Investigating the Influence of Computer-Mediated Interaction, Modality and 3D Animation on Work Settings and STEM Education: A Cross-Cultural Analysis of Educational YouTube Channels

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Introduction

In the wake of the global pandemic, the world experienced an unprecedented surge in the digitization of platforms and communication methods. Traditional modes of communication were swiftly abandoned, making way for new approaches to bridge the gap created by the necessity of remote interactions. As individuals adapted to this unfamiliar landscape, it became evident that active participation in every aspect of virtual meetings was not always essential. Technology offered a means for participants to communicate their level of engagement selectively. Recognizing this, arguments have emerged advocating for video_meeting_systems to widen the scope of involvement levels available to remote_participants. This ongoing research seeks to explore the common behavioral changes prompted by the global pandemic, particularly focusing on the intensified frequency of mandatory online meetings and conferences. Many professionals, students, and individuals found themselves grappling with the challenge of acclimating to this new mode of interaction, leading to heightened exhaustion. Within this context, several questions arise for investigation:

- Why did individuals find online meetings exhausting?
- Were there alternative approaches to alleviate this exhaustion?
- What is the impact of text and sound in imparting and retaining information, particularly when compared to the use of visual imagery and motion?
- How quickly are learners able to grasp differing STEM concepts when viewed in three dimensional visualizations?
- What measures can be taken to enhance the effectiveness of task-based online interaction?

Addressing these questions is crucial to gaining a comprehensive understanding of the challenges and opportunities presented by computer-mediated communication in the post-pandemic era. By examining the factors contributing to meeting exhaustion, exploring alternative approaches, and assessing the influence of different modalities in information delivery, we can inform the development of strategies and technologies that mitigate fatigue and enhance remote collaboration. Additionally, examining methods to

decrease meeting frequency and optimize task-based online interaction can contribute to improved productivity and well-being in virtual work and educational environments.
In the following work, we will analyze how different modes of knowledge acquisition and information delivery affects remote collaboration and learning STEM based concepts.

Abstract

Social connection in our environment is increasingly being mediated by technology. And modern technologies affect our attempts to communicate. "Are we evolving into tech-savvy conversationalists, or is technology itself evolving into a more conversational entity?" was the question that was posed by Ian Hutchby in his book *Conversation and technology: From the telephone to the Internet*. He concentrated on four examples: telephones, workplace computerized expert systems, speech-based public inquiry systems, and multi-user Internet spaces. Contemporary theory and empirical studies in conversation analysis, ethnomethodology, and the social creation of technology are all incorporated into Conversation and Technology. Hutchby contends that while we ourselves are shapers of both the cultural and interactional properties of these technologies, technological media can profoundly shape the ways in which we interact. His original contributions to each of these fields supported this claim. The book started out by looking at various theoretical stances on this problem. Truly, the time has arrived for us to develop a new appreciation of the relationship between human communication and technology.
While embracing online communication technologies can never replicate the in-person conversations, it has been found that avoiding communication has also become much easier now, lower social engagement on video meetings being not just a product of network limitations is a plausible argument today. There are teams, groups, companies, regions, countries, and many more types and levels of culture that may be important to comprehending how low engagement in online meetings could be a social practice. However, notwithstanding these restrictions, it has been speculated that it is very likely true for some subset of any community that low engagement can be a social decision, not merely a reaction to limits but also an exploitable social resource on the basis of those limitations. Although most video meeting services and meeting gurus would certainly disagree with this decision, it does have its own design ramifications. The point of the matter is that we need to understand which method of communication (text, sound, visual, emoticons) could be a better option for different tasks such as learning, allotting assignments, giving directions, and more.
The digitization of education has transformed the teaching and learning of STEM concepts, with computer-mediated interaction and 3D animation playing a crucial role in enhancing educational experiences. This paper investigates the impact of computer-mediated interaction and 3D animation on STEM education through a comprehensive case study of ten prominent educational YouTube channels from diverse cultural backgrounds. The channels studied include Professor of How, Kurzgesagt - In a Nutshell, TED-Ed, The Infographics Show, CrashCourse, MinutePhysics, CGP Grey, India In Pixels by Ashris, OverSimplified, and Veritasium. These channels employ various strategies, such as gamification, visual storytelling, and interactive elements, to engage learners and facilitate understanding of STEM concepts.

1. Performance Metrics Analysis:

- ❖ Analyzing views, likes, comments, and video length to understand the factors contributing to the success of specific videos on the studied YouTube channels.
- ❖ Investigating the impact of search engine optimization techniques, including video tags, on the visibility and ranking of STEM education videos.

2. Language Adaptation and Cross-Cultural Context:
   - ❖ Exploring the role of language in video creation and its influence on the comprehension of STEM concepts across different cultural contexts.
   - ❖ Highlighting the importance of language adaptation and culturally inclusive content to enhance learners' understanding and engagement.
3. Effective 3D Animation Strategies:
   - ❖ Examining the use of gamification, visual storytelling, and interactive elements in 3D animated videos to foster student engagement and knowledge retention.
   - ❖ Assessing the correlation between video length and viewer engagement, and the impact of search engine optimization techniques on video visibility and ranking.
4. Designing Interactive Learning Experiences:
   - ❖ Proposing the integration of quizzes, simulations, and emerging technologies like virtual reality (VR) and augmented reality (AR) to create immersive STEM learning environments.
   - ❖ Highlighting the potential of interactive elements in enhancing student engagement and facilitating deeper understanding of STEM concepts.
5. Long-Term Impact Assessment:
   - ❖ Emphasizing the need for longitudinal studies to assess the long-term impact of computer-mediated interaction and 3D animation on students' retention and application of STEM knowledge.
   - ❖ Investigating the transferability of learning from virtual environments to real-world problem-solving situations.

In this study, we will investigate how the modality—such as speech, text, or visualization—in which information is delivered affects how that information is interpreted. The project will also specifically concentrate on the investigation and comparison of two preferred communication contexts: computer-mediated human user communication and human agent communication. This paper aims to delve into these areas of inquiry, offering insights and recommendations that bridge the gap between the advances in research and the practical adoption of technologies for computer-mediated communication in education and work settings.

Related Work

Numerous corporations are endeavoring to surmount the stigma linked with the lower ambient staff visibility of remote labor. Distant labor is on the upswing, and video conferences are one of the facilitating technologies in the 'any time, any device, any place’ work revolution. Nonetheless, there are still numerous limitations when participating in meetings remotely, and research on video-mediated communication is strewn with systems developed to address these constraints. The burgeoning realm of Attentional User Interfaces (AUI) concentrates on possibilities for "amplifying computing and communication systems by considering human attention as a central construct and governing principle".

Deepening our grasp of the pivotal traits of attentive systems, a rapidly expanding body of AUI research investigates attention from the viewpoint of managing computational resources, interruption of users, and as a fountain of data for predictive models concerning users' objectives, intentions, and needs.

Nevertheless, a gap remains between research breakthroughs and the current technological landscape. Individuals adapt to technological limitations, and conversely, they adapt technology to serve as a framework for their communal practices. These communal practices are methodical, engaged, and judicious treatments of the technology. Grasping such practices offers a meaningful backdrop for embedding novel solutions within the existing usage panorama.

Another body of research examines the influence of specific animations and visualizations on understanding and conceptual change for students of varying ages in various science subjects. The studies provide information about specific types of visualization, purposes for and methods of application, and the contexts and conditions in which visualizations have been used successfully to support conceptual understanding. Although some studies have found that animations do not make a significant difference in student learning and conceptual change, others have shown that under certain circumstances animations can be a useful learning resource.

Özmen, Demircioğlu and Demircioğlu (2009) investigated the effects of animations on overcoming alternative conceptions of chemical bonding. The study included 28 students who received conceptual change texts coupled with computer animation instruction, and a comparison group of 30 students who received regular instruction with a teacher who used lots of examples and illustrations in a "chalk and talk" approach. The computer animation instruction, which involved active engagement and interaction, did not significantly change students' alternative conceptions of chemical bonding. These results suggest that it may be necessary to consider other ways of enhancing the learning of particular chemistry concepts. In contrast, Yarden and Yarden (2010) compared the comprehension of the polymerase chain reaction (PCR) by Grade 12 students using animations as an aid with that of students using still images. The most salient finding was that PCR animations showed a distinct advantage over still images for student learning. However, the researchers caution that although animation was effective for demonstrations of molecular phenomena, the results may not generalize to other physical phenomena, such as motion.

Research on the influence of animations and visualizations on understanding and conceptual change in science education has explored their effectiveness and the specific conditions under which they are most beneficial. Studies have shown that the use of animations can be a useful learning resource, although their impact may vary depending on the subject and context. For instance, animations have been found to be effective in overcoming alternative conceptions of chemical bonding. However, the effects of animations may be dependent on factors such as the complexity of the learning material and the meaningful representation of processes or systems. Comparative studies have highlighted the advantages of dynamic media, such as 3D animations, over static media in enhancing learning performance. The effectiveness of animations is influenced by instructional practices, such as providing practice opportunities, cueing students' attention to graphic details, and integrating animations with other instructional activities. Additionally, computer visualization programs have been developed to supplement traditional textbooks, facilitating visualization, understanding, and manipulation of chemical interactions.

The role of diagrams in science learning has also been investigated, revealing that students may face difficulties in comprehending certain types of diagrams. The combination of diagrams with explanatory

text has been found to enhance recall, comprehension, and attitudes toward laboratory work. However, visualizations and diagrams are most effective when explicit instruction is provided on how to use them and when students possess the necessary visual and spatial skills. Explicit instruction and careful planning are essential to ensure effective use of visualizations in science education. While visualizations have the potential to transform and communicate complex scientific concepts, their usefulness depends on understanding how to interpret and employ them appropriately in different contexts.

Method

To gather performance metrics for the ten YouTube channels studied in this research, the following methodology was employed:

1. Selection of YouTube Channels: Ten educational YouTube channels were selected based on their popularity, relevance to STEM education, and availability of publicly accessible data. The selected channels included Professor of How, Kurzgesagt - In a Nutshell, TED-Ed, The Infographics Show, CrashCourse, MinutePhysics, CGP Grey, India In Pixels by Ashris, OverSimplified, and Veritasium.

2. Performance Metric Analysis: SocialBlade, a third-party analytics platform specializing in YouTube channel analytics, was utilized to retrieve performance metrics for the selected YouTube channels. SocialBlade provides comprehensive insights into channel rankings, subscriber growth, video views, estimated earnings, and other relevant metrics.

3. Data Collection: The performance metrics for each YouTube channel, including subscriber ranks, video views ranks, estimated earnings, and other relevant statistics, were extracted from SocialBlade. The data covered a specific timeframe, typically up until August 2021, to ensure consistency and comparability across the channels.

4. Analysis and Interpretation: The collected performance metrics were analyzed to understand the reach, engagement, and overall impact of the YouTube channels in the context of STEM education. The metrics were used to identify patterns, trends, and variations among the channels, allowing for insights into their effectiveness and popularity.

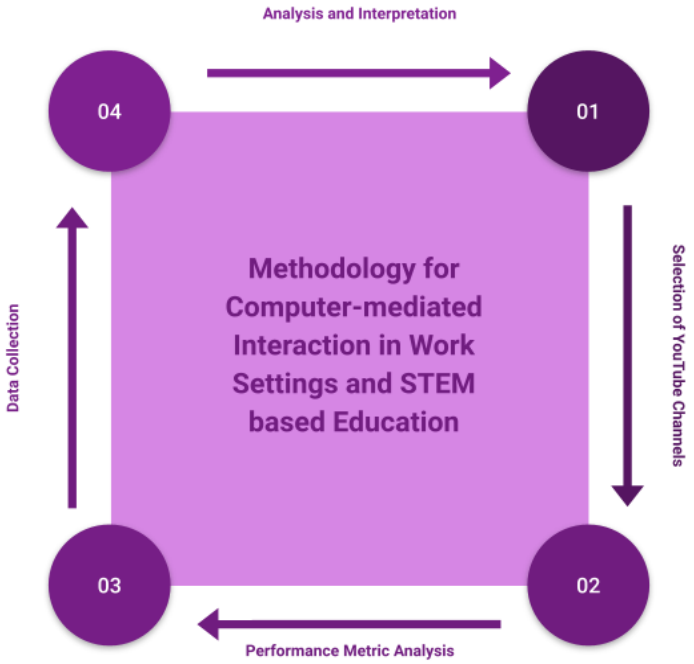


Figure 1. Methodology Diagram

Importance and Selection of SocialBlade:

SocialBlade was chosen as the analytics tool for this study due to its wide adoption and reputation for providing reliable YouTube channel data. It offers a user-friendly interface, comprehensive metrics, and a robust database of YouTube channel statistics. By using SocialBlade, we were able to access key performance indicators, such as subscriber ranks, video views ranks, estimated earnings, and growth trends, which are crucial for understanding the impact and reach of the YouTube channels. SocialBlade's popularity among content creators, researchers, and YouTube enthusiasts ensures that it remains a valuable resource for obtaining accurate and up-to-date performance metrics. The tool's ability to provide historical data, track changes over time, and present metrics in an organized manner makes it particularly useful for analyzing the performance of YouTube channels. By utilizing SocialBlade in this research, we were able to gather relevant and insightful performance metrics for the selected YouTube channels, allowing for a comprehensive analysis of their influence and effectiveness in STEM education.

Result

Our study revealed that users typically perceived that the technological limitations of video meetings resulted in decreased participation among remote staff. It was identified that engagement manifested as an intentional social decision through two distinct avenues. Primarily, the act of toggling the video on or off could indicate commitment to engagement expectations. Secondly, opting for remote participation could serve as a purposeful indication of limited involvement. We generated performance metric reports for the

analysis of their channels and to find out which videos were performing better and how the effects were transforming across different cultures, that is, on channels from different countries and languages.

We selected ten YouTube channels for the research and this was based on several criteria aligned with the research subject, which focused on the impact of computer-mediated interaction and 3D animation on STEM education. The criteria for channel selection included:

1. Relevance to STEM Education: The channels were chosen based on their focus on educational content related to STEM subjects, such as science, technology, engineering, and mathematics. This ensured that the selected channels were directly applicable to the research subject.

2. Popularity and Reach: The channels selected had a significant subscriber base and a high number of video views, indicating their popularity and reach among the audience. This allowed for a more comprehensive analysis of the impact of computer-mediated interaction and 3D animation in STEM education.

3. Variety of Content: The selected channels represented a diverse range of content styles and formats, including animated explanations, short clips, full-length videos, and gamified learning approaches. This diversity allowed for a broader exploration of the effectiveness of different approaches in engaging and educating learners in STEM subjects.

4. Cross-cultural Perspective: The selection of channels may have aimed to include a global perspective by considering channels from different regions or countries. This allowed for an examination of the impact of computer-mediated interaction and 3D animation on STEM education across different cultural and educational contexts.

5. Channel Reputation: The channels chosen may have had a reputation for providing high-quality educational content and being recognized as reliable sources for learning in STEM subjects. This ensured that the research was based on channels with a strong educational focus and credibility.

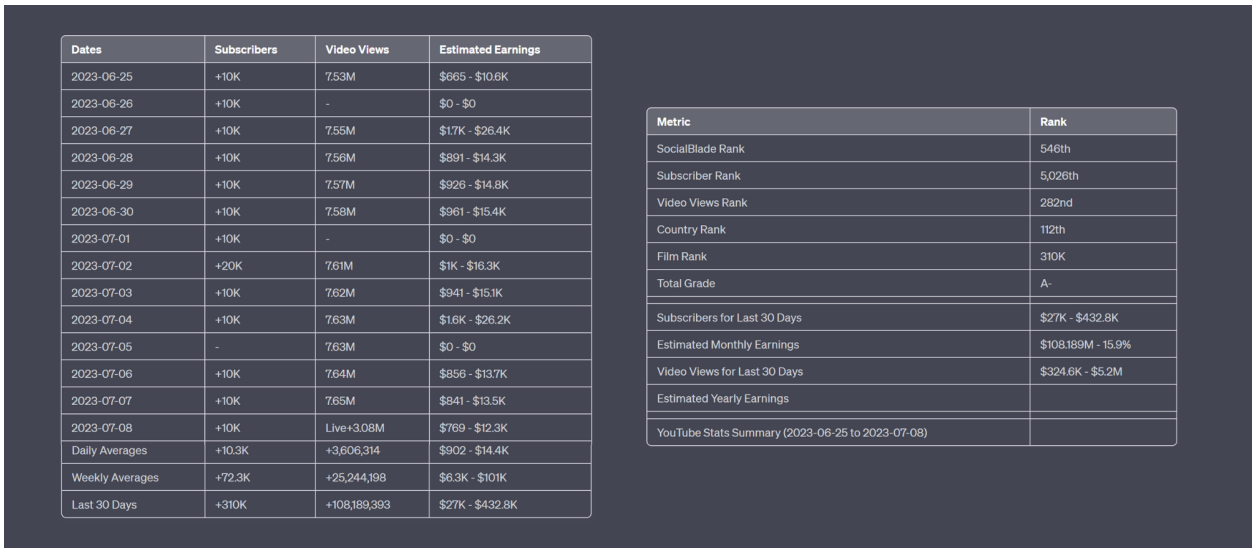
The performance metric reports were calculated and scrutinized.

(a) Professor Of How

According to their YouTube channel description the channel's videos are owned by BrainRig Studios located in Jaipur, India. Their vision is for their channel to be a platform where youth turn to visualize "How Things Look & Work?" in three dimensions.

The YouTube channel, Professor of How, ranks 5,026th in terms of subscribers, 282nd in video views, and 546th in Social Blade ranking. It is ranked 112th in India. The estimated monthly earnings range from $27K to $432.8K, with an estimated yearly earnings of 108.189M. The channel has shown consistent growth in subscribers and video views over the last 30 days, with an average increase of 10.3K subscribers and 3.6 million video views per day. Overall, Professor of How demonstrates strong performance metrics, indicating its popularity and success in the

YouTube educational space. The video topics cover a wide range of subjects, including health (fever, crying, stye), science (clouds, electricity, poison), general knowledge (earth's end, jellyfish, vehicle keys), and safety (fire extinguisher).



Dates	Subscribers	Video Views	Estimated Earnings
2023-06-25	+10K	7.53M	$665 - $10.6K
2023-06-26	+10K	-	$0 - $0
2023-06-27	+10K	7.55M	$1.7K - $26.4K
2023-06-28	+10K	7.56M	$891 - $14.3K
2023-06-29	+10K	7.57M	$926 - $14.8K
2023-06-30	+10K	7.58M	$961 - $15.4K
2023-07-01	+10K	-	$0 - $0
2023-07-02	+20K	7.61M	$1K - $16.3K
2023-07-03	+10K	7.62M	$941 - $15.1K
2023-07-04	+10K	7.63M	$1.6K - $26.2K
2023-07-05	-	7.63M	$0 - $0
2023-07-06	+10K	7.64M	$856 - $13.7K
2023-07-07	+10K	7.65M	$841 - $13.5K
2023-07-08	+10K	Live+3.08M	$769 - $12.3K
Daily Averages	+10.3K	+3,606,314	$902 - $14.4K
Weekly Averages	+72.3K	+25,244,198	$6.3K - $101K
Last 30 Days	+310K	+108,189,393	$27K - $432.8K

Metric	Rank
SocialBlade Rank	546th
Subscriber Rank	5,026th
Video Views Rank	282nd
Country Rank	112th
Film Rank	310K
Total Grade	A-
Subscribers for Last 30 Days	$27K - $432.8K
Estimated Monthly Earnings	$108.189M - 15.9%
Video Views for Last 30 Days	$324.6K - $5.2M
Estimated Yearly Earnings	
YouTube Stats Summary (2023-06-25 to 2023-07-08)	

Figure 2: Performance Metrics Report of the Professor Of How YouTube channel

(b) Kurzgesagt - In a Nutshell

Kurzgesagt – In a Nutshell is an animated educational channel that has been producing engaging content since 12,013 originating from Germany. With a philosophy of optimistic nihilism, the channel aims to explain complex concepts and ignite curiosity about science and the world. The team consists of talented illustrators, animators, and number crunchers, all dedicated to delivering captivating storytelling through their videos. Their unique approach proves that no topic is boring when presented with a compelling narrative. Their YouTube channel maintains a strong performance and popularity in the educational content category. The channel holds a Total Grade of B+ and a Social Blade Rank of 202nd. It ranks 2nd in terms of video views in Germany and demonstrates significant estimated monthly earnings of 41.435M (18.6%). With a Subscriber Rank of 3,883rd, Kurzgesagt – In a Nutshell stands out as a successful channel in terms of viewership and financial performance.

Metric	Value
Total Grade	B+
Social Blade Rank	17,481st
Subscriber Rank	212th
Video Views Rank	3,928th
Country Rank	2nd
Education Rank	21st
Subscribers for Last 30 Days	100K+
Estimated Monthly Earnings	$7.2K - $115.7K
Video Views for Last 30 Days	28.921M
Estimated Yearly Earnings	$86.8K - $1.4M

Figure 3: Performance Metrics Report of the Kurzgesagt - In A Nutshell YouTube channel

(c) The Infographics Show

The Infographics Show is a popular YouTube channel that focuses on creating animated and informative videos covering a wide range of topics, including history, science, geography, and mysteries. The channel uses engaging animations and narration to present facts, statistics, and interesting stories in a visually appealing manner. With a large subscriber base and millions of views on their videos, The Infographics Show has become a go-to source for people seeking educational and entertaining content. The channel's unique approach of combining information with captivating visuals has contributed to its success in sparking curiosity and knowledge exploration among its audience.

Metric	Value
Total Grade	B+
Social Blade Rank	8,608th
Subscriber Rank	286th
Video Views Rank	1,257th
Country Rank	169th
Education Rank	45th
Subscribers for Last 30 Days	100K+
Estimated Monthly Earnings	$12.6K - $202.3K
Video Views for Last 30 Days	50.563M
Estimated Yearly Earnings	$151.7K - $2.4M

Figure 4: Performance Metrics Report of The Infographics Show YouTube channel

(d) TED-Ed

TED-Ed is a prominent educational YouTube channel associated with TED Talks, known for producing high-quality animated educational videos. The channel features a wide array of topics, from science and history to literature and philosophy. With its captivating animations and engaging storytelling, TED-Ed aims to make complex concepts and ideas easily accessible to viewers of all ages. The channel boasts a large subscriber base and has accumulated millions of views on its videos. TED-Ed's commitment to sharing knowledge and fostering curiosity has made it a valuable resource for learners seeking informative and thought-provoking content.

Metric	Value
Total Grade	B+
Social Blade Rank	17,070th
Subscriber Rank	231st
Video Views Rank	2,179th
Country Rank	117th
Education Rank	25tht
Subscribers for Last 30 Days	200K+
Estimated Monthly Earnings	$7.1K - $113.9K
Video Views for Last 30 Days	28.485M
Estimated Yearly Earnings	$85.5K - $1.4M

Figure 5: Performance Metrics Report of the TED-Ed YouTube channel

(e) CrashCourse

Crash Course is a popular educational YouTube channel that offers in-depth and entertaining courses on various subjects, including history, science, literature, and more. With its engaging hosts and dynamic animations, the channel aims to make learning fun and accessible for viewers of all ages. Crash Course has garnered a large following and boasts millions of views on its videos. The channel's comprehensive courses and well-researched content make it a valuable resource for students, educators, and curious minds alike. Through its entertaining approach to education, Crash Course continues to inspire and enlighten viewers on a wide range of topics.

Metric	Value
Total Grade	B+
Social Blade Rank	67,973rd
Subscriber Rank	271st
Video Views Rank	5,585th
Country Rank	156th
Education Rank	36th
Subscribers for Last 30 Days	--
Estimated Monthly Earnings	$1.7K - $27.1K
Video Views for Last 30 Days	6.778M
Estimated Yearly Earnings	$20.3K - $325.4K

Figure 6: Performance Metrics Report of the CrashCourse YouTube channel

(f) MinutePhysics

MinutePhysics is a popular educational YouTube channel that specializes in explaining complex physics concepts in short and engaging animated videos. The channel's content is delivered by its creator, Henry Reich, who uses simple animations and clear explanations to make physics accessible and enjoyable for viewers. With millions of views and a substantial subscriber base, MinutePhysics has become a go-to resource for anyone looking to grasp fundamental physics principles in a fun and easy-to-understand manner. The channel covers a wide range of topics, from relativity and quantum mechanics to everyday phenomena, all presented in under a minute. MinutePhysics continues to be a valuable educational tool for students, teachers, and science enthusiasts worldwide.

Metric	Value
Total Grade	B
Social Blade Rank	247,722nd
Subscriber Rank	749th
Video Views Rank	24,360th
Country Rank	--
Tech Rank	55th
Subscribers for Last 30 Days	10K
Estimated Monthly Earnings	$300 - $4.8K
Video Views for Last 30 Days	1.201M
Estimated Yearly Earnings	$3.6K - $57.7K

Figure 7: Performance Metrics Report of the CrashCourse YouTube channel

(g) CGP Grey

CGP Grey is a highly acclaimed educational YouTube channel known for its informative and visually engaging videos. Run by an anonymous creator, CGP Grey produces content that covers a wide array of topics, including geography, history, politics, and complex concepts made easy to understand. The channel's unique animations and distinctive voice-over style have earned it a dedicated global audience. With millions of views and a strong subscriber base, CGP Grey has become a trusted source for learning about a diverse range of subjects in a clear, concise, and entertaining manner. The channel's videos often combine humor and critical analysis, making learning enjoyable for viewers of all ages.

Metric	Value
Total Grade	B
Social Blade Rank	17,481st
Subscriber Rank	212th
Video Views Rank	12,830th
Country Rank	121st
Education Rank	191st
Subscribers for Last 30 Days	20K
Estimated Monthly Earnings	$1.8K - $29.2K
Video Views for Last 30 Days	7.291M
Estimated Yearly Earnings	$21.9K - $349.9K

Figure 8: Performance Metrics Report of the CGP Grey YouTube channel

(h) India In Pixels - By Ashris

India In Pixels is a data storytelling channel on YouTube that produces video essays exploring the cultural artifacts of India, including languages, films, music, stories, and life. The channel aims to present data-driven narratives that highlight the connections and complexities of Indian culture in an engaging and informative way.

In addition to their YouTube channel, India In Pixels has cultivated a thriving ecosystem on the Discord Community and website. This ecosystem allows users to interact and collaborate in creating maps and other data visualization charts related to various aspects of Indian culture. The community-driven approach fosters a sense of participation and inclusivity, enabling users to contribute to the exploration and understanding of India's rich cultural heritage through data-driven insights.

Metric	Value
Total Grade	B
Social Blade Rank	158,265th
Subscriber Rank	1,876th
Video Views Rank	276,239th
Country Rank	1,477th
Education Rank	1,187th
Subscribers for Last 30 Days	17K
Estimated Monthly Earnings	$659 - $10.5K
Video Views for Last 30 Days	2.636M
Estimated Yearly Earnings	$7.9K - $126.5K

Figure 9: Performance Metrics Report of the India In Pixels - By Ashris YouTube channel

(i) OverSimplified

Oversimplified is a popular YouTube channel that produces animated historical videos. The channel's content focuses on simplifying complex historical events and narratives in a humorous and engaging manner. Through entertaining animations and witty storytelling, Oversimplified presents historical topics in a way that appeals to a wide audience, making history more accessible and enjoyable. The channel covers a diverse range of historical events, battles, and figures, providing viewers with a simplified yet informative glimpse into the past. As a result, Oversimplified has gained a large following and continues to be a beloved source of historical education and entertainment on YouTube.

Metric	Value
Total Grade	B
Social Blade Rank	59,732nd
Subscriber Rank	542nd
Video Views Rank	11,538th
Country Rank	351st
Education Rank	123rd
Subscribers for Last 30 Days	70K
Estimated Monthly Earnings	$2.2K - $34.8K
Video Views for Last 30 Days	8.697M
Estimated Yearly Earnings	$26.1K - $417.5K

Figure 10: Performance Metrics Report of the OverSimplified YouTube channel

(j) Veritasium

Veritasium is a prominent science and education YouTube channel hosted by Derek Muller. The channel's primary focus is on exploring and explaining various scientific concepts, phenomena, and experiments. With a unique blend of hands-on demonstrations, interviews with experts, and engaging storytelling, Veritasium aims to make complex scientific topics accessible and intriguing to a broad audience. The channel covers a wide range of subjects, including physics, chemistry, biology, psychology, and more. Veritasium's content is known for its high-quality production, insightful explanations, and thought-provoking discussions, making it a go-to destination for those seeking entertaining and educational science content on YouTube.

Metric	Value
Total Grade	B+
Social Blade Rank	10,932nd
Subscriber Rank	279th
Video Views Rank	4,471st
Country Rank	163rd
Education Rank	39th
Subscribers for Last 30 Days	200K+
Estimated Monthly Earnings	$10.9K - $174.3K
Video Views for Last 30 Days	43.571M
Estimated Yearly Earnings	$130.7K - $2.1M

Figure 11: Performance Metrics Report of the Veritasium YouTube channel

Engaging remotely brings about a host of challenges.

Our exploration indicated that users generally perceived remote engagement as intricate due to technological limitations. Our investigation revealed that the notion of reduced engagement among remote employees in work meetings was linked to motivation deficits, both in terms of active involvement and cognitive investment. Remote workers weren't stigmatized; instead, the blame was placed on the technological constraints making remote participation challenging. According to the responses, external participants tend to engage less, as contributing to the conversation becomes much tougher, even if the chair prompts them. Expressing a desire to speak up or joining a conversation is considerably more arduous for them. Individuals who are vocal in person become quieter when remote. Interrupting others is simpler in person, but remote engagement makes it more difficult. Moreover, in-person attendees appear to have more influence and receive a warmer reception. Remote participants often need to put in extra effort to gain positive feedback. If you're one of the few joining remotely, it's hard to make your voice heard, as people don't provide space. While these responses attribute the challenges to technology, this simple cause-and-effect interpretation doesn't encapsulate the entire issue; technology frames our capabilities but doesn't dictate our actions. We possess agency. Employees aren't

mere automations obliged to maximize engagement perpetually. Our interviews uncovered that remote participation was a conscious choice for lower engagement levels, using the technological affordances of remote engagement as a way to engage less compared to in-person meetings. The participants mentioned that toggling video on or off could communicate engagement intentions. They recognized the constraints of remote participation and made deliberate choices to signal different levels of engagement. Notably, turning video on or off was seen as a significant signal. They indicated that initiating or disabling video as a remote participant was a means to indicate either heightened or lowered engagement. One participant mentioned that on Skype, it felt like others were watching, making it easier to stay attentive. Another participant mentioned that without video, it was easier to do other tasks and that they might fall asleep or work on emails. A third participant said that they were more likely to multitask with audio alone, as video revealed their wandering attention. So, they preferred having video on. The participants mentioned that making video mandatory, whether technologically or socially enforced, could enhance engagement. However, they also said that people choose to enable or disable video for various reasons, including vanity, anxiety, or privacy. One of these reasons, they noted, was opting for lower engagement, as one participant said that when they can't fully focus, they'd rather not show their video, especially when they're mainly listening in. Therefore, they mentioned that using video off during a meeting leverages control over video as a strategic barrier to engagement. In this context, it becomes a symbol, both for oneself and others, of the decision to engage less. This, they believed, was an aspect of the broader observation that remote participation can indicate lower engagement levels deliberately.

Elevating the Significance of Remote Engagement: Unveiling Lowered Participation

A study delving into remote engagement discovered that participants' preferences for attending meetings in person versus remotely were motivated not only by the idea that technological constraints diminished motivation but also by the notion that remote participation could be wielded as a deliberate social cue—to oneself and others—indicating low interest or perceived insignificance of the meeting. Participants mentioned that they chose to attend in person if they were interested; otherwise, they opted for remote participation to avoid paying full attention. Another participant mentioned that they typically attended in person when they felt they could make a valuable contribution. They leaned toward Skype meetings when they were remote or when their contribution wasn't as critical, but they wanted to remain available. Another participant expressed that their goal was to blend in and be inconspicuous. They didn't want to draw attention; they wanted others to focus on their discussion. Additionally, they mentioned that it felt akin to attending an in-person talk or viewing a live stream. They emphasized the significance of being physically present in a meeting room, where contextual cues effectively directed their complete focus to the meeting at hand.

The study's results indicate that participants who chose to engage remotely in meetings did so primarily due to low motivation and the convenience of technological constraints. Remote participation was perceived by others as an indication of low meeting importance, especially if colleagues were also choosing to join remotely. Some participants reported being susceptible to distractions and multitasking during remote meetings, while others saw multitasking as a viable option, allowing them to engage at their desired level.

Remote participants assumed more passive roles in meetings, considering themselves spectators rather than active participants. They prioritized listening and gathering information unless they had something essential to contribute.

Discussion

Understanding Remote Meeting Dynamics: Patterns of Low Engagement as Methodical Communication Practice

The study's preliminary data indicates that both remote and in-person meeting participants associate remote participation with lower motivation, reduced meeting importance, and decreased levels of behavioral engagement. The reasons behind this association could be diverse, including technological issues like network latency, low video quality impacting nonverbal cues, and setup problems. Users' explanations for their low engagement suggest that they view technology as limiting their ability to contribute, experience social inclusion, and maintain focus, leading to increased susceptibility to distractions. These patterns appear to be more than mere constraints, reflecting social adaptations and deliberate communication practices commonly observed among individuals familiar with a specific culture. The findings highlight the significance of examining remote meeting dynamics and the unique communication behaviors associated with such contexts.

Limitations

This research clearly has its limitations. While SocialBlade is a widely used analytics tool, it is always important to cross-reference data from multiple sources and consider any limitations or biases that may be associated with the tool or the data it provides. Despite the thematic consistency in our data, the size of our sample is small and, of course, from only ten YouTube channels. While our study offers valuable insights, we recognize that uncontrolled age and gender distribution might influence the overall acceptance of remote meetings and video usage during such interactions. A more expansive and meticulously curated sample would undoubtedly enhance our understanding of prevalent practices, varied behaviors, and rationale. Moreover, potential priming or recency effects stemming from specific meeting types on interview responses were not factored into our analysis. While typical ethnographic concerns such as biased assessments and recall precision persist, the realm of video-mediated communication remains relatively silent on the significance of these controls. Thus, there's potential for future research to explore this avenue of inquiry.

Despite these limitations, however, we would hypothesize that the central point that low engagement in classrooms and the notion that offices are not just reactive solutions to constraints, but rather dynamic social choices harnessing these constraints as exploitable resources, holds significant merit within various demographic segments. While this choice might raise eyebrows among meeting aficionados and video conferencing services, it bears profound implications for design innovation.

Future for Design Innovation

Remote engagement in video meetings offer valuable implications for the design of computer-mediated communication in education, particularly when utilizing visual aids and animation in STEM subjects. Just as remote meeting participants have described various spectra of engagement, incorporating nuanced

ways for learners to actively choose their level of involvement during educational sessions could enhance the learning experience. Much like the idea of "Monitoring" or "Listening in" roles in video meetings, educators could introduce similar low-engagement roles for students, such as "Observer" or "Supportive Learner," allowing learners to have flexibility in their participation while still benefiting from the educational content. These roles could be untethered from technological capabilities and be more socially driven, providing learners with the opportunity to set their engagement levels based on their interests, expertise, or learning preferences.

Drawing inspiration from successful YouTube channels that use animation to engage audiences in STEM subjects, educators can harness the power of visual aids to enhance understanding and retention of complex concepts. Animation has proven to be an effective mode of communication, making learning more enjoyable and accessible to a wide range of learners. By incorporating visually engaging content in computer-mediated education, educators can cater to diverse learning styles and capture students' attention in a manner akin to how engaging content is used to foster participation in remote meetings.

In the context of the research paper's exploration of the impact of modality on information interpretation in computer-mediated communication for education, the identification of parallels between remote engagement in meetings and learning through visual aids emphasizes the importance of designing communication platforms that cater to individual preferences and facilitate active learning. By offering students the ability to choose their level of engagement and incorporating visual aids like animation, educators can create a more dynamic and participative learning environment. Such an approach not only improves information interpretation but also encourages deeper engagement and meaningful interactions in the virtual educational space.

Conclusion

In conclusion, this research paper delved into the role of modality in information interpretation within computer-mediated communication for education. Through the analysis of performance metric reports of various educational YouTube channels, we gained valuable insights into the effectiveness of visual aids in fostering engagement and active learning. The calculation of these metrics was crucial as it provided concrete evidence of how animated content and visual storytelling positively impact viewer engagement and comprehension in STEM subjects.

The parallels drawn between remote engagement in video meetings and learning through visual aids underscored the significance of designing communication platforms that cater to individual preferences, promoting more inclusive and interactive educational experiences. By understanding the power of visual storytelling and the impact of engagement levels, we can better design and implement effective educational tools that facilitate learning and knowledge retention.

As we move forward, this research opens the door to new possibilities in educational technology, offering educators and learners alike the potential for transformative experiences. With the ever-evolving landscape of digital communication and the vast potential of visual aids, we are optimistic about the

future of education. By leveraging these insights, we can foster a more engaging, inclusive, and effective learning environment for students worldwide. As technology continues to advance, we envision a future where education transcends boundaries, empowering learners from all walks of life to explore and comprehend the world's wonders with ease and enthusiasm.

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