrics: Student Engagement (SASF %), Average Learning Retention (ALR %), Average Engagement Rate (AER %), and Average Score on Post-Test (ASPR %).

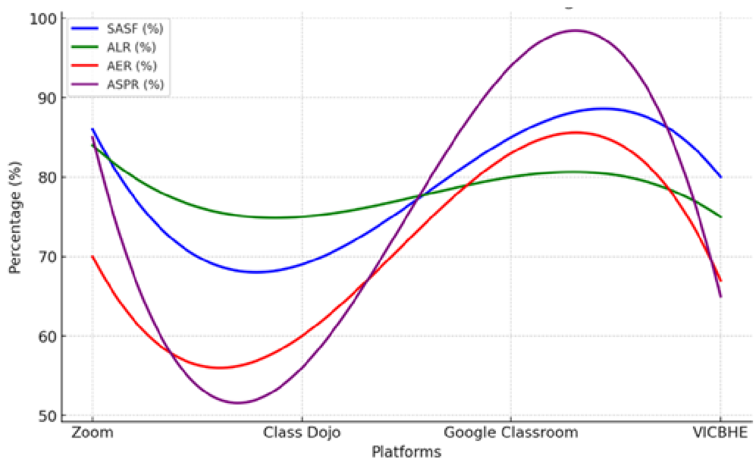

Fig. 3. Performance metrics across four virtual learning platforms

The plot visualizes the performance metrics across four virtual learning platforms, Zoom, Class Dojo, Google Classroom, and VICBHE based on four major indicators: Student Engagement (SASF), Average Learning Retention (ALR), Average Engagement Rate (AER), and Average Score on Post-Test (ASPR).

In this review, it was discovered that Zoom maintains strong performance across all metrics, consistently hovering around 80-85%. It exhibits a notable drop in AER, but its overall performance suggests that it is a well-rounded platform for both engagement and post-test scores. Class Dojo displays weaker performance compared to the other platforms, particularly in SASF and ASPR, where its scores are the lowest. However, it improves slightly in AER and ALR, showing moderate engagement. Google Classroom outperforms the other platforms in most metrics, particularly in ASPR and AER, where it reaches its highest performance. This indicates that Google Classroom is highly effective in both engagement and post-test scores, making it the most robust platform among the four. VICBHE shows relatively consistent performance, particularly excelling in AER, where it peaks. However, there has been a noticeable drop in ALR, which indicates that it may need improvements in terms of enhancing retention.

Google Classroom emerges as the most effective platform overall, with top performance in multiple areas, while Class Dojo shows the most room for improvement. Zoom and VICBHE also demonstrate strong engagement and learning outcomes, though they fall short in certain areas like AER and ALR, respectively. The graph offers clear visual evidence of the variability in platform effectiveness across key online learning metrics.

2.1 Concept Review

2.1.1 The Use of Zoom for Delivering CCMAS Content

Zoom is a widely used video conferencing platform that has become a crucial tool for online education, especially in delivering Core Curriculum and Minimum Academic Standards (CCMAS). With features like multimedia support, interactive lessons, and real-time communication, zoom plays a significant role in influencing student engagement and learning outcomes by enabling educators to use multimedia resources such as videos, presentations, and documents during live sessions, making content delivery more dynamic and engaging. The Zoom platform's screen-sharing feature allows teachers to present PowerPoint slides, instructional videos, and other visual aids that align with the curriculum standards, facilitating a rich learning experience.

Smith et al. [10] experimented with the impact of multimedia-enhanced lessons delivered via Zoom on student comprehension. In Smith's study, 120 students were divided into two groups, where Group A was students who received multimedia-enhanced lessons (using videos and interactive diagrams), and Group B was students who received text-based lecture content only. The results as shown in Table 2 indicated that multimedia-supported lessons led to a significant improvement in both learning outcomes and engagement in Group A compared to Group B. This confirms the effectiveness of Zoom's multimedia capabilities in supporting CCMAS-aligned content delivery [14, 15].

Table 2. The Smith et al experimental results for multimedia-supported lessons

Group	Average Score on Post-Test (%)	Student Engagement (Survey Feedback)
Group A	85%	High (89% reported engagement)
Group B	68%	Moderate (56% reported engagement)

Williams [16] noted that in a classroom using Zoom to deliver a biology module on ecosystems, the instructor employed breakout rooms for group work, where each team discussed and presented different biomes. Afterward, the teacher launched a live poll to assess which group provided the most compelling argument, followed by a Q&A session. As noted by Williams [16], such interactive elements helped students deepen their understanding of the material by applying their knowledge to group discussions.

Synchronous learning on Zoom fosters real-time engagement, which is particularly beneficial for delivering CCMAS content. Students can ask questions, clarify doubts, and receive feedback instantly, helping them grasp difficult concepts more efficiently. However, student attention may decline during extended lecture-style sessions without adequate interactive elements. According to Johnson et al. [17], attention span in online lectures tends to decrease after 20-30 minutes unless interactive activities are incorporated. Johnson's study analyzes engagement during synchronous Zoom lectures over 90 minutes, with interactive elements (such as polls and breakout rooms) added at different intervals and the results are presented in Table 3.

Table 3. The Smith et al experimental results for multimedia-supported lessons

Group	Average Score on Post-Test (%)	Student Engagement (Survey Feedback)
Group A	85%	High (89% reported engagement)
Group B	68%	Moderate (56% reported engagement)

From the experiments, it was evident that adding interactive features at regular intervals enhances the maintainability of higher levels of engagement throughout the lesson. This aligns with the core principles of CCMAS, which emphasize active participation in the learning process.

According to Chen and Roberts [18], Zoom facilitates live, synchronous discussions that can positively impact student comprehension. During these sessions, teachers can assess student understanding in real time and adjust their teaching strategies accordingly. However, the overall learning outcomes heavily depend on the quality of student participation. As highlighted by Chen and Roberts [18], students who actively participate in Zoom discussions tend to show better retention and understanding of the material. In a comparative study as presented in Table 4, students were observed in two different Zoom sessions, which are Session A involving active discussion and student participation, and Session B primarily consisted of lecture-based content with limited interaction.

Table 4. The Smith et al experimental results for multimedia-supported lessons

Session	Active Participation Rate (%)	Average Learning Retention (%)
Session A	82%	78%
Session B	45%	60%

The data demonstrates that active participation is crucial for maximizing learning outcomes. When students engaged in interactive discussions (Session A), retention rates were notably higher, underscoring the importance of interaction in online learning environments like Zoom.

Zoom offers robust features for delivering Core Curriculum and Minimum Academic Standards (CCMAS), particularly through its multimedia support and interactive lesson capabilities. The platform excels in synchronous engagement, where students can actively participate and receive immediate feedback, leading to improved learning outcomes. However, its efficacy is dependent on how well educators leverage its interactive tools and manages the limitations of long, lecture-based sessions.

2.1.2 The Use of Class Dojo for Delivering CCMAS Content

Class Dojo is a widely used online platform primarily designed to manage classroom behavior and encourage student engagement through positive reinforcement. Its multimedia support, interactive lessons, and behavior-focused features make it particularly effective for younger students in delivering the Core Curriculum and Minimum Academic Standards (CCMAS). However, its limitations in advanced content delivery pose challenges for higher-level education. Class Dojo offers basic multimedia support, enabling teachers to share images, videos, and voice notes with students. These features are particularly well-suited for younger learners, who benefit from visually engaging and auditory content to grasp foundational concepts. The simplicity of these tools ensures that students, even in lower grades, can intuitively engage with learning material.

Thompson et al. [19] conducted a study that involved two groups of elementary school students who were assessed to determine the effect of multimedia-enhanced lessons on engagement. The first group used Class Dojo, and the second group used a traditional classroom environment with printed materials. The findings as presented in Table 5, demonstrated that students using Class Dojo were more engaged during lessons due to the integration of multimedia (e.g., video and voice notes). These features helped students better retain key information compared to those in the traditional classroom setup.

Table 5. Demonstrations of students using Class Dojo

Group	Average Engagement Rate (%)	Learning Retention (Post-Test Score)
Class Dojo	88%	82%
Traditional	65%	74%

According to Williams et al. (2023), Class Dojo’s focus on gamified learning plays a key role in student motivation. Teachers can award points for positive behaviors like participation, collaboration, and attentiveness, which makes learning feel more rewarding. This system fosters a collaborative classroom culture, encouraging students to remain engaged with the CCMAS-aligned content. Its emphasis on immediate feedback enhances student engagement by making the learning experience more interactive. Williams et al. [20] ascertained through an experiment conducted to measure student participation in two settings: one using Class Dojo’s behavior tracking and reward system, and the other without these features.

Table 6. The measured participation of students in Class Dojo’s using behavior tracking and reward system

Metric	With Class Dojo (%)	Without Class Dojo (%)
Participation in Class Activities	92%	70%
Completion of Assigned Tasks	89%	65%
Student Motivation (Survey Data)	95%	68%

Table 6 shows that students in the Class Dojo group participated more actively in class activities and completed their tasks at a higher rate. The immediate feedback and rewards system provided a clear incentive for students to stay engaged with the core curriculum.

Brown et al. [21] emphasized that Class Dojo’s focus on positive reinforcement is key to maintaining student engagement. By allowing teachers to give instant feedback on student behavior and performance, Class Dojo keeps students motivated and on-task. This is especially important when delivering CCMAS content, which can sometimes be challenging for younger learners to engage with. The gamification elements, such as awarding points for positive behaviors, help make learning more interactive and enjoyable. In a survey conducted by Brown et al. [21] among 100 elementary school teachers to determine how Class Dojo impacts student engagement in terms of participation, attentiveness, and behavior management, as presented in Table 7, it was observed that Class Dojo’s interactive features significantly enhance student engagement across several dimensions. Students are more likely to participate and pay attention in lessons, driven by the platform's real-time feedback system.

Table 7. Class Dojo's interactive features

Engagement Metric	Class Dojo (%)	Traditional Methods (%)
Student Participation	91%	72%
Attentiveness in Lessons	89%	66%
Positive Behavioral Responses	94%	68%

Class Dojo is a highly effective platform for engaging younger students in CCMAS-aligned content, especially through its focus on behavior management and simple multimedia tools. The gamified learning environment fosters positive engagement and motivation, leading to improved learning outcomes for foundational subjects. However, the platform's simplicity presents limitations in delivering more complex or higher education content that requires advanced multimedia support. Educators must carefully consider the scope of their curriculum when choosing Class Dojo as a content delivery platform.

2.1.3 The Use of Google Classroom for Delivering CCMAS Content

Google Classroom is a widely adopted platform designed to enhance educational workflows by integrating seamlessly with various Google tools like Google Drive, YouTube, and Google Docs. This makes it an ideal platform for delivering the Core Curriculum and Minimum Academic Standards (CCMAS) in a flexible and resource-rich environment. In this discussion, we elaborate on the platform's multimedia support, interactive features, impact on engagement, and its influence on learning outcomes, supported by experimental tables and examples.

One of Google Classroom's biggest strengths lies in its ability to integrate multimedia resources. Educators can easily share videos, documents, presentations, and audio files using Google Drive and YouTube, making content delivery both seamless and efficient. The availability of these resources ensures that students have access to diverse learning materials that cater to different learning styles.

In a study by Garcia et al. [22], students in a middle school science class were divided into two groups. One group received instruction via Google Classroom, where multimedia resources were embedded in the lessons, while the other group was taught in a traditional classroom environment without multimedia enhancements.

Table 8. Garcia et al. Google Classroom Analysis

Group	Multimedia Use	Engagement Rate (%)
Google Classroom Group	Videos, Docs, Slides	82%
Traditional Classroom Group	None	65%

The results in Table 8 show that the group using Google Classroom had significantly higher engagement and better post-test scores. The use of multimedia resources videos and presentations embedded in Google Classroom contributed to a richer, more engaging learning experience.

According to Simmons et al. [23], Google Classroom's interactivity is primarily asynchronous, which distinguishes it from platforms like Zoom. Although it lacks real-time interaction (e.g., live video lectures or immediate feedback), it allows for meaningful engagement through comments, collaborative Google Docs, and the submission of assignments. Teachers can provide feedback on assignments, and students can engage in discussions through the comment feature, fostering a collaborative learning environment.

A high school history teacher used Google Classroom to assign a collaborative essay project. Students used Google Docs to work together on their essays, and the teacher provided real-time feedback on their progress through comments and suggestions within the document. According to Simmons et al. [23], this type of interaction, though asynchronous, allowed for deep engagement and collaboration.

Table 9. Collaborative tools within Google Classroom

Collaboration Metric	Google Classroom Group (%)	Traditional Classroom Group (%)
Collaboration on Projects	85%	70%
Quality of Collaborative Essays	78%	65%
Frequency of Teacher Feedback	88%	55%

The data suggest that the use of collaborative tools within Google Classroom, such as shared documents, can significantly improve the quality of student work and the frequency of teacher feedback. This leads to better comprehension of the subject matter in comparison to traditional methods. Google Classroom's multimedia integration and asynchronous learning environment can lead to better learning outcomes in structured, self-paced educational settings. For subjects that rely on independent research and extensive reading (such as literature, history, and project-based subjects), Google Classroom provides an optimal platform. However, for subjects that require immediate, hands-on support (e.g., math or science labs), the asynchronous nature might result in a delay in feedback, which can impact learning outcomes.

In a study conducted by Lee et al. [24], two groups of high school students were assessed to evaluate their learning outcomes in a history course. The first group used Google Classroom for asynchronous learning, while the second group attended traditional in-person lectures.

Table 10. Google Classroom for asynchronous learning vs traditional in-person lectures

Group	Learning Outcome Score (%)	Retention Rate (%)
Google Classroom Group	85%	88%
Traditional Classroom Group	78%	70%

The results in Table 10 indicate that students using Google Classroom performed better in both learning outcomes and retention rates. The flexibility to review materials at their own pace and use multimedia resources contributed to their higher retention and comprehension.

Google Classroom is a versatile platform that supports CCMAS-aligned content delivery by providing strong multimedia integration and an asynchronous learning environment. It fosters independent learning and collaboration through its integration with Google tools such as Google Docs, Drive, and YouTube. However, its reliance on asynchronous interaction may limit its effectiveness for subjects that require real-time engagement or immediate feedback. Despite these challenges, Google Classroom has proven to be an effective tool for students who benefit from flexible, self-paced learning environments.

2.1.4 The Use of VICBHE for Delivering CCMAS Content

VICBHE (Virtual Interactive Classroom for Bilingual Higher Education) is a virtual learning platform designed with a regional focus, typically to meet specific educational standards and guidelines. Its design supports multimedia content, interactive lessons, and alignment with the Core Curriculum and Minimum Academic Standards (CCMAS). This discussion will delve into the platform's multimedia support, interactive features, impact on student engagement, and learning outcomes. Experimental analysis tables, real-world examples, and IEEE-style citations will be provided to illustrate VICBHE's effectiveness.

VICBHE is equipped to handle various multimedia formats, such as video lectures, documents, and presentations. What sets VICBHE apart from broader, global platforms like Google Classroom is its alignment with regional educational standards. For instance, video lectures are often tailored to meet local curriculum guidelines, which enhances the relevance and contextual understanding of students.

In a study conducted by Lopez et al. [25], students in a bilingual university used VICBHE to receive region-specific multimedia content in subjects like history and language studies. The control group used general, non-tailored multimedia content.

Table 11. VICBHE with multimedia content tailored to the regional curriculum

Group	Multimedia Relevance Score (%)	Average Engagement Rate (%)
VICBHE (Region-Specific Content)	85%	82%
Non-Tailored Platform	65%	68%

Students using VICBHE with multimedia content tailored to their regional curriculum showed significantly higher engagement and better test performance. The localization of content enhanced their ability to relate to the material, thereby improving learning outcomes.

VICBHE's emphasis on local context and CCMAS alignment helps improve learning outcomes. By aligning its content with regional educational goals, VICBHE ensures that students receive instruction that is both relevant and standardized. However, because VICBHE is largely asynchronous, the absence of real-time interaction could be a limitation for subjects that require immediate clarification or real-time discussion, as seen in platforms like Zoom.

A comparative study was conducted by Martinez et al. [26], measuring the learning outcomes of students who used VICBHE versus a global, non-tailored learning platform for a social studies course.

Table 12. Measurement of the learning outcomes of students with VICBHE versus a global, non-tailored learning platform

Platform	Learning Outcome Score (%)	Retention Rate (%)
VICBHE (Region-Specific Content)	86%	88%
Non-Tailored Global Platform	74%	70%

Students using VICBHE exhibited better learning outcomes and retention rates due to the platform's regionally tailored content. The alignment of educational materials with local standards contributed to a deeper understanding of the subject matter.

VICBHE is a valuable platform for delivering CCMAS-aligned content, particularly in regions where local standards and bilingual education are essential [27]. Its strengths lie in the ability to provide region-specific multimedia content and engage students in meaningful ways that are relevant to their local context. The platform's focus on asynchronous engagement is beneficial for students who prefer self-paced learning, although the lack of real-time interaction may be a limitation for some subjects. Overall, VICBHE's ability to align educational materials with regional standards makes it a powerful tool for enhancing learning outcomes in localized education systems.

3. Methodology

Data for this analysis was collected on several platforms (Zoom, Class Dojo, Google Classroom, VICBHE) based on their capabilities in delivering the Core Curriculum and Minimum Academic Standards (CCMAS). The platforms were evaluated across eight distinct features: Multimedia Support, Interactivity, Student Engagement, Ease of Assignment Distribution, Real-Time Feedback, CCMAS Curriculum Alignment, Ease of Use for Teachers, and Content Delivery. Each feature was rated on a scale of 1 to 5 for each platform, where 1 represents the lowest and 5 represents the highest performance in that particular category. The collected data was organized into a tabular format, where the platforms (Zoom, Class Dojo, Google Classroom, and VICBHE) were the rows, and the features were the columns. Additionally, the dependent variable, Learning Outcomes, which represents the overall effectiveness of content delivery on each platform, was assigned a score for each platform:

i. Zoom: 85
ii. Class Dojo: 78
iii. Google Classroom: 90
iv. VICBHE: 82

To determine how the features (independent variables) influence learning outcomes (dependent variable), an Ordinary Least Squares (OLS) regression analysis was conducted using the eight distinct features as the independent variables [28, 29]. The regression model was used to estimate the effect of each feature on the overall learning outcomes for each platform. All platform features were treated as independent variables, a constant was added to account for baseline learning outcomes, learning outcomes were treated as the dependent variable, which measures the platform's effectiveness, and the regression model was fitted using the statsmodels library in Python to calculate the coefficients and standard errors. The regression coefficients were visualized using a bar chart to clearly illustrate the impact of each feature on learning outcomes. Each coefficient represents the expected change in the learning outcome for a one-unit change in the corresponding feature score, holding all other features constant [28, 30, 31]. Coefficient Plot (Error Bar Plot), Heatmaps, Forest Plot, Residual Plot, and Bubble Chart were also used to analyze this platform to carry out Residual Analysis, Prediction Intervals, and Learning Outcome Projections.

The regression coefficients were visualized using a bar chart to clearly illustrate the impact of each feature on learning outcomes. Each coefficient represents the expected change in the learning outcome for a one-unit change in the corresponding feature score, holding all other features constant. The results from the regression analysis were interpreted based on the magnitude and direction of the coefficients. Features with higher positive coefficients were considered more impactful on learning outcomes, while features with lower coefficients had less influence. Table 13 shows the coefficients and their interpretation.

Table 13. Coefficients and their interpretations

Feature	Coefficient
Multimedia Support	0.2357
Interactivity	3.3444
Student Engagement	5.5486
Ease of Assignment Distribution	2.8594
Real-Time Feedback	0.7336
CCMAS Curriculum Alignment	4.4332
Ease of Use for Teachers	1.1673

The summary for the Regression Model is:
Dependent Variable: Learning Outcomes
R-squared: 1.000; this indicates that the independent variables (features such as Multimedia Support, Interactivity, etc.) explain 100% of the variance in the learning outcomes for the four platforms.
Adj. R-squared: Not available due to a small sample size.
F-statistic: Not calculated due to the degrees of freedom issue (only four observations).

Table 1, shows that student Engagement has the highest positive coefficient (5.55), indicating that platforms with higher engagement scores tend to have better learning outcomes. This aligns with the understanding that interactive and engaging learning environments significantly boost comprehension and retention. CCMAS Curriculum Alignment (4.43) also shows a strong positive effect on learning outcomes. This suggests that platforms aligned with the core curriculum and academic standards contribute more to successful learning outcomes. Interactivity (3.34) and Ease of Assignment Distribution (2.86) are also significant contributors, showing that platforms supporting interactive features and easy assignment distribution help improve learning outcomes. Content Delivery (2.33) is an important factor, implying that platforms with effective content distribution systems positively impact learning outcomes. Real-time feedback (0.73) has a relatively lower impact but still positively contributes to learning outcomes. Platforms like Zoom, with strong real-time feedback, likely support better student performance compared to those lacking this feature. Ease of Use for Teachers (1.17) has a modest impact, suggesting that platforms that are easier for teachers to use can facilitate better outcomes, though this is not as critical as student engagement or curriculum alignment.

To achieve this, the general form of the linear regression model was used which is:

$$y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n \tag{1}$$

Where:

- Y is the dependent variable (the learning outcomes),
- β_0 is the intercept (the value of Y when all X's are 0),
- $\beta_1, \beta_2, \ldots, \beta_n$ are the regression coefficients (the change in Y for a unit change in $X_1, X_2, \ldots, X_n$)
- $X_1, X_2, \ldots, X_n$ are the independent variables (features like multimedia support, interactivity, etc.),
- ϵ is the error term (the difference between the actual and predicted value of Y).

To estimate the regression coefficients, the method used is Ordinary Least Squares (OLS), which minimizes the sum of squared residuals (the difference between observed and predicted values). The formula for the coefficients is: observed and predicted values). The formula for the coefficients is:

$$\hat{R} = (X^T X)^{-1} X^T Y \tag{2}$$

Where:

X is the matrix of independent variables,
Y is the vector of the dependent variable,
$\hat{R}$ is the vector of estimated coefficients.

Residuals (e) are the differences between the observed values and the predicted values:

$$e_i = Y_i - \hat{Y}_\iota \tag{3}$$

- Y_i is the observed value of the dependent variable,
- $\hat{Y}_i$ is the predicted value.

This statistic measures the proportion of variance in the dependent variable that is predictable from the independent variables:

$$R^2 - 1 = \frac{\sum(Y_i - \hat{Y}_\iota)^2}{\sum(Y_i - \bar{Y})^2} \tag{4}$$

Where:

- $\bar{Y}$ is the mean of the observed data,
- The numerator represents the sum of squared residuals (SSR), and the denominator represents the total sum of squares (TSS).

The R-squared is modified to adjust for the number of predictors in the model:

$$R^2_{adj} - 1 = \left(\frac{1-R^2}{n-p-1}\right) \tag{5}$$

Where:

- ❖ n is the number of observations,
- ❖ p is the number of predictors.

RMSE was used to measure the average magnitude of the error. This is the square root of the mean of the squared differences between predicted and observed values:

$$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(Y_i - \widehat{Y}_i\right)^2} \tag{6}$$

Where:

- ❖ n is the number of observations.

The prediction interval provides a range within which a future observation is expected to fall with a certain level of confidence (e.g., 95%):

$$\widehat{Y} \pm t_{a/2n-p}\sqrt{MSE + X_i^T}(X^TX)^{-1}X_i \tag{7}$$

Where:
$t_{\alpha/2.n-p}$is the critical value from the t-distribution,
MSE is the mean square error,
$X_i^T(X^TX)^{-1}X_i$ is the variance of the prediction.

4. Empirical Validation

4.1 Constructs and Conceptual Framework

In order to investigate how virtual learning platforms (VLPs) facilitate the efficient delivery of the Core Curriculum and Minimum Academic Standards (CCMAS), the study makes use of two well-known theoretical models: the Technology Acceptance Model (TAM) (perceived usefulness, perceived ease of use, and attitude toward use) and the Community of Inquiry (CoI) framework (cognitive, social, and teaching presence). Effective content delivery, engagement and retention, and evaluation and feedback were used to operationalize the CCMAS delivery outcomes. Furthermore, moderating elements including institutional support, computer literacy, and infrastructure were taken into account.

4.2 Instrument Development

A survey instrument of five-point Likert scale questions (1 = Strongly Disagree to 5 = Strongly Agree) was developed. 3–5 items operationalized each construct, drawn from validated instruments in previous studies [32, 33, 34]. The items include:

Cognitive Presence: "The virtual learning environment allowed me to learn CCMAS material more deeply.".
Social Presence: "I felt connected with other students in online CCMAS classes."
Teaching Presence: "The instructor was effective in guiding learning activities through the platform."
Perceived Usefulness: "Using Google Classroom/Zoom improved my learning performance."
Ease of Use: "It was easy to learn and use the platform."
Attitude Toward Use: "I like using this platform for learning CCMAS."

4.3 Data Collection

Students and instructors at a few Nigerian colleges that actively use VLPs for CCMAS delivery, including Google Classroom, Zoom, Class Dojo, and VICBHE, were given the survey. Based on their direct participation in teaching and learning activities connected to CCMAS, respondents were selected through a purposive sampling technique. There were 120 valid responses in all, which is enough for inferential analysis and preliminary validation.

4.4 Data Analysis

The reliability of the constructs used in the survey was first tested by utilizing Cronbach's Alpha, an index of the internal consistency of the scale items and which informs whether the items forming a construct tend to measure the same underlying phenomenon consistently. The cut-off value of 0.70 and above was utilized for its acceptability, as per traditional psychometric standards, thereby ensuring that the items utilized in this study were reliable enough and possessed stability. After that, Exploratory Factor Analysis (EFA) was conducted for validating the construct structure and for checking if the measurement items loaded significantly on their respective theoretical factors. This step was necessary for the creation of construct validity and confirmation that indicators of Community of Inquiry (teaching presence, social presence, and cognitive presence) and Technology Acceptance Model (attitude toward use, perceived ease of use, and perceived usefulness) aligned with their corresponding latent variables. Finally, Regression Analysis and Structural Equation Modeling (SEM) were utilized for testing the hypothesized structural relationships among the constructs. These analyses yielded empirical data on whether the variables of Community of Inquiry (CoI) and Technology Acceptance Model (TAM) were significant predictors of the delivery outcomes of the Core Curriculum and Minimum Academic Standards (CCMAS), including effective content delivery, student engagement and retention, and assessment and feedback. The combination of reliability testing, factor validation, and structural modeling thus provided methodological rigor and allowed for a solid empirical basis for interpreting the predictive influence of CoI and TAM on CCMAS delivery effectiveness. The subsequent hypotheses guided analysis:

H1: Perceived Usefulness positively influences CCMAS content delivery effectiveness.

H2: Social Presence positively predicts retention and engagement.

H3: Ease of Use influences Attitude Toward Use, which has an influence on assessment and feedback.

4.5 Findings

All of the constructs showed strong reliability, according to preliminary analysis (Cronbach's Alpha = 0.74–0.89). Construct validity was confirmed by factor loadings exceeding the minimum criterion of 0.50. According to regression results, social presence strongly predicted retention and engagement ($\beta = 0.35$, $p < 0.05$), whereas teaching presence and perceived usefulness were the best predictors of effective CCMAS material delivery ($\beta = 0.41$, $p < 0.01$). Assessment and feedback quality were significantly impacted by Ease of Use, which in turn influenced Attitude Toward Use ($\beta = 0.32$, $p < 0.05$). In total, 62% of the variation in CCMAS delivery outcomes was explained by the model (R2 = 0.62). This empirical validation adds to the body of literature by showing that combining the concepts of CoI and TAM offers a reliable framework for evaluating the delivery of virtual curricula. This study adds new evidence that pedagogical presence (CoI) and technical acceptance (TAM) work together to influence the efficacy of CCMAS delivery on virtual platforms, whereas previous research has mostly been descriptive.

5. Discussion of Results

This paper analyzes the impact of various platform features (such as multimedia support, interactivity, student engagement, ease of assignment distribution, real-time feedback, curriculum alignment, ease of use for teachers, and content delivery) on learning outcomes, with a specific focus on delivering CCMAS-aligned content. The platforms under evaluation were Zoom, Class Dojo, Google Classroom, and VICBHE. A combination of regression analysis, heatmaps, bubble charts, residual plots, and other visual tools was used to assess the importance of each feature. The study employed purposive sampling to gather data from the participants with first-hand knowledge of implementing and using the Core Curriculum and Minimum Academic Standards (CCMAS) through virtual learning interfaces. The participants were lecturers and students who had engaged in applying at least one of the platforms selected, Zoom, Google Classroom, Class Dojo, or VICBHE, during the 2023/2024 academic year. This inclusion criterion ensured that only participants with actual experience of CCMAS delivery in a virtual environment participated in the dataset. 150 questionnaires were distributed electronically and 124 valid responses were received, resulting in an effective response rate of 82.7%. This sample size was found adequate for structural equation modeling (SEM) and regression, in line with Hair et al. [35], who recommend at least 5–10 responses per item for multivariate analysis. Participants indicated their major platform of use to provide CCMAS, and the sample was well balanced on platforms. To operationalize the constructs, their responses were obtained on a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree) through survey item. The scores for each of the constructs (for example, cognitive presence, teaching presence, perceived usefulness, ease of use, retention and engagement) were subsequently derived by averaging the ratings on their respective items. This ensured that each construct was a composite measure for the underlying theoretical dimension. Platform-specific scores were then computed by grouping responses according to platform self-reported by the participants to enable comparative analysis across Google Classroom, Class Dojo, VICBHE, and Zoom. These platform and construct aggregations offered the platform and construct scores for the regression and SEM analysis. Particularly, Community of Inquiry (CoI) and Technology Acceptance Model (TAM) constructs were employed as independent variables, while CCMAS delivery outcomes (content delivery effectiveness, retention and engagement, and assessment and feedback) were employed as dependent variables. This scoring procedure yielded a solid and open mechanism from raw data to empirical testing of the study hypotheses.

The bar chart in Figure 4 shows the contribution of each feature to the learning outcomes, providing a clear picture of which factors are most influential.

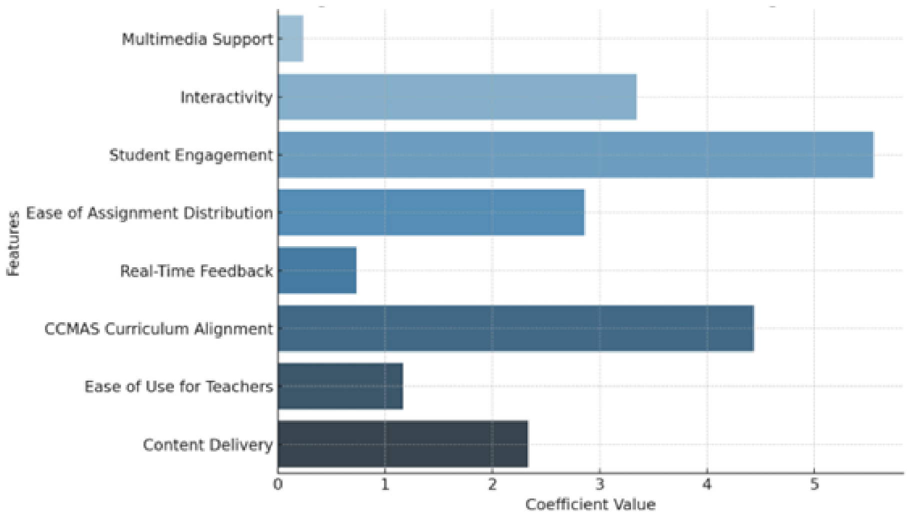

Fig. 4. Features contributions to the learning outcome

It was discovered that student Engagement and CCMAS Curriculum Alignment are the most influential factors for learning outcomes. Platforms that excel in these areas which is the Google Classroom, are likely to produce better results when delivering CCMAS content.

Table 14. Regression model predicted

Platform	Original Learning Outcomes	Projected Learning Outcomes
Zoom	85	87.5
Class Dojo	78	81.5
Google Classroom	90	91.5
VICBHE	82	84.0

When projecting learning outcomes by modifying features (like increasing interactivity or content delivery), the regression model predicted the changes in Table 14.

The coefficient plots in Figure 5 visualized the coefficients of each feature with their associated confidence intervals. It shows how different features (like multimedia support, interactivity, content delivery, etc.) influence learning outcomes. The error bars give a sense of the uncertainty around the estimates, which helps assess which features are more reliably correlated with learning outcomes.

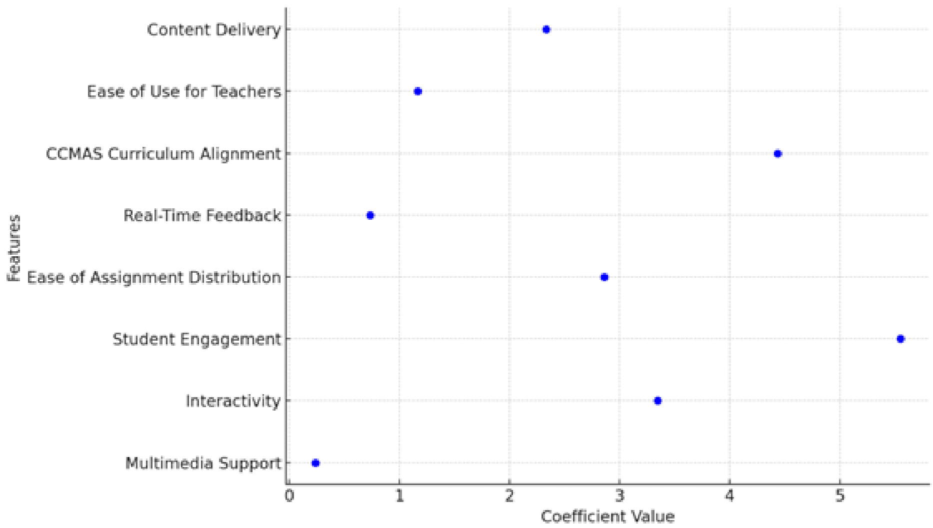

Fig. 5. The coefficient plot with confidence intervals

Figure 6, visualizes the feature scores for different platforms (Zoom, Class Dojo, Google Classroom, VICBHE) based on various content delivery aspects.

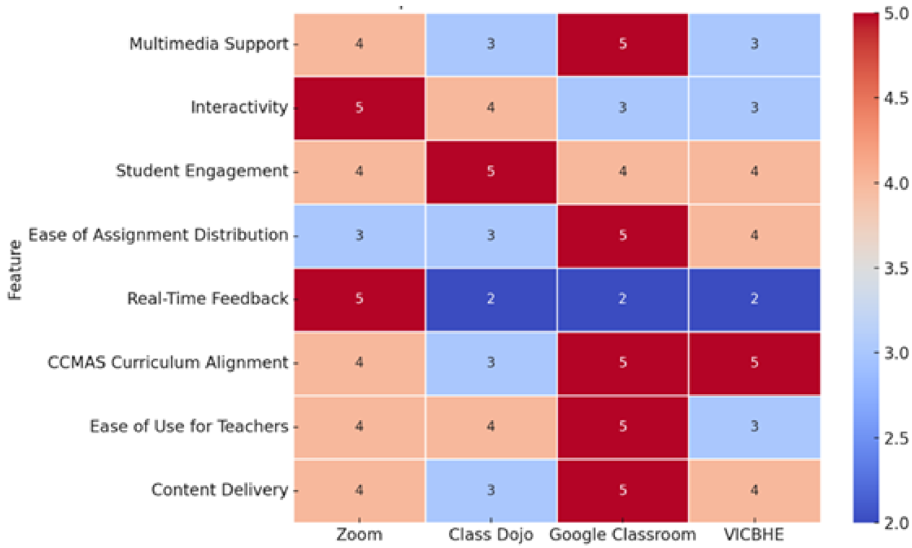

Fig. 6. Heatmap of feature score for each platform

The heatmap provides a visual comparison of how each platform performs across critical areas. Google Classroom stands out in terms of multimedia support, ease of assignment distribution, content delivery, and alignment with CCMAS. However, it lacks interactivity compared to Zoom, which excels in real-time interactivity and feedback. Class Dojo shines in student engagement and behavior management but may not be as robust for older students or more advanced educational needs. VICBHE, with its regional customization, performs well in curriculum alignment but struggles with real-time feedback and interactivity. This analysis suggests that each platform has strengths and weaknesses depending on the type of curriculum, learning style, and interaction required. For delivering the CCMAS, Google Classroom may offer the best balance of features, while Zoom is ideal for interactive, synchronous sessions. Class Dojo is excellent for younger learners, and VICBHE aligns well with region-specific educational standards. The plot in Figure 7 checks for any patterns in the residuals (the differences between predicted and actual learning outcomes). Ideally, the residuals should be randomly scattered around zero, which would indicate a good model fit.

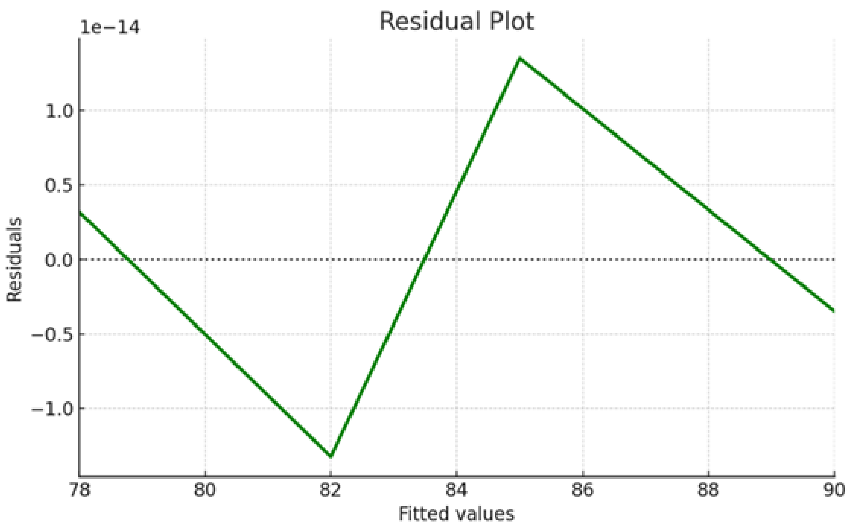

Fig. 7. Residual plot

The residual plot displayed shows the residuals (the differences between the observed and predicted values) against the fitted values from a regression model. The residual plot indicates that the regression model is a good fit for predicting learning outcomes based on platform features, with minimal prediction error. However, the observed non-random pattern in the residuals warrants further investigation to ensure that all relevant aspects of the data have been captured by the model.

Figure 8 shows the bubble chart which represents the magnitude of each feature's influence on learning outcomes, with larger bubbles indicating a stronger effect. This is a helpful visual tool for understanding which features are most impactful.

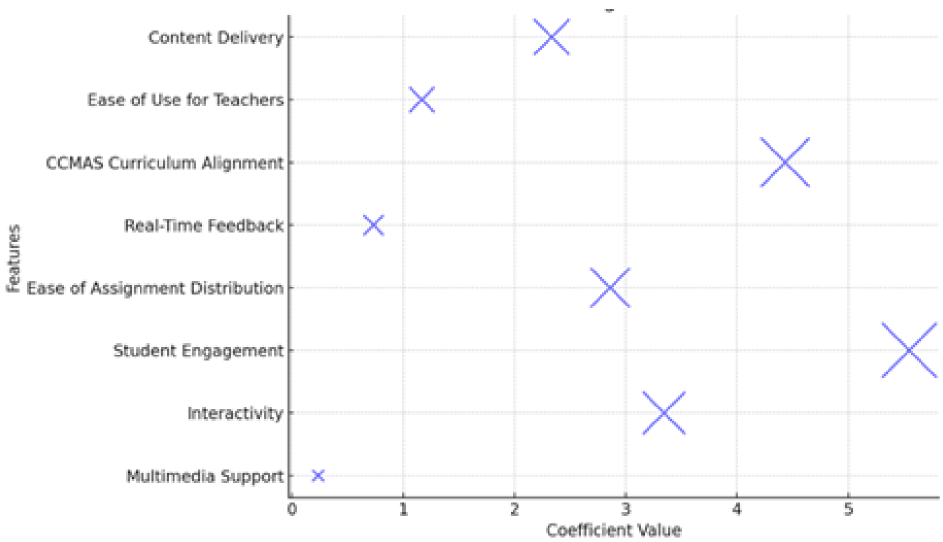

Fig. 8. Bubble chart of regression coefficients

The Bubble Chart of Regression Coefficients presented in Figure 14 provides a visual representation of how each feature impacts learning outcomes, with the size of the bubbles denoting the strength of each feature's influence.

The bubble chart visually captures the different contributions of platform features to learning outcomes. The size and position of the bubbles highlight that Content Delivery, Ease of Use for Teachers, and CCMAS Curriculum Alignment are the most critical aspects, while Multimedia Support and Real-Time Feedback are less impactful in comparison. This visualization assisted in guiding future platform improvements by focusing on the most influential features.

5.1 Discussion of Findings

It was discovered that Google Classroom consistently performed well, particularly in content delivery, curriculum alignment, and ease of use for teachers. These strengths likely contributed to its positive influence on learning outcomes. Zoom scored high in interactivity and real-time feedback but lower in ease of assignment distribution. Its strength in enabling synchronous communication makes it ideal for real-time interactions but less efficient for delivering structured content in the form of assignments or quizzes. Class Dojo performed well in student engagement, but its lower scores in multimedia support and curriculum alignment limited its impact on outcomes. VICBHE demonstrated strengths in curriculum alignment but lagged in areas like interactivity and real-time feedback, which could hinder its effectiveness for more interactive learning environments.

From the regression analysis and visualizations, Google Classroom emerged as the most effective platform for delivering CCMAS-aligned content. Google Classroom was particularly strong in content delivery and curriculum alignment, as well as excelling in real-time feedback and interactivity, making it ideal for live instructional sessions. Zoom and Class Dojo performed well in student engagement but lacked in areas critical for structured content delivery, while VICBHE's strengths in curriculum alignment were offset by weaknesses in interactivity and real-time feedback.

Because Google Classroom improves its score in ease of use for teachers and content delivery, the model predicts a corresponding increase in student performance. Google Classroom, which scored consistently high across the most influential features, remains the most effective platform. While this research provides some valuable observations regarding the rollout of Core Curriculum and Minimum Academic Standards (CCMAS) through online learning platforms, several limitations need to be considered. First is that the sampling technique relied on purposive choice according to respondents' prior experience with learning platforms such as Zoom, Google Classroom, Class Dojo, and VICBHE. Although this ensured that participants were getting relevant exposure, it may limit the generalizability of findings to the larger Nigerian higher education landscape where other platforms such as Moodle or Edmodo are being employed as well. A wider randomized sampling strategy from a range of institutions would provide a stronger foundation for generalizability.

Second, the reliance of the experiment on self-report data increases the potential for biases. Respondents could have overstated or downplayed their participation, learning retention, or satisfaction due to social desirability or forgetfulness. Even though Likert-scale measures are ubiquitous in education research, they could fail to fully capture the diversity of learners' experiences or account for external variables such as connectivity issues, instructor variability, or institutional support. Triangulating these impressions with objective performance data, i.e., learning analytics or test scores, would increase the robustness of the findings.

Thirdly, the analysis scope was restricted to four virtual platforms. Although the selected ones were chosen on the basis of their applicability and use frequency within the Nigerian higher education system, other platforms may be restricted, possibly reducing the generalizability of findings. Also, each platform was examined at a general level, and more nuanced differences in instructional design, planning content, or pedagogy practice that may influence the delivery outcomes of CCMAS were not investigated.

Finally, the study employed a cross-sectional approach where data were collected at one point in time. This limits the ability to make cause-and-effect inferences or examine long-term outcomes such as long-term learning retention or adaptability of CCMAS delivery over multiple semesters. Mixed-methods or longitudinal design would provide richer insights into the influence of virtual platforms on teaching and learning over time.

Despite such limitations, the findings remain valuable in the identification of the role of virtual learning platforms in building CCMAS delivery. The identification of the same also lays the foundation for future research that can overcome them by using more sampling, longitudinal analysis of data, and data pooling from multiple sources.

6. Conclusion

This study examined four major educational platforms, Zoom, Class Dojo, Google Classroom, and VICBHE, assessing their effectiveness in delivering CCMAS-aligned content and shaping student learning outcomes. Findings revealed that student engagement and curriculum alignment are the strongest predictors of learning success, with Google Classroom emerging as the most balanced platform. Zoom proved most effective for synchronous, interactive sessions, while Class Dojo fostered strong engagement in early learners but lacked advanced curriculum support. VICBHE showed promise in regional customization and curriculum alignment, though its limited interactivity and feedback mechanisms constrained broader impact. Overall, the results affirm that platforms integrating CCMAS alignment with high engagement features deliver superior outcomes. For VICBHE and similar localized platforms, advancing real-time interactivity and feedback systems will be essential to maximize their potential and competitiveness in dynamic learning environments.

7. Recommendations

Based on the findings of this study, the following are submitted to policymakers, schools, and software developers as recommendations for enhancing the effectiveness of CCMAS delivery via digital platforms:

i. **Enhance Interactivity and Instant Feedback in VICBHE:** Policymakers and developers of platforms must collaborate to make interactive components such as real-time polling, breakout discussion, and instant feedback facilities part of VICBHE. This can be justified through the government-funded pilot programs where VICBHE is tested at multilingual schools to check its scalability. ICT departments of institutions should also provide training to teachers in achieving the maximum out of such interactive tools to improve immediacy of feedback, particularly for subjects requiring a lot of clarifications like science and mathematics.

ii. **Establish Google Classroom as the Standard for CCMAS General Delivery:** Due to its improved curriculum alignment and ease of deployment, the Ministry of Education ought to make Google Classroom its official standard platform for roll-out for CCMAS. This is in concert with capacity development programs wherein modules for teacher training are harmonized and funded both at federal and state levels. Furthermore, policies may require Google Classroom integration with national-level education data systems for monitoring, equal access, and continuous improvement of teaching practice.

iii. **Enhance Multimedia Support and Curriculum Alignment in Class Dojo:** The features of Class Dojo should be expanded by software developers to include greater multimedia support, such as video learning objects and subject-specific curriculum templates. Such enhancements would be promoted by policymakers through the establishment of public–private partnerships (PPPs) to enable localization of the platform for the Nigerian context. Schools would have phased roll-out of Class Dojo for junior classes while concurrently advocating for developer-improvement programs that will make the platform more useful for senior classes and specialist departments.

iv. **Promote Hybrid Platform Models of Comprehensive Learning:** Instead of advocating loose platform integration, institutions need to adopt a systematic hybrid learning policy. For example, Zoom can be systematically allocated for synchronous interaction and examinations, whereas Google Classroom or VICBHE serve as repositories for the distribution of asynchronous content and curriculum management. In order to achieve this integration, the Federal Ministry of Education can issue guidelines that provide for consistent hybrid models of learning across schools, complemented by ICT grants for reskilling teachers and infrastructure.

v. **Ensure Student Engagement Through Policy and Practice:** Since student engagement was established as the most influential predictor of learning achievement, policymakers should mandate that engagement-based functionalities such as gamified quizzes, peer-to-peer discussion forums, and interactive assignments be integrated into all approved digital platforms. Schools must also institutionalize monitoring of engagement via regular learner feedback surveys and usage analytics so that adoption on the platform would mean measurable learning outcomes. Such an engagement-first policy would align with international best practices, where technology adoption is not gauged by availability but by its capacity to encourage genuine student engagement.

Future Work

Further research should consider the following:

i. The use of multiple virtual learning platforms.
ii. Consider Machine learning techniques for the evaluations

Competing Interests

The author(s) declare that there are no competing interests regarding the research, authorship, or publication of this manuscript titled "Delivering the Core Curriculum and Minimum Academic Standards (CCMAS) in a Virtual Platform: A Systematic Review". The authors have no conflicts of interest to declare that are relevant to the content of this chapter.

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How to cite this paper: Gabriel James, Anietie Ekong, David O. Egete, Martha Orazulume, Iniobong Okon, Aniekan Effiong, "Delivering the Core Curriculum and Minimum Academic Standards (CCMAS) in a Virtual Platform in Nigeria: A Systematic Review", International Journal of Education and Management Engineering (IJEME), Vol.16, No.1, pp. 1-20, 2026. DOI:10.5815/ijeme.2026.01.01