*International Journal of Internet, Broadcasting and Communication Vol.16 No.4 174-180 (2024)*
*http://dx.doi.org/10.7236/IJIBC.2024.16.4.174*

**IJIBC 24-4-20**

# Cognitive Overload Reduced Online Meeting and Education Platform

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***Abstract***

*Recently, with the rapid advancement of high-speed internet and interactive streaming technology, numerous video conferencing platforms such as Zoom, ZED, and Google Meet have been developed.. Furthermore, the COVID-19 pandemic, in particular, served as a catalyst for the global spread of online meetings and online education. This led to a significant reduction in people's resistance to online education and meetings. Nowadays, it has become common for people to use video conferencing platforms like Zoom not only for meetings but also for online education, seminars, and classes. Along with this trend, more specialized online platforms have been released, and research has been conducted on platforms that people can use more comfortably and for longer periods. This study specifically analyzes the current online video conferencing platforms from the perspective of Cognitive Overload and proposes a method to reduce Cognitive Overload. Additionally, a system was developed to address this issue. In other words, this research aims to analyze the limitations of previous online video conferencing and education platforms regarding Cognitive Overload and identity recognition, and to propose an online video conferencing and education platform that can overcome these challenges.*

***Keywords:*** *Online meeting, Cognitive overload, Online Class, Platform, Video conference*

## 1. Introduction

With the recent advancements in high-speed internet and interactive streaming technology, a variety of video conferencing platforms such as Zoom[1], ZED[2], Virbela[3], and Google Meet[4] have emerged. Moreover, the COVID-19 pandemic significantly accelerated the global adoption of online meetings and education, reducing the initial reluctance many had towards these digital formats[5][6][7]. Today, it is commonplace for people to utilize platforms like Zoom for not just meetings, but also for online education, seminars, and classes. Furthermore, with the advancement of metaverse technologies, metaverse platforms for learning are actively being developed. Due to the worldwide popularity and demand for learning Korean, online platforms for Korean language education have also become highly popular. In response to this shift, more specialized platforms have been developed, accompanied by research into making these tools more user-friendly and sustainable for long-term use.

Manuscript Received: September. 23, 2024 / Revised: September. 28, 2024 / Accepted: October. 3, 2024
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With the growing adoption of online platforms, many IT companies have sought to launch new services that are easier to use and designed to prevent user fatigue. To achieve this, the Cognitive Load Theory (CLT) has been consulted for insights on platform design[8][9]. The core principle of Cognitive Load Theory is that our working memory has a limited capacity for processing information at any given time. Consequently, CLT suggests that during online meetings or educational sessions, the brain should not be overwhelmed with excessive information or tasks, thereby helping to prevent users from experiencing fatigue quickly.

This research delves into the current video conferencing platforms, focusing on Cognitive Overload, and proposes strategies to mitigate this issue. It has been shown in the study of the Standford University team that when presented with an unfamiliar environment that differs physically from the real world, individuals tend to use excessive brain energy to adapt[10]. However, if a 3D environment resembling the real world is provided, cognitive overload is reduced, leading to improved student focus. Furthermore, they also argue that a product that is neurologically superior is needed because it reduces cognitive load by allowing the immediate recognition of non-verbal behaviors (such as nodding, facial expressions, gestures, etc.). In response to these issues, we aim to develop a system that incorporates principles from CLT to minimize these challenges. By refining platform design to better align with the cognitive capacities of users, it is possible to create a more engaging and less exhausting experience, especially for prolonged use in educational and professional settings. Moreover, by integrating features such as real-time attention monitoring and intuitive feedback mechanisms, the platform can help educators and presenters dynamically adjust their content delivery to maintain audience engagement and focus.

We begin by analyzing existing platforms, examining their strengths and weaknesses, particularly in terms of user interface design and platform functionalities. This analysis focuses on how these elements can be optimized to reduce cognitive strain and improve the overall user experience. Then, we propose our interactive education platform which overcomes the limitations of earlier video conferencing and education platforms in relation to cognitive overload and user fatigue.

## 2. Comparitive Analysis between existing online meeting platforms

In this section, we are going to compare widely-used online meeting platforms from a view of user fatigue and with respect to both user reality feeling and user fatigue. The most widely used online platform is Zoom, which gained significant popularity during the COVID-19 pandemic. During this time, many people had to attend educational classes through online video systems, with Zoom being the most commonly used platform. However, frequent use of Zoom led to fatigue, largely due to the stress of having one's face constantly visible and exposed to others for extended periods. As a result, many participants chose to turn off their cameras, but this created a disconnect, making it feel as though they were simply listening to a radio broadcast, with no interaction between students. Teachers also felt like they were speaking to themselves, unable to see students' expressions, and therefore could not gauge whether the students were engaged or following the lesson. As an alternative to traditional video conferencing platforms, metaverse platforms have emerged, offering graphical environments that resemble classrooms, giving students the feeling of being in a virtual space. ZEP, for example, introduced a two-dimensional virtual classroom to help students overcome the sense of disconnection experienced with platforms like Zoom. However, adapting to a two-dimensional classroom can be challenging, as the brain is naturally accustomed to three-dimensional environments. This adaptation process requires extra cognitive effort, resulting in increased cognitive load and reduced focus on the lecture. The brain has a limited capacity for processing information, and when overloaded, it can become overwhelmed, leading to reduced functionality—often experienced as mental fatigue or strain. This cognitive

overload occurs subtly, often without the user's awareness, and is primarily caused by suboptimal design of the educational platform.

To address the sense of unreality caused by two-dimensional environments, platforms like Virbela, which offer three-dimensional virtual spaces, have been introduced. However, in Virbela, the avatars have an unrealistic appearance, diminishing the sense of immersion. Additionally, since facial expressions cannot be seen, it is impossible to recognize non-verbal behaviors, which would otherwise help reduce cognitive load by providing important visual cues for communication and interaction. We summarized the features, strength and weaknesses of existing online education service platforms in Table 1.

**Table 1. Comparing the features, strengths, and weaknesses of existing educational online service platforms**

| Service | Features | Strength | Weaknesses |
|---|---|---|---|
| **Zoom** | · Used for real-time online classes, internet lectures, working from home, etc. | · Global demand has increased rapidly due to the Corona Virus since 2020.<br>· Mainly used in schools, various organizations, and companies. | · Occurence of Zoom Fatigue Syndrome<br>· Side effects such as decreased concentration, feelings of isolation, and blurred boundaries between work and daily life. |
| **ZEP** | · Face-to-face, real-time conversation is possible using a dot method similar to games from the 90s | · Applying consumer needs according to zoom fatigue.<br>· A two-dimensional metaverse video conferencing platform that explores the imbalance of existing video conferencing platforms. | · Does not satisfy the needs of users who want a three-dimensional feeling of reality |
| **Virbela** | · A platform that provides a 3D metaverse space, starting with the online collaboration platform 'Open Campus' service. | · Offering a campus with an expo center designed with offices, meeting rooms, conference halls, auditoriums and trade show booths. | · Unfavorable character appearance,<br>· No video chat function |

## 3. Proposed Cognitive Overload reduced online meeting platform

As mentioned in the previous section, when presented with an alien space that is physically different from the real world, people use excessive brain energy to become familiar with it. Therefore, providing a space similar to the real world in 3D reduces cognitive overload and increases student's concentration. However, as a virtual space cannot express non-verbal behaviors of other attendees in the platform, real-time video conferencing should also be allowed to be running in parallel with the three dimensional virtual environment so that participants allowed immediate recognition of non-verbal behaviors such as head nods, facial expressions, and gestures.

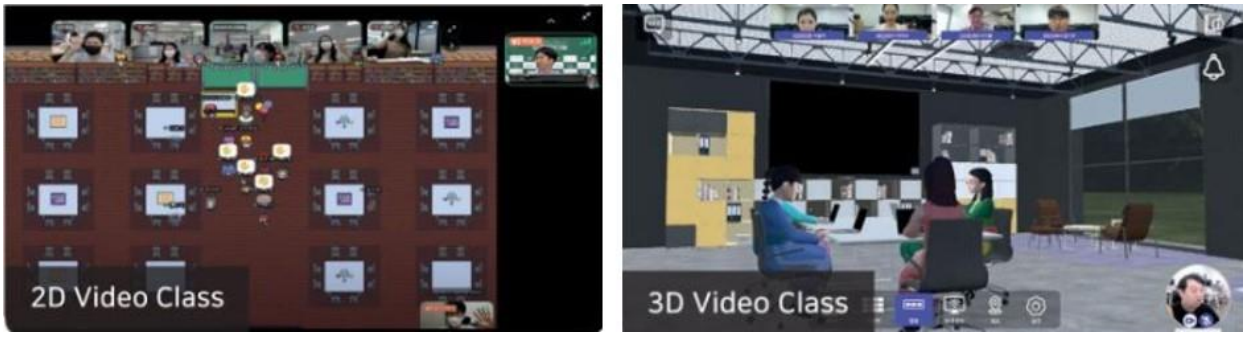


**Figure 1. Comparing the 2D and 3D virtual environments in educational online platforms**

Figure 1 compares the 3D virtual environment of our Edumeta education platform with the 2D virtual environment of the ZEP platform. Both systems integrate parallel video conferencing to enhance realism by displaying attendees' facial expressions. However, in the ZEP platform, the 2D projection of the real world offers little distinction from standard video conferencing platforms like Zoom, leading users to focus too heavily on the video feed, which can replicate the same issues associated with Zoom fatigue. In contrast, the 3D environment of the Edumeta platform, combined with video conferencing, creates a more immersive classroom experience, where user focus is more balanced between the virtual space and the video conference, preventing over-concentration on one element.

Figure 2 illustrates the overall functional diagram of the proposed online educational platform, named EduMeta. As the platform simultaneously supports both 3D virtual environments and video conferencing services, ensuring that these services run concurrently in real-time is critical. The 3D virtual space accepts input from interactive devices such as a mouse or keyboard. Key user actions within the 3D space, performed through an avatar, include entering the virtual environment, customizing the avatar, and enabling avatar interactions and communication between users.

When a user switches to the real conference mode by turning on their camera, the platform facilitates audio-video conferencing. Additional services include live screen sharing, live chat, and interactive whiteboards. In EduMeta, the 3D virtual space and real conference space can operate simultaneously, with communication between these spaces occurring via a real-time communication layer. To alleviate the computational burden of audio-video conferencing, the platform employs video encoder-decoder modules for efficient processing.

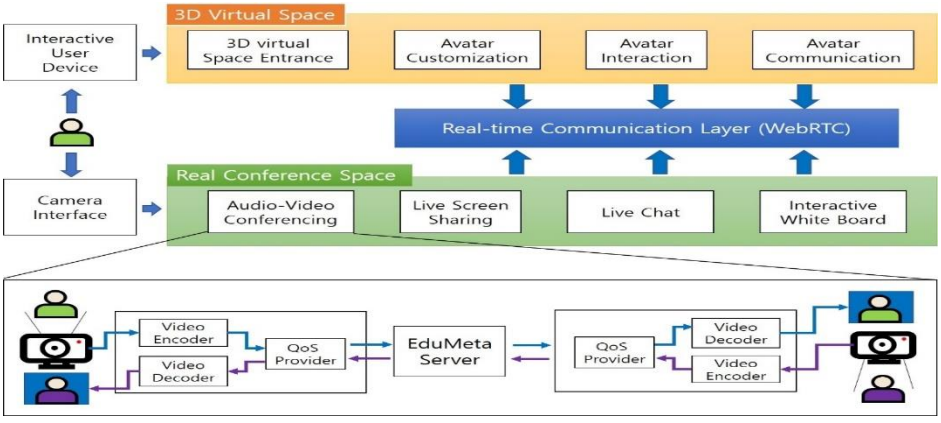


**Figure 2. Overall functional diagram of the proposed online educational platform**

As discussed in the previous section, when individuals are introduced to an unfamiliar environment that differs significantly from the real world, they tend to expend more mental effort to acclimate. To reduce cognitive overload and enhance student focus, creating a 3D space that closely resembles the real world is beneficial. To achieve this sense of familiarity, we designed high-quality graphics that offer a realistic experience. Our platform includes various 3D virtual environments in addition to standard digital classrooms, where students can study and present their work. These spaces also include a library, counseling room, and examination space, all rendered with high-quality graphics. Figure 5 illustrates the realistic, high-quality 3D virtual spaces available on the EduMeta platform.

(a) (b) (c)

**Figure 3. High Quality 3D Virtual Environments in the EduMeta Educational platform (a) library (b) counselling room (c) examination space**

We sought to improve upon the Virbela platform, which features unappealing characters that detract from user immersion. By designing higher-quality characters that offer a more realistic experience, we aimed to enhance user immersion and reduce cognitive overload. Unlike platforms that use low-polygon models to optimize speed, we employed high-polygon models to achieve this realistic effect. Figure 6 compares the characters from the Virbela platform with those of our platform, demonstrating how our more lifelike characters can increase user immersion and reduce cognitive strain.

However, using high-polygon models introduces computational challenges that can affect real-time performance. To mitigate this, we have implemented several optimization techniques, including file compression, occlusion culling, and mipmapping, to improve system speed and efficiency. Occlusion culling is a rendering optimization technique that prevents the GPU from processing or rendering objects that are obscured by other objects in a scene. For instance, the occlusion culling ensures that hidden objects are not rendered for example if a wall obstructs the view of objects behind the wall to reduce the computational load and improved performance. Meanwhile, MipMapping is a texture optimization technique which creates multiple scaled-down versions of a texture where each version is smaller than the original texture. Furthermore, we make the textures that are farther from the camera smaller according to the distance.

**Figure 4. Comparison between the characters of the Virbela and the EduMeta platform. Left: Character of the Virbela platform. Right: Character of the EduMeta platform.**

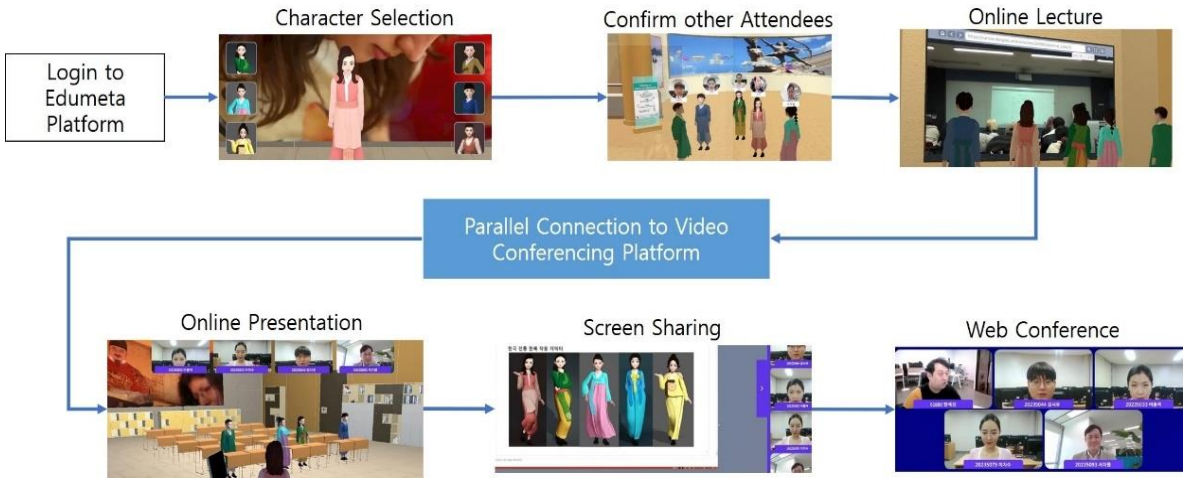


**Figure 5. Example of User Experience in the EduMeta System.**

Figure 5 showcases a sample user interaction within the EduMeta platform, illustrating how students can navigate and engage with the 3D virtual spaces, communicate through avatars, and transition between virtual environments and real-time video conferencing. The high-quality graphics and seamless integration of various interactive elements contribute to a realistic and immersive learning experience. After logging into the system, the user selects a character that will serve as the user's avatar. The user can then interact with other attendees through real-time communication within the virtual environment. Online lectures take place in 3D virtual classrooms, providing an immersive learning experience. When the user wishes to participate in a conference, the user will be simultaneously connected to the video conferencing platform, allowing the user to engage in both the 3D virtual space and the video communication space at the same time. This simultaneous access helps reduce the user's cognitive load by creating a more integrated and seamless experience.

## 4. Conclusion

Reducing cognitive overload in online meeting and education platforms requires a holistic approach. The design of the EduMeta platform integrates multiple factors, including real-time video conferencing within a realistic 3D virtual space, to balance user focus and enhance immersion. By mimicking real-world environments and enabling the immediate recognition of non-verbal cues, the platform reduces the mental strain associated with adapting to unfamiliar digital spaces. The combination of high-quality graphics, optimization techniques, and intuitive user interactions ensures a seamless, efficient, and cognitively sustainable experience. These innovations make EduMeta a promising solution for addressing the challenges of online education and meetings in the modern digital era.

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